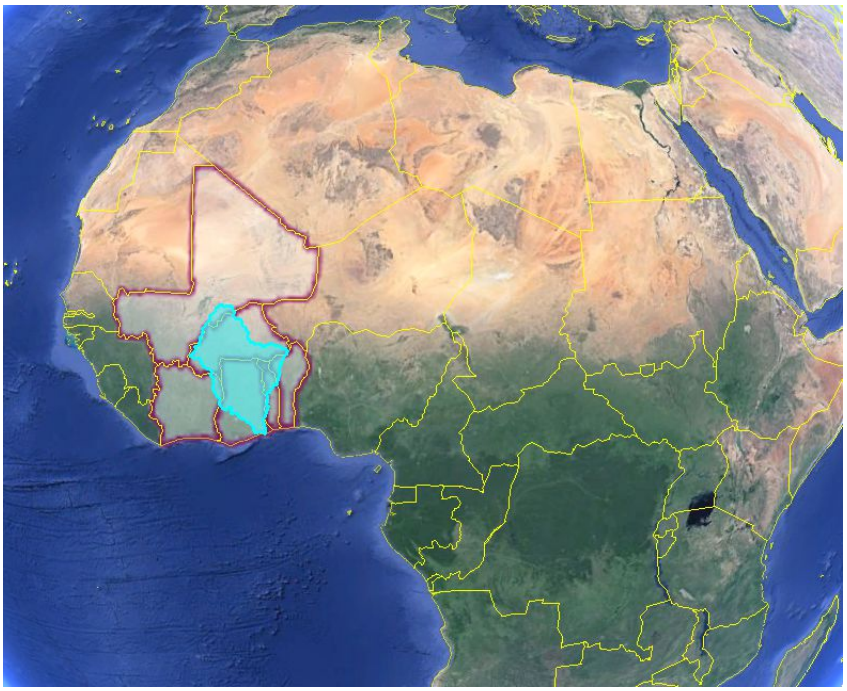
WORLD METEOROLOGICAL ORGANIZATION

Global Water Partnership West Africa

Country Needs Assessment REPORT - Ghana

Project Preparation for the Implementation of Integrated Flood Management with a focus on Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali, Togo and the Volta River Basin



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This report was prepared and valided in 2016 by key institutional actors and other stakeholders in charge of the coordination and involved in the management of floods in Ghana, under the initiative « **Project Preparation for the Implementation of Integrated Flood Management – IFM-** » **on the Volta River Basin with its riparian countries** (Benin, Burkina Faso, Ivory Coast, Ghana, Mali and Togo).

The initiative contributes to the implementation of the Volta Basin Strategic Action Program (SAP) by the Volta Basin Authority (VBA), with the support from the Associated Program on Flood Management (APFM) of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP), the Water Climate and Development Program (WACDEP Africa) of African Ministers' Council on Water/ African Union (AMCOW/AU) implemented by the GWP.

Imitative « Project Preparation for the Implementation of Integrated Flood Management – IFM- » on the Volta River Basin with its riparian countries (Benin, Burkina Faso, Ivory Coast, Ghana, Mali and Togo).

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List of Acronyms

APFM	Associated Programme on Flood Management
AAP	Africa Adaptation Programme
AOC-HYCOS	Système d'Observation du Cycle Hydrologique de l'Afrique de l'Ouest et Centrale
BRRI	Building and Road Research Institute
CBA	Cost-Benefit Analyses
CCA	Climate Change Adaptation
CECAR-Africa	Climate and Ecosystem Changes in Semi-Arid Africa
CPC	Cocoa Processing Company
CREW	Community Resilience through Early Warning
CSR	Corporate Social Responsibility
CWP-Ghana	Ghana Country Water Partnership
CWSA	Community Water and Sanitation Agency
DHI	Danish Hydraulic Institute
DRR	Disaster Risk Reduction
DSS	Decision Support System
DVGs	Disaster Volunteer Groups
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EU	European Union
EWS	Early Warning Systems
FEWS	Flood Early Warning System
FC	Forestry Commission
GCWP	Ghana Country Water Partnership
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GIDA	Ghana Irrigation Development Authority
GMet	Ghana Meteorological Agency
GPRS	Ghana Poverty Reduction Strategy
GSGDA	Ghana Shared Growth and Development Agenda
GWCL	Ghana Water Company Limited
GWP	Global Water Partnership
HNI	Human Network International
HSD	Hydrological Services Department
IFM	Integrated Flood Management
ISDR	International Strategy for Disaster Risk Reduction
IUCN	International Union for the Conservation of Nature
IWA	International Water Association
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
LC	Lands Commission
LI	Legal Instrument
MC	Minerals commission
MCA	Multi-Criteria Analyses

MDAs	Ministries Departments and Agencies
MESTI	Ministry of Environment, Science, Technology and Innovation
MMDAs	Metropolitan, Municipal and District Assemblies
MWRWH	Ministry of Water Resources Works and Housing
NADMO	National Disaster Management Organisation
NCCAS	National Climate Change Adaptation Strategy
NDPC	National Development Planning Commission
NEP	National Environmental Policy
NGO	Non-Governmental Organisation
NHSs	National Hydrological Services
RCC	Regional Coordination Council
SEA	Strategic Environmental Assessment
TAHMO	Trans-African Hydro-Meteorological Observatory
TOR	Terms of Reference
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme UNEP
UNISDR	United Nations International Strategy for Disaster Risk Reduction
VBA	Volta Basin Authority
VRA	Volta River Authority
WACDEP	Water, Climate and Development Programme
WASH	Water Sanitation and Hygiene
WB	World Bank
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organisation
WRC	Water Resources Commission

Executive Summary

The Ghana Country Water Partnership (CWP-Ghana) of the Global Water Partnership together with other Volta basin Country Partnerships received support on flood management from the WMO/GWP Associated Programme on Flood Management (APFM) this year, 2016. Following the request from the countries, the WMO/GWP Associated Programme on Flood Management (APFM), in partnership with GWP West Africa and the GWP WACDEP Africa Coordination Unit developed an initiative on Project Preparation for the Implementation of Integrated Flood Management (IFM) in the Volta Basin riparian countries with the main aim to develop capacities of national institutions and stakeholders to apply the concepts of Integrated Flood Management (IFM) and to prepare bankable projects on IFM. In view of this, a needs assessment was carried out from April till August 2016 to identify the existing efforts and gaps in integrated flood management in Ghana so as to develop the capacity of key institutions in applying IFM concepts and further develop projects on IFM in the Volta basin which could attract funding.

Information was gathered through desk studies of materials on IFM, Integrated Water Resources Management (IWRM) in general, government policy/laws and traditional protocols on water use within flood-prone areas in the Volta basin by the CWP-Ghana and other key stakeholders. The review of the document was complimented with consultations with the stakeholders through structured and unstructured interviews on the use of floodplains, water sources, water storage and use, water quality, landuse, siting of Water Sanitation and Hygiene (WASH) facilities, and the state of hydro-meteorological equipment for water and weather monitoring. Access to key infrastructure, topography landmarks, geological formations and WASH facilities from reports and satellite imagery by the stakeholders in areas known to be flood-prone especially in the White Volta basin was investigated.

The impacts of floods on livelihoods are enormous. Floods per se, are not bad but when not well managed result in devastating consequences with the loss of lives and livelihoods. In the Volta basin, the worst floods were recorded on 6 September 2009 in the White Volta basin after a rise in water level as a result of heavy rainfall forced water from the Bagre dam to be spilled prompting a reaction from the Ghana Military and National Disaster Management Organisation (NADMO) in Northern Ghana. Prior to this flood event, there had been experiences of some flooding in the White Volta basin in September 2007 and 2008. In the 2007 event the three Regions of Northern Ghana (Upper West, Upper East and Northern Regions) were impacted by the floods resulting in over 300,000 people being affected. On September 10, 2010 due to prolong flooding as a result of the heavy rainfall and the spilling of the Bagre dam*, 17 people lost their lives, 3,234 houses from 55 communities collapsed, 23,588 farmers had their farmlands destroyed, 1,109 ruminants were carried away, and 25,112 people displaced in the Central Gonja District of Northern Ghana". The event in 2010 prompted the Government of Ghana to plan towards securing a US$500 Million loan facility* to construct the Pwalugu dam in the White Volta Basin to attenuate the peak flows resulting from the spillage of water from the Bagre dam. These events also led to the development of the Flood Early Warning System (FEWS-Volta) by the Water Resources Commission (WRC) in 2012 for the White Volta Basin which will be extended to the Oti Sub-basin this year, 2016. In June 2015, although not directly as a result of floods in the Volta basin, scores of Ghanaians (almost 100 people) lost their lives in Accra after a two-day heavy down pour in the capital city of Ghana coupled with an explosion at a Goil fuel station located at Kwame Nkrumah Circle in Accra.

Strangely enough, prior to the 2007 floods, the country and the Volta basin in general had experienced drought that resulted in the Akosombo dam nearly being shut-down because it could not produce half of the 6GWh a day of the electrical energy needed. These two extreme scenarios lay emphasis for the need for an Integrated Flood Management approach to be implemented in the Volta basin and Ghana, in particular.

The conclusions from the needs assessment are as follows:

i. Flood management is a key challenge in Ghana. The country experiences mostly riverine and urban floods which are caused by anthropogenic activities which could be curtailed with the enforcement of laws and regulations;
ii. Key stakeholders in the basin already have some capacity with regards to flood management which would help reduce the amount of time and resources needed to further develop their capacities on the concept of Integrated Flood Management through tailored trainings or workshops;
iii. WRC basin offices exist in all the major sub-basins of the Volta. These together with the NADMO National, 10 Regional, 243 offices in the 216 Districts and 900 Zonal Platforms could be used to promote IFM in Ghana. There is therefore a framework which could be built on;

iv. Hydrological models for flood hazard mapping exist at the WRC, NADMO, HSD and GMet and can be further developed into a national decision support system (DSS) maintained by these institutions with clearly defined roles and responsibilities for IFM;
v. Flood models highly rely on satellite data and hydro-meteorological data for localised and accurate model output. It also needs very good database management. The current state of hydro-meteorological infrastructure in Ghana needs to be improved. There is some support from the Norwegian government, World Bank, WMO, UNDP, JICA and TAHMO to support these agencies upgrade their facilities to state-of-the –art in Africa or the world. However, support from the Ghanaian government is essential. South Africa and Kenya could be used as good examples for Ghana;
vi. Communities along the banks of the Volta river (especially in the White Volta) are quite vulnerable to flood risk especially areas with less economic development within the Volta basin. There is therefore good relationship between the level of socio-economic development and vulnerability to flood;
vii. Structural measures help to reduce the incidences of floods but these needs to be combined with non-structural measures in an integrated way so as to not only reduce the impact of floods but fully exploit the economic benefits in a more sustainable way;
viii. Over-dependence on external (donor) support for flood management could be catastrophic to IFM in Ghana.

The following opportunities and recommendations are therefore drawn from the study:

i. There is opportunity to implement IFM at the national and transboundary levels through the Water Resources Commission of Ghana and NADMO with the support of other national agencies such as the National Development Planning Commission (NDPC) and key stakeholders in the Land, Forest, Water, Agriculture, Fisheries, Mining, Energy and Housing Sectors. The use of the River basin offices with the IWRM mechanisms in place in the Volta basin as well as the regional, districts and zonal NADMO platforms used for disaster management offers an enormous opportunity to implement national and basin IFM;

ii. The White Volta Basin Transboundary Committee on Integrated Water Resources (including Burkina Faso, Ghana and Togo) could also be used as a platform to promote IFM at the transboundary level;

iii. WRC and NADMO have developed hydrological models which could be used as basis for the development of a Decision Support System (DSS) on IFM for Ghana;

iv. Key institutions like WRC, NADMO, GMet, HSD and EPA have some capacity to implement IFM, however there is the need for these capacities to be developed further through tailored trainings;

v. Keys stakeholders need their capacities developed to enable them write bankable proposals to get funding from the Ghana government and development partners for the development and implementation of a national and basin IFM plans;

vi. There is the need for synergy and coordination between the Volta Basin Authority, regional, national, and basin institutions to enhance IFM;

vii. There are some structural and non-structural interventions in the Volta Basin of Ghana to support IFM. The non-structural measures need to be enforced or fully implemented whereas the structural ones well operated, so the project might not need to invest in huge infrastructural projects which might make it unfeasible to implement.

viii. IFM has not been integrated into development planning and decision-making processes yet. There is therefore a huge opportunity to do this through the mainstreaming of water security and climate resilient development which have been mainstreamed into the Medium- and Long-Term Development Plans with the support of the WACDEP project;

ix. There are a lot of vulnerable communities in the Volta basin of Ghana especially in the White Volta basin who need support to deal with the impacts of floods. This project could give them a nice opportunity to solve their problems and enhance their socio-economic development. There would therefore be a lot of stakeholder acceptance and approval for the project. Again, there would be some pilot communities which are hotspots to start with;

x. There is an urgent need to develop the capacities of key stakeholders on the concept of IFM and the development of bankable proposals on IFM at the national, regional and district levels. An effective way to go about this is to start from the national level with a training of trainers for the regions to train the people in their districts with some technical backstopping from WACDEP;

xi. Key institutions in the country including WRC, GMet, HSD, NADMO and EPA needs their capacities developed on database management so as to enable the easy sharing of data and information across these institutions;

xii. The capacity of the stakeholders need to be developed to maintain (and update) the hydrological models developed for them by HKV Consultants and Royal HaskoningDHV;

xiii. There is some support from the Norwegian government, World Bank, WMO, UNDP, JICA and TAHMO to support flood related activities in Ghana. It therefore should not be difficult to approach these agencies through the respective local/regional offices for support on the development of an integrated flood management plan and its implementation in some pilot basins in the country. There is already some support from the WMO to carry out this study and some workshops; and

xiv. Funds could be sourced by writing bankable proposals to respond to calls on grants on flood management or climate change in general. The Green Climate fund that supports investments in low-emission and climate-resilient development could also be a possible source of funding for the development of national/basin IFM plans.

