Volta Flood and Drought Management

ADAPTATION FUND

Project: “Integrating Flood and Drought Management and Early Warning for Climate Change Adaptation in the Volta Basin”

(VFDM Project)

REGIONAL TRAINING OF TRAINERS WORKSHOP ON END-TO-END FORECASTING AND EARLY WARNING PROCESSES FOR FLOODS AND DROUGHT

(May 16 to 19, 2023 in Lomé, Togo)

Final report

Executing Partners

WORLD METEOROLOGICAL ORGANIZATION

ABV / VBA – Autorité du Bassin de la Volta / Volta Basin Authority

Global Water Partnership West Africa

Volta Flood and Drought Management

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List of initials, acronyms and abbreviations

ABV	:	Volta Basin Authority
AF	:	Adaptation Fund
GIRI	:	Integrated flood risk management
GWP	:	Global Water Partnership
GWP-AO	:	Global Water Partnership in West Africa
WMO	:	World Meteorological Organization
CAP	:	Common Alerting Protocol
computer	:	Flood Forecasting
PGIRI	:	Integrated Flood Risk Management Plan
ORSEC map	:	Civil security response organization plan
NTP	:	Numerical Weather Prediction
PRESASS	:	Seasonal agro-hydro-climatic forecasts in Sudano-Sahelian Africa
DRR	:	Disaster Risk Reduction
SAP	:	Early Warning System
SAP	:	Early Warning System
SAP-BEB-PC	:	End-to-End Early Warning System for Flood Forecasting
GIS	:	Geographic information system
NMHS	:	National meteorological and hydrological services
SONABEL	:	National Electricity Company of Burkina Faso
SPI	:	Normalized precipitation index
VFDM	:	Integrating Flood and Drought Management and Early Warning for Climate Change Adaptation in the Volta Basin
WRSI	:	Water needs satisfaction index

1. Introduction

From May 16 to 19, 2023, was held in the conference room of the Hotel Concorde in Lomé, Togo, the regional train-the-trainer workshop on end-to-end forecasting and early warning processes for floods and drought in the Volta Basin.

The regional workshop is part of the implementation of "Integrating Flood and Drought Management and Early Warning for Climate Change Adaptation in the Volta Basin" project financed by the Adaptation Fund (AF) and executed by the consortium made up of Meteorological Organization (WMO), Volta Basin Authority (VBA) and Global Water Partnership West Africa (GWP-WA). He follows the series of five (5) core courses covering all stages of end-to-end flood forecasting and early warning as well as integrated drought management (forecasting, monitoring and early warning). It was attended by around forty representatives national meteorological and hydrological services (NMHS), civil protection, water resources management (Annex 1) of the six member countries of the VBA.

Indeed, as part of the implementation of the VFDM project, The consortium WMO/VBA/GWP-WA together with partners have developed and conduct an online training program (based on the WMO and Global Water Partnership –GWP- on flood and drought management adapted to the hydro-meteorological and socio-economic conditions of the Volta Basin).

The learning program mainly aims to empower learners and their home institutions to better collaborate and work together to co-design, co-produce, deliver and use hydrological and meteorological services for flood and drought risk reduction. in the Volta basin. It is aimed at professionals from the six countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo) of the basin and at the regional level, providers of hydrometeorological services (NMHSs, International/regional and research organizations) and users (in charge of civil protection, disaster risk management,

Distance learning is articulated autbearfive (5) following online courses administered from September 2021 to April 2023:

- basic hydrology for professionals working in hydrological modeling and forecasting in the riparian countries of the Volta Basin;
- application of geospatial information technologies to flood and drought risk management in the Volta Basin;
- monitoring and early warning for integrated drought risk management in West Africa;
- conducting field measurements and inspections of equipment at hydrometric and rainfall data collection stations; And
- dissemination, decision support and early warning response to floods and drought.

The regional training of trainers workshop was organized with a view to having a pool of trainers available to deliver courses on end-to-end flood and drought forecasting and early warning processes in the countries of the Volta Basin.

This report reflects the proceedings of the regional workshop. It revolves around the following three (3) main points:

- the initiation of the regional training workshop;
- the process and products of the work of the regional workshop;
- the summary and closing of the regional training workshop.

2. Launch of the regional train-the-trainer workshop

2.1. Opening ceremony of the regional training of trainers' workshop

The opening ceremony of the regional workshop took place under the chairmanship of the Ministry of Water and Village Hydraulics of Togo, represented by its Chief of Staff. It was marked by four speeches respectively: (i) by the Director of Water Resources of Togo, Mr. Gninpale KOLANI, Coordinator of the National Focal Structure of VBA in Togo; (ii) the Executive Secretary of GWP-WA, Mr. K. Armand HOUANYE; (iii) the Executive Director of the VBA, Mr. Robert Y. DESSOUASSI and (iv) the Minister's Chief of Staff.

Photo1: officials at the opening ceremony

The Director of Water Resources of Togo, speaking first, welcomed the participants. Also, he thanked them for having responded to the invitation of the partners of the Consortium in charge of the execution of the VFDM. The Coordinator of the National Focal Structure of the VBA was delighted with the choice of Togo to host the regional training workshop. He wished the participants a good stay in Lome and a smooth progress of the work of the regional workshop for the training of trainers.

The Executive Secretary of GWP-WA also welcomed all the participants and wished them a pleasant stay in Lomé. He further underlined the importance of capacity building in decision-making processes for the proper management of flood and drought risks in the Volta Basin, which now has reliable and proven technical capacities to against these risks. Mr. K. Armand HOUANYE indicated that the regional workshop identifies itself, among other things, as a crucible for consolidating the knowledge base already acquired by the participating executives on end-to-end flood and drought forecasting and early warning processes. The Executive Secretary of GWP-WA thanked all the actors of the countries and the regional level for the spirit of cooperation, which allows to move forward in the implementation of the VFDM project. He reiterated GWP's thanks to the AF for financing the VFDM project and the close monitoring of its execution.

As for the Executive Director of the VBA, at the start of his speech, he first welcomed all the participants to Lomé; before giving them a brief overview of the Volta basin which, due to its enormous potential, remains the essential source for meeting the development needs of its populations in terms of drinking water supply, hydroelectric production, industrial and mining exploitation, irrigation, fishing, navigation, tourism, etc. He then recalled the harmful effects of climate change that the basin has suffered since the 1970s, which are characterized, among other things, by floods and droughts with, each time, significant material and even human damage. The Executive Director of the VBA did not fail to recall the context of the organization of the regional training workshop, before congratulating the professionals who took part in the various online courses and thanking all the partners for their respective contributions. Mr. Robert Y. DESSOUASSI also expressed his deep gratitude to the national authorities of Togo, to the Executive Secretariat of GWP-WA and to all the structures involved in the organization of the regional workshop. Finally, he very sincerely thanked all the technical and financial partners for their multifaceted support to the VBA and more particularly to AF, which finances the regional training workshop for trainers as well as the implementation of all the activities of the VFDM. before congratulating the professionals, who took part in the various online courses and thanking all the partners for their respective contributions. Mr. Robert Y. DESSOUASSI also expressed his deep gratitude to the national authorities of Togo, to the Executive Secretariat of GWP-WA and to all the structures involved in the organization of the regional workshop. Finally, he very sincerely thanked all the technical and financial partners for their multifaceted support to the VBA and more particularly to AF, which finances the regional training workshop for trainers as well as the implementation of all the activities of the VFDM. before congratulating the professionals, who took part in the various online courses and thanking all the partners for their respective contributions. Mr. Robert Y. DESSOUASSI also expressed his deep gratitude to the national authorities of Togo, to the Executive Secretariat of GWP-WA and to all the structures involved in the organization of the regional workshop. Finally, he very sincerely thanked all the technical and financial partners for their multifaceted support to the VBA and more particularly to AF, which finances the regional training workshop for trainers as well as the implementation of all the activities of the VFDM. DESSOUASSI also expressed its deep gratitude to the national authorities of Togo, to the Executive Secretariat of GWP-WA and to all the structures involved in the organization of the regional workshop. Finally, he very sincerely thanked all the technical and financial partners for their multifaceted support to the VBA and more particularly to the AF, which finances the regional training workshop for trainers as well as the implementation of all the activities of VFDM project. DESSOUASSI also expressed its deep gratitude to the national authorities of Togo, to the Executive Secretariat of GWP-WA and to all the structures involved in the organization of the regional workshop. Finally, he very sincerely thanked all the technical and financial partners for their multifaceted support to the VBA and more particularly to AF, which finances the regional training workshop for trainers as well as the implementation of all the activities of VFDM project.

