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)"

Consultation mission report on capacities and needs assessment of the Executive Directorate of the Volta Basin Authority for the establishment of an effective forecasting and early warning system for floods and drought

Project partners:

WORLD METEOROLOGICAL ORGANIZATION

AUTORITE DU BASSIN DE LA VOLTA – VBA – VOLTA BASIN AUTHORITY

Global Water Partnership West Africa

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ACRONYMS

AfDB	African Development Bank
CCWR	ECOWAS Center for Coordination of Water Resources
CIMA	International Center for Environmental Monitoring
CLE	Local Water Committees
CSSTE	Space Science and Technology Education Center
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision support system
ECOWAS	Economic Community of West African States
ED	Executive Directorate of the Volta Basin Authority
EO	Earth observation
EWS	Early warning system
FANFAR	Strengthened cooperation to provide operational flood forecasting and warnings in West Africa
FDMT	Flood and Drought Monitoring Tool
GIS	Geographic information system
GMES	Global Monitoring for Environment and Security
GWP-AO	Global Water Partnership - West Africa
HSD	Hydrological Service Department of Ghana
HYCOS	Hydrological cycle observation system
IDB	Inter-American Development Bank
IWRM	Integrated Water Resources Management
MBA	Mono Basin Authority
MiFMASS	Multi-scale flood monitoring and assessment services in West Africa
NDC	National contributions determined
NHS	National Hydrological Service
NMHS	National Meteorological and Hydrological Services
NRM	Natural Resources Management
PAGE	Partnership for environmental governance in West Africa
PAGEV	Project for the improvement of water governance in the Volta basin
PANA	National adaptation programs of action
PNA	National adaptation plan
PREE	Regional Partnership on Water and the Environment in Central and West Africa

PREMI	Poverty Reduction and Environmental Management Initiative
REWARD	Reversing Ecosystem and Water Degradation in the Volta River Basin
SONABEL	National Electricity Company of Burkina
TBO	Transboundary Basin Organism
UNEP	United Nations Environment Program
VBA	Volta Basin Authority
VCER	Vulnerability, Exposure, Capacities and Risks
VFDM	Flood and drought management in the Volta
WADB	West African Development Bank
WASCAL	West African Science Service Center on Climate Change and Adapted Land Use
WB	World Bank
WMO	World Meteorological Organization
WRCU	Water Resources Coordination Unit
WRIS	Water resources information system

1. Introduction

This report aims to assess the capacities and needs of the Executive Directorate of the Volta Basin Authority (VBA ED) necessary for the development of the flood and drought forecasting and early warning system and also to ensure the governance of the same system, within the framework of the Volta Flood and Drought Management (VFDM) project.

A consultation meeting on understanding the current institutional capacities and needs, in forecasting and Early Warning System (EWS) for floods and drought, of the VBA ED was organized, during a mission to Ouagadougou, Burkina Faso, on October 10, 2019. The terms of reference are presented in Annex 1. The results of the meeting were integrated into a desk study carried out in December 2019 and January 2020 and the information collected is reported in this document. The interim report was shared with the Volta Basin Authority for review and to provide additional information that was not identified during the initial consultations and secondary desk review. The updated report was then presented and discussed with VBA during an half-day workshop, where also the Global Water Partnership - West Africa (GWP-AO) was participating, as a project partner, and the World Meteorological Organization (WMO) and consultants were virtually connected due to the Covid-19 pandemic. Its analysis enabled a joint discussion with the workshop participants, in order to finalize the general recommendations and the action plan. After the workshop, this consultation report was finalized.

The report is structured as follows: firstly, a general presentation of the VBA ED, followed by a summary of the results of a documentary study on its institutional role; then an analysis of its current capacities at technical, material and management levels is presented, also taking into account the availability of hydrometeorological data (considering each of the components of the EWS). Furthermore, an overview of projects carried out, in progress and in preparation related, among other things, to the management of floods and drought in the Volta basin is included. Finally, general needs, recommendations and an action plan are presented. For each part of the report the link and correlations with the VFDM project are highlighted with a graphical representation that shows the central role of VBA in the project.

At the end of 2020 and at the beginning of 2021, national workshops were organized in the six countries of the basin to present findings of the capacity and needs assessment reports for the development of the forecasting and early warning system for floods and the drought under the VFDM project (in each country national consultations were carried out and a specific individual report was then produced). These national reports and the current report concerning the VBA ED are complementary, with the objective of having a reference framework for the establishment of the cross-border EWS for floods and drought, also on the basis of the mandates of VBA and the national agencies involved in the Disaster Risk Management (DRM).

2. VBA presentation

The Volta Basin Authority (VBA) was created in Ouagadougou through the signature of its convention by the Heads of State on January 19, 2007[1]. This is the result of an agreement between Benin, Burkina Faso, Ivory Coast, Ghana, Mali and Togo to promote and strengthen cooperation in the management and development of water resources in the Volta Basin, which covers approximately 400,000 square kilometers. The creation of a basin authority responds to the primary concern of having a structure to facilitate the dialogue among the Member States to ensure better coordination and harmonized and consensual management of the basin's water resources. It meets this need in five main ways, according to the mandate presented on its website:[2]

1. Promote permanent consultation between stakeholders for the development of the basin;
2. Promote the implementation of integrated water resources management and an equitable distribution of the benefits derived from the different uses of the resources;
3. Authorize the establishment of infrastructures and the implementation of individual stakeholder projects likely to have significant impacts on the water resources of the basin;
4. Develop and carry out joint works and projects;
5. Contribute to the reduction of poverty, to the sustainable development of the Member States of the basin and to a better socio-economic integration of the sub-region.

[1] https://VBA.int/mandat/
[2] http://VBA.int/mandat/

The mandate and scope of the VBA, as presented in Article 6 of the Convention of 19 January 2007, are closely interconnected with the objectives, activities and expected results of the VFDM project. This interconnection is illustrated in Figure 1.

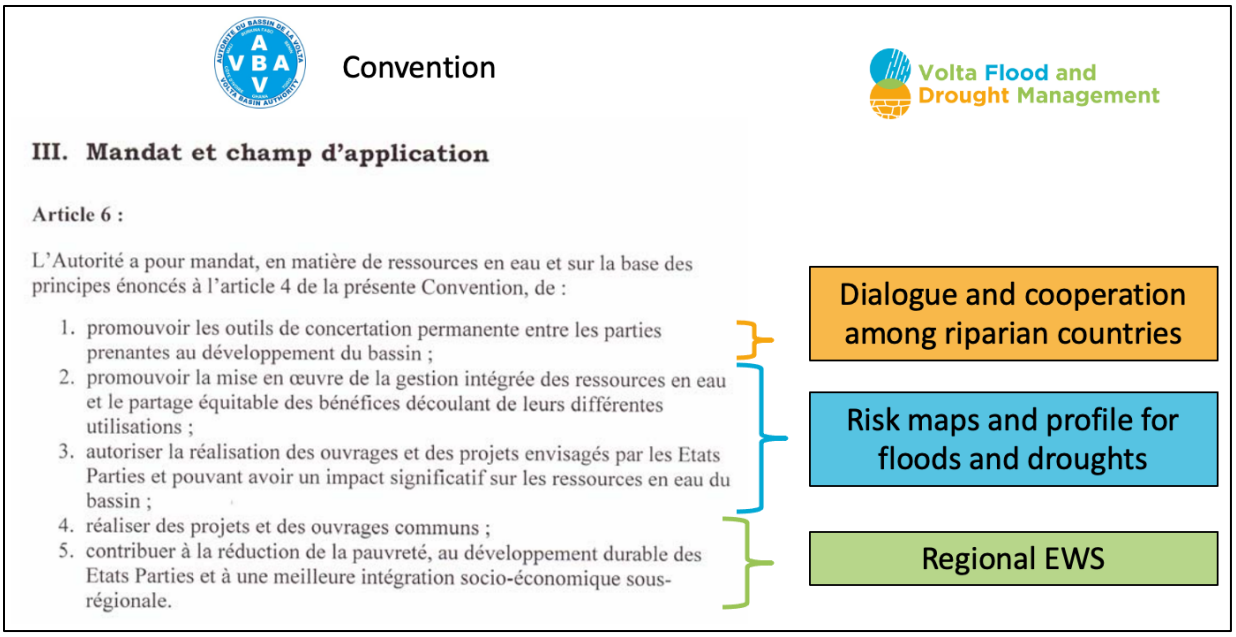

Figure 1: Interconnection between VBA mandate and the objectives and expected results of the VFDM project.