0. Background

0.1. Introduction

The Ghana Country Water Partnership of the Global Water Partnership together with other Volta basin Country Partnerships has received support on flood management from the WMO/GWP Associated Programme on Flood Management (APFM) this year, 2016. Following the request from the countries, the WMO/GWP Associated Programme on Flood Management (APFM), in partnership with GWP West Africa and the GWP WACDEP Africa Coordination Unit developed an initiative on Project Preparation for the Implementation of Integrated Flood Management (IFM) in the Volta Basin riparian countries with the main aim to develop capacities of national institutions and stakeholders to apply the concepts of Integrated Flood Management (IFM) and to prepare bankable projects on IFM. In view of this, a needs assessment was carried out from April till August 2016 to identify the existing efforts and gaps in integrated flood management in Ghana so as to develop the capacity of key institutions in applying IFM concepts and further develop projects on IFM in the Volta basin which could attract funding.

The expected outcomes of the project include the following:

1. An understanding of the IFM concept by key institutions and actors in flood management in Ghana and the Volta river basin;
2. A Decision Support System (DSS) and manual for IFM targeted at decision-makers at regional, country and district levels developed;
3. Workshops organized, participants and stakeholders granted access to tools to develop bankable proposals;
4. Capacities of decision makers developed and equipped to develop and implement IFM action plans, policies and bankable project proposals to leverage investments and financial resources; and
5. Interventions/projects on integrated flood management planned and owned by the competent authorities, attract funding and are being implemented in various sub-basins of the Volta river system.

The expected impacts from the Terms of Reference and background document of the project include:

1. Increased synergy and coordination between national, the Volta Basin Authority and regional basin institutions leading and involved in the management of flood issues;
2. Integrated Flood Management mainstreamed or enhanced in development planning and decision-making processes in Ghana and in the Volta basin;
3. National, transboundary and regional institutions and stakeholders with enhanced capacity to integrate flood management into development planning and decision-making processes in Ghana and in the Volta basin;
4. Investments and financial resources leveraged to support integrated flood management in Ghana and in the Volta basin;
5. Community resilience to flood risks enhanced at local level in Ghana and in the Volta basin; and

6. Social and economic damages related to flood risks (such as loss of life, population displacement, loss of livelihood, water use conflicts, health problems, etc.) and flood-related deaths significantly reduced in Ghana and in the Volta basin.

This report covers the needs assessment carried out.

0.2. Methodology

Information was gathered through desk studies of materials and document presented to the consultant on IFM, IWRM in general, government policy/laws and traditional protocols on water use within flood-prone areas in the Volta basin by the Ghana Country Water Partnership of the Global Water Partnership (GCWP-GWP) and other key stakeholders. The review of the document was complimented with consultations with the stakeholders through structured and unstructured interviews on the use of floodplains, water sources, water storage and use, water quality, landuse and siting of WASH facilities. Access to key infrastructure, topography landmarks, geological formations and WASH facilities from reports and satellite imagery by the stakeholders in areas known to be flood-prone especially in the White Volta basin was investigated. The needs assessment was validated by stakeholders through a workshop held in Accra.

0.3. Country Context

Flood and drought management in Ghana has received recent attention by the Water Resources Commission of Ghana, the Hydrological Services Department (HSD), the Ghana Meteorological Agency (GMet), the National Disaster Management Organisation (NADMO) and the Environmental Protection Agency (EPA). These national institutions have received some support from the World Bank as well as the United Nations Development Programme (UNDP) and quite recently from the World Meteorological Organisation (WMO) through the Global Water Partnership to develop projects and carry out activities to support the Ghanaian populace against these climate shocks. The concept of Integrated Flood Management is gaining prominence in integrated water resources management discussions in Ghana especially with the concept of flood recession agriculture being promoted by the International Water Management Institute (IWMI) and water storage and reuse by the Ghana Irrigation Development Authority (GIDA). However, there is no IFM plan for Ghana at the moment. There have been several projects on flood management or drought management in the country. Some of these include the Flood and Drought Management Tools Project which started from 2014 and will end in 2018, supported by The Global Environment Facility (GEF), the Flood Early Warning system (FEWS) supported by the World bank and hosted by the Water Resources Commission, and the Norwegian Government sponsored and UNDP supervised project on Community Resilience through Early Warning (CREW) hosted by NADMO.

0.4. Basin Profile

The Volta basin covers 6 countries: Benin, Burkina Faso, Cote d'Ivoire, Ghana, Togo and Mali. Ghana and Burkina Faso cover most (85% of the ≈400,000km^2) of the basin in terms of surface area (See Table 1). The area covered by the two countries as well as their upstream-downstream relations make projects limited by resources concentrate on only these two countries for some basin-wide interventions. The map of the Volta basin (Figure 1) shows the main rivers and tributaries such as the White Volta river, Red Volta river, Black Volta river, and the Oti River all ending up in the Volta lake- one of the largest man-made lakes in the world.

Table 1: Proportion of riparian countries in the Volta Basin[1]

Country	Surface Area (km²)	Area of the basin within country (km²)	% of basin within country	Land area of country within basin (%)
Benin	117086	15133	3.78	12.92
Burkina Faso	272531	170070	42.50	62.40
Ghana	239144	164897	41.21	68.95
Ivory Coast	321955	13247	3.31	4.11
Mali	1256410	10660	2.66	0.85
Togo	57356	26144	6.53	45.58

[1] Source: IUCN-VBA (2012). Update of the Water Audit of the Volta Basin.

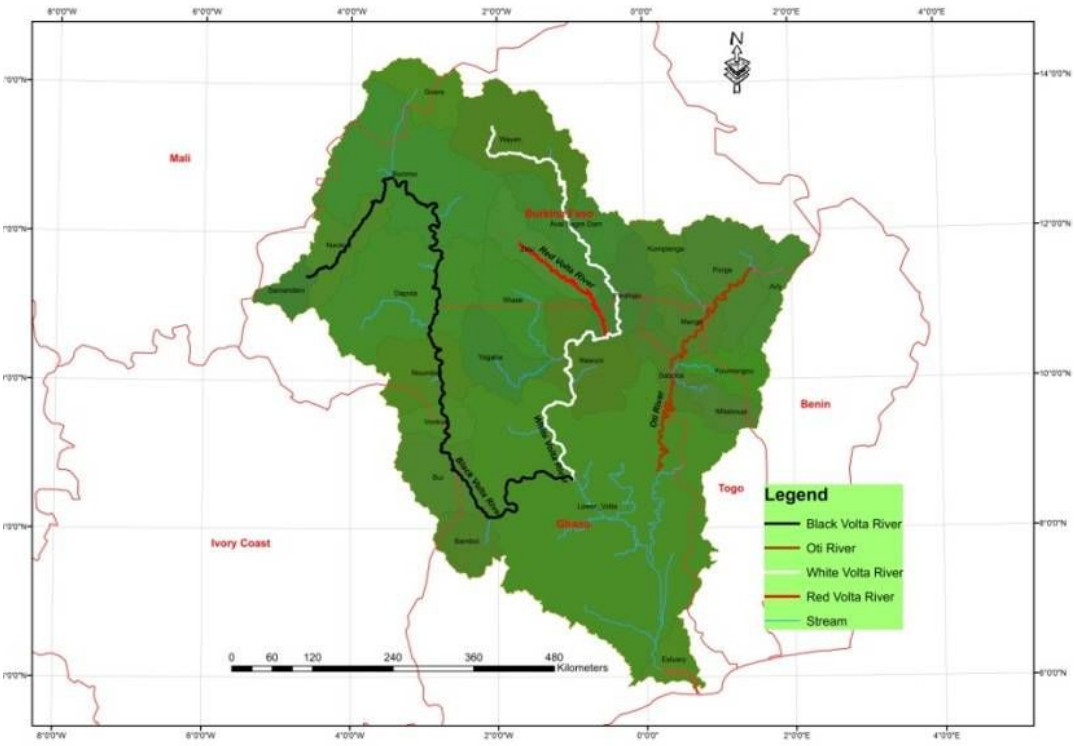

Figure 1: Volta River System Network (Source: IUCN-VBA, 2012)

The population in the Volta basin is over 25 Million people and is expected to increase to about 34 Million by 2025[2]. The river systems in the basin have been modified slightly through infrastructure development to ensure that the water and food needs of the inhabitants are met. While these are for very good causes, they have also led to environmental challenges with regards to water quality degradation, water shortages, drought and floods downstream of most of these infrastructures especially the Bagre dam in Burkina Faso and the Akosombo and Kpong dams in Ghana. The basin as at now continues to attract investments in water infrastructure to support the needs of a growing population[3].

[2] Study on the Pre-investment Programme in the Volta Basin, draft report 2009.

[3] Source: IUCN-VBA (2012). Update of the Water Audit of the Volta Basin.

1. Chapter 1: Previous Impacts of Flooding

1.1. Impacts on lives and livelihoods in the Volta basin

The impacts of floods on livelihoods are enormous. Floods per se, are not bad but when not well managed results in devastating consequences with the loss of lives and property. In the Volta basin, the worst floods were recorded on 6 September 2009 in the White Volta basin after a rise in water level as a result of heavy rainfall forcing water from the Bagre dam to be spilled prompting a reaction from the Ghana Military and NADMO in Northern Ghana[4]. Prior to this flood event, some flooding in the basin had been experienced in the White Volta in September 2007 and 2008[5]. In the 2007 event the three Regions of Northern Ghana (Upper West, Upper East and Northern Regions) were impacted by the floods resulting in over 300,000 people being affected[6]. On September 10, 2010 due to prolong flooding as a result of the heavy rainfall and the spilling of the Bagre dam, *17 people lost their lives, 3,234 houses from 55 communities collapsed, 23,588 farmers had their farmlands destroyed, 1109 ruminants were carried away, and 25,112 people displaced in the Central Gonja District of the Northern Ghana"*[7]. The event in 2010 prompted the Government of Ghana to plan for the US$500 Million loan to construct the Pwalugu dam in the White Volta Basin to attenuate the peak flows resulting from the spillage of water from the Bagre dam[7]. These events also lead to the development of the Flood Early Warning System (FEWS-Volta) by the Water Resources Commission (WRC) in 2012 for the White Volta Basin which would be extended to the Oti Sub-basin this year. In June 2015, although not directly as a result of floods in the Volta basin, scores of Ghanaians (almost 100 people) lost their lives in Accra after a two-day heavy down pour in the capital city of Ghana coupled with an explosion at a Goil fuel station located at Kwame Nkrumah Circle in Accra.

Strangely enough, prior to the 2007 floods, the country and the Volta basin had experienced drought resulting in the Akosombo dam nearly being shut-down because it could not even produce half of the 6GWh a day of the electrical energy needed. These two extreme scenarios lay emphasis for the need for an Integrated Flood Management approach to be implemented in the Volta basin and Ghana in particular.