The Chief of Staff, Mr. Affo Boni ADJAMA, representing the Minister of Water and Village Hydraulics of Togo, welcomed all the participants and thanked them for their trip from their respective place of origin to Lomé. Then, he recalled the context of the regional workshop which is part of the implementation of the Project titled VFDM, funded by the AF and implemented by VBA/WMO/GWP-WA consortium in the six countries sharing the Volta basin: Benin, Burkina, Côte d'Ivoire, Ghana, Mali and Togo. Mr. Affo Boni ADJAMA pointed out that the regional training workshop is being held in a context where the member countries of the VBA, like other countries, are bearing the full brunt of the effects of climate change, marked among other things by floods and drought with enormous damage to people and their property. He then noted that thus, VFDM project aims to develop innovative and participatory solutions and approaches in the basin for disaster risk reduction and adaptation to climate change. Before pronouncing the opening of the regional training workshop, the Representative of the Minister thanked all the technical and financial partners who contributed to the holding of the meeting, in particular WMO, VBA, GWP-WA and AF. By proceeding to the official opening of the regional training workshop, the Director of Cabinet invited the participants to the assiduity and to fruitful exchanges with a view to improving the risk management of floods and drought in the Volta Basin.

Following the speeches, the various participants introduced themselves in turn.

2.2. Presentation of the concept note and validation of the workshop agenda

The presentation of the concept note and the agenda of the workshop was made by Mr. Niampa BOUKARI of the ABV.

The main objective of the regional training workshop is to improve the practical knowledge and skills of the participants on end-to-end flood and drought forecasting and early warning processes. Specifically, it was:

- to build at the level of the participants a harmonized understanding of the key concepts of forecasting, early warning, flood and drought;
- to bring participants to deepen their knowledge of the different components of the end-to-end forecasting and early warning process for floods and droughts;
- to define an effective and operational mechanism for coordination and collaboration between the different agencies involved in the end-to-end forecasting and early warning process for floods and droughts in the Volta Basin.

The main outputs and outcomes expected from the workshop are:

- participants have a harmonized understanding of the key concepts of forecasting, early warning, flood and drought;
- participants deepened their knowledge of the different components of the end-to-end flood and drought forecasting and early warning process;
- an effective and operational mechanism for coordination and collaboration between the different agencies of the end-to-end forecasting and early warning process for floods and droughts in the Volta Basin is defined.

2.3. Methodological approach

The organization of the regional workshop was facilitated by GWP-WA in collaboration with WMO and VBA.

The methodological approach of the regional workshop was articulated around three main stages: preparation, conduct and reporting.

- the preparation stage focused mainly on the finalization of the concept note and the indicative timetable, the preparation of the sessions including practical case studies, the targeting and mobilization of participants as well as the making logistical arrangements;
- the unfolding stage, which alternated the development of sessions followed by debates as well as group work, the results of which were presented in plenary;
- the reporting stage, which consists of synthesizing and analyzing all the productions resulting from the regional training workshop on the one hand and preparing the report on the other.

Prior to the regional training workshop, the participants had to develop practical case studies on the experiences of their structure of origin on the end-to-end forecasting and early warning processes. to floods as well as integrated drought management at local and national levels.

The workshop took place over a period of four (4) days around the sessions (Annex 2) below:

- Session 0: Opening ceremony and start-up of the regional training workshop;
- Session 1: Key concepts of forecasting, early warning, flood and drought;
- Session 2: End-to-end flood forecasting and early warning process;
- Session 3: End-to-End Drought Forecasting, Monitoring and Early Warning Process;
- Session 4: Definition of an effective and operational mechanism for coordination and collaboration between the different agencies of the end-to-end flood forecasting and early warning processes as well as integrated drought management in the Volta Basin.

Moderation and facilitation of the workshop proceedings were provided by:

- Mr. K. Armand HOUANYE, Executive Secretary of GWP-WA
- Prof. Ernest AMOUSSOU, Trainer;
- Dr. Héou Maléki BAJANA, Trainer;
- Mr. Niampa BOUKARI, Project Manager at VBA;
- Dr. Rafatou FOFANA, Acting Director of the VBA Observatory;
- Mr. Maxime TEBLEKOU, Project Manager at GWP-WA;

At the end of the regional workshop, each participant received a certificate and the digital media for the products and communications.

3. Process and work products of the regional workshop

3.1. Session 1: Key Concepts of Forecasting, Early Warning, Flood and Drought

This session was interactive, and participants were asked to work in groups to choose the right definitions of key concepts related to forecasting, early warning, flooding, and drought. These include the concepts of early warning, early warning system (EWS), hazard, risk, vulnerability, forecasting, flooding, integrated risk management (IFRM), main steps of end-to-end EWS for flood forecasting (E2E-EWS-FF), hydrological modelling, indicator, index, integrated drought management, pillars of integrated drought management. Table 1 below highlights the definition of each concept.

Table 1: Concept definitions

concepts	Definitions
Early warning	A message or information that precedes the hazard or threat while there is still time to reduce damage or loss, or even avert disaster
Hazard	It is the considerable impact of an event on ecological, human, economic and development systems.
Risk	It is the interaction between the hazard, the exposure of populations, environments and activities to this hazard and the vulnerability
Vulnerability	The degree to which a system is susceptible, or unable, to cope with the adverse effects of a hazard
Hydrological modeling	The mathematical representation of a given hydrosystem as well as the processes that govern it in order to simulate part or all of its hydrological behavior
Flood or drought indicator	It is qualitative/quantitative information (a variable or a parameter) or a set of information contributing to the assessment of a given flood or drought situation. These are variables or parameters that are used to describe flood or drought conditions.
Flood or drought index	It is most often the numerical representation of the intensity of flooding or drought, or others that are calculated from the hazards
	It essentially allows monitoring and anticipating the impacts of flooding or drought and designing applications
Pillars of integrated drought management	(1) Establishment of drought monitoring and early warning systems; (2) Drought Vulnerability and Risk Assessment; and (3) Implementation of measures to limit the impacts of drought and better respond to it.
Early Warning System	Process comprising the collection of data, the processing and analysis of the results, the dissemination of forecasts concerning a given risk with a view to decision-making
Flood forecast	It is a system put in place to anticipate the damage linked to floods on the populations.
	It provides specific precipitation forecasts in terms of amount and timing
Integrated Flood Risk Management (GIRI)	A process to stimulate integrated action to control floods, and which integrates the development of land and water resources in a river basin

concepts	Definitions
Main Steps of End-to-End EWS for Flood Forecasting	Data collection - Modeling and forecasting - Dissemination of early warning - Decision support - Response to the alert

This session 1 also served as a framework to collect participants' expectations and fears.

The main expectations expressed by the participants in relation to the workshop are as follows:

- have a better understanding of the concepts related to EWS floods and EWS drought;
- have a better knowledge of E2E-EWS-FF and the pillars of integrated drought management.

As for the fears raised by the participants, they relate, among other things, to:

- the failure to set up a post-training follow-up mechanism for participants;
- the lack of effective application of the knowledge acquired during training at the country level;
- the time too limited for the work of the workshop

3.2. Session 2: End-to-end flood forecasting and early warning process

The second session of the workshop was facilitated through presentation and exchanges on: (i) generalities; (ii) current end-to-end flood forecasting and warning processes in the Volta Basin countries; (iii) end-to-end flood forecasting and warning processes; and (iv) group work.

3.2.1. General information on BEB's flood forecasting and warning processes

This communication was presented by Dr. Rafatou FOFANA of VBA. It emphasizes the definition as well as the different stages of the E2E-EWS-FF.

Indeed, the E2E-EWS-FF is a flood warning system, consisting of various integrated sequences ranging from data collection, processing and analysis of results to the dissemination of forecasts (results) with a view to decision-making by the various users for early warning response actions at all levels.

The different stages of E2E-EWS-FF are 5 in number, namely (Figure 1): data collection, processing and analysis of results, dissemination of alerts, decision-making and response to alerts.

Data collection should be in real time for forecasting flood severity, including when it occurs, extent and magnitude. The data to be collected are hydrological and meteorological. And the real problem in the basin today is the unavailability of real-time data for forecasting. Instruments for measuring hydrological and meteorological data do not work well and require periodic maintenance. Field missions to collect data are rare due to a lack of financial resources and the remotely transmitted data measurement instruments put in place no longer work because the solar panels supplying them with electrical energy have been stolen or vandalized.

Data processing and analysis of results are the work of technicians to produce forecasts and alerts. Data processing is done using forecasting software.

Once the alerts have been produced, they must be communicated to the actors concerned for decision-making. Appropriate channels should be used to disseminate alerts as well as actions to be taken.