3. Role and functioning of the Institution

The VBA aims to harmonize national policies for the integrated management of water resources and the socio-economic development of the basin, where around 30 million people live and depend (directly and indirectly) on the resources of the river.[3]. On the other hand, the VBA is currently not directly involved in operational hydrological forecasts, but it facilitates the exchange of information concerning the operational management of dams in cross-border areas. For example, the National Electricity Company of Burkina (SONABEL) regularly informs the VBA about water levels of the dams located in the Volta basin, as well as the need to open the valves in the dams in cross-border areas (Bagré, Kompienga). The VBA relays the information with the national part of Burkina, as well as the downstream parts of Ghana and Togo. With this project the VBA could further facilitate the exchange of data and information among riparian countries. Ideally also

[3] The population was 25 million in 2010 and is projected to be 35 million in 2025; so today the estimated population must be around 30 million, according to the VBA.

results of operational hydrological forecasts of transboundary interest could be shared and this can be useful for disaster risk reduction and management (DRR / DRM) activities.

The VBA coordinates studies and research on the whole basin for the development of water resources, in particular about water supply for the population, production of hydroelectricity, irrigation, breeding, fishing and conservation of aquatic systems. The authority works through national focal points, while the establishment of national structures bringing together different actors in each country, with a coordinator at ministerial level, is still ongoing.

The Volta Basin Authority exercises control over the measures envisaged by the Member States of the basin that may have a significant impact on water resources. Thus, when a Member State plans to implement such measures in its national portion of the basin, it has the obligation to request authorization from the VBA for this purpose. This authorization is given following the notification, consultation and negotiation procedure provided by the VBA convention, ensuring that the interests of all the Member States concerned are taken into account.

Promoting the implementation of Integrated Water Resources Management (IWRM) is part of the mandate of the VBA, which should also promote and ensure an equitable distribution of the benefits derived from the different uses made of the water resources. According to the VBA Strategic Plan[4], the main planning tool to that end is a Master Plan for the Development and Sustainable Management of Water Resources in the Volta Basin. This is a strategic orientation document which establishes the rules for a balanced management of water resources over a period of 10 to 15 years, making it possible to provide a framework to the choices of all stakeholders in the Basin whose activities have an impact on water resources. Such a document will constitute, with the Water Charter, a solid framework in order for the VBA to take the necessary management actions for the socio-economic development of the Volta Basin.

Financial support for VBA is provided by riparian countries through the shared support mechanism illustrated in the Figure 2.

[4] http://archive.iwlearn.net/gefvolta.iwlearn.org/project-resources/studies-reports/vba-strategic-plan/vba-strategic-plan-final-french/at_download/VBA%20STRATEGIC%20PLAN-Final% 20-French.pdf

	% of VBA Annual Budget			
Member States	Equal Sharing of 30% of Budget	70% of Average of 3 Criteria	Recommended	Actual Negotiated
Benin	5.0	5.13	10.13	10.0
Burkina Faso	5.0	24.24	29.24	29.0
Cote d'Ivoire	5.0	8.10	13.10	9.0
Ghana	5.0	21.82	26.82	29.0
Mali	5.0	4.27	9.27	9.0
Togo	5.0	6.42	11.42	14.0
	30	70	100	100

Figure 2. VBA annual budget cost sharing criteria[5]

The statutory bodies of the VBA are made up of[6]:

- The Conference of Heads of State and Government

  the Conference is the supreme body responsible for the general cooperation and development policy of the Authority and for supervising its implementation;
- The Council of Ministers in charge of water resources

  The Council is responsible for formulating and monitoring sectoral policies and programs;
- The Forum of Stakeholders in the Development of the Volta Basin

  The Forum is a consultative body that brings together all stakeholders in the basin;
- The Expert Committee

  The Committee provides technical advice to inform and facilitate decision-making;
- The Executive Directorate

  the Directorate manages the daily activities.

Decisions are taken at the level of the Council of Ministers and the Conference of Heads of State and Government, then the role of the VBA is to organize consultation and concertation to help decision-making. To ensure effective international cooperation, the VBA has created, in addition

[5] https://www.riob.org/sites/default/files/IMG/pdf/Volta-Basin-Authority.pdf
[6] https://iwlearn.net/resolveuid/467c3ef0a6ce4f48870594ebf9e20e4b

to the statutory bodies, an advisory group of technical and financial partners whose main objective is to promote complementarity in the provision of technical and financial support to the VBA.

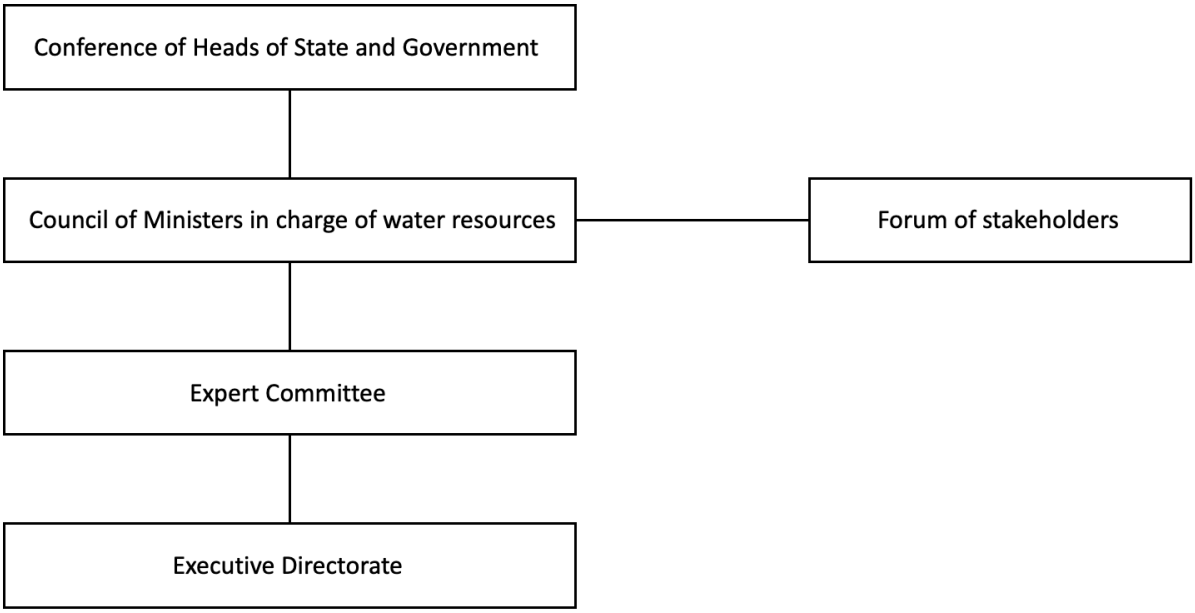

Figure 3. Organization chart of the authorities of the Volta Basin Authority[7]

The Volta Basin Authority is currently working to strengthen its institutional framework with the ratification of a Water Charter, validated in July 2019. This Charter will provide more details on the roles and responsibilities of member countries about the use of resources, will strengthen VBA's mandate and define the principles of sustainable use of water resources in the Volta Basin in an integrated manner.[8]

Taking into account the role and functioning of the VBA, the VFDM project with its objectives, activities and expected results aims to fit into the framework of the documents guiding strategy and actions of the VBA (such as the Water Charter and the Master Plan for the Development and Sustainable Management of Water Resources in the Volta Basin). This relationship is illustrated in Figure 4.