[4] Amoah, M. (2011). Nationalism, Globalisation and Africa. Palgrave Macmillan, Macmillan Publishers Limited, England. DOI 10.1057/9781137002167. ISBN 978-1-137-00216-7

[5] GWP (2014). Final Report on the Assessment of the Current State of Water Management and Climate Change in the Volta Basin as part of the Establishment of an Observatory for Water Resources and related ecosystems.

[6] Asumadu-Sarkodie, S., Owusu, P. A., and Rufangura, P. (2015). Impact analysis of flood in Accra, Ghana. Advances in Applied Science Research, 2015, 6(9):53-78.

[7] Amoah, M. (2011). Nationalism, Globalisation and Africa. Palgrave Macmillan, Macmillan Publishers Limited, England. DOI 10.1057/9781137002167. ISBN 978-1-137-00216-7

1.2. Socio-economic impacts in Ghana

The Associated Program on Flood Management highlighted in 2013 some impacts due to floods[8]. These included the following in the Volta basin;

i. **Loss of lives and property**: In the basin, many lives and property have been destroyed as a result of the 2007, 2008 and 2010 floods. Farmlands close to river channels especially in the White Volta basin were destroyed, livestock were washed away, and several WASH infrastructures destroyed leading to the outbreak of waterborne diseases;

ii. **Loss of livelihoods**: The road and power infrastructure in the 3 Northern regions of Ghana are already in deplorable states especially the feeder roads connecting the villages and small towns. Hence during floods, communities are cut-off and economic activities come to a halt resulting in various economic and social hardships long after the floods. One of such communities which are often cut-off in the West Mamprusi District due to floods has been nicknamed "overseas". This community is sometimes cut-off from the rest of the country for several weeks after flood events. Compounding this issue of poor road infrastructure was weak communication linkages. However, there has been much improvement in communication in recent times due to the fierce market competition between telecommunication companies in Ghana;

iii. **Decreased economic and social activities**: The three poorest regions in Ghana are the Upper West, Upper East and the Northern Region. These regions especially the parts within the White Volta basin also suffer most in terms of the impacts of floods and drought. During floods, drinking water sources are contaminated due to the open defecation largely practiced in these regions (the Upper East ranks the highest in Ghana on open defecation). Ghana in 2015, was ranked 2nd in Africa after Sudan as the country with the largest percentage of people practicing open defecation (19% of the populace)[9]. The populace in times of floods are sometimes cut-off from their farms as well as electricity, education and health facilities resulting in decreasing economic growth due to low productivity in these areas;

iv. **Mass migration**: Areas prone to floods often see very little investments that could lead to socio-economic development. Due to the low rate of economic development in these regions within the Volta basin which experiences frequent flooding which leads to loss of lives and livelihoods, as well as prolonged socio-economic impacts, high numbers of people migrate to cities in Ghana such as Accra, Kumasi and Takoradi for non-existent jobs. These migrants are sometimes lured into social vices which affects them and the country negatively because most of them end up settling in slumps (especially waterways) which leads to further flooding in the cities they migrate to;

v. **Psychosocial effects**: The trauma people go through after floods as a result of loss of property, livelihoods or lives imposes a lot of stress on the surviving families of the victims. Some people hardly recover from such stresses leading to deep depression with its concomitant effects;

[8] http://www.apfm.info/?p=2459

[9] http://citifmonline.com/2015/11/18/ghana-ranked-2nd-in-open-defecation/

vi. **Hindrance to economic growth and development**: The government during relief exercises spends a lot of money to recover from the shocks caused by floods. These monies could have been used for projects to enhance economic developments. Again, areas very prone to floods are not considered attractive locations for huge or long-term investments by the private sector and sometimes government. The lack of investment coupled with low man-power as a result of migration might further lead to economic downturn;

vii. **Political implications**: Tackling of flood issues and handling of flood victims has a strong political connotation. The rescue and relief operations sometimes lead to political outcry of some communities being left out as a result of their political affiliations which could result in social-inequity and political unrest[10].

1.3. Effects on key sectors

Floods affect many sectors of the economy. Key among these sectors include transportation, agriculture, hydropower, and domestic water supply.

Transportation: the disruptions caused by floods to the transport sector especially in rural areas in the Volta basin and cities in Ghana are the greatest due to the fact that most of these roads are feeder roads in poor conditions. This makes it very difficult for people to move freely from one community to the other.

Agriculture: this sector is by far the most affected in terms of economic losses from the perspective of flood victims in the basin. The situation is aggravated in the White Volta basin by the fact that most farms are too close to and even some in the floodplains. Although the WRC has the buffer zone policy this needs to be enforced. On the other hand, floodwaters could be stored and made good use of in the dry season. This is therefore could be seen as a positive impact.

Hydropower: the operation of dams upstream during heavy down-pour and peak flows affect hydropower production plants and communities downstream. Higher flows do not necessary result in optimal power generation if not well managed. If the water storage is not well managed, it results in spillage leading to devastating effects downstream and losses in the potential to generate hydropower. The impacts of floods on hydropower production is often very positive as it helps increase inflows and thereby storage.

Domestic Water Supply: water supply is enhanced with floods as water sources are replenished. The only problem is normally with the water quality which sometimes gets worse as a result of the washing of pollutants upstream into water bodies (sources) downstream.

1.4. Quality of life or changes in life style-poverty

The aftermaths of floods are often worrisome especially when the impacts are negative with the loss of lives, property, crops and livestock. As explained in earlier sections, the trauma people go through affects their lives as well as their livelihoods. Some people are unable to recover from such shocks leading to abrupt poverty and some even migrate to cities and larger towns for greener pastures.

[10] http://www.apfm.info/?p=2459

1.5. Mapping of areas most at risk of flooding

In 2012, the WRC with the support of the World Bank started the FEWS-Volta project that sought to map flood prone areas in the White Volta basin and issue advance notice of imminent floods through an early warning system (See Figure 2). In 2015, these flood hazard maps were validated with the support of key stakeholders in 29 District workshops in the White Volta basin[11].

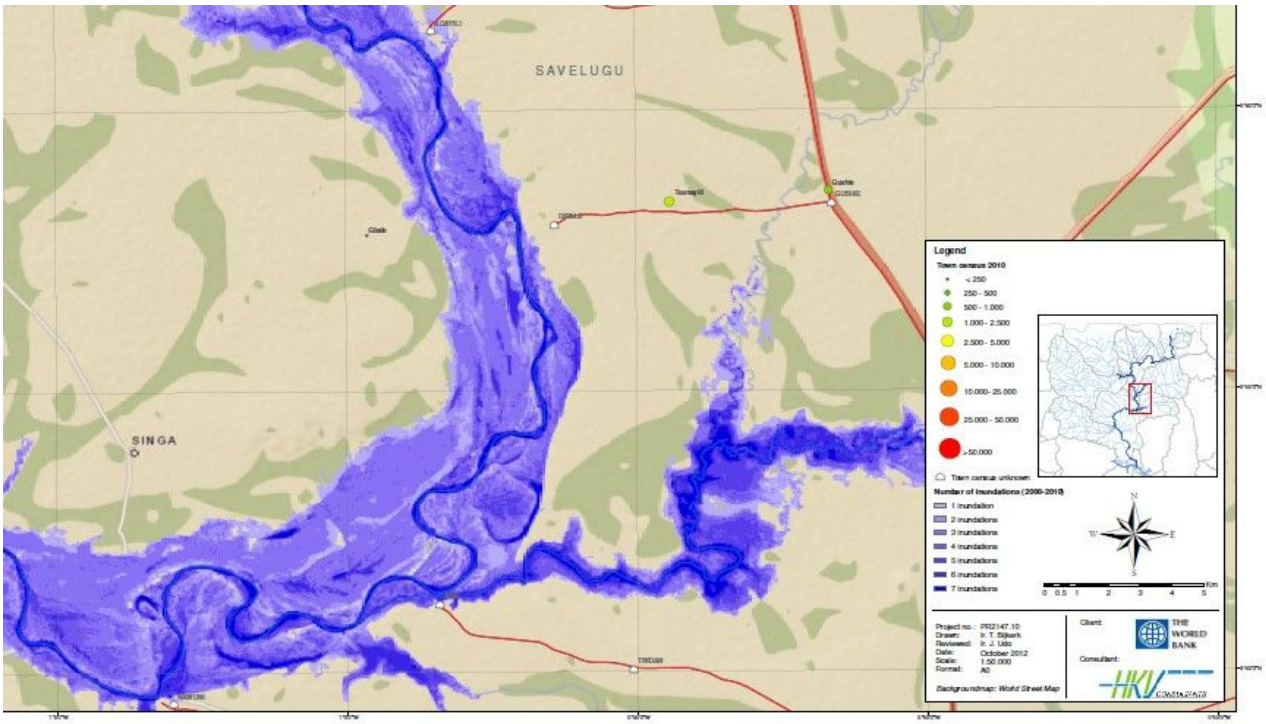

Figure 2: Flood Hazard Map for the White Volta with inundation frequency for the last 10 years[12]

(Source: HKV Consultants)

During the same period (2013-2016), the UNDP together with the Norwegian government supported NADMO (host of the project) and its partners (the WRC, GMet, and HSD) to implement the Community Resilience through Early Warning (CREW) project. The project mapped the hotspots for floods in 1 pilot District in each of the 10 regions of Ghana[13]. An example of the hotspot mapping is shown in Figure 3.

[11] https://www.gfdrr.org

[12] http://portal.gdacs.org/Expert-working-groups/Global-Flood-Working-Group/2013-Workshop/Presentations/ItemID/261/ModID/880

[13] https://crewghana.files.wordpress.com/2016/01/risks-profile-of-hotspot.pdf

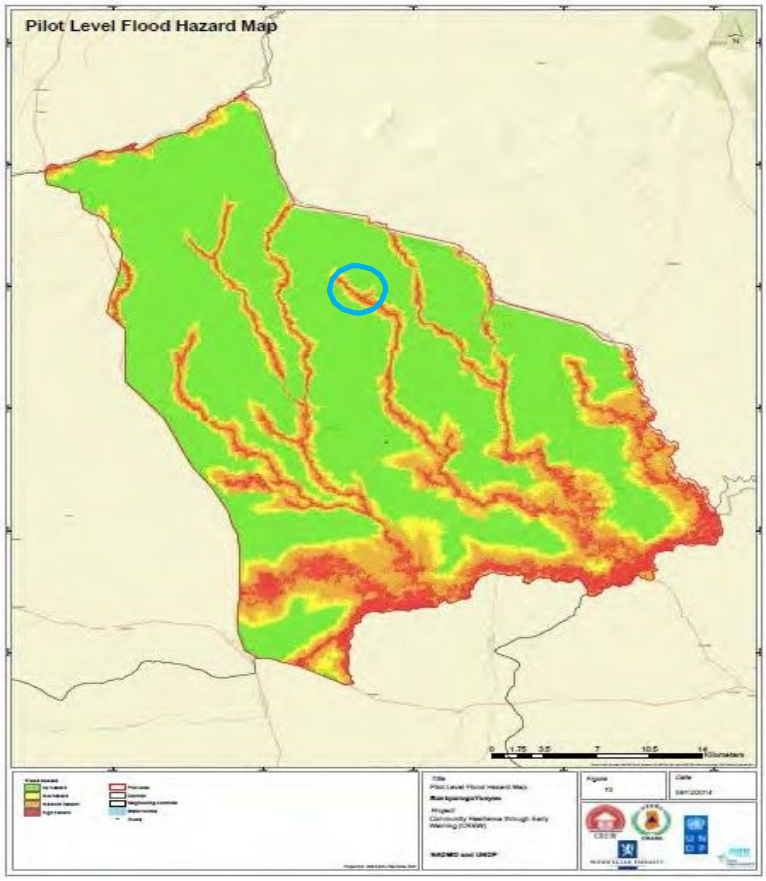

Figure 3: Flood Hazard map for Bungpurugu-Yunyoo[14] (Source: Royal HaskoningDHV)

Nyarko *et al.* (2015) mapped floodplain wetlands in the White Volta basin of Ghana. They used a logistic regression model in a GIS environment to map almost 260 km^2 of landmass estimated as probable floodplain wetland sites within the White Volta basin.

1.6. Quantified benefits of flood plains

Floodplains have social, ecological and economic benefits. The floodplains have soils enriched with nutrients to support flood recession agriculture which is an economic benefit if the agriculture activity is well managed. Floodplains often contain wetlands that help that serve as storage for excess water in the river system, improve water quality, serve as recharge points for groundwater and also serve as habitats for flora and fauna. Floodplains do not work in insolation but as an integral part of the watershed system including the surface water (river), groundwater, flora and fauna to sustain the environmental, social and economic functions of the entire river basin. Floodplains are therefore dynamic natural systems[15] and serve their purpose if not encroached on.