Decision-making concerns in particular the authorities at various levels in collaboration with the technical executives to determine the possible impacts on the communities and the infrastructures.

The response to warnings is nothing more than the actions or arrangements taken by relevant agencies and communities to contain the risk of flooding.

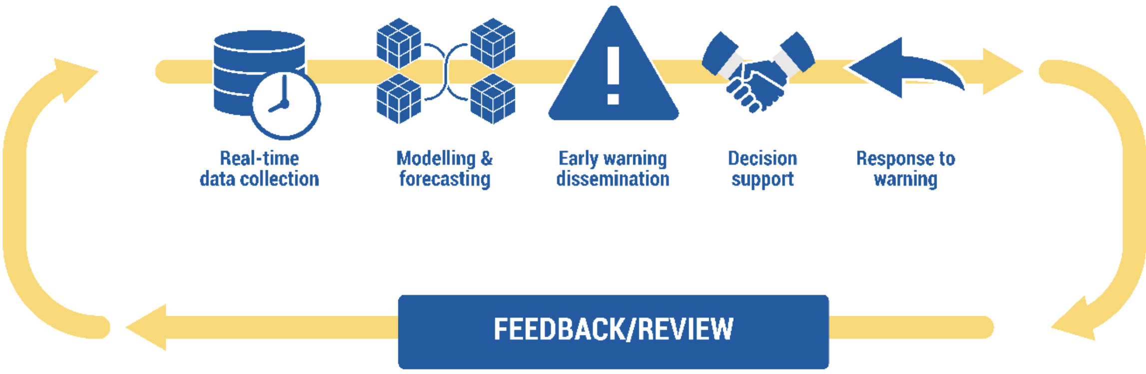

figure1: Different steps of the E2E-EWS-FF process

3.2.2. Current end-to-end flood forecasting and warning processes in the Volta Basin countries and at the regional level

Following the overview presentation, each country shared the current process in place for end-to-end flood forecasting and early warning.

In all the countries of the Volta Basin,data collection for the flood SAP is provided by the technical departments in charge of hydrology (daily water height, daily flow rate obtained from a network of staff gauges and a few automatic recorders) and meteorology (the amount and intensity of rain, temperature, wind strength and direction, insolation and humidity obtained from a network of automatic, conventional stations, radars and satellites). The difficulties encountered in most countries of the basin are, among others: insufficient financial resources to ensure continuous monitoring, routine upkeep and maintenance of collection equipment, weak coverage of observation networks.

Flood modeling and forecasting are also carried out by the technical departments in charge of hydrology and meteorology in the countries of the basin. The forecasting models used are flow-flow transformation models, rain-flow models. In some countries, forecasts are made based on the definition of alert thresholds and models such as PUMA 2015, Synop observation, models of major forecast centers, CPT, FEWS_OTI, FUNES, FANFAR, prediction matrices based on the community participatory approach, etc.

Regarding the dissemination of alerts, it is ensured in the countries by the national civil protection structure or agency as well as disaster risk reduction or management platforms. Forecast and alert messages often relate to the water level in watercourses and bodies of water, the rainfall forecast, the probable consequences and the precautions to be taken by the populations in order to guarantee their safety. In most countries, there are standards or protocols that institutions must follow to communicate and disseminate alerts.

Overall, we note that the countries of the basin are making efforts to monitor floods during high water periods. However, they suffer from insufficient financial resources to acquire or maintain automated hydrometeorological equipment to obtain real-time data. Some basin countries also highlighted the absence of impact forecasts, the non-operationalization of hydrological forecasting models, the absence of a flood forecasting model and the lack of qualified human resources to carry out the forecasts.

At the regional level, the Volta Basin Observatory is the main player in the flood forecasting and warning process, in collaboration with the Hydrological and Meteorological Services of the basin countries and SONABEL. Seasonal forecasts in the basin are done through the Seasonal Agro-Hydro-Climate Forecasts in Sudano-Sahelian Africa (PRESASS) and FANFAR. At basin level, the VoltAlarm platform is under development. There are also other forecasting systems in the basin but none are currently functioning.

For the dissemination of forecasts and warnings, the VBA works with the NMHSs and civil protection agencies of the countries of the basin in order to inform a large number of actors in the basin.

Participants' concerns about the presentations revolved around:

- the critical alert threshold from which populations must be evacuated. The critical rainfall threshold is 50 mm of water in countries such as Côte d'Ivoire and Togo;
- impact-based forecasting, which is not developed in all the countries of the Volta basin apart from Côte d'Ivoire and Benin;
- the operationalization of the centralized hydrological and meteorological database;
- the failure to set up a centralized database system;
- the reliability of the data collected from the field.

3.2.3. End-to-end flood forecasting and early warning process

This subsection concerned the five (05) stages of the E2E-EWS-FF and was marked by four (04) communications with practical exercises.

3.2.3.1. Continuous data collection – Modeling and development of forecasts and alerts

The first communication was presented by Dr. Héou Maléki BADJANA. In the introduction, we note that data collection and modeling are two essential elements on which a real EWS is based. The collection of data allows a better knowledge of the risk in particular the hazard, the exposure, the risk, the vulnerability, etc. but also the monitoring and forecasting of the hazard. Regarding hydrological modeling, it is one of the crucial elements on which the efficiency and effectiveness of an integrated flood forecasting and warning system depends. Continuous data collection and modeling are therefore two essential links in the E2E-EWS-FF.

The essential technical requirements to pass the first two stages of the E2E-EWS-FF are:

- the need for a real-time data collection system for receiving and processing relevant information;
- access to the results of a numerical weather prediction (NWP) model for weather forecast data;
- a forecasting model to estimate the total flow at the outlet of the basin, at the required time intervals, including an assessment of uncertainties;
- a hydrodynamic model to estimate the displacement/propagation of the flood wave along the watercourse, the water heights, the effects of dyke failures, as well as the interaction with the floodplain and inundated areas ;
- appropriate means of communication, GIS software and decision support systems.

The data to be collected continuously in the field are essentially:

- hydrological data, in particular river flows (volume of water flowed per unit of time [m3.s-1 or ls-1]), water level. But in most natural rivers, flow is not measured continuously; what we know how to measure "easily" is the continuous water level and the occasional flow rate (gauging);
- meteorological data including the intensity and duration of precipitation, precipitation forecasts, historical data (rainfall and climatology) for the calibration of rain-flow models;
- climate data beyond ground-based instruments can come from satellites or numerical climate prediction models at global, regional and local levels and serve as input data for flood forecasting models.

Overall, there are two flood forecasting methods. Stochastic methods and methods using rainfall-runoff relationships for hydrological response analysis. According to the nature of the relations used for the representation of the processes, one distinguishes the empirical rain-flow models, the conceptual rain-flow models and the physically based rain-flow models.

Following the different forecasting methods, the Communicator shared the different stages of the process of developing a flood forecasting model which includes: model construction, model calibration and model evaluation (Figure 2) .

The calibration can be done manually or automatically from the optimization algorithms. It can be accompanied by a sensitivity analysis of the model parameters (global or local sensitivities). Updating models are best suited for flood forecasting.

The communication ended with the forecast and flood alerts, and we note that there are two types of flood alert: meteorological alert and hydrological alert. Flood alerts are based on "trigger thresholds" related to the critical level of rivers or the amounts of precipitation, which are indicative of the approach or worsening of a flood. The weather alert is an accumulation exceeding a certain threshold over a given period, rainfall intensity exceeding a given rate, etc. As for the hydrological alert, it is about the level of the rivers increasing up to a defined level of vigilance, speed of rise of the level faster than a defined threshold, etc.