[7] https://www.mrcmekong.org/assets/Publications/governance/MRC-Technical-Paper-Org-Structure-of-RBOs.pdf

[8] https://lefaso.net/spip.php?article90720

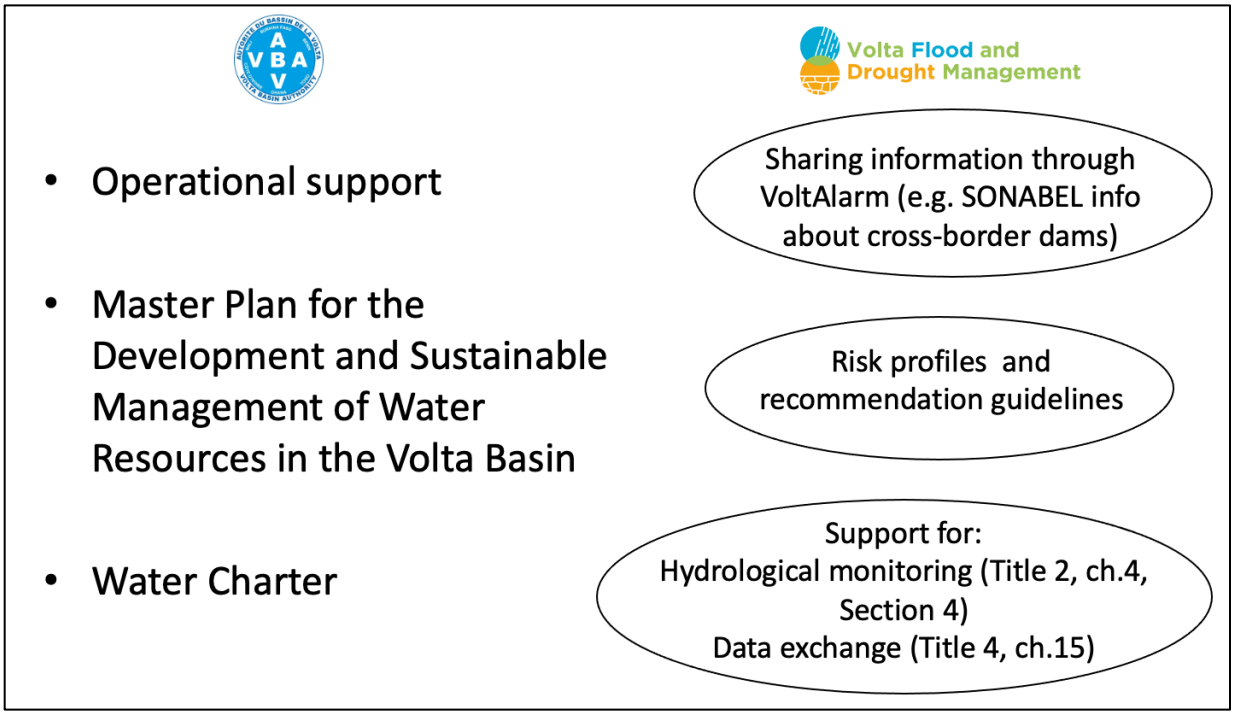

Figure 4: Representation of the relations between the role of the VBA, its strategic documents and the VFDM project.

4. Assessment of hydrometeorological needs and capacities of the VBA ED for the establishment of a cross-border EWS

According to the VBA Statute, among the specific objectives of the Authority we find the following:

"Create and/or strengthen the tools and networks for collecting, processing, storing and disseminating the data and information necessary for scientific research, planning, development and management of natural resources in the basin, and in particular of its water resources. "

Even if in 2007 forecasting and disaster risk management were not explicitly mentioned in the VBA Statute, they are of course included in the activities defined as "*..scientific research, planning, development and management. of the natural resources of the basin* ". Particularly, the Statute also describes the role and the attribution of the Executive Directorate. It is the executive body of the Authority: it provides thes secretariat of all the bodies of the Authority and manages the daily activities, which also include collecting, processing and disseminating information and

hydrometeorological data, as well as supporting the National Meteorological and Hydrological Services (NMHS) in forecasting and setting up early warning systems (EWS). According to WMO[9] the components of a multi-hazard, effective and people-centered EWS are four: A) disaster risk knowledge, B) monitoring and forecasting, C) warnings dissemination and communication and D) preparedness and response.

We considered each of these four components in order to carry out an assessment of current capacities and needs of VBA ED at the institutional, technical, material (infrastructure and IT equipment) and data availability levels for the implementation of a cross-border EWS at basin scale. The evaluation was first conducted within the consultation meeting held in Ouagadougou in October 2019; then also a documentary review of subsequent information and of all documentation provided in the following months by the VBA ED, made it possible to complete the assessment, summarized in the following table.

[9] https://library.wmo.int/doc_num.php?explnum_id=4463

EWS components	Capacities in place		Needs	Response to needs provided by projects
A Disaster risk knowledge	Data series	GIS files, maps and GIS atlases as processed data: thematic maps of the Volta Basin which were used to make an atlas of the VBA. They date from 2010.	Update of the thematic maps of the VBA atlas	Flood and drought risk maps will be produced in the VFDM project for the extent of the Volta basin.
		Satellite images (Sentinel 1, 2 Landsat 8) from 2016 and 2017, provided by ESA as part of the TigerNet project (led by ESA and now completed).	Search for new projects / funds to gain access to satellite products useful for disaster risk management.	---
	Information systems for water resources management	GLOWA Volta Geoportal: this is a platform where information and data from the works / results of GLOWA VOLTA, WASCAL and other projects are collected with the aim of improving the exchange, acquisition and use of data for water resources management.	Reactivation of Geoportal GLOWA and update of data dating from 2011.	---

B Monitoring and forecasting	Hydrological forecasting models	In the Volta Basin there is the Delft-FEWS model on the basins - Oti (Togo and Ghana), hosted both at the VBA and at the Hydrological Services Department in Ghana (HSD). - White Volta, hosted on the servers of the Hydrological Services Department in Ghana (HSD).	It would be important to strengthen the transfer and sharing of data from and among concerned agencies in member countries.	The VFDM project is working for the integration of data from the Delft-FEWS model into the VoltAlarm platform. In general, the platform could be a trigger tool and a round table for the reinforcement of data exchange in the Volta basin.
	Hydrological monitoring systems	WRIS (Water Resources Information System) The software is currently in the desktop version because the web version, which requires a license, could not be installed yet due to a version issue. The software manages time series of hydrological data, such as water discharges and water levels. The VBA Water Resources Observatory is based on the WRIS system for monitoring and managing water discharge and level data.	The VBA would like to improve the quality of hydrological data.	The update of the WRIS version is foreseen in the REWARD project.

		Access to the Flood and Drought Monitoring Tool portal (FDMT, hosted on servers of the international consultant DHI) for flood and drought management. (www.flooddroughtmonitor.com)	Identify funds to improve and strengthen the FDMT portal.	Support by the REWARD project is currently under discussion to strengthen and operationalize the FDMT portal within member countries.
	Weather monitoring system	---	The VBA would like to have access to real-time meteorological data (or data from automatic stations) for any use that may be important for member countries. It would be important to strengthen data transfer and sharing from and among concerned agencies in member countries.	The VFDM project aims to work for the establishment of centralized databases in each member country to be then connected to the VoltAlarm platform. Based on the data sharing policies and rules of the involved agencies, the platform will be able to facilitate access to certain data for the different users.
C Warnings dissemination and communication	Warning dissemination and communication systems	FEWS dashboard for Oti and White Volta for floods early warning in the two mentioned Volta sub-basins.	Reactivation of the access to model outputs (FEWS dashboard for Oti and Volta Blanche) from outside the internal network of the Ghana Hydrological Service Department (HSD).	The work is being carried out by the VFDM project, the HSD and the international consultant HKV.