[14] https://crewghana.files.wordpress.com/2016/01/risks-profile-of-hotspot.pdf
[15] http://snohomishcountywa.gov/

2. Chapter 2: Institutional Environment

2.1. Main national actors and institutions

There are several state institutions and private companies in Ghana dealing with floods in Ghana spanning from the local level to the national level. The key national institutions including those directly involved in flood management with their mandates are given in Table 2.

Table 2: key national institutions directly involved in flood management

Institution	Mandate with respect to floods management
Water Resources Commission of Ghana (WRC)	Develop policies for the protection of water bodies in Ghana. Regulate water use and activities along water bodies especially the use of floodplains for Agriculture and mining.
Hydrological Services Department (HSD)	Responsible for programming and coordinating coastal protection works, construction and maintenance of storm drains and the monitoring and evaluation of surface water bodies in respect of floods[16].
Ghana Meteorological Agency (GMet)	Collection and provision of localised, accurate and reliable meteorological data or information that could be used for flood and drought forecasting.
Ghana Irrigation Development Authority (GIDA)	Responsible for the formulation and execution of policies and plans to promote the sustainable development of land and water resources in Ghana for crop production, livestock watering, aquaculture, agricultural related industries and institutions while ensuring plans for all year-round agriculture production in Ghana[17]. Hence IFM is an integral part of their core activities.
National Disaster Management Organisation (NADMO)	Responsible for the management of flood disasters and emergencies. They are mostly involved in rescue and recovery operations.
Environmental Protection Agency (EPA)	Responsible for the implementation of environmental policies ensuring that the environment is protected through sustainable exploitation of

[16] http://www.mwrwh.gov.gh/index.php/dept-agencies/34-dept-agencies/75-hydrological-services-department-hsd

[17] http://mofa.gov.gh/site/?page_id=2976

Institution	Mandate with respect to floods management
	natural resources.
Ghana Water Company Limited	Responsible for the planning and development of water supply systems in urban communities in the country[18]
Community Water and Sanitation Agency	Responsible for the planning and development of water supply and sanitation systems in rural communities in the country[19]
National Development Planning Commission (NDPC)	Responsible for advising the President on development planning policies and strategies including the protection of the natural and physical environment[20] which is directly related to floods.
Metropolitan, Municipal and District Assemblies (MMDAs)	Support with the implementation of flood management plans in their districts and to help coordinate flood rescue operations with NADMO and other state institutions.
Ministry of Water Resources Works and Housing (MWRWH)	Responsible for initiating, formulating, implementing and co-ordinating of policies and efficient implementation of programmes on Works, Housing, Water Supply and Sanitation, Hydrology and Flood Control Systems in the country [21].

2.2. Overview of financial partners/donors in flood management in the country/transboundary basin and their interventions

There have been several projects on flood management in the country. Some of these include the Flood and Drought Management Tools Project which started from 2014 and will end in 2018, supported by The Global Environment Facility (GEF). This project is being implemented by the United Nations Environment Programme (UNEP) with the aim to improve the ability of Water Managers, Planners and land surveyors/managers operating in transboundary river basins with tools to help them implement their Integrated Water Resources Management Plans and Water Safety Plans. The executing agencies are the Danish Hydraulic Institute (DHI) and the International Water Association (IWA).

[18] http://www.gwcl.com.gh/pgs/services.php

[19] http://www.mwrwh.gov.gh/index.php/dept-agencies/34-dept-agencies/71-community-water-and-sanitation-agency-cwsa

[20] https://www.ndpc.gov.gh/about/

[21] http://www.mwrwh.gov.gh/

In 2012, the World Bank through the Global Facility for Disaster Reduction and Recovery (GFDRR) Fund of US$ 1.3 Million approved a project to strengthen the institutional capacity of the agencies responsible for flood and disaster risk management in support of Ghana's efforts to achieve the Hyogo Framework for Action for disaster reduction[22]. The project looked at two specific areas: i) strengthening flood forecasting in the White Volta Basin; and ii) strengthening institutional capacities for disaster preparedness. It was hosted by the Water Resources Commission of Ghana (WRC) with the Hydrological Services Department, the Ghana Meteorological Agency, and the National Disaster Management Organisation. The scope of the project was the entire country for the advocacy and capacity building component while the modelling and early warning system was set up for the White Volta Basin only. The project was carried out by the HKV consultants based in the Netherlands and completed in 2014. The Early Warning System is being extended to the Oti sub-basin within the Volta basin by the World Bank this year. It will still be hosted by the Water Resources Commission of Ghana.

As stated in the previous section, the CREW project (about US$5.16 Million) was sponsored by the Norwegian Government and implemented by the UNDP through NADMO. The project started in 2013 and ended in 2016. It was a follow up of the Africa Adaptation Programme (AAP) in Ghana where flood and drought risk mapping was carried out for another 10 pilot districts in the country. One pilot district was selected from each of the 10 regions in Ghana. Within the pilot districts, hotspots or communities were identified for more in-depth flood and drought risk profiling as well as drawing up of possible mitigation measures proposed. In each of the districts, risk, hazard and vulnerability mapping was carried out as well as the setting up of an Early Warning System for the District just like was done for the FEWS-Volta. In most districts up to 3 hotspots/communities were mapped[23]. The project was supported by the Royal HaskoningDHV and HKV Consultants, all based in the Netherlands. Through the project, a national flood risk map was prepared (See Figure 4).

The Volta Basin Authority (VBA) has hosted two main projects related to floods in the basin. These were the Volta Basin Observatory and the Volta HYCOS projects. The Volta Basin Observatory was a 3-year €2.7 Million project which was commissioned in 2011 and had a contribution of €1.2 Million from the French Development Agency (AFD)[24]. The project had three (3) main components: (i) Baseline survey of the Environmental Situation in the 6 riparian states of the Volta basin; (ii) Establishment of a monitoring system for the Water Resources and associated environment in the basin and; (iii) Stakeholder engagement in water and Environmental management. The Volta-HYCOS started in the January 2006 supported by the World Meteorological Organisation (WMO) as part of the “Système d'Observation du Cycle Hydrologique de l'Afrique de l'Ouest et Centrale” (AOC-HYCOS) project which was the West and Central African component of the World Hydrological Cycle Observing System (WHYCOS) project[25].

22 http://documents.worldbank.org/curated/en/748421468031458107/pdf/870750ISDS0P1400Box385196B00PUBLIC0.pdf

23 https://crewghana.files.wordpress.com/2016/01/risks-profile-of-hotspot.pdf

24 https://www.devex.com/funding/pipelines/2656

25 http://whycos.org/whycos/sites/default/files/public/pdf/projects/volta/volta-hycos_07_e.pdf

The Volta-HYCOS project had four (4) main objectives including the following[26]:

i. Establishment of a network of reliable national hydrological observing systems with telemetry, providing coherent quality information, transmitted to national and regional databases through the WMO Global Telecommunications System or other appropriate channels;
ii. Strengthening of the technical and institutional capacities of the National Hydrological Services (NHSs) in the Volta basin to enable them collect, process and respond to the need of users with regards to the provision of relevant and reliable hydrological information to support the monitoring and management of water resources;
iii. Promoting and facilitating the dissemination and use of developed information and adapted products associated with water resource management, environmental protection and protection of human life and property against water related risks (floods and droughts) by using the most appropriate means of dissemination using recent advancement of ICT; and
iv. Strengthening the technical and institutional capacity of Volta Basin Authority for the evaluation of water resources in the basin so as to improve international cooperation which is essential for the rational and sustainable management and utilization of the water resources. This will contribute to poverty alleviation and sustainable development of the member countries.

Main financial partners who have supported projects on flood management in the Volta basin of Ghana in the last decade include the Norwegian Government, World Bank with the support of the UNDP and WMO as implanting partners.

[26] http://whycos.org/whycos/sites/default/files/public/pdf/projects/volta/volta-hycos_07_e.pdf

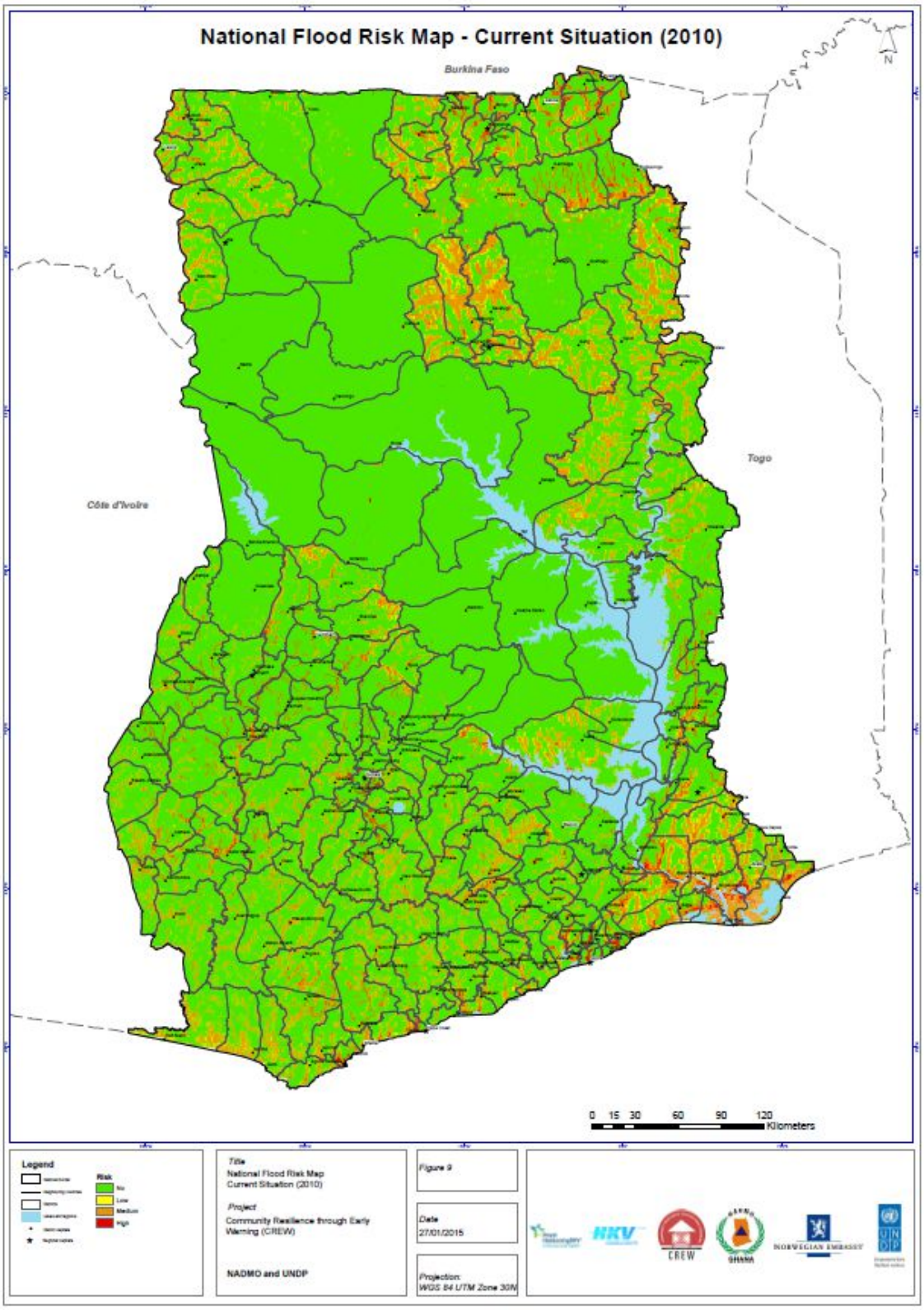

Figure 4: 2010 Flood Risk Map of Ghana (Source: NADMO)[27]

[27] https://crewghana.files.wordpress.com/2016/01/figure-9-flood-risk-current.pdf

2.3. Existing coordination and cooperation mechanism(s) for flood management

Co-ordination between key national institutions especially the Water Resources Commission, Ghana Meteorological Agency, Hydrological Services Department, National Disaster Management Organisation and the Environmental Protection Agency has been good with every institution being on each other's board. Communications between the institutions have been very good but have been mainly based on projects where they are partners, especially on flood management in the Volta basin. Sharing of data has been good but needs some improvements. Data is not seamlessly shared. It is however, always provided upon request.