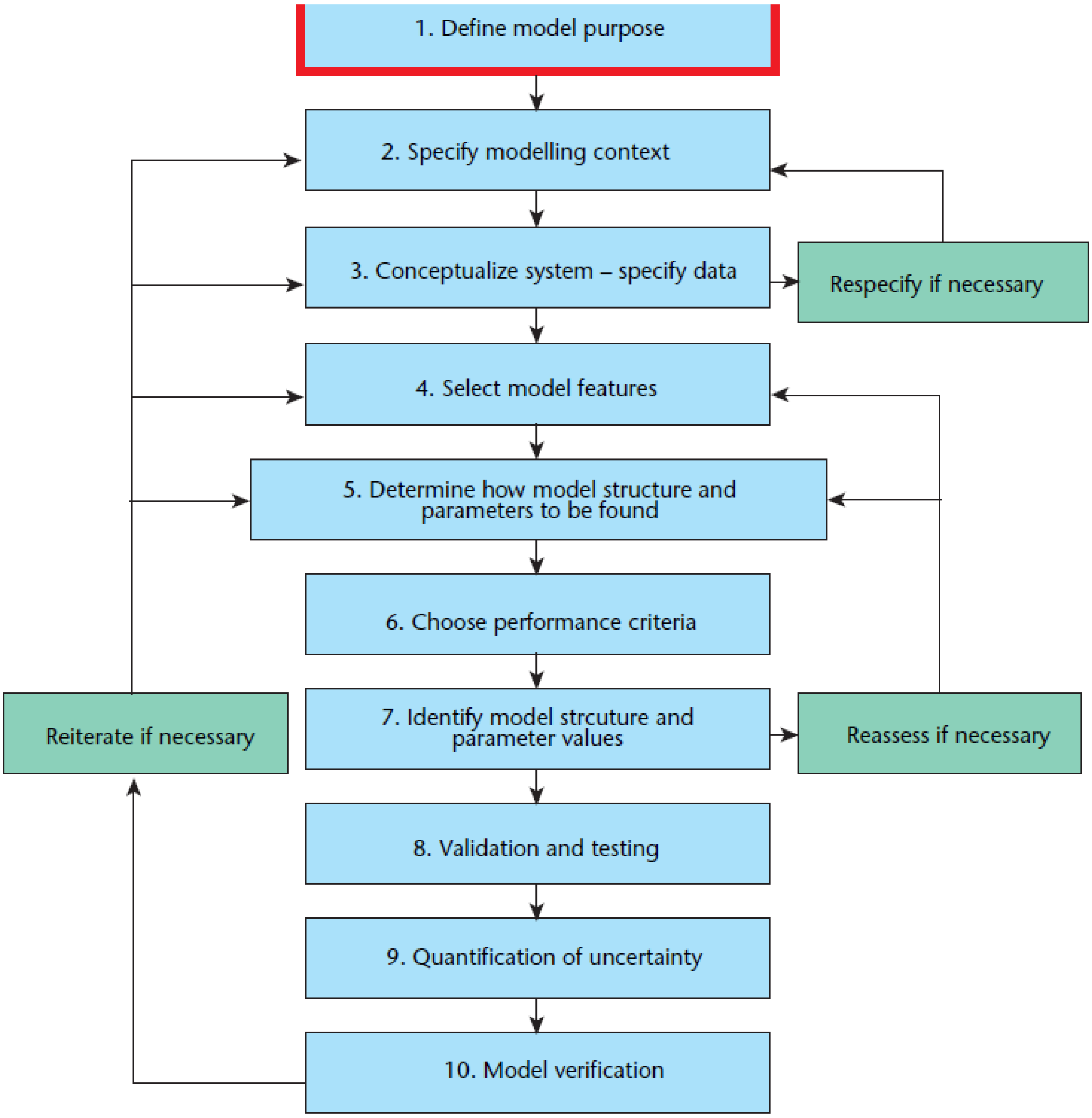

figure2: Different stages of the development process of a flood forecasting model

Discussions on this segment focused on:

Why do we say that a good model must be parsimonious? Isn't it restrictive to use a model with less parameters?

As an answer to this question, it was first recalled that parsimonious models (i.e. models with few parameters) are easy to optimize and generally have good performance compared to models that have many parameters. of parameters. Then, parsimony is a principle in hydrology. Of two models that do the same thing, the parsimonious model is recommended because it is the least complex. The more complex the model, the more it requires enough data, which is not necessarily all available, the more it also requires a lot of parameters which will make calibration difficult, the more uncertainties there will be and the less its performance will be. In addition, the parameters of a model must have a physical meaning and the fact of having more parameters sometimes loses their physical meaning.

Why is it said that a global conceptual model cannot be used to assess the impacts of land cover changes in the basin when it simulates its hydrological behavior which depends on its physical characteristics?

As an answer to this question, it is recalled that the global conceptual models relate to the rain-flow relationship without explicitly considering surface states such as land use, topography, etc. as do semi-distributed or distributed models. In a global conceptual model, everything is implicitly considered in the processes that govern the rainfall-runoff relationship, and the basin is considered as a single entity without taking into account its different characteristics. Contrary to the conceptual models, the surface states are explicitly considered in a semi-distributed or distributed model and the impact of the change of a factor of the medium at a point of the basin can be evaluated.

How can verification be done without observation data, for example evapotranspiration?

To this question, it was specified to the participants that the verification of the model does not necessarily require the observed data series. One can verify, for example, that the evapotranspiration simulated by a model is realistic by comparing the seasonality and the annual values resulting from the model with those present in the literature to ensure that the simulated flow is realistic in relation to the hydrological context. basin climate.

How do we use meteorological data to make forecasts and develop alerts with a valid model?

It is explained here that to make the forecast for the next five days, for example, as specified by the participant who asked the question, it is necessary to have the model input data from the weather forecast for the next five days that will be used to simulate flows or water levels over the next five days. Depending on simulation results and on the basis of previously defined thresholds, the alert can be generated.

Subsequently, the participants carried out practical work which consisted in the use of the IHACRES model and more precisely the IHACRES-CWI version to simulate the hydrological response of the Kara River watershed in Naboupi. The model was executed using the HYDROMAD package in the R software. For this purpose, the data and the scripts were previously prepared and made available to the participants. The work focused first on the installation of the tools and then on the reading of the data and their visualization, the setting up of the model and the definition of the calibration and validation periods, the manual calibration and the automatic calibration with algorithms, validation then calibration considering uncertainties.

The practical guide for practical work on hydrological modeling and flood forecasting is attached to this report (Annex 3).

3.2.3.2. Communication and dissemination of flood early warning

The second communication for this session was presented by Mr. K. Armand HOUANYE of GWP-WA. It was very interactive and focused on the following points: (i) a brief introduction; (ii) the early warning communication and dissemination process; (iii) formulation of flood warning messages tailored to specific targets; (iv) appropriate media and channels for communication and dissemination of flood early warning; (v) key messages.

In the introduction, we note that communication and dissemination are essential to achieve the objective of the E2E-EWS-FF. They are based on the three main phases of disaster risk reduction and require the use of appropriate tools and strategies.

The early warning communication and dissemination process considers the different fundamental phases of disaster risk preparation and management (floods or drought): before, during and after the event (Figure 3).

In the prevention phase, attention should be focused on raising awareness, preparing, and involving the population. During the emergency, attention is focused on issuing warnings and guidance to encourage appropriate behavior, coordination for the disclosure of information. During the post-event phase, the information must relate to the compensation and reimbursement procedures, the analysis of the information campaigns, the capitalization of the "lessons learned" as well as the review and the necessary adjustments to be made.

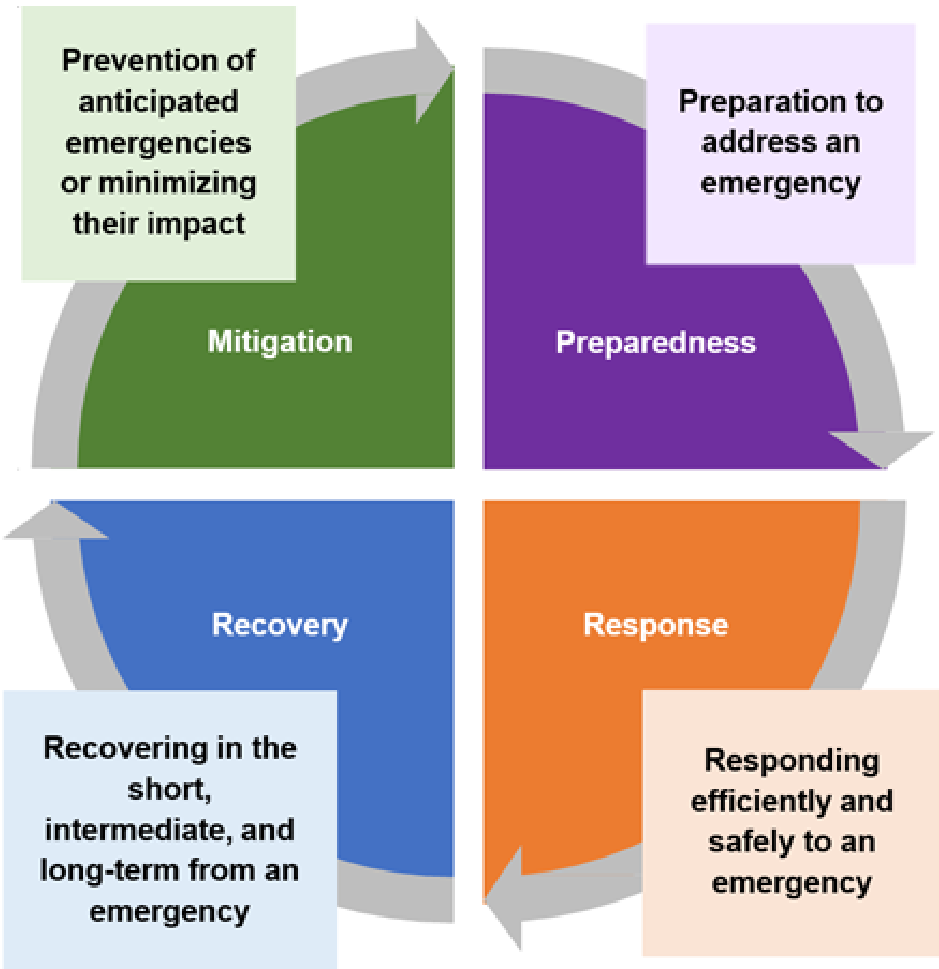

figure3: Fundamental Phases of the Risk Preparedness and Management Lifecycle

The challenges related to the communication and dissemination of the alert include:

- understand vulnerable groups and their needs;
- to ensure the clarity of the messages sent;
- establish/have adequate communication systems to provide timely, accurate and meaningful information;
- to make the best use of the channels available to ensure the dissemination of information;
- to ensure the good quality of telecommunications systems and technologies;
- to ensure the solid confidence of the community in the information disseminated;
- secure effective media and private sector engagement;
- to remove any obstacles to the dissemination of information due to the social structure;
- to have good performance, simple and user-friendly tools and equipment.

From the presentation, it is noted that the Common Alerting Protocol (CAP) is an international standard for emergency alerting and public warning, designed by the International Telecommunication Union and whose use is encouraged by several organizations. The CAP is a standardized format for communicating about all hazards (weather phenomena, earthquakes, tsunamis, volcanic eruptions, threats to public health, power outages and all kinds of other emergencies). The CAP uses all means and channels of communication and dissemination of information (television, radio, telephone, fax, road signs, email, websites, etc.) on hazards to reach the entire population, specific target groups (civil authorities, emergency services, etc.

With regard to the roles of the media in the EWS, we note that:

- social media promotes cross-platform accessibility and a constant flow of information;
- social media provide a framework for the work of journalists and for public discussion and debate.
- the use of social media for malicious purposes could harm the EWS: attempts to persecute people or damage their reputation

For those whom it concerns the characteristics of the alert messages to be broadcast, it should be noted that to be effective, it should contain five elements of information such as:

- the hazard and threats (nature and importance);
- the place ;
- the duration (duration of the hazard and development of the threat or time of impact);
- guidance and advice (recommended actions);
- the source of the information;
- the dimensions of the messages, which must meet the criteria of specificity, consistency, accuracy and clarity.

Overall, the main early warning communication channels and tools are:

- text-only channels and tools (newspapers, email, phone text messages);
- channels and tools limited to audio (radio stations, broadcast voice messages, sirens that can alert, etc.);
- channels and tools limited to audiovisual (television, images and sounds indicating the alert, etc.);
- interpersonal channels and tools (community outreach programs, friends/families, colleagues, trusted neighbors, etc.);
- sign-based channels and tools (green, yellow and red colored flags);
- a combination of channels and tools.

As key messages to remember about this step of EWS, we note that:

- the communication and dissemination of early warning must make it possible to reach the greatest possible number of people in time, especially the most vulnerable;
- the communication and dissemination of the alert must relate to clear, simple, useful, coherent and understandable information on the hazard and the threats, the place and the duration;
- the media are key actors whose capacity building and participation are crucial for all phases;
- the formulation and communication of early warning presuppose a good knowledge of the various vulnerable groups and their specific needs.

At the end of the presentation, a few warning messages were presented and commented on in plenary, while highlighting their strengths and shortcomings to be corrected.

3.2.3.3. Flood Early Warning Decision Support

The third communication concerns the fourth step of the E2E-EWS-FF process. It was presented by Mr. K. Armand HOUANYE of GWP-WA, initially recalled that decision support for early warning is an important component of the E2E-EWS-FF. Decision-making calls for good planning, which requires putting in place the necessary tools and mechanisms.

The disaster risk preparation and management process, including floods, integrates the stages of: (i) prevention and mitigation; (ii) preparation; (iii) response; and (iv) recovery (Figure 4).

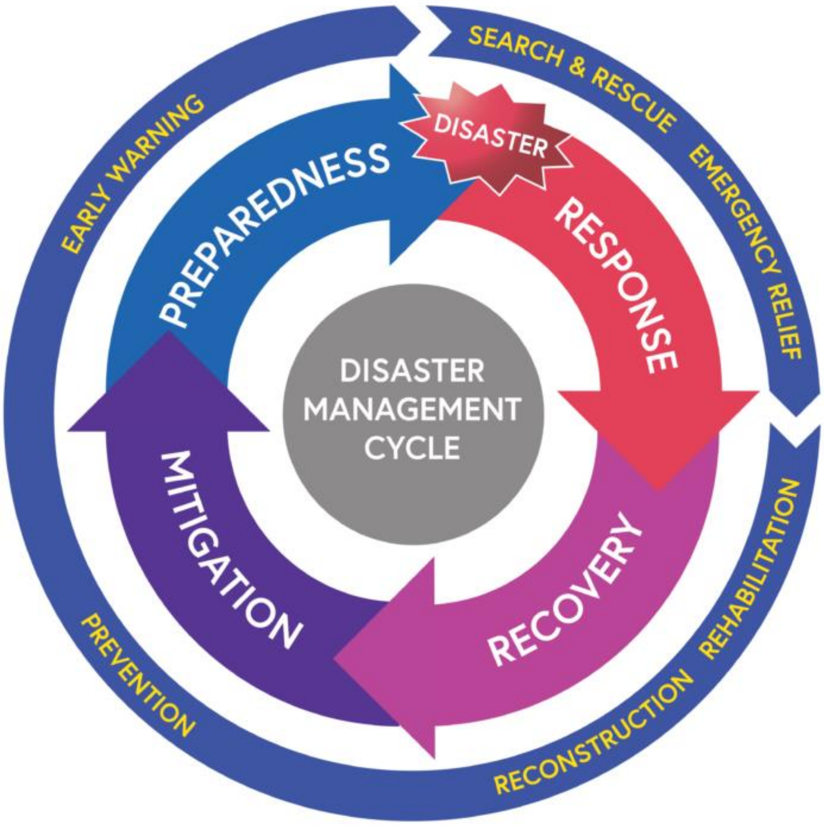

figure4: Disaster Risk Preparedness and Management Cycle

Prevention and mitigation refer to actions taken before disaster strikes. These measures are designed to mitigate the impacts of flooding and reinforce the resilience to these impacts as well as the level of emergency response preparedness.

Preparation is key to an effective response to the alert. It refers to the arrangements and measures put in place to prepare people and increase institutional coping capacities, provide forecasts or warnings, and ensure a coordinated and effective response to flood and drought risks. Response is the set of efforts undertaken to preserve life and maintain the basic subsistence needs of affected people during or immediately after a disaster risk. An effective response must be rapid, concerted and coordinated due to pre-disaster planning and preparation. Recovery calls for decisions and actions taken after the crisis stage with a view to restoring or improving the living conditions of affected communities, Disaster risk management must ensure the involvement of communities, in particular through the use of the participatory approach at all levels and at all stages of the EWS. It must, in a specific context, ensure the participation of sections of the population at risk in the decision-making process and put in place strategies based on the demand of the most vulnerable sections.

Flood preparedness and management planning tools include:

- hazard and risk mapping;
- the contingency plan;
- the civil security response organization plan (ORSEC Plan);
- the integrated flood risk management plan (IFRM);
- setting up an E2E-EWS-FF.

Regarding rapid impact assessment, it focuses on policies, institutions and practices relating to disaster risk preparedness, response and recovery. It is often steered by the competent administration in the country concerned, upon designation of the national authorities, like the national disaster risk management structure. This helps ensure alignment of the assessment and recovery plan with the national and regional system.

The evaluation team must be constituted:

- national experts in sectoral themes concerned with disaster risk management, including floods and drought; And
- experts from the World Bank, the European Union and other United Nations agencies, including a specialist in recovery and another in post-disaster needs assessment.

Where coordination mechanisms exist, these should be consulted or invited to participate in the assessment process, so that their support matches the recovery plan.