D Preparation and response	Disaster response plan	---	It would be interesting to develop a strategy and / or disaster response plan at the level of the Volta basin, especially for the organization of the response in cross-border areas. This plan or strategy can be developed with the competent national structures and finally adopted by member countries.	During the VFDM project, it is planned to assess and review national (PANA, PAN, NDC) and cross-border (MSDPM, EWS, etc.) governance plans, policies and guidelines on long-term flood and drought management, including data and information sharing, with the six countries. The VBA will play a major role in this activity, which may lead to laying the foundation for the development of a basin-wide disaster response strategy / plan.
Transversal	Data transfer and exchange	Although there is a Memorandum of Understanding (MoU) to improve data exchange between riparian countries and VBA, the agreement is not yet implemented and data is not exchanged regularly. According to the MoU, the VBA is supposed to provide financial support to countries to enhance data validation. Currently, the only operational data exchange process takes place with the agencies that are managing the dams in the basin.	The VBA would like to move forward with the implementation of the agreement and strengthen the transfer and sharing of data from and among concerned agencies in member countries.	The VFDM project aims to work for the establishment of centralized databases in each member country, to then be connected to the VoltAlarm platform. In general, the platform could be a trigger tool for the implementation of the agreement to improve the data exchange in the Volta basin, between the riparian countries and the VBA.

	Systems for project management, contracts and human resources	TomPro software, used for the financial management of contracts and fixed assets.	---	---
		Human resources management software	---	---
	Staff	The Volta Basin Authority has 30 people and is made up of 3 technical units: • Observatory Unit: head of unit, 2 hydrologists, 1 IT / GIS and 1 administrator • Hydroelectric unit • Agriculture unit	The VBA would like to have more human and financial resources to devote to disaster risk management activities.	---
	Integrated system for early warning and decision-making support in flood and drought risk management	---	The VBA would like to have a facility that functions as an operational center at the technical, IT and organizational level to host a complete system capable of providing decision-making support for early warning and management of flood and drought risks.	One of the main activities of the VFDM project aims to set up an integrated IT system that can support all the national structures involved in an early warning system for floods and drought, as well as VBA, for what concerns data sharing, real-time monitoring and forecasting with local and global information and the development and dissemination of warnings.

From a cross-analysis of current capacities and needs, it is possible to affirm that there is a general need for improvement, updating and production of data useful for understanding risks, as well as for strengthening and making operational the data exchange between the riparian countries and the VBA, especially concerning hydrometeorological monitoring and forecasting. One of the main activities of the VFDM project aims to respond to the need to have an integrated IT system able to support all the national agencies involved in an early warning system for floods and drought, as well as the VBA, in terms of data sharing, real-time monitoring and forecasting with local and global information and also development and dissemination of warnings. A technological tool with these characteristics could strengthen the entire early warning system in all its components and meet the main needs above mentioned, as illustrated in the following figure.

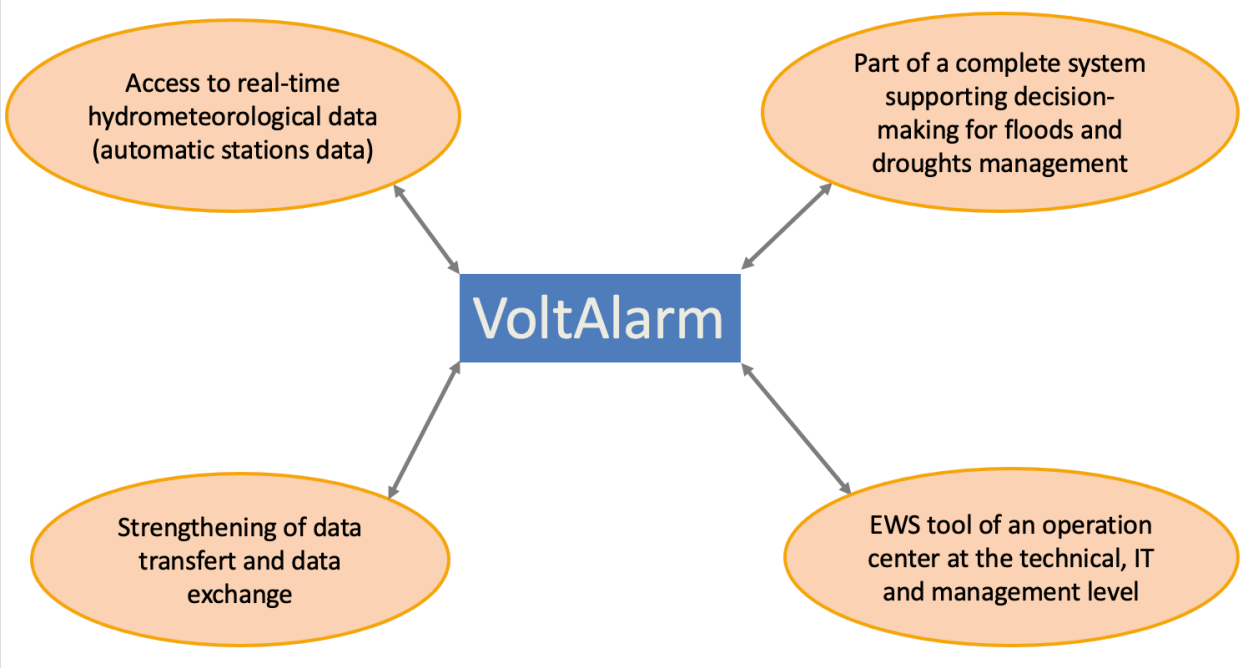

Figure 5: The VoltAlarm platform as a response to the needs of the VBA ED in terms of hydrometeorological capacities and EWS.

A first presentation of the VoltAlarm platform functionalities was carried out for the national structures involved in the DRM during the various national workshops, held between September 2020 and January 2021, and for the VBA during the workshop held on March 25, 2021. The presentation was designed to show the platform's capacity: an empty box that can be adapted and configured according to the needs of the context and of the agencies involved. In addition,

VoltAlarm can integrate and connect to other portals, platforms, forecast models and databases existing in the Volta Basin, providing a unique point of access to all products useful for early warning (Figure 6).

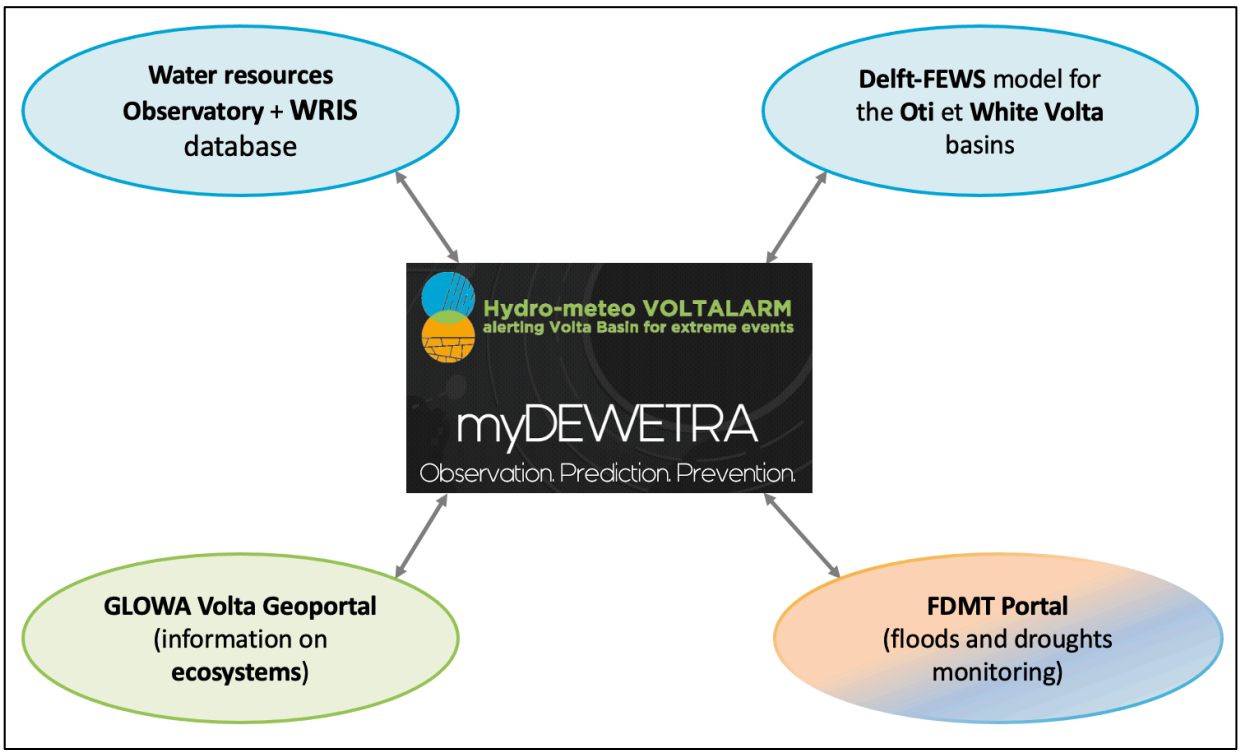

Figure 6: Diagram of possible connections and integrations between the VoltAlarm platform and existing portals / platforms / models / databases within the Volta basin.