The National Platform for Disaster Risk Reduction and Climate Change Adaptation (DRR & CCA) serves as an avenue for continued cooperation of major stakeholders on disaster management in general.

2.4. Existing enabling environment for stakeholders' participation in flood management

The national institutions noted in Table 2 work hand-in-hand with the Metropolitan, Municipal and District Assemblies (MMDAs) to get the citizenry and key institutions involved in discussions of projects on flood management. There is no specific law on the engagement of grass-root project participants on flood management. Currently, it is done as part of civic obligation although there exists the Act of Parliament 517 of 1996 which established the National Disaster Management Organisation (NADMO) under the Ministry of Interior. Essentially, the Organisation is structured to coordinate emergency response with the relevant civil authorities at all levels (National, Regional and District) in Ghana[28]. The management of disasters including floods and drought under NADMO is carried out through their 10 regional offices, about 243 offices at the District level and 900 zonal offices so as to involve grass-root participation as much as possible. However, there is still a lot to do to get appreciable level of participation from citizenry to participate on flood and drought management.

There is the need to draw up a framework for flood management as well as the enforcement of bye-laws and Legal Instruments (LIs) to support IFM in Ghana. As part of the Hyogo Framework for Action, the International Strategy for Disaster Risk Reduction (ISDR) serves as a platform for national consultations on disaster management. There has been some good achievement with regards to the use of the platform in Ghana. These include those gives in Table 3 gleaned for the national report for the year 2013-2015 for the 3 strategic outcomes from the 3 Hyogo Framework for Action goals in Ghana.

[28] http://www.mint.gov.gh/nadmo.htm

Table 3: Progress of work done on the implementation of the Hyogo Framework for Action in Ghana[29]

Strategic Goal	Strategic Outcome	Achievements as of 2015
1. Effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction.	National, Regional, District and local institutions have been empowered on disaster Management	i. A bill is at cabinet level which will empower these institutions especially NADMO to enforce their regulations on disaster risk reduction regulations. ii. NADMO Act 842 already exist to protect critical databases at all levels from Districts to National in terms of security; iii. All 10 regional platforms on disaster risk reduction are functional and help districts to draw up their Disaster Risk Reduction (DRR) Management Plans. The platforms have established some DRR desks in companies like Guinness Ghana, Vodafone Ghana and the Cocoa Processing Company (CPC); iv. An Africa Institute of Sanitation and Waste Management has been launched in Accra to serve as an education and training resource for sanitation and environmental management experts in Ghana and the sub-region.
2. Development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards.	More Disaster Volunteer Groups (DVGs) are being created throughout the country to engage them in afforestation (Teak tree planting) to empower them economically and also to contribute to climate change adaptation	i. A number of workshops and training programs have been organised for stakeholders by NADMO. This includes International Disaster Management Course, Incidence Command System, UN- Spider Technical Advisory Workshop on Adaptation of Space Technology and WEB EOC; ii. Specifically, on floods, the CREW project was implemented to build the capacities of key institutions (NADMO, HSD, GMet, WRC) in harnessing indigenous and using contemporary early warning knowledge towards increasing the capacity of communities for better preparedness and mitigation of the impact of flood and drought disasters; iii. Through the Ghana/Japan joint research project titled “Enhancing Resilience to Climate and Ecosystem Changes in Semi-Arid Africa: An Integrated Approach (CECAR-Africa), some Automatic Weather Stations were given to GMet and programmes developed to build the capacity of GMet in Numerical Weather Predictions through the Japan International Cooperation Agency (JICA) project;

[29] NADMO (2015). Ghana National progress report on the implementation of the Hyogo Framework for Action (2013-2015) – Interim Report.

Strategic Goal	Strategic Outcome	Achievements as of 2015
		iv. 18 Communities were supported through the "Expanding Climate Change Resilience" in Northern Ghana Project from 2013-2014 to establish considerable acreage of wood logs and given access to weather information through mobile phones which provided early warning for late rainfalls and droughts.
3. The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities.	A presidential task force has been set up to deal with illegal galamsey mining which often leads to destruction of the forest and pollution of water bodies affecting various communities in terms of water.	i. Education campaigns at the community level has been adopted to sensitize the citizenry towards the maintenance of a sound and sustainable environment; ii. MMDAs have been assisted to build capacities of their staff in waste management and sanitation through the use of benchmarking; iii. EPA has set up an environmental performance rating surveillance for the mining companies popularly called AKOBEN; iv. Zoom Lion together with KNUST have set up the KNUST-Africa Institute of Sanitation and Waste Management; v. NADMO continues to provide timely and effective response to emergencies with the support of its partners; vi. NADMO continues to monitor the Wasakuse dredging project in Ada which has economic activities for the youth and fishermen of Ada; vii. NADMO continues to coordinate the activities of GNFS and MASLOC to effectively respond to emergencies; viii. The Ghana foundation planted three thousand (3000) trees in the Savelugu District in the White Volta basin to improve the harsh climatic condition of the area; ix. Rescue operation equipment and vehicles have been provided to NADMO, the Ghana Fire Service, the Police Service, the Ghana Ambulance Service to enhance their emergency response to disasters; x. A simulation exercise dubbed "Operation Saamo Ohe" literally translated from Ga to English as "Operation Get Prepared" was organized to equip emergency personnel with skills on handling emergencies.

2.5. Environmental Impact Assessment for new developments with a potential impact on floodplains

Development of unapproved structures in floodplains have been on the ascendency in the country. Waterways are blocked with unauthorised structures. There are several policies, bye-laws and regulations that forbid the use of floodplains for infrastructural projects such as buildings, farming, mining etc. The National Environmental Policy (NEP 1991) from which the Environmental Assessment Regulation, LI 1652 of 1999 and the Strategic Environmental Assessment (SEA) done by the MMDAs is to protect the environment against such developments however they are not always fully enforced. The EPA Act of 1994 (ACT 490) requires the preparation of an Environmental Impact Assessment for any activity which has the potential to impact negatively on the environment. Based on the results of the assessment, an environmental permit may be issued by the Environmental Protection Agency to the developer or the person involved in that particular activity. Environmental Protection Inspectors are supposed to be visiting floodplains often to see if they have been used for any development which poses a threat to the environment and demolish or stop them.

2.6. Strategic Environmental Assessment in developing plans and policies with a potential impact on floodplains

Ghana has adopted the Strategic Environmental Assessment (SEA) as a tool for mainstreaming environmental and climate change issues in all developmental projects or programmes including the Ghana Poverty Reduction Strategy (GPRS), the Ghana Shared Growth and Development Agenda (GSGDA) and thereby the District Medium Term Development Plans of the MMDAs in accordance with the National Development Planning commissions (NDPC) guidelines[30]. The main aim of the SEA is to enhance the integration of national policies and development needs at the grass-roots starting from the District Assemblies which is the lowest level of governance for a more coordinated and improved decision-making process in Ghana[28]. It is mandatory or a requirement by all institutions to screen developmental projects, plans, programmes and policies using the SEA. This helps the institutions to predict the impact of their policies, plans and programmes on the environment. SEA is used at the planning stage[31] whereas in mostly in Basin Flood Management Processes Environmental Impact Assessment (EIA) is used at the design and implementation stage whilst.

[30] Odame-Ababio (2014). Draft Final Report. Review of National Policies, Strategies and Programmes in the context of Water Security and Climate Resilience. Ghana Country Water Partnership (CWP-Ghana) Water, Climate and Development Programme (WACDEP).

[31] WMO (2007). A Tool for Integrated Flood Management. The Associated Programme on Flood Management (APFM) Technical Document No. 8, Flood Management Tools Series A.

2.7. Existing National Policy Framework

Issues on floods and drought are handled under the National Climate Change Policy drafted by the Ministry of Environment, Science, Technology and Innovation (MESTI) and approved in 2013 by the Cabinet of Ghana. The policy gives strategic guidance on how to coordinate efforts towards adapting and mitigating against climate change in the country. The National Climate Change Adaptation Strategy (NCCAS) specifically looks at [32]

i. Ensuring a consistent, comprehensive and a targeted approach to increasing the resilience and decreasing the vulnerability of the populace;
ii. Deepening the awareness and sensitisation of the general populace and policy makers in particular on their critical roles in enhancing national adaptation efforts;
iii. Strategically positioning the country to attract funding to meet her national adaptation needs;
iv. Strengthening international recognition to facilitate action; and
v. Facilitating the mainstreaming of climate change and disaster risk reduction into national development.

However, guidelines to promote cross-border cooperation in relation to flood prevention actions are weak[33] and needs to be improved with joint implementation of transboundary activities to enhance the cooperation.

As explained in section 2.4, the International Strategy for Disaster Risk Reduction (ISDR) and the United Nations International Strategy for Disaster Risk Reduction (UNISDR)[34] serves as a platform for national consultations on disaster management. This is covered the UNISDR's Africa office and hosted by the National Disaster Management Organisation (NADMO) as the focal point for Ghana.

[32] National Climate Change Adaptation Strategy

[33] Odame-Ababio (2014). Draft Final Report. Review of National Policies, Strategies and Programmes in the context of Water Security and Climate Resilience. Ghana Country Water Partnership (CWP-Ghana) Water, Climate and Development Programme (WACDEP).

[34] https://www.unisdr.org/partners/countries/gha

2.8. Lessons learnt in flood management

Flood Management needs strategic planning, effective stakeholder engagement and well-planned investments. The country until most recently has relied heavily on reactive measures which often focus on recovery instead of disaster reduction or mitigation. Although the cause of floods in rural Volta basin in Ghana is much different from urban areas, the lessons learnt, and key messages are the same. In cities floods are mostly caused by pollution and stagnation of flowing water (streams and rivers) from improper waste management, clogged drains, inappropriately sized drains and culverts, buildings and other structures in waterways in addition to the impacts of climate change[35]. In rural areas in the Ghana portion of the Volta basin, floods are mostly caused by encroachment of floodplains of major rivers and streams as well as the operations of dams such as the Bagre and Akosombo dams upstream of vulnerable communities.

Some key messages on floods gleaned from the urban platform of Ghana which is applicable to the urban and rural Volta in Ghana are summarised below[36]:

i. Improper land use or land management aggravates natural hazards and increases disaster risk;
ii. Apathy and irresponsibility on the part of the citizenry does no one any good in flood management especially in reducing the harm caused by others on the environment;
iii. There is the need for an in-depth vulnerability assessment of communities prone to floods which will lead to the development of the state-of the-art early warning systems for floods and drought as well as detailed flood hazard maps for an integrated flood management plan;
iv. There is the need to invest in hydraulic infrastructure to attenuate flood peaks. These could include dams, weirs and reservoir as well as storm drains in urban areas in particular;
v. There is the need for public education and awareness creation on flood management to be enhanced and effective citizenry engagement in integrated flood management;
vi. Effective engagement of researchers with policy makers and the use of valuable research findings; and accountable governance with enhanced enforcement of regulations with institutions and individuals living up to their responsibilities, actions and tasks.

[35] http://africanurbanism.net/accra-floods-2015/
[36] http://africanurbanism.net/accra-floods-2015/

2.9. Risk transfer and risk sharing mechanisms concerning floods

The main aim of integrated flood management is to minimise loss of life and maximise derived benefits of floods from floodplains[37]. Management of flood risk is not an easy task. It entails a combination of processes to address *"risk reduction, retention and transfer using structural and non-structural measures for preparedness, response and recovery"* (WMO, 2013). Risk management and transfer is basically a measure of cost and who bears it. This could be borne by the individuals, communities, government (national, regional, district) or private companies or NGOs as part of their Corporate Social Responsibility (CSR). Risk sharing mechanism could be equated to cost sharing mechanism in flood preparedness, response and recovery. The Associated Programme on Flood Management (APFM) has developed a comprehensive tool[38] for flood risk sharing which addresses all the components listed above.

Risk reduction is normally the first step in flood management. This entails using structural measures like dams, reservoirs, drains, culverts and other structures to minimise or reduce the flood peaks so the probability of the flood causing damage (loss of life and property) is reduced, or using non-structural measures such as economic disincentives for building in floodplains and improper waste disposals, the use of Early Warning Systems (EWS) to warn citizenry of imminent floods, and measures aimed at reducing the costs of flood damage, the cost of structural measures, the cost of flood-proofing, and the cost of land use adjustment[39]. In Ghana most of these are taken care by the national government with the support of development planners and some NGOs.