With regard to the categories of actors involved in disaster risk management, we note: (i) multisectoral disaster risk reduction (DRR) platforms; (ii) national DRR planning and implementation agencies; (iii) the institutional mechanism for communication and harmonized early warning. According to the communicator, the guiding principles of a good institutional DRM strategy are: (i) effective governance and appropriate institutional arrangements; (ii) consideration of gender and social inclusion; (iii) decentralization of implementation processes; and (iv) a spirit of participatory, interactive and coordinated efforts.

The Communicator ended his presentation with the funding mechanisms for disaster risk management and some key messages including:

- effective decision-making on alert requires the establishment and/or strengthening of an adequate legal, institutional, political and strategic framework;
- good preparation for the alert is necessary to put in place appropriate responses;
- risk management tools are to be put in place upstream of the occurrence of flood-related risks;
- capacity building for all stakeholders and access to financial resources are decisive in alert decision-making;
- the development and application of decision support tools should take into account specific gender needs.

3.2.3.4. Flood Early Warning Response

The fourth presentation of this session focused on the response to the alert. It was also developed by the Executive Secretary of GWP-WA. It is noted that an appropriate response is necessary to the alert issued. This response consists of immediate action (emergency rescue) and delayed action (rehabilitation). There are three types of emergency measures:

- rescue preparedness measures;
- rescue measures; And
- recovery measures.

A rapid and effective response to a disaster, based on early warning, requires concerted action by the actors and coordinated by an officially mandated higher authority. Coordinating a response involves a combination of actors from several fields, such as science and research, land use planning, environment, finance, development, education, health, energy , communications, transport, labor and social security as well as national defence.

The presentation ended with the sharing of the following key messages:

- disaster risk reduction is the collective effort of several actors, including public, private, regional and international organizations under the coordination of the Government;
- a rapid assessment of the impacts of floods allows better adaptation of the implementation of the response plan to needs;
- post-disaster monitoring and evaluation of an emergency response plan is essential to improve existing institutional and operational arrangements.

3.3. Session 3: End-to-End Drought Forecasting, Monitoring and Early Warning Process

3.3.1. Overview of end-to-end drought forecasting, monitoring and early warning processes

General information on end-to-end drought forecasting, monitoring and early warning processes was presented by Dr. Rafatou FOFANA from VBA. In his communication, it is noted that the vast majority of disasters in Africa are of hydro-meteorological origin, with droughts affecting the greatest number of people.

Drought risk can be thought of as the probability of experiencing harmful drought events with different severities of impacts over a given period. A drought EWS is a system for providing timely information before or during the early onset of drought so that rapid action can be taken (using trigger points), as part of a management plan drought risks; to reduce potential impacts.

Drought EWS generally aims to monitor, assess and provide relevant information on climatic, hydrological and water supply conditions and trends. It forms the foundation for integrated drought management, which rests on three (3) main pillars defined in accordance with the principles of disaster risk reduction (Figure 5). It is :

- Pillar 1: Establishment of drought monitoring and early warning systems;
- Pillar 2: Drought Vulnerability and Risk Assessment;
- Pillar 3: Implementation of measures to limit the impacts of drought and better respond to it.

figure5: Three interconnected pillars of integrated and effective drought management

3.3.2. Current end-to-end drought forecasting, monitoring and early warning processes in the Volta Basin countries and at the regional level

Like flooding, the institutional framework for drought management is ensured by the institutions in charge of meteorology, agriculture, hydrology, environment, etc. Data collection is carried out mainly through conventional and automatic weather stations. The types of data used for monitoring, forecasting and their spatio-temporal resolution are rainfall data and Potential Evapotranspiration. In some countries, other data are collected to characterize the drought, including environmental and agricultural hydrological data. Drought forecasting and modeling are the prerogative of agencies and departments in charge of meteorology and hydrology. Monitoring is done by calculating drought indices. The drought indicators and indices used are the duration of dry sequences and pockets and the rainfall of the zones. Indices are calculated for the synoptic stations of the country to highlight the dry years. To do this, the formulas for calculating the rainfall deficit index, the normalized precipitation index (SPI), the water needs satisfaction index (WRSI) were presented.

WRSI is used to monitor crop development and stress in agricultural areas.

At the level of the dissemination of forecasts / and drought alerts, the responsible actors are, among others, agencies and technical departments in charge of meteorology, hydrology, agriculture, environment and protection. civil. It is done through usual communication channels and media: radio, television, social networks, etc.

The products of communication and dissemination of drought alerts are messages related to the drop in water level, the disappearance of plant cover and species. The protocols, with certain Institutions, to communicate the drought warning are the same as those on the flood. Despite the feedback on the disaster risk reduction and climate change adaptation platform, several challenges remain to be met, such as: improving the availability of warning products, the availability of equipment and tools specific to the risk of drought and building the capacities of actors.

In all the countries of the Volta Basin, there is no such thing as a drought EWS. Only in Burkina Faso and Mali, we note the existence of EWS Foods. However, it is noted that the basin countries have national drought plans; but which are not implemented due to a lack of competent financial and human resources.

In terms of difficulties, we note in the countries of the Volta basin: the lack of means for the acquisition of forecasting models, the lack of qualified personnel for the use of forecasting models, the obsolescence of equipment for collecting data, the low capacity of technicians on the models used for better forecasting.

At the end of the presentations, the discussions revolved around:

- the number of automatic synoptic stations in Benin, of which there are 17 in total;
- understanding of the impact map presented during the Mali drought case study. In reality this map shows that the impact is not big enough in the North than in the Centre;
- agricultural insurance, the procedures for which are underway in Benin, but the country can benefit from the experiences of Togo and Mali, which have already subscribed agricultural insurance;
- Mali's induced rain program and the injection of significant resources by the government to bring the rains down;
- the lack of a drought forecasting and warning system in the countries of the basin.

The participants also wished the reinforcement of their capacities of the actors of the countries of the basin of the Volta on the tools of forecasting and climatic projection, the calculation of the indices of dryness. They have also offered study tours to learn from the experiences of other countries in this area.

3.3.3. Components of E2E drought forecasting, monitoring and early warning process

This communication was developed by Prof Ernest AMOUSSOU, Teacher Researcher at the University of Parakou in Benin.

Prof Ernest AMOUSSOU recalled the importance of having a drought management policy based on actions aimed at improving the prevention of drought and the mitigation of the impacts of episodes. He also highlighted that risk-based management is a crucial approach to mitigating drought-related impacts in societies where different vulnerabilities exist.

Prof Ernest AMOUSSOU also recalled the definition of drought, the types of drought and their consequences. Thus, we can remember that drought is a period of significant deficit (or absence) of precipitation. It is also defined as a significant deficit of moisture (rain, groundwater, flow) of a natural environment compared to the average availability, over a large area and for a period long enough for the economy of the region suffers. Drought is a temporary anomaly, unlike aridity which is a permanent feature of climate. There are four (4) main types of drought: (i) meteorological drought; (ii) hydrological drought; (iii) agricultural drought; and (iv) socio-economic drought.

- lack of water in quantity and quality;
- the increase in food shortages and famines and in addition epidemics due to malnutrition;
- population dehydration and disease outbreaks;
- social unrest and conflicts over natural resources (water and food);
- the migration of populations and the increase in climate refugees;
- the modification, disruption or even destruction of ecosystems, particularly wetlands;
- increased forest fires and reduced electricity production.

Following the generalities on drought, the trainer discussed in detail the three pillars of drought management.

3.3.3.1. Pillar 1: Establishment of drought monitoring and early warning systems

For the first pillar of drought management, the trainer focused on the components of the drought EWS and the elements to be considered in the drought risk management strategy.

Thus, we retain that the drought EWS is a system for providing information in good time before or during the early onset of drought to be able to act quickly (using the trigger thresholds), within the framework of a drought risk management plan and reduce potential impacts. Drought SAP aims to monitor and evaluate climatic and hydrological conditions, the state of water supply and the evolution of these parameters, and to transmit the corresponding information. It includes the four (4) components of a E2E-EWS: (i) knowledge and assessment of disaster risks, based on systematic data collection; (ii) detection, monitoring, analysis and forecasting of hazards and their possible consequences; (iii) dissemination and communication of alerts; and (iv) preparation at all levels to react and respond to alerts received.

A good disaster risk management strategy should consider the following elements:

- the safety and security of people and property;
- the mobilization of specific resources for the implementation of plans and strategies;
- capacity building of actors at all levels;
- the establishment of a monitoring-evaluation system;
- consideration of gender and social inclusion;
- an appropriate institutional arrangement and good coordination of disaster risk management;
- the participatory approach throughout the decision-making process.