In general, it can be said that the VBA, as well as each actor involved in the early warning system in the six member countries, in accordance with its mandate and its needs, would like to have a technological tool to be able to exchange and analyze data, as also to develop or receive warning bulletins.

The VFDM project, with all its planned activities, will be able to meet many of the capacity building needs of the VBA for implementing an effective end-to-end EWS at the basin level. Some other needs will be probably addressed within the REWARD project. Here below a list of needs that will need to be addressed by other interventions in the future to continue and complete the capacity building process of the VBA ED.

EWS components	Needs
A Disaster risk knowledge	Update of all thematic maps of the VBA atlas (which date from 2010).
	Seeking new projects / funds to gain access to satellite products useful for disaster risk management.
	Reactivation of Geoportal GLOWA and update of data dating from 2011.
D Preparation and response	It would be interesting to develop a strategy and / or disaster response plan at the level of the Volta basin, especially for the organization of the response in cross-border areas. This plan or strategy can be developed with the competent national structures and finally adopted by member countries.
Transversal	The VBA would like to have more human and financial resources to devote to disaster risk management activities.

5. Review of programs, projects or initiatives (completed, under implementation or in preparation) related to flood and drought forecasting and EWS

Projects in which VBA is one of the partners:

- **Regional Partnership on Water and Environment in Central and West Africa - PREE**

The PREE is a regional project built mainly on the achievements of PAGEV[10], from the PREMI[11], from PAGE[12]and those of the various regional institutions and countries on the major challenges to be taken up, namely: (i) integrated management of water resources and associated ecosystems in West Africa and in the basins of Lake Chad and the Fouta Djalon Mountain; (ii) management of conflicts related to water and associated ecosystems; (iii) climate change and (iv) capacity building of sub-regional integration institutions and cross-border basin organizations in West and Central Africa. The Project will be implemented in the basins of the Volta, Niger, Senegal, Mono rivers, Lake Chad and the Fouta Djalon Mountain and essentially aims to strengthen the resilience of natural ecosystems and local communities in these river and lake basins.

For this first phase of PREE implementation, four (4) specific activities are planned in the Volta Basin and divided into objectives 1; 2; 3 and 5. These activities will be carried out in collaboration with national partners, including the communities of the intervention area, following specific approaches described below. Certain activities will be extended to the Mono basin through internal collaboration agreements between the Executive Directorates of VBA and MBA (Mono Basin Authority). The VBA Executive Directorate remains the lead and responsible towards IUCN for the technical and financial management of the following activities:

Activity 1.7: Establishing or strengthening early warning systems for floods, droughts and low water levels (the current budget for the activity is not operational)

[10] Project for the improvement of water governance in the Volta basin
[11] Poverty Reduction and Environmental Management Initiative
[12] Partnership for environmental governance in West Africa

Activity 2.5: Supporting the Niger and Volta basin authorities and the national water agencies in the development, adoption, integration and operationalization of gender strategies and action plans in the implementation of IWRM
Activity 2.6: Supporting the establishment and operationalization of Local Water Committees (CLEs) at the level of the sub-basins of Chari / Logone, Black Volta and Niger
Activity 3.3: Strengthening the capacities of States and TBOs in the collection and processing of water data
Activity 5.6: Develop climate investment plans for the Volta and Senegal basins

Synergies with the VFDM project: The establishment of a Volta Basin-wide early warning system for floods and drought is one of the main objectives of the VFDM project. Strengthening early warning systems for floods and drought is also part of the activities of the PREE project: it would therefore be very important to ensure the complementarity of actions with the VFDM project, considering that the PREE project covers several basins from Central and West Africa. The PREE project actively involves VBA and IUCN, which are also involved in the VFDM project. A specific attention to ecosystem services, which is central in the above-mentioned project, is also a component of the VFDM project, which aims to analyze the risks for riparian forests and the Mangrove-type ecosystem in the Volta Basin and produce basin-wide integrated guidelines for wetlands to promote the sustainability of ecosystem services.

- **REWARD (in preparation)**

https://www.thegef.org/project/reversing-ecosystem-and-water-degradation-volta-river-basin-reward-volta-river-basin

The project, implemented by UNEP, aims to implement the main priority strategic actions for the development of ecosystem management tools. These tools will be used to identify stress reduction measures aimed at establishing sustainable management and use of the resources of the Volta Basin.

Synergies with the VFDM project: A specific attention to ecosystem services, which is central in the above-mentioned project, is also a component of the VFDM project, which aims to analyze the risks for riparian forests and the Mangrove-type ecosystem in the Volta Basin and produce basin-wide integrated guidelines for wetlands to promote the sustainability of ecosystem services. Therefore it would be very important to create a dialogue with the

REWARD project team to analyze the possible complementarity of actions with the VFDM project.

Projects in which the VBA has previously acted or is currently acting as a technical reviewer / advisory committee:

- ECOWAS activities on 1) development of a flood management strategy, 2) hot spot mapping and 3) flood forecasting. A fruitful collaboration with the ECOWAS Center for Coordination of Water Resources (ECOWAS CCWR) is currently ongoing. This center supports VBA in the various negotiations and in leading projects. Projects' concept notes have been submitted to various donors, such as the AfDB which has hired consultants to analyze the submitted projects. The ECOWAS CCWR has mandated:
    - the AGHRYMET Regional Center for the development of a climate model for flood and drought management based on the analysis of existing models;
    - WASCAL for a study on "the impacts of climate change and the costs of adaptation on the sectors of agriculture, water resources and coastal areas in West Africa".

  The VBA is still involved in these initiatives, as well as in the development of the regional strategy for disaster risk management.

  Synergies with the VFDM project: Being the VBA in constant collaboration with the ECOWAS CCWR, it would be interesting to create a link between the VFDM project team and the CCWR to see any possible integration into the early warning system of the Volta basin (VoltAlarm) of products for monitoring, forecasting and management of floods set up by the CCWR (such as the climate model developed by AGRHYMET).

- **Activities with AGRHYMET: FANFAR (Reinforced cooperation to provide operational forecasting of floods and warnings in West Africa)** (2018 - ongoing)

https://fanfar.eu/about/

In collaboration with the AGRHYMET Regional Center, the FANFAR project, coordinated by the Swedish Hydrometeorological Service (SMHI), aims to ensure reliable and efficient flood management in West Africa. FANFAR brings together a cascade of actors from various disciplines at regional, national and local levels, coming from 17 West and Central African countries as well as external and European partner countries.

Synergies with the VFDM project: Being the above-mentioned project towards the end of its implementation, it will be interesting to create a link between the two project teams to see the possible integration into the Volta Basin Early Warning System (VoltAlarm) of products for monitoring, forecasting and management of floods set up by the FANFAR project.