Risk transfer includes the sharing of risk with third parties such as insurance providers so as to minimise the cost of recovery on an individual, community, project or company. Flood risk home insurance is rare for the *"average"* Ghanaian. Most homes, property are not insured against floods even those in flood prone areas.

Risk retention is also the sharing of risk with third parties however not all risks are transferred. In risk retention, the acceptance of losses by deductibles are planned and some property are deliberately not insured; thus loss-sensitive plans are implemented[40]. Anytime a policy requires deductibles it contains some risk retention and the very fact that something of value is not insured is risk retention in itself[41]. It could therefore be hypothetically true that lots of Ghanaians are into risk retention by definition.

[37] WMO (2013). Risk Sharing in Flood Management. Integrated Flood Management Tool Series No. 8. The Associated Programme on Flood Management (APFM).

[38] http://www.apfm.info/publications/tools/APFM_Tool_08.pdf

[39] James, L. D. (1965). Nonstructural Measures for flood control. *Water Resources Research*, Vol.1-1, pg. 9-24. DOI: 10.1029/WR001i001p00009

[40] https://www.irmi.com/online/insurance-glossary/terms/r/risk-retention.aspx

[41] http://rris-insurance.com/rr/

2.10. Land use regulation and enforcement

2.10.1. Building standards for flood proofing

There is a need to look into land management even before looking at building standards. The Lands Commission (LC) was established by Article 258 of the 1992 Constitution and the Lands Commission Act, 2008 (Act 767) with the following functions[42]:

i. Manage government lands;
ii. Advise government, local/traditional authorities on the policy framework for the development of specific areas of the country to ensure that development of individual pieces of land are well coordinated and in conformance with the development plan for the area of interest;
iii. Develop policies with respect to land use suitability or capability;
iv. Help register titles of lands throughout the country and maintain the register;
v. Register deeds and instruments that affect land throughout the country;
vi. Help government acquire land legally;
vii. Establish land survey and mapping standards and regulate such;
viii. Provide survey and mapping services as needed by the state and individuals;
ix. License practitioners and cadastral survey;
x. Provide land and land related valuation services;
xi. *"**Ensure** that through sound, sustainable land use planning, socio-economic activities are consistent with sound land use through sustainable land use planning in the long-term national development goals"*
xii. *"In collaboration with other institutions instil law and order/discipline into the land market through curbing the incidence of land encroachment, unapproved development schemes, multiple or illegal sales of lands, land speculation and other forms of land racketeering";*
xiii. Enhance the collaboration of bodies to minimise or eliminate where possible the sources of protracted land disputes, conflicts and litigations to reduce associated costs of drugging these issues for long;
xiv. Enhance community participation and public awareness on sustainable land management;
xv. Promote research on land ownership, tenure, land market and operations;
xvi. Impose and collect land levies, fees or charges for services rendered;
xvii. Establish and maintain a comprehensive and up-to-date land information system; and perform other functions as may be assigned to them by their Ministry.

[42] http://www.ghanalap.gov.gh/index.php/implementing-agencies/lands-commission

If all these functions listed above were effectively carried out, the incidence of loss of life and property through floods caused by improper land management would have been almost completely eliminated. However, in Ghana, development control using the land use ordinance and the building code do not necessarily go hand-in-hand with the state of socio-economic development. The use of lands is regulated by the Lands commission and the planning done by the MMDAs through the Town and Country planning department however the lack of enforcement of the rules and regulations on land management has had detrimental impacts on the environment with regards to floods. Land management has been politicised hence difficult to control. There is the state Lands Act, 1962 (Act 125) now amended to Act, 2000 (Act 586) which looks at the acquisition and management of state lands in Ghana, setting up of site advisory committees to look into state lands and for example its' appropriateness of use. These are however not always strictly adhered to and thus how come the country finds it so difficult to manage floods. The Ghana building code drafted by the Building and Road Research Institute (BRRI) based in Kumasi, under the auspices of the Ministry of Water Resources Works and Housing with funding from the UNDP in 2012, together with the National Housing Policy (2012) and National Urban Policy (2010) were done with the focus of aiding with spatial/landuse planning, urban development and management. However, translating these policies and using the codes of practise on the ground remains a big challenge. These challenges led to the passing of a Bill on Landuse and Spatial Planning in 2016 by the parliament of Ghana. The bill was prepared to revise and consolidate existing laws and regulations on landuse and spatial planning and to provide for the sustainable development of land and human settlements through a decentralised planning system to enhance public safety and socio-economic development[43].

More information on the incorporation of climate change and disaster risk reduction into the Ghana building code can be found in Annor (2014)[44]. Flood-proofing are structural and non-structural measures implemented to reduce or eliminate flood damage to people and property including public infrastructure[45]. Often these are guided by building codes, regulations and policies. These are in the building codes but unfortunately not enforced such as leaving green areas in residential areas or not paving of all areas of buildings, and the promotion of roof water harvesting.

[43] http://www.parliament.gh/publications/36/1266

[44] Annor, F.O. (2014). Draft Report. Review of National Adaptation Responses in the context of Water Security and Climate Resilient Development. Ghana Country Water Partnership (CWP-Ghana) Water, Climate and Development Programme (WACDEP).

[45] http://www.fema.gov/floodproofing

2.10.2. Preparedness planning about floods

Since flooding is a natural process that cannot be stopped and could also be aggravated by improper land and water management. There is therefore the need to develop a preparedness planned to minimise losses incurred as a result of floods. A flood preparedness plan should normally include warning (alert), evacuation/response and recovery. This therefore requires some efforts in planning, equipping, training, exercising and communication. Plans have to be put in place to detect imminent floods through the development of early warning systems which produces near real-time hazard maps showing places that could possibly be inundated and safe grounds for rescue operations. In addition to this, there should be regular drills for key institutions involved in rescue missions like the Military, Police Service, Fire Service, Ambulance and NADMO together with the citizenry on how rescue operations should be carried out including the following[46]:

i. Conditions that will activate the plan
ii. Chain of command
iii. Emergency functions and responsibilities
iv. Specific evacuation procedures, including routes and exits
v. Procedures for accounting for personnel, customers and visitors

The plans have to be reviewed often and the necessary equipment and logistics procured for the rescue teams and institutions. Access to logistics and equipment remain a key challenge for disasters preparedness in the country.

2.10.3. Emergency response and recovery plans about floods

An effective communication plan with the grass-root stakeholders is paramount in disaster response and recovery missions. An emergency preparedness plan is often a prerequisite to respond to floods and help victims recover from the shocks. The response and recovery plan should have the following[47]:

i. Provide a thought-out plan to facilitate public safety by notifying all key authorities;
ii. Provide information to all stakeholders regarding the series of actions to take in case of emergencies with respect the level of warning;
iii. Set up effective ways of communication should all normal channels (SMS and voice, fax, social media, emails) of communication stop functioning.

[46] https://www.osha.gov/dts/weather/flood/preparedness.html

[47] WRC (2013). National Dam Safety Manual. National Dam Safety Unit (NDSU) of the Water Resources Commission of Ghana.

In the Volta basin of Ghana, a number of these measures have been put in place mainly by NADMO and the Volta River Authority (VRA) and supported by other institutions like the WRC, HSD, GMet, Environmental Protection Agency (EPA), Police Service, Military, National Fire Service, the National Ambulance Service among many others. Communication between these agencies or institutions is mostly through emails, phone calls and short message service. Automatic systems are not in place where one can monitor the activities of all others at the same time to trigger alerts. This is still on the drawing board. The use of social media (twitter, WhatsApp, Facebook) for communication between the institutions is being given some attention now.

3. Chapter 3: Flood Risk Management - Hazard Assessment

3.1. Characterization of the main basins

The major sub-basins of Volta within Ghana include the Black Volta basin, White Volta basin, the Oti basin and the Lower Volta basin which includes the Volta Lake. Unlike the Oti basin and the Black Volta basin, the White Volta basin has been extensively studied and has the largest number of projects or activities on flood management and climate change in general. The basin is also one that experiences a lot of issues on floods due to the fact that it is highly modified compared to the other three sub-basins of the Volta. A number of dams have been constructed on the White Volta including the Bagre dam. The White Volta River has seen some large encroachment on its floodplains in the past decades from farmers and Small-scale miners; although at the moment the Water Resources Commission through the Buffer Zone Policy is reversing this trend. Due to these characteristics, the White Volta Basin saw the establishment of the first Early Warning System in the Country developed by the Water Resources Commission through HKV and sponsored by the World Bank called FEWS-Volta. Plans are far advanced for the development of a similar system for the Oti basin.

The other sub-basins including the Lower Volta basin also experience some flooding however, these are not as pronounced as in the White Volta due to the attenuation of the flood peaks by the dams in the basin as well as the relatively low activities along their main river banks. A list of dams in the various basins is given in Table 4. The operations of the dams are largely responsible for how floods are attenuated especially on the Ghana portion of the basin.

Table 4: Existing dams in the Volta Basin[48]

Country	Sub-basin	Dam Name	Capacity (Mm^3)	Year of operation	Purpose
Benin	Oti-Pendjari	-	-	-	-
Burkina Faso	Black Volta	Samendeni	1,050	2012	- Hydropower - Irrigation
		Lery	300	1980	- Irrigation
		Bagre	1,700	1995	- Hydropower - Irrigation
		Ziga	200	2000	- Potable water supply
	White Volta	Loumbila	36	1990	- Potable water supply
		Ouaga II+III	5	1980	- Potable water supply
	Oti-Pendjari	Kompienga	2,050	-	- Hydropower
Cote d'Ivoire	Black Volta	-	-	-	-

[48] IUCN-VBA (2012). The Volta Basin Water Update. Final Report. Project for Improving Water Governance in the Volta basin (PAGEV).

Country	Sub-basin	Dam Name	Capacity (Mm^3)	Year of operation	Purpose
Ghana	White Volta	Tono	100	1982	- Potable water supply - Irrigation
		Vea	17	1968	- Irrigation
	Black Volta	Bui	12,300	2014	- Hydropower - Irrigation
	Lower Volta	Akosombo	148,000	1966	- Hydropower - Irrigation
		Kpong	200	1984	- Potable water supply - Irrigation
Mali	Black Volta	-	-	-	-
Togo	Oti	Dalwak	10		- Potable water supply
		Kara	5		- Potable water supply

3.2. Typology of flooding - flash floods, riverine, coastal, mud flows, urban

Ghana largely experiences riverine and urban floods. The causes of these floods have been highlighted in section 2.8 and shown in Figure 5.

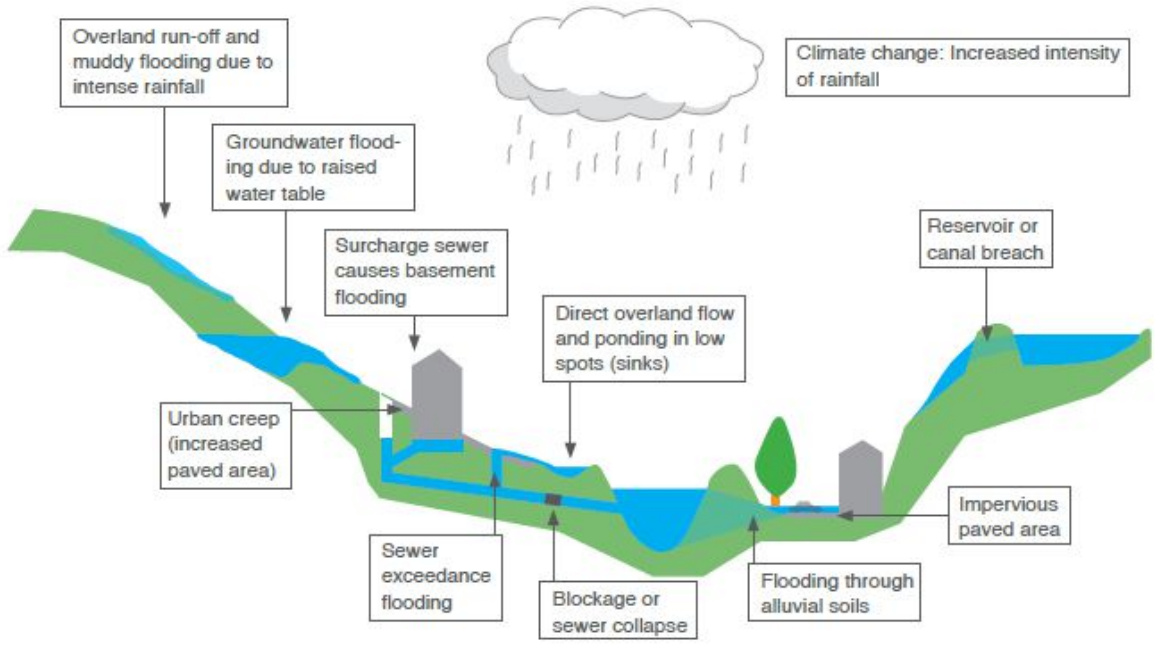

Figure 5: Causes of Floods and types of floods[49]

[49] Office of Public Works (2009). The Planning System and Flood Risk Management Guidelines for Planning Authorities. Ireland. http://www.opw.ie/media/Planning%20System%20and%20Flood%20Risk%20Management%20Guidelines.pdf

Riverine or what is sometimes called fluvial floods is caused by rivers overflowing their banks because their capacities are exceeded hence the water spreading to adjacent developed areas and property. Riverine floods could be classified as inundation flood (see Figure 6) or flash flood (Figure 7). An inundation or overbank flood occurs when the capacity of the river or channel is exceeded and starts overflowing its banks which could be caused heavy and prolonged rainfall events or opening of spillways of dams upstream.