3.3.3.2. Pillar 2: Drought Vulnerability and Risk Assessment

Concerning the 2nd pillar of drought management, the Communicator emphasized the characterization of risks and vulnerability linked to drought. He also focused on indicators and indices. Thus, we retain that risk management requires the assessment of hazards, exposure, vulnerability and impacts; a EWS (monitoring and forecasting) and preparedness and mitigation measures (WMO, UNCCD and FAO, 2013). In the context of the drought, Prof Ernest AMOUSSOU has used the calculation of indicators and indices, which accurately represent the impacts suffered. Indicators are variables or parameters used to describe drought conditions such as, for example, precipitation, temperature, river flow, groundwater and reservoir levels,

The indices are most often numerical representations of the intensity of droughts, which are calculated from climatic or hydrometeorological values, including the indicators mentioned above. The indices provide quantitative information about the severity, timing, duration and extent of a drought. Severity represents a deviation from the norm and drought severity thresholds identify the start, end and location of drought. The timing of the onset and end of the drought is also very important; as its impact can be highly variable, depending on when there is a shortage of moisture and other factors.

Drought indicators and indices are an essential tool for decision-makers and the general public; to detect drought, assess its impacts and take action to reduce risk. However, there are basically three ways to monitor drought conditions and facilitate early warning and assessment:

- use a single indicator or index;
- use several indicators or indices (Example: SPI/the Franquin curve);
- use composite or hybrid indicators.

Several indices are determined, including: temporal, thermal, water and crop-specific indices. In tropical Africa, water-related indices are the most widely used, including:

- the climate balance: Bc = P-ETP;
- the water needs satisfaction index (ISBE) = (ETR/ETM) x 100;
- the humidity index (IH)= (P/ETP) x 100;
- the agro-climatic (stress) index: (ISA) = [(ETM-ETR) / ETM] x 100.

We also note the graphic methods (ombro-thermal curve) such as that of Gaussen (1954) and Franquin et al. (1988).

The data used for the calculation of the indices are among others:

- climatological data: Maximum temperature, Minimum temperature, Average temperature, ETP and Precipitation;
- hydrometric data: Flow, Water height;
- remote sensing data: Normalized Difference Vegetation Index (NDV), sentinel images;
- socio-anthropological data: Qualitative data.

3.3.3.3. Pillar 3: Implementation of measures to limit the impacts of drought and better respond to it

Regarding the last pillar of drought management, the Communicator focused on the actions to be taken to better manage the risks of drought. He also highlighted the policies and plans to be put in place for better drought risk management.

In summary, end-to-end drought forecasting, monitoring and early warning processes refer to the capacity building of actors. This is an important link in the effective and inclusive governance of disaster risk management. To do this, a needs assessment is necessary; to identify areas of capacity building for preparedness, response and recovery. Relevant indicators and triggers should be selected carefully.

Drought risk assessment provides important information to help authorities tailor drought crisis prevention, mitigation and response measures for the most vulnerable communities and sectors, and where the characteristics of the drought are or should be the most severe. Several structural (physical) and non-structural measures can be used by countries, sectors and communities to reduce the effects of drought. There are several innovative mechanisms that protect communities against extreme droughts, including smart insurance products (microinsurance, reinsurance) and the extension of risk pools at national, regional and global scales.

At the end of the presentation, the discussions revolved around:

- the vulnerability of all countries in the world to drought. All countries in the world are vulnerable to drought;
- the difference between drought and the dry season;
- the existence of indices for the rational use of water resources in the Volta basin;
- the dependence of States on development partners for the implementation of response measures to alerts instead of relying on their national resources;
- the establishment of a training program to build the capacity of countries in the basin to set up drought forecasting and warning systems;
- the definition of ecological drought;
- the establishment of scholarships to encourage students from the sub-region to develop drought forecasting models in the basin;
- actions in response to the drought alert.

Overall, response actions to the drought alert are of two types:

- structural measures (construction of built infrastructure, construction of water retention structures, etc.); And
- non-structural measures including development and implementation of drought management plans, capacity building plans, EWS, modeling

Session 3 ended with the installation and manipulation of statistical software calculation of different indices according to the type of drought. Thus, the script allows working on meteorological (SPI, SPEI), hydrological (PDHI, PDSI) and remote sensing (NDVI, NDWI) droughts. The software user guide is anointed in Appendix 4 to this report.

3.4. Session 4: Definition of an effective and operational mechanism for coordination and collaboration between EWS flood and drought agencies

3.4.1. Proposals for necessary improvements to the EWS for floods and droughts in place at different levels in the Volta Basin

The brief is to propose necessary improvements to the current end-to-end flood and drought forecasting and early warning processes in place at the local, national and transboundary levels in the Volta Basin. The participants worked in groups by country and at the level of the Executive Direction of the VBA.

It should be noted that the countries of the Volta basin suffer from a real problem of data availability linked to a low coverage of the network for the collection of automatic hydrological and meteorological data, the maintenance of the stations and the lack of a precise reporting mechanism. The poor quality of the internet connection makes it impossible to have real-time data, especially for tele transmitted stations. Most countries do not have models at local and national level for flood forecasting. In terms of the dissemination of alerts, there is little use of channels and media for the dissemination of alerts. We also note in the countries of the Volta basin, an absence contingency plans at municipal level. There are also limited resources available to effectively respond to flood warnings in time. As a result, the participants proposed, among other things:

- to densify the hydrometeorological observation network in the countries of the basin; and
- to acquire flood forecasting and warning models.

The distribution of alerts should be done in several languages; while using multiple communication channels or mediums.

Regarding drought, we note that the countries of the Volta basin do not have an EWS. Countries do not have specific drought indices and indicators. Drought management plans are not implemented work in the ABV countries, in raison to a lack of financial resources.

At the end of the exercise, the participants recommended that the VBA States:

- recruit and build the capacity of staff of national hydrological and meteorological services;
- strengthen and ensure the maintenance of the observation network in place;
- set up a group of multidisciplinary experts on flood and drought risk management in the countries.

To the place of VBA, the participants recommended:

- of work towards the interconnection and harmonization of the hydro data collection network meteorological;
- strengthen and ensure the maintenance of the observation network in place;
- strengthen regional coordination for the implementation of a flood and drought EWS;
- to build the capacity of basin stakeholders on the SAP-BEB to floods and drought.

To the technical and financial partners, it was recommended:

- of support the financing of actions related to the development of EWS in VBA countries;
- to support the States of the basin in setting up local forecasting tools and then in identifying the thresholds for triggering alerts and impacts;
- to support the States in the implementation of drought plans as well as contingency plans at the local level.

3.4.2. Definition of an effective and operational mechanism for coordination and collaboration between the different EWS agencies for floods and droughts

Regarding the second series of group work, the members of the groups were asked to identify:

- key actors involved in coordination/collaboration at different levels;
- coordination/collaboration objects at different levels;

- the constraints justifying the absence/deficit of coordination/collaboration at different levels;
- existing opportunities to be seized to promote coordination/collaboration at different levels;
- the actions to be implemented to develop and strengthen coordination/collaboration at different levels.

The participants also worked in groups by country as well as at the level of the Executive Direction of the VBA. Overall, we note that the key actors involved in coordination and collaboration are, among others: local authorities, decentralized technical services, observers/data collectors at the local level. At the national level, the participants identified the technical departments in charge of hydrology, civil protection and meteorology, agriculture, sustainable development, national defense, and humanitarian Non-Governmental Organizations (NGOs). At the regional level, we note among others: VBA, AGRYMETH Center, NBA, CILSS, ACMAD, etc.

The objects of coordination/collaboration concern the collection and reporting of data at the national level, the dissemination of alerts, the response to alerts and rehabilitation. At the national level, the areas of collaboration or coordination are: data collection, analysis and modelling, communication and dissemination of alert messages, response to alerts.

As for the constraints justifying the absence and/or lack of coordination and/or collaboration at different levels, we note among others: lack of leadership, low availability of data and information, administrative slowness, non-existence of an SAP-BEB, the lack of financial means and qualified human resources, the poor dissemination of flood and drought risk management tools, etc.

Regarding the existing opportunities to be seized to promote coordination/and or collaboration, we note the existence of key technical services at various levels, the existence of DRR platforms at various levels, the existence of development plans at the local level, contingency plans, drought management plans, the availability of technical and financial partners, the existence of FANFAR tools, VoltAlarm, etc.

Regarding actions to develop and strengthen coordination/collaboration at different levels, countries proposed to:

- organize experience sharing meetings on the implementation of an E2E-EWS;
- build the capacity of basin stakeholders on the SAP-BEB through training sessions, the allocation of material and financial resources to countries, etc.;
- develop memoranda of understanding for data sharing and information charters;
- develop and implement E2E-EWS drought and flood;
- set up a regional coordination mechanism;
- mobilize financial resources for the development of joint projects in connection with the E2E-EWS and the management of flood and drought risks.