- **GLOWA Volta Project** (2000 - 2009)

https://www.geographie.uni-wuerzburg.de/en/fernerkundung/research/completed-projects/glowa-volta/
https://www.zef.de/fileadmin/template/Glowa/Downloads/SDRC-Report_GLOWA-VBAGeoPortal_Ghana.pdf
https://link.springer.com/chapter/10.1007/978-1-4020-5591-1_18

The project aimed to set up a scientifically sound decision support system (DSS) for the management of water resources. The project was funded by the German Federal Ministry of Education and Research, with additional funding from the Ministry of Science and Research of North Rhine-Westphalia. Within the project, a geoportal has been created. The geoportal contains data on hydrological and meteorological measurements, land use, vegetation changes, soils, as well as settlements, population and households. Users can also combine this data to create maps.[13]

Synergies with the VFDM project: The GLOWA project geoportal could contain useful data and information, especially in relation to ecosystem services. It would be interesting to check the status and availability of the geoportal, as well as the date of last update of data, to assess the possibility of using them for the development of basin-wide integrated guidelines for

[13] https://www.zef.de/fileadmin/webfiles/downloads/press_coverage/Geoportal_res-in-germ_090618.pdf

wetlands to promote the sustainability of ecosystem services. In addition, it will be important to verify its usefulness also in terms of early warning in order to assess its possible integration within the early warning system of the Volta basin (VoltAlarm).

- **Flood and Drought Monitoring Tool (FDMT), UNEP-DHI Partnership (2014-2018)**

https://fdmt.iwlearn.org/about
http://www.flooddroughtmonitor.com/home?register=true&ug=CTCN
https://iwa-network.org/projects/flood-and-drought-management-tools/

A methodology has been developed to improve the management of 3 cross-border river basins, including the Volta basin. Developing flood and drought management tools for regional organizations and local users, the project aimed to improve the management of water resources at the basin level. One of the tools developed is a web portal that integrates information on climate variability and changes and it provides access to near real-time data on drought and flood indices.

Synergies with the VFDM project: The web portal of the FDMT project could contain useful data and information, especially in relation to the Volta Basin Flood and Drought Early Warning System (VoltAlarm), which the VFDM project aims to set up. It would be interesting to check the status and availability of the web portal, as well as the date of last update of data, to assess the possible integration into the VoltAlarm platform.

- **Volta HYCOS Project - African Water Facility (2006-2009, 2011-2015)**

https://library.wmo.int/index.php?lvl=notice_display&id=20494#.XohminJS9PY
https://www.africanwaterfacility.org/fileadmin/uploads/awf/Projects/AWF-Project-appraisal-report-MULTIN-VBA.pdf

Funded by WMO with a total budget of 1.2 million euros, the project targeted VBA and National Hydrological Services (NHS) of Member States with the ultimate goal of improving information services, data hydrological resources for users and achieving an efficient integrated transboundary water resources management (IWRM).

The results of the project are as follows: (1) enable the establishment of an operational and sustainable HYCOS network and associated operations in all VBA member countries; (2)

provide relevant, reliable and timely hydrological information products to identified users; (3) strengthen the capacity of VBA to initiate and implement water development projects in the basin; and (4) support the National Hydrological Services (NHS) in each of the 6 riparian countries in the transmission of HYCOS data to the Regional Project Center (RPC) database, hosted by VBA; (5) improve the capacities of VBA by providing relevant and reliable training products to users and stakeholders, including the Observatory.

Synergies with the VFDM project: The network of stations and their data, as well as the hydrological information products generated by the HYCOS project, are surely of great interest for the VFDM project and the establishment of an early warning system for floods and drought for the Volta basin (the VoltAlarm platform). It would be interesting to check the status of the stations, the availability of their data, the procedures for sharing and exchanging network data between the different countries and the VBA, as well as the availability and date of last update of the hydrological information products, in order to assess the possible integration into the VoltAlarm platform.

- **PDI-Volta project**: the project aims to promote the socio-economic and environmental development of the basin, with a duration of 10 years. The funder is the Islamic Development Bank.

- **Natural Resources Management Project (NRM)**: the project aims to improve living conditions on the basis of integrated management of natural resources in the Volta basin. The project is financed by the West African Development Bank (WADB) for an amount of 25 million dollars.

- **Project: Strengthening flood management in the Volta basin (World Bank)**

The objectives of the project were (i) to study the magnitude and severity of flood risks in the basin, (ii) to assess the exposure of various assets and communities to floods, (iii) to discuss structural and non-structural protection measures for floods, (iv) to build capacity, to test and develop an operational early warning system for floods. For the White Volta river and the Oti river, similar flood forecasting approaches were followed. This approach is based on an in-

depth analysis of historical hydrometeorological data, field studies and the development of a hydrological-hydraulic model (1D2D), combined with consultations with stakeholders in vulnerable areas and intensive on-the-job training for forecasters in Ghana and Togo. The hydrological and hydraulic model was developed on the basis of SOBEK, while the flood forecasting platform was developed with Delft-FEWS.
In addition to the flood early warning system, the hydrologic-hydraulic model was used to develop accurate flood hazard and risk maps and to discuss the possibility of structural and non-structural interventions to better manage floods in the Oti basin.

Synergies with the VFDM project: Being the above-mentioned project already completed, it will be interesting to verify the operationality of the hydrological forecasting systems for the Oti and White Volta Basin and create a link with the Department of the Hydrological Service of Ghana (HSD) to see the possible integration into the Volta Basin Early Warning System (VoltAlarm) of FEWS flood monitoring and forecasting products, implemented throughout this project.

- **Multi-scale flood monitoring and assessment services in West Africa (MiFMASS)**

The multi-scale flood monitoring and assessment services in West Africa (MiFMASS) are one of the actions under the Global Monitoring for Environment and Security and Africa initiative (GMES & AFRICA).
The Centre for Space Science and Technology Education (CSSTE) located within Obafemi Awolowo Ile-Ife University in Nigeria, is one of the grant recipients of the GMES & AFRICA support program. As part of this support program, the CSSTE will manage multi-scale flood monitoring and assessment services for West Africa using Earth Observation satellite data.
The overall objective of the project is "to improve the effectiveness of flood monitoring, assessment and management in West Africa by providing real-time Earth observation (EO) services to disaster management organizations and strengthening their human capacity to adapt to their services". In this context, the Executive Directorate of VBA is the leader and responsible towards CSSTE for the management of the activity T3.4 "Generation of relevant geospatial layers". The activity foresees the creation of necessary but unavailable geospatial layers, as well as the updating of available but obsolete geospatial databases, to be used for the

realization of riverine flood modeling of the GMES / MifMASS program (damage assessment and mapping of the flooding extent). Different layers and maps of geospatial data will be generated for the five (5) study sites in the different countries of the five (5) partners (Burkina Faso, Ghana, Nigeria, Côte d'Ivoire and Republic of Benin) by analyzing available Earth Observation and ancillary data.

Synergies with the VFDM project: The generation of new relevant geospatial layers, as well as the updating of existing geospatial databases, could be very useful also for the activities of the VFDM project, in particular the production of flood and drought risk maps for the Volta basin. In addition, also the results of the modeling of riverine floods, planned in the GMES / MifMASS program, may be interesting in order to evaluate a possible integration into the early warning system of the Volta basin (the VoltAlarm platform). It would be useful to have access to the geospatial data produced and all corresponding reports, as well as create a link with the GMES / MifMASS program team to study the possible complementarities with the VFDM project.

A graphic representation to summarize the possible synergies, interactions and connections between the VFDM project and all the other projects where the VBA is involved, is presented in the following figure, according to four thematic macro-components.