Figure 6: Inundation flood[50]

Flash floods are attributed to high velocity flow of water within existing channels which occur within a very short time with very little to no notice. It could happen as a result of a breach of a dam upstream. Flash floods are mostly dangerous as a result of the high flow velocities and associated debris carried by flowing water[51]. This causes a lot of mess during and after the floods.

Coastal floods are caused by high tidal waves and strong winds which caused erosion of shores and low-lying areas below the sea level. In Ghana storm and surge barriers (See Plate 1 - Keta sea defence wall) have been constructed along the coastal belt to minimise the impact of coastal floods.

In most urban areas in Ghana including the ones within the Volta basin, flooding is caused as a result of a lack of drains or improper sizing and clogging of drains and culverts as a result of poor waste management which makes channels overflow their bank to adjacent properties.

[50] WRC (2014). Module 1 – Practical and Implemental IWRM in Ghana. Sensitisation on water resources conservation and catchment protection for sustainable water supply. The programme for accelerating sanitation and water for all in Ghana. A Government of Netherlands-UNICEF Partnership for WASH in West Africa.

[51] http://www.intermap.com/risks-of-hazard-blog/three-common-types-of-flood-explained

Figure 7: Flash flood[52]

Plate 1: Keta Sea Defence Wall[53]

[52] http://www.utdhome.com/PhotoShow/view.php?topic=120

3.3. Status of the hydro-meteorological observation network

Discussions with key staff (Annex 1) of the Ghana Meteorological Agency (GMet) and the Hydrological Services Department (HSD) led to the findings below.

There is a "good" network of hydro-meteorological stations in Ghana even though not all of them are functioning optimally. GMet has close to 100 Automatic Weather stations, 61 Manual Climate Stations, 173 Manual Rainfall stations and 22 Synoptic Stations. However, some of the manual stations are not functioning anymore. About 60% of the GMet stations can be found in the Volta basin of Ghana. Some of these stations were acquired through national government and projects (e.g. Volta-HYCOS, JICA, TAHMO etc.). The current network density does not meet the WMO requirement (stations being at most 30 km apart). The network of stations in Ghana are sometimes placed more than 100 km apart in some regions and parts of the country within the Volta basin. Within the White Volta basin, due to the FEWS-Volta project, most of the old stations have been rehabilitated and new ones procured including river gauge stations for the HSD. There are over 20 river gauge stations in the Volta basin of Ghana but not all are functioning at the moment. The issue has always been dwindling funds from national government to support GMet and HSD to man their network of stations. Through the CREW project and the FEWS-Volta project a few (about 10) river gauge stations fitted with telemetry were procured for HSD. These national institutions need a lot of support with respect to resources to upgrade facilities to the state-of-the-art hydro-meteorological observatories. The Trans-African Hydro-Meteorological Observatory (TAHMO) - a private NGO, JICA, the Norwegian Government, the WMO and the World Bank are supporting these institutions (some through the Water Resources Commission and NADMO) to upgrade their facilities and improve their network of stations to meet the WMO requirement of 1 station per every 30 km placement density. More support is however required from the national government to support the institutions carry out their statutory functions.

3.4. Status of flood forecasting and early warning solutions in the country/basin

The White Volta Basin has a Flood Early Warning System (FEWS-Volta) developed by the Water Resources Commission through HKV Consultants from the Netherlands as discussed in the previous sections. There are also 10 pilot districts with early warning systems with 6 of them being in the Volta basin developed by NADMO through Royal HaskoningDHV (also based in the Netherlands) and HKV Consultants for the Community Resilience through Early Warning (CREW) Project.

[53] Copyright: Great Lakes Dredge and Dock (GLDD) www.gldd.com

3.5. Status of flood mapping/national programme

Through the FEWS-Volta and CREW projects some flood hazard maps were prepared and validated for the White Volta basin as well as some selected districts within the country. These maps are continuously being updated by the Water Resources Commission and NADMO. However, the hydrological models which generated the maps will now be run from the Hydrological Services Department and the Ghana Meteorological Agency.

3.6. Availability and accessibility of the basic data and information for informed decision making for flood management

Through the FEWS-Volta project and the CREW projects, and other initiatives such as TAHMO, plans are far advanced to send weather alerts and flood warnings to end-users at all levels (national, regional, district and communities) using mobile platforms (SMS and voice mails) as well as web-based applications. Some telecommunication companies in Ghana like Vodafone and MTN (through Ignitia) are supporting with some of these initiatives. Mobile Service providers such as Farmerline Limited, ESOKO, Human Network International (HNI) are supporting farmers to get access to weather and hydrological information as well as agronomic and financial tips.

3.7. Map of the river's natural course

The river network map produced by IUCN-VBA (2012) can be found in Figure 1 in the first chapter of this report. It shows the White Volta, the Red Volta, the Black Volta as well as the Black Volta rivers.

4. Chapter 4: Flood risk management - Vulnerability assessment

4.1. Economic vulnerability

4.1.1. Use of floodplains as protective measures

As discussed in previous sections, floodplains normally have three roles. These roles include[54]

i. Recharging the groundwater systems
ii. Replenishing wetlands (including improving water quality)
iii. Supporting agriculture and fisheries systems

Naturally, flood plains are reserved to help attenuate floods by allowing the flow of water on it. However, humans have encroached the floodplains hence disturbing the natural functions of the floodplain. The buffer zone policy of Ghana has been drafted by the WRC to monitor activities within 90 m from the river banks to curtail unapproved activities within this zone.

4.1.2. Economic development in flood-prone areas

Due to the fact that floodplains have very rich soils and are most of the time of the year wetter than other areas, it is not surprising to see a lot of economic activities and developments within this area. This trend has existed for so many years in Ghana and other countries. Floodplains are used mainly for agriculture and fishing within the Volta basin. This is due to pressure on water and other natural resources with increasing population. Of late, the floodplains and even riverbeds have seen the explosion of (alluvial) mining activities within the Volta basin. These activities serve as sources of livelihoods for people living close to the river. However, flooding poses a severe risk to developments and economic activities on floodplains. While one cannot completely get people off the floodplain with sometimes the government having to support with flood protection measures to protect lives and properties, measures have to be put in place to regulate and monitor these activities. The Buffer Zone Policy which has been drafted to handle these issues needs an LI to ensure strict compliance. This calls for an integrated approach in managing floods. Some investments would not take place in certain basins due to the fact they are considered high risk zones with respect to floods due to the fact that they have no flood control measure. This means people leaving in these areas sometimes have to battle with poverty since there are no alternative livelihood activities available to them. The White Volta basin Lower Volta basin have seen most development activities within their floodplains hence are also the hotspots for damages caused by floods in the country.

[54] WMO (2007). Economic Aspects of Integrated Flood Management. The Associated Programme on Flood Management (APFM) Technical Document No. 5, Flood Management Policy Series. WMO No.- 1010.

4.1.3. Existing structural measures to reduce exposure

Structural measures used in reducing flood exposure have existed for centuries. In Ghana there used to be few dams in the Volta basin (almost natural river system) therefore allowing the occasional flooding of floodplains to support economic activities. However recent developments in the basin as given in Table 4 (including the Bui dam, Bagre dam in Burkina Faso, Akosombo and Kpong dams in the Lower Volta) shows that the rivers are modified creating both positive impacts with regards to flood attenuation but also negative impacts with regards to highly modified flows. This trend has therefore reduced the booming economic activities in the floodplains in time past while offering some protection to people living along the banks of the Volta river. There are therefore trade-offs in flood management. There are new dams in the pipeline to be constructed in the country with the Pwalugu dam taking centre stage of this infrastructural development. While structural measures are robust in the long term, they could fail with unforeseen events or flood events with very high return periods that were not used for design. Again, the fact that the risks are transferred spatially means conflicts could arise as well as inequalities[55]. There is therefore the need to combine structural measures with non-structural ones to manage floods in a more integrated manner.

4.1.4. Flood preparedness/vulnerability of infrastructure, such as buildings, sanitation works, electricity supply, roads and transportation

As discussed in section 4.1.3, without flood protection, buildings (especially resorts) along the river banks in the Volta basin wouldn't have been constructed due to the high risk of being exposed to floods. This therefore means that flood protection also attracts high value socio-economic developments along the floodplains. A typical example is the springing up of resort in the Ada area of the Volta estuary. Existing buildings especially in rural Volta areas are quite vulnerable to floods due to the fact that most are not properly constructed and therefore have weak foundations. In times of floods they easily give way. Again, road networks especially the feeder roads are not well maintained so give way with the little amount of flood. This does not just cut off some communities from others for exchange of goods and services but also make rescue operations extremely difficult since Ghana doesn't have enough helicopters for these operations.

[55] WMO (2007). Economic Aspects of Integrated Flood Management. The Associated Programme on Flood Management (APFM) Technical Document No. 5, Flood Management Policy Series. WMO No.- 1010

4.2. Social Vulnerability

4.2.1. Well-being, strength and resilience

The well-being of people is paramount in any flood management plan. Peoples' welfare is put first, socio-economic development and then the environment. The criteria used for the trade-offs are not always clear. People also develop their resilience to floods from past experiences. In Ghana the trade-offs are mostly between human survival and socio-economic development with the environment relegated to the background. The consequences of floods in the Volta basin in Ghana have mostly been destruction of farmlands and property and less of loss of life. Flood relieves are made available after flood events by NADMO so issues of acute malnutrition as an aftermath of flood events hardly arise in Ghana.

4.2.2. Occupation in a risky area

Floodplains if well-regulated could be used for livelihood activities like farming and fishing. Controlled activities in floodplains are rare in Ghana due to lack of enforcement. Although people working in floodplains know the consequence of their operations, the lack of alternatives for livelihood options compels them to continue these activities.

4.2.3. Population pressure

Population growth and the need to meet food and water demands put undue pressure on natural resources including the use of floodplains. The population in the Volta basin is estimated to be growing at a rate of 2.5% per anum[56].

4.2.4. Social support networks/community organizations – existence and threats

There are no special groups for fishermen or farmers working in floodplains. This group of workers join the water users associations, fishermen groups and farmers unions. Generally, there is almost a quick response to flood victims from the government through NADMO in all types of disasters including floods with the support of NGOs and development partners.

4.2.5. Communication network

Communication with communities on issues of floods is done through the information services departments' community information system, radio programmes, websites and mobile platforms. The most effective way of communication is through mobile platforms however communities trust and follow the messages from their information centres. There is therefore a need for NADMO and institutions such as the HSD and GMet to explore the use of multiple channels of communication.

[56] IUCN-VBA (2012). The Volta Basin Water Update. Final Report. Project for Improving Water Governance in the Volta basin (PAGEV).

4.2.6. Motivational/attitudinal conditions

The motivation to engage in activities within floodplains is quite high due to the benefits outlined in the earlier sections. There are disincentives or punitive measures to prevent people in engaging activities which would lead to aggravating floods. However due to the fact these measures are not strictly enforced, people's attitude towards following the right processes or complying with rules and regulations are poor. It must be noted that at times some of the rules are obsolete and needs to be amended to reflect modern development. There should be regular review of rules and regulations that are often flouted especially for Integrated Flood Management.

4.2.6.1. Awareness of development issues, rights and obligations

Public awareness on issues of floods is not extremely low. People know their rights and obligations and civic duties even though some level of education is needed to improve their knowledge. The fact that plans, rules and regulations are not followed boils down to the lack of enforcement and apathy on the part of individuals and institutions.