4. Closing of the workshop and recommendations

The closing ceremony of the workshop was chaired by the Coordinator of the Focal National structure of VBA in the presence of the Executive Director of VBA and the Executive Secretary of GWP-WA. Before the intervention of the officials, the participants expressed their gratitude for the training and took the opportunity to thank the organizers.

Overall, they all expressed their deep gratitude to the participants for their attendance and active participation in the work of the workshop. Their gratitude also goes to the national authorities of Togo. They also expressed their thanks to the technical and financial partners of the VFDM project, in this case the FA and all those who, directly or indirectly, worked to achieve the objectives of the workshop governed training course.

The participants have recommended especially:

- to share the achievements of the training with the national actors;
- to support the development of flood and drought prediction models in the Volta Basin;
- to support the establishment of EWS-BEBs for floods and droughts in the countries of the Volta Basin;
- to encourage countries to subscribe to agricultural insurance.

Appendices

Volta Flood and Drought Management

Annex 1: List of participants

ADAPTATION FUND — WORLD METEOROLOGICAL ORGANIZATION — VBA — Global Water Partnership West Africa

Atelier régional de formation des formateurs sur les processus de prévision et d'alerte précoce de bout en bout du Voltalarm aux inondations et à la sécheresse / *Regional training workshop of trainers on the Voltalarm's end-to-end processes on the forecasting and the early warning for floods and drought*

Liste de présence du 16 mai 2023 / *List of presence of May 16th, 2023*

Dates : 16, 17, 18 et 19 mai / *May* 2023

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Annex 2: Agenda of the regional workshop

Hourly	Activities	Methodology	Speakers
Tuesday, May 16, 2023			
07h30-08h30	**Registration of participants**	Secretariat	▪ DGRE/ MEHV_ ABV Focal Point of Togo ▪ GWP-AO and ABV
08h30-10h00	**Session 0: Opening ceremony and start-up of the workshop**		
	▪ Partner Speeches ▪ Opening speech	Plenary	▪ DGRE/ MEHV_ ABV Focal Point of Togo ▪ SE of GWP-WA ▪ DE of the ABV ▪ Minister of Water and Village Hydraulics of Togo
	▪ Presentation of the participants	card games	▪ Assistant Project Manager VFDM_ABV ▪ Technical Assistant of the VFDM/ GWP-AO Project ▪ RAF_GWP-AO
	▪ Collection of expectations/fears		
	▪ Presentation and validation of the objectives of the training workshop	Exposed Trades	
	▪ Presentation of the logistical aspects / management standards of the training workshop		
10h00-10h15	**COFFEE BREAK**		
10:15–11:00 a.m.	**Session 1**: Key Concepts of Forecasting, Early Warning, Flood and Drought	Brainstorming Presentation/ debate/	▪ SE of GWP-WA ▪ Assistant Project Manager VFDM_ABV ▪ Technical Assistant of the VFDM/ GWP-AO Project ▪ Participants
11h00-13h30	**Session 2**: End-to-End Flood Forecasting and Early Warning Process ▪ **Overview** ▪ **Case studies**on the current end-to-end flood forecasting and early warning processes in place in each of the 6 Volta Basin countries	Brainstorming Presentation / debate	▪ Director Volta Basin Observatory ▪ Participants - Benign - Burkina Faso - Ivory Coast - Ghana - mali - Togo - ABV
1:30 p.m.-2:30 p.m.	**LUNCH BREAK**		

Hourly	Activities	Methodology	Speakers
2:30-5:00 p.m.	**Session 2**: End-to-End Flood Forecasting and Early Warning Process ▪ **Step 1**: Continuous data collection ▪ **2nd step**: Modeling, development of forecasts and alerts ▪ **Practical exercises**	Presentation/ debate/ Exercises	▪ Dr Hèou Maleki Badjana ▪ Participants
5:00 p.m. - 5:15 p.m.	**Evaluation and end of the 1st day**	Plenary	▪ GWP-AO ▪ experts ▪ Participants

Hourly	Activities	Methodology	Speakers
Wednesday, May 17, 2023			
08h30- 09h00	Day 1 reminder	Exposed	▪ GWP-AO ▪ experts ▪ Participants
09h00 -10h30	**Session 2**: End-to-End Flood Forecasting and Early Warning Process ▪ **Step 3**: Communication and dissemination of early warning ▪ **Practical exercises**	Presentation/ debate/ Exercises	▪ SE of GWP-WA ▪ Participants
10h30-11h00	**COFFEE BREAK**		
11h00-13h00	**Session 2**: End-to-End Flood Forecasting and Early Warning Process ▪ **Step 4**: Help with the decision ▪ **Step 5**: Response to the alert ▪ **Practical exercises**	Presentation/ debate/ Exercises	▪ Dr Hèou Maleki Badjana ▪ Participants
1:00 p.m. – 2:00 p.m.	**LUNCH BREAK**		
2:00 p.m. - 5:00 p.m.	**Session 3**: End-to-End Drought Forecasting, Monitoring and Early Warning Process ▪ **Overview** ▪ **Case studies**on the current end-to-end drought forecasting and early warning processes in place in each of the 6 Volta Basin countries	Presentation/ debate/ Exercises	▪ Director Volta Basin Observatory ▪ SE of GWP-WA ▪ Participants - Benign - Burkina Faso - Ivory Coast - Ghana - mali - Togo - ABV
5:00 p.m.-5:15 p.m.	**Evaluation and end of the 2nd day**	Plenary	▪ GWP-AO ▪ experts ▪ Participants
Thursday, May 18, 2023			
08h30- 09h00	Reminder of the2nd day	Plenary	▪ GWP-AO ▪ experts ▪ Participants

Hourly	Activities	Methodology	Speakers
09h00-10h30	**Session 3**: End-to-End Drought Forecasting, Monitoring and Early Warning Process ▪ **Pillar 1**: Establishment of drought monitoring and early warning systems ▪ **Pillar 2**: Drought Vulnerability and Risk Assessment ▪ **Practical exercises**	Presentation/ debate/ Exercises	▪ Teacher. Ernest Amoussou ▪ Participants
10h30-11h00	**COFFEE BREAK**		
11h00-13h00	▪ **Practical exercises**(Continuation and end)	Presentation/ debate/ Exercises	▪ Teacher. Ernest Amoussou ▪ Participants
1:00 p.m.-2:00 p.m.	**LUNCH BREAK**		
2:00 p.m. – 5:00 p.m.	**Session 3**: Components of the end-to-end drought forecasting process and early warning system • **Pillar 3**: Implementation of measures to limit the impacts of drought and better respond to it • **Practical exercises**	Presentation/ debate/ Exercises	▪ Teacher. Ernest Amoussou ▪ Participants
5:00 p.m.-5:30 p.m.	**Rating of the day**	Plenary	▪ GWP-AO ▪ experts ▪ Participants
Friday, May 19, 2023			
08h30- 09h00	Reminder of the 3thdaytime	Plenary	▪ GWP-AO ▪ experts ▪ Participants
09h00 – 10h30	**Group work**on needed improvements to the current end-to-end flood and drought forecasting and early warning processes in place in each of the 6 Volta Basin countries	Works in groups Plenary	
10h30-11h00	**COFFEE BREAK**		
11 a.m. – 1 p.m.	**Group work (TG)** (Continuation and end)	XL Plenary	▪ GWP-AO ▪ experts ▪ Participants
1:00 p.m.-2:00 p.m.	**LUNCH BREAK**		
2:00 p.m.-4:00 p.m.	**Session 4**: Definition of an effective and operational mechanism for coordination and collaboration between the different agencies of the end-to-end forecasting and early warning processes for floods and droughts in the Volta Basin	Group work	▪ SE of GWP-WA ▪ Assistant Project Manager VFDM_ABV ▪ Technical Assistant of the VFDM/ GWP-AO Project ▪ Participants
4:00 p.m.-4:30 p.m.	**COFFEE BREAK**		

Hourly	Activities	Methodology	Speakers
4:30-5:30 p.m.	**Delivery of certificates to participants** **Closing of the training workshop**	Plenary	▪ DGRE/ MEHV_ ABV Focal Point of Togo ▪ WMO representative ▪ SE of GWP-WA ▪ DE of the ABV ▪ Minister of Water and Village Hydraulics of Togo

Annex 3: Practical guide for practical work on hydrological modeling and flood forecasting

(Guide to be attached to the report)

Appendix 4: User guide for statistical software for calculating different drought indices

(Guide to be attached to the report)