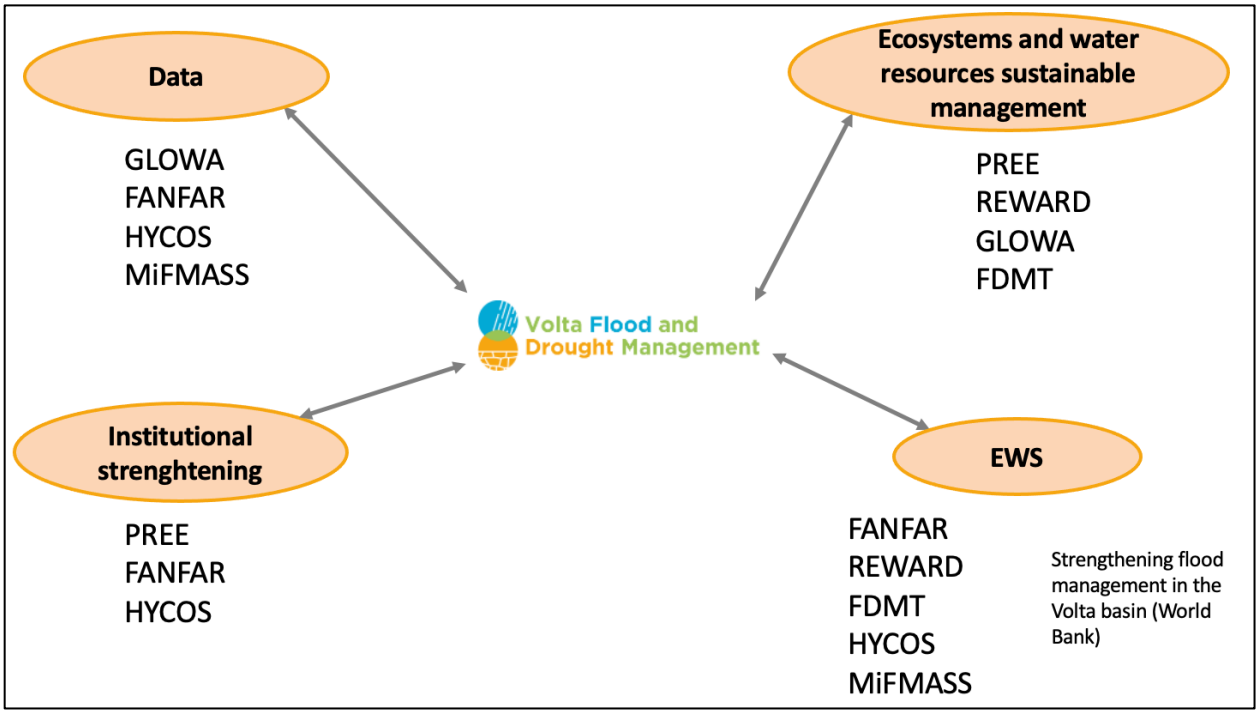

Figure 7: Diagram of possible synergies, interactions and connections between the VFDM project and all the other VBA projects according to four thematic macro-components.

The VBA also plays a major role in the implementation of European initiatives on cross-border basins in Africa, with the ultimate goal of promoting cross-border IWRM in the basin. Until now, the implementation of this initiative was ensured by the ECOWAS Water Resources Coordination Unit (WRCU), which represented the Volta basin.

6. Final considerations and the Volta project

The VBA ED has technical capacities relevant for the VFDM project. Its unit within the Observatory is relatively small, but with qualified and motivated people.

Unfortunately, the data available or stored in the VBA is outdated; the authority has a geoportal that contains information on exposure, land use, hazards, water resources and infrastructures, but it must be rehabilitated.

Three main needs are identified related to the potential support of the VBA to the VFDM project:

1- Risk mapping for the entire hydrographic basin in order to update the hydrographic basin master plan including the management of flood and drought risks, and also to inform concerned stakeholders. This master plan could have a lot of potential, in particular for the impact that risk mapping would have on VBA prevention policy. The VBA experts have clearly indicated that risk mapping has not yet been developed at the basin level. The VFDM project will develop risk maps for the entire Volta Basin, also by validating and integrating existing information from previous projects and other national works.

Within the framework of the VFDM project, it is envisaged that the VBA will receive risk information bulletins, by each of the national entities, with an identified level of risk. The VBA will merge the risk level bulletins of the six national entities and develop risk bulletins with maps for the cross-border Volta basin. This bulletin on cross-border risks could be generated with a fixed frequency and distributed to the VBA stakeholders concerned (national water resources management authorities, river basin authorities, water services, etc.).

2- Currently, the Volta Basin region lacks a decision-making framework and cross-border strategies to overcome the challenges of water resources management at the basin level.

The water charter has been adopted by the states, but it remains its approval, then its ratification by the parliaments of the countries. To do this, meetings will be organized with the legal units of the parliaments of the member countries in order to explain the reasons for the establishment of the Charter.

Regarding the preparation of the Master Plan for the Development and Sustainable Management of Water Resources for the horizon 2020-2050, or even 2100, the VBA has approached partners such as the AfDB, the IDB, the WADB, the WB to seek the support needed to move forward on the drafting of this important strategy document.

The Volta Basin Authority will play a major role within the framework of the VFDM project a for the evaluation and review of national (PANA, PAN, NDC) and cross-border (MSDPM, EWS, etc.) plans, policies and governance guidelines on long-term flood and drought management (including data and information sharing) with the six countries (involving ministers, decision-makers, operational staff, civil protection, communities, etc…).

3- Rapid access to reliable information in real time is fundamental for the decision-making process before and during an emergency. A shared Web-GIS platform, with accessible products, tools and database, would allow the various VBA stakeholders to get access to real-time information. Modern technologies offer practical solutions to improve data exchange, encouraging systematic and real-time sharing of data and information among different institutions. The MyDewetra digital platform (which will be called VoltAlarm once it will be fully developed as EWS tool for the Volta basin) is a practical open source solution for this challenge. VBA could be one of the custodians of the platform serving as an information center on cross-border risks. National and regional data will be available in the platform, which will also allow the sharing of processed information between national entities and VBA. The national entities will process the available data to produce information on risks and they will share this information with VBA. Therefore, VBA will develop a regional overview to be shared with the national authorities of the riparian countries, in addition to all other relevant stakeholders of the VBA. Responsibility for the interpretation of forecasts and the dissemination of early warnings would remain at national level with the national meteorological and hydrological services. National forecasts and alerts will be produced by national services and disseminated via the VoltAlarm system. System maintenance (which includes ensuring that national stakeholders continue to provide real-time data and information to keep the system running) should be entrusted to a regional technical center with 24-hour operational capacities (ideally the VBA, if it will have the possibilities to assume this role with an appropriate capacity building process). National agencies (national meteorological and hydrological services, water resources management, civil protection) from the six countries will be involved to identify the design, development and functionalities of VoltAlarm together with the

VBA. The system will strengthen the role of VBA for an effective management of transboundary river basins. Therefore, in the future, new products, tools and services could be developed and integrated through new projects or investments from other funding institutions. The sustainability of the EWS set up within the VFDM project will be guaranteed with the negotiation of other funds and support, according to the commitment signed by the VBA already during the preparation phase of the concept note of the VFDM project itself.

7. VBA action plan for current and upcoming activities

In addition to the management and coordination of the project activities as described and agreed in the annual work plan, the VBA will participate and contribute to the development of the project activities at the cross-border level. VBA and all national entities will acquire the knowledge and skills necessary for the development, use and maintenance of tools and products provided as part of project activities, mainly risk maps and EWS based on a Web-GIS platform. The table below presents the list of products, tools and services that will be provided as part of the project activities, as well as the expected roles and responsibilities of the VBA associated with each one.

EWS components	Planned outputs / Results	Level	Activities / Tasks	Roles and responsibilities expected by VBA
A Consolidate disaster risk knowledge	Development of flood and drought risk maps for the Volta basin	National / Cross-border	Availability of information on vulnerability, exposure, capacity and risk (VCER) at the national level	Ensure that national and local agencies are contacted and that relevant information on VCERs is collected
			Training of national staff in the development of vulnerability and exposure maps	Participation of VBA staff in national training workshops in Mali, Côte d'Ivoire and Burkina Faso to develop vulnerability and exposure maps
			National staff develop vulnerability and exposure maps	Follow up with national staff to develop vulnerability and exposure maps according to training and skills provided