4.2.6.2. Beliefs, customs and fatalistic attitudes

Interactions with communities and stakeholders show that traditional beliefs and customs needs to well-integrated with modern science to enhance the acceptance and compliance with rules and regulations governing flood management. For example, people would not just move from a flood prone area because they hold strong bonds with their ancestors in those areas and do not want to be seen as abandoning them. They therefore have some attachment with the land and will continue to stay there no matter the severity of the damages caused by previous floods. Such situations require a deep understanding of their traditions and beliefs to enable one find a lasting solution which sometimes could just be done through flood-proofing measures, so they could live with the floods. Traditional ways of receiving warnings of imminent floods are sometimes consistent with modern science so should be embraced and integrated into early warning systems so as to increase the uptake of the information shared through other channels. Communities should be engaged through two-way communications in flood forecasting, so they can trust the information being given out as well as improve the accuracy of the predictions.

4.2.6.3. Dependence on external support

Dependence on external support in itself is not bad for flood management since structural measures require huge sums of money. However, over dependence of the country on external support always slows down development and does not ensure that people and institutions live up to their own responsibilities. Problems that can be resolved by communities are shifted to the central government and thereby donors no matter how small it is or how long it takes for the problems to be resolved. Currently there is a shift in paradigm from aid to trade and investment so that developments could be sustained and owned by indigenes.

4.2.6.4. Existing participatory and capacity building mechanisms

- ***Information sharing, public hearings, consultations, collaboration in decision making and delegation of responsibilities***

Sharing of information between the relevant institutions in Ghana as well as between Ghana and Burkina Faso through the WRC has improved over the past few years. Information on water levels is shared as well as meteorological information. Due to the implementation of Integrated Water Resources Management (IWRM) at various river basins in Ghana, stakeholder participation in decision making has been enhanced. What needs a lot of improvement is the stage (inception, design and implementation) of projects at which grass-root stakeholders are engaged. Most grass-root participants are informed rather engaged and normally this is done at the project implementation stage. This does not promote ownership and sustenance of projects and initiatives. People should be given roles and functions, so they could live up to their responsibilities.

Capacity building initiatives for institutions at all levels (National, Regional, District and Community) are not well coordinated. The regional coordinating councils (RCC) who are supposed to coordinate the capacity building initiatives in the regions are woefully under resourced to do so. Even when these trainings are donor driven, coordination is not effective hence there is a lot of repetition and waste of resources in capacity building. Again, the right individuals are often not sent to capacity building workshops due to various reasons.

- ***Representation of women, youth, people with disabilities and indigenous people***

Most boards and groups on disaster management in general have a good representation of women and indigenous people since these have gained a lot of attention of late. The inclusion of youth and people with disabilities on the other hand is lacking.

- ***Training sessions and workshops***

Several training sessions and workshops have been organised by the Africa Adaptation Programme, the Water Resources Commission, NADMO, EPA and other NGOs within the Volta basin on climate extremes (drought and floods). The WACDEP programme trained regional planners, basin officers and staff of the HSD and research institutions on Water Security and Climate Resilient Development in Ghana and other countries within Africa. In all 12 people were trained across the country. This was a training of trainers programme.

- ***Networking for information sharing***

A good network has been established through the NADMO platforms to help with flood management. The network is however missing key sectors such as the Media, Land, Agriculture, Fisheries, Transport and energy. To enhance integrated flood management, all these sectors have to be brought on board to share data and information and not just the water practitioners.

❖ ***Secondments of key personnel in other organizations***

Some staff from the Ministries Departments and Agencies (MDAs) are sometimes seconded to other national organisations. For example, some procurement officers from the Ministry of Finance have been seconded to the Ghana Meteorological Agency to support them with their procurement processes. This however is not a very common practise.

❖ ***Public awareness raising campaigns***

There is a lot of public awareness immediately after big flood events by the government, media and NGOs. However, after a short while all this dwindles. This needs to be done continuously to have the desired impact.

4.3. Environmental Vulnerability

4.3.1. Environmental conditions and economic analysis in floodplains

The environment will remain vulnerable if a combination of structural and non-structural measures is not put in place to attenuate flood peaks. The continuous exposure of the environment to hydro-morphological changes poses severe risk to its ecosystem services[57].

In carrying out economic analyses of floodplains, two main methods have been used extensively and are often used jointly[58]. These are Cost-Benefit Analyses (CBA) and Multi-Criteria Analyses. Unlike economic valuation, Social valuation (e.g. equity) is difficult to incorporate in Cost Benefit Analyses but could be done easily in MCA (WMO, 2007). This however, requires a more effective consultation with those affected by the floods during all stages of the analyses. Economic analyses helps with decision making by evaluation the scale of impacts and benefits that an action or inaction might make to determine its' feasibility[59] often looking at trade-offs.

4.3.2. Mechanisms to assess/monitor environmental degradation

Currently in Ghana environmental assessment is done by the Environmental Protection Agency and supported by the MMDAs, WRC, Forestry Commission (FC) and the Minerals Commission (MC). Often activities that degrade the environment are done at the micro-level with lots of them cumulating into degradation at the macro-level. Monitoring is done by physical inspection and regular water quality tests. EPA could benefit from the use of satellite and possibly drones to do near real-time monitoring so as not to wait until conditions have deteriorated before taking actions.

[57] European Environmental Agency (2016). Flood risks and environmental vulnerability. Exploring the synergies between floodplain restoration, water policies and thematic policies The EU Floods Directive (2007). EEA Report No 1/2016

[58] WMO (2007). Economic Aspects of Integrated Flood Management. The Associated Programme on Flood Management (APFM) Technical Document No. 5, Flood Management Policy Series. WMO No.- 1010.

[59] WMO (2007). Economic Aspects of Integrated Flood Management. The Associated Programme on Flood Management (APFM) Technical Document No. 5, Flood Management Policy Series. WMO No.- 1010

The implementation of the buffer zone policy also requires frequent assessment and monitoring of the activities on floodplains. This is currently a challenge to the WRC.

4.3.3. State of the environment and preservation efforts

Developments on floodplains and waterways have been on the ascendancy of late which requires that measures are put in place to curtail these. The custodians of the lands (chiefs and elders of stool lands) are often the worse culprits. There is therefore the need to effectively engage them in Integrated Flood Management.

5. Chapter 5: Conclusions

Integrated flood management (IFM) aims at minimising loss of life and maximising derived benefits of floods from floodplains. This needs assessment was carried mainly to assess the capacity needs of key institutions in applying the concepts of Integrated Flood Management (IFM) and further develop projects on IFM in the Volta basin which could attract funding. The following conclusions are drawn from discussions with key stakeholders and extensive review of available literature on the relevance of the approach for Ghana and its national part in the Volta Basin:

i. Flood management is a key challenge in Ghana. The country experiences mostly riverine and urban floods which are caused by anthropogenic activities which could be curtailed with the enforcement of laws and regulations;
ii. Key institutions like WRC, NADMO, GMet, HSD and EPA have some capacity to implement IFM, however there is the need for these capacities to be developed further through tailored trainings;
iii. Keys stakeholders need their capacities developed to enable them write bankable proposals to get funding from the Ghana government and development partners for the development and implementation of a national and basin IFM plans;
iv. WRC basin offices exist in all the major sub-basins of the Volta. These together with the NADMO National, 10 Regional, 243 offices in the 216 Districts and 900 Zonal Platforms could be used to promote IFM in Ghana. There is therefore a framework which could be built on;
v. There is the need for synergy and coordination between the Volta Basin Authority, regional, national, and basin institutions to enhance IFM;
vi. Hydrological models for flood hazard mapping exist at the WRC, NADMO, HSD and GMet and can be further developed into a national decision support system (DSS) maintained by these institutions with clearly defined roles and responsibilities for IFM;
vii. Flood models highly rely on satellite data and hydro-meteorological data for localised and accurate model output. It also needs very good database management. The current state of hydro-meteorological infrastructure in Ghana needs to be improved. There is some support from the Norwegian government, World Bank, WMO, United Nations Development Programme (UNDP), JICA and TAHMO to support these agencies upgrade their facilities to state-of-the –art in Africa or the world. However, support from the Ghanaian government is essential. South Africa and Kenya could be used as good examples for Ghana;
viii. There are some structural and non-structural interventions in the Volta Basin of Ghana to support IFM. The non-structural measures need to be implemented fully whereas the structural ones well operated;
ix. IFM has not been integrated into development planning and decision-making processes yet. There is a huge opportunity to do this through the mainstreaming of water security and climate resilient development which have been mainstreamed into the Medium- and Long-Term Development Plans with the support of CWP-Ghana;
x. Communities along the banks of the Volta river (especially in the White Volta) are quite vulnerable to flood risk especially areas with less economic development within the Volta basin. There is therefore good relationship between the level of socio-economic development and vulnerability to flood;
xi. Structural measures help to reduce the incidences of floods but these needs to be combined with non-structural measures in an integrated way so as to not only reduce the impact of floods but fully exploit the economic benefits in a more sustainable way;
xii. Over-dependence on external (donor) support for flood management could be catastrophic to IFM in Ghana.

6. Chapter 6: Recommendations

6.1. Opportunities to implement IFM at a national and transboundary basin level

There is some opportunity to implement IFM at the national and transboundary levels through the Water Resources Commission of Ghana and NADMO with the support of other national agencies such as the National Development Planning Commission (NDPC) and key stakeholders in the Land, Forest, Water, Agriculture, Fisheries, Mining, Energy and Housing Sectors. The use of the River basin offices with the IWRM mechanisms in place in the Volta basin as well as the 10 regional, 243 districts and 900 zonal NADMO platforms used for disaster management offers an enormous opportunity to implement national and basin IFM.

The White Volta Basin Transboundary Committee on Integrated Water Resources (including Burkina Faso, Ghana and Togo) could also be used as a platform to promote IFM at the transboundary level.

Key stakeholders in the basin already have some capacity with regards to flood management which would help reduce the amount of time and resources needed to further develop their capacities on the concept of Integrated Flood Management through tailored trainings or workshops.

WRC and NADMO have developed hydrological models which could be used as basses for the development of a Decision Support System (DSS) on IFM for Ghana.

Some development partners and NGOs (such as the Norwegian government, World Bank, WMO, UNDP, JICA, TAHMO) have supported the country in time past with flood management and might want to continue with this support. This implies there is a high chance of getting external support and hopefully government support to develop and implement a national/basin IFM plan.

There are some structural and non-structural interventions in the Volta Basin of Ghana to support IFM. The non-structural measures need to be enforced or fully implemented whereas the structural ones well operated, so the project might not need to invest in huge infrastructural projects which might make it unfeasible to implement.

IFM has not been integrated into development planning and decision-making processes yet. There is therefore a huge opportunity to do this through the mainstreaming of water security and climate resilient development which have been mainstreamed into the Medium- and Long-Term Development Plans with the support of the WACDEP project;

There are a lot of vulnerable communities in the Volta basin of Ghana especially in the White Volta basin who need support to deal with the impacts of floods. This project could give them a nice opportunity to solve their problems and enhance their socio-economic development. There would therefore be a lot of stakeholder acceptance and approval for the project. Again, there would be some pilot communities which are hotspots to start with.

6.2. Prioritized activities and APFM support in capacity development at a national and transboundary basin level

There is an urgent need to develop the capacities of key stakeholders on the concept of IFM and the development of bankable proposals on IFM at the national, regional and district levels. An effective way to go about this is to start from the national level with a training of trainers for the regions to train the people in their districts with some technical backstopping from WACDEP;

Key institutions in the country including WRC, GMet, HSD, NADMO and EPA need their capacities developed on database management so as to enable the easy sharing of data and information across these institutions.

The capacity of the stakeholders need to be developed to maintain (and update) the hydrological models developed for them by HKV Consultants and Royal HaskoningDHV.

6.3. Potential sources for funding IFM at a national and transboundary basin level

There is some support from the Norwegian government, World Bank, WMO, UNDP, UNEP, JICA and TAHMO to support flood related activities in Ghana. It therefore should not be difficult to approach these agencies through the respective local/regional offices for support on the development of an integrated flood management plan and its implementation in some pilot basins in the country. There is already some support from the WMO to carry out this study and some workshops.

Other sources of funds could include writing bankable proposals to respond to calls on grants on flood management or climate change in general. The Green Climate fund that supports investments in low-emission and climate-resilient development could also be a possible source of funding for the development of national/basin IFM plans.

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Annexe 1: Some of the Key people interviewed during the needs assessment

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