A Consolidate disaster risk knowledge	Creation of a centralized national database	National	Databases, network, infrastructure and existing capacity building needs at the national level are identified	The VBA will carry out consultations and studies at the national level with the support of WMO and CIMA Research Foundation and will also provide information on the database, IT network and skills available within the VBA.
B Improve monitoring and forecasting				
C Develop warnings dissemination and communication				
A Consolidate disaster risk knowledge	EWS design and development (VoltAlarm)	Cross-border	Configuration of the myDewetra platform and visualization of data and information	An IT expert from VBA as well as IT focal points identified at national level in the NHMS of the 6 countries will receive the necessary training on the configuration of the system and

				how the information and data are visualized.
			Integration of information from past and current projects in the VoltAlarm EWS and development of synergies and complementarities with current and future projects	The VBA will support the liaison with national agencies and other complementary projects (FDMT, REWARD, ECOWAS FM strategy, FANFAR) and will ensure that existing information is visualized and that synergies are developed.
B Improve monitoring and forecasting			Identification of local and national hydrological and meteorological models for flood forecasting and drought prediction	The VBA will provide support in the identification of local and national hydro-meteorological models through their focal points and international project partners.
C Develop warnings dissemination and communication			Configuration of the tool for the semi-automatic production of flood and drought warning bulletins for	The VBA will receive bulletins from the national agencies responsible for producing information, then it will merge

			the part of the national territory belonging to the Volta basin	the national bulletins to develop cross-border bulletins.
A, B, C			Operational training to national agencies about the VoltAlarm platform based on the MyDewetra system	The VBA will participate in the training to ensure that knowledge and skills are developed at cross-border level
B Improve monitoring and forecasting	Pilot trials of EWS VoltAlarm to test applicability and effectiveness during monsoon and dry season in 10 identified pilot areas of the Volta Basin.	National / Local	Coordination and institutional strengthening among the different stakeholders (from national to local and community level). Assign roles and responsibilities to each stakeholder at national and local levels Perform simulation exercises and share lessons learned and feedback with operational entities	The VBA will help coordinate with national and local agencies to organize the testing of the EWS system
C Develop warnings dissemination and communication				
D Improve preparedness and response				

C Develop warnings dissemination and communication	Community based flood and/or drought management (CBFDM)	Local	Identify local partners Coordinate and support local partners to implement community activities to develop preparedness and resilience to floods and/or droughts	VBA will provide support in identifying local partners and carry out regular technical monitoring and coordination Ensure that all activities described in the Terms of Reference (ToR) are implemented in the six communities identified To make operational the six stations equipped with teletransmission, VBA will share with CIMA the location map of these stations. The six hydro-weather stations provided by WMO (with CIMA) will be transported by the VBA to the respective local communities / agencies and they will take care
D Improve preparedness and response				

				of the installation and maintenance of the system.
A Consolidate disaster risk knowledge	Ecosystem risk assessment and capacity building for nature-based solutions for developing bankable project proposals	National	Collection of information at the national level on ecosystem services and environmental indicators Development of an integrated basin-wide guidance document Capacity building on nature-based solutions Development of bankable project proposals	VBA will coordinate with IUCN to implement activities at the national level and will also participate in various workshops. VBA will lead the development of bankable project proposals with relevant national institutions and IUCN
C Develop warnings dissemination and communication				
D Improve preparedness and response	National and transboundary governance plans, policies and guidelines regarding management at long-term	Cross-border / national	Conduct studies and meetings with partners to identify cross-border governance plans, policies and guidelines for flood and drought management with	The VBA will lead the study process and meetings to define the methodology for involving regional, national and local stakeholders (meteorological, hydrological, civil protection

	floods and droughts are assessed and updated		their strengths and gaps and underlying needs Propose long-term actions to be implemented to strengthen resilience and capacities at national and cross-border levels	services, other ministries involved in flood and drought management) and will ensure that reports are developed taking into account the strengths, gaps and underlying needs

Volta Flood and Drought Management

Annex 1: Consultation to understand current capacities and needs to strengthen VBA institutional support

Terms of Reference for Consultative Meetings

Introduction

This document describes the methods and tools for carrying out a national consultation project on hydrological capacities for forecasting floods and droughts in the countries of the Volta basin, within the framework of the Volta project and drought management (VFDM) entitled "Integration of flood and drought management and early warning systems in the Volta basin".

Objectives and scope of the national consultation

Understand the existing capacities and the work carried out (resources, IT, projects implemented, etc.) by the Volta Basin Authority

Methodology and tool

A half-day consultation meeting will be organized with VBA staff to identify their current work. The agenda for the meeting is presented below. The project consultation team is composed of 2 consultants from the CIMA Research Foundation and a representative of WMO (the leader of the VFDM project), the representative of WMO for West Africa and a consultant in operational hydrology.

The consultation team should perform the following tasks:

i. Collect information on the main areas affected by floods and drought, based on the available basin-wide datasets on vulnerability, exposure and risks in countries and combine with existing knowledge on hydrometeorological services available as well as on the effects of flooding on the population and socio-economic sectors;

ii. Examine the hydrological and meteorological (and other sectors) data management mechanism (collection, transmission, storage, monitoring and sharing) and the possible approach for integration with the open source cross-border early warning system platform.

iii. Examine the capacities and needs of current hydrological and meteorological forecasting, as well as warning (dissemination and communication), application of assessment tools to the National

Directorate and bodies mainly responsible for hydrology and meteorology operational and early warning communication (civil protection, disaster management, etc.);

iv. Collect information relating to the institutional framework, policies, legal mandates, infrastructure, tools and human resource capacities (skills acquired and training) for flood and drought management.

v. Review programs, projects or initiatives (completed, under implementation or in preparation) related to the flood and drought forecasting and warning system. Propose an approach for the links or complementarities of these initiatives with the future system, at cross-border level, Hydro-Météo VoltAlarm.

vi. Collect recommendations and action plans with different options from national agencies, for the design and implementation of a flood and drought forecasting and early warning system for the transboundary region of the river basin of the Volta taking into account relevance, efficiency, effectiveness, impact and sustainability, as well as any relationship to other available resources.

Before consultation meetings

The consultation team will review existing documentation, tools or products available in the country, as well as information on national services involved in flood and drought forecasting, warning and response. National bodies are encouraged to share with other consultation teams documents, fact sheets or web links providing information on their activities or area of work.

Expected results

The consultation team will prepare an VBA consultation report, summarizing the information gathered with the most important findings and comments. The VBA consultation report will also include recommendations or general considerations.

The report of the consultation meeting will be drafted and shared with the VBA before April 25, 2020 and a half-day workshop will be organized with the VBA to present the conclusions and recommendations for validation and ownership, most likely in June 2020.

Provisional agenda for the institutional assessment of the Volta Basin Authority (VBA)
October 11, 2019
Location: VBA offices, Ouagadougou

Hour	Activities	Presenter / Facilitator
9: 00-09: 30	Meeting with the VBA team and presentation of the participants	
9:30 am-11:00am	-Presentation of VBA -Context, flowchart -Projects or initiatives (past, current or future) -Available infrastructure (equipment or software) -Website and awareness	
11h00-12h30	Visit of the premises of the VBA and meeting with the teams of the units _	
12:30 p.m. to 2:00 p.m.	**Lunch**	
2:00 p.m. to 3:00 p.m.	Discussion with the general management of the VBA	
3:00 p.m. - 5:00 p.m.	• Budget plan for VBA and GWP-WA activities, • VFDM Website, • Communication plan • AoB	
5:00 p.m.	Conclusion of the meeting	

Annex 2: Overview of HYCOS stations in the Volta basin (number by country, characteristics, state)

Country	PCD with meteosat transmission	PCD without remote transmission	Water level gauges + reader equipped with a radio	Water level gauges + reader + GSM	Water level gauges + reader	Total number of stations	Operating state
Benign	1	1	0	0	1	**3**	**1 non-functional station; 2 stations in unknown conditions**
Burkina Faso	6	14	2	0	2	**24**	**5 functional stations; 7 non-functional stations; 12 stations in unknown conditions**
Ivory Coast	1	2	0	0	0	**3**	**2 non-functional stations; 1 station in unknown conditions**

Ghana	9	4	0	1	2	**16**	**2 functional stations; 7 non-functional stations; 7 stations in an unknown conditions**
Mali	1	0	1	0	1	**3**	**1 functional station; 2 non-functional stations**
Togo	2	4	0	0	5	**11**	**8 functional stations; 3 non-functional stations**
Total	20	25	3	1	11	**60**	**16 functional stations; 22 non-functional stations; 22 stations in unknown conditions**