CTCN assistance in Ghana

Improving Resiliency of Crops to Drought through Strengthened Early Warning within Ghana

Roadmap documentation in transfer of technology and scale up

Report / Technical Note

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The expert in WATER ENVIRONMENTS

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CTCN assistance in Ghana

Improving resiliency of crops to drought through strengthened early warning within Ghana Needs Assessment report

Roadmap documentation in transfer of technology and scale up

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Acronyms and Abbreviations

AAP	Africa Adaptation Project
CSO	Civil Society Organisation
CTCN	Climate Technology Centre & Network
DHI	DHI - see more at www.dhigoup.com
EMC	Environmental Management Committees
EPA	Environmental Protection Agency
EPA	Environmental Protection Agency
FASDEP	Food and Agriculture Sector Development Policy
GCF	Green Climate Fund
GIDA	Ghana Irrigation Development Authority
GMET	Ghana Meteorological Agency
GoG	Government of Ghana
GWP	Global Water Partnership
HSD	Hydrological Services Department
MESTI	Ministry of Environment, Science, Technology and Information
METASIP	Medium Term Agriculture Sector Investment Plan
MMDA	Metropolitan, Municipal and District Assemblies
MoF	Ministry of Finance
MOFA	Ministry of Food and Agriculture
MSW	Ministry of Sanitation and Water
NADMO	National Disaster Management Organisation
NAP	National Action Plan
NCCAS	National Climate Change Adaptation Strategy
NCCP	National Climate Change Policy
NDA	National Designated Authority
NDPC	National Development Planning Commission
NGO	Non-Governmental Organisation
NIE	National Implementing Entity
PFJC	Planting for Food and Jobs
SLWM	Sustainable Land and Water Management
UNEP	United Nations Environment Programme
UNEP-DHI	UNEP-DHI Partnership – Centre on Water and Environment
VBA	Volta Basin Authority
WFP	World Food Programme
WMO	World Meteorological Organisation
WRC	Water Resources Commission

1 Introduction

1.1 Backgound and objectives to GCF and CTCN activities

The technical assistance funded by GCF readiness funds and CTCN relates to improving resiliency of crops to drought through a strengthened early warning in Ghana. The objective is to facilitate technology transfer and capacity building for climate change adaptation focusing on dry season management and planning. The support has utilised existing knowledge and capacity and further developed and validated these for applications to local issues with focus on northern Ghana.

GCF Readiness funds have also been allocated to this CTCN technical assistance in order to investigate the potential up-scaling of this scheme to a large scale GCF project to be implemented at the national level. The objective with the potential GCF funded up-scaling is to improve the climate resilience of vulnerable communities by: i) building capacity for water and drought management; ii) strengthening hydro meteorological services; iii) implementing innovative water management practices; and iv) improving knowledge management. The proposed GCF funded upscaling is being developed based on the outcomes of the GCF readiness and CTCN activities.

The CTCN technical assistance was initiated in October 2016 by an **Inception workshop** held in Accra. Based on feedback and discussions from stakeholder consultations a **Needs Assessment report** was prepared to present the objectives and requirements for the technical assistance. The recommendations have then been taken into consideration to draft a more detailed description of the proposed outcome in the **Technology specification report** delivered in February 2017.

Based on the outlined requirement the **Drought Monitoring and Early warning system for Ghana** has been developed and a first version was presented at a **national training** held in Accra in October 2017. This was the opportunity to give insight into the developed system and get feedback from key stakeholders.

In October 2017, a **Second National workshop** was held at the Water Resources Commission in Accra to initiate the **GCF Readiness funds** that had been allocated to this CTCN technical assistance.

Following this workshop, the main applicant (WRC), supported by National experts, has carried out a thorough review of the system followed by a validation of the performance of the latter. The findings have been described in the **Technology Validation report,** delivered in January 2018.

National experts have also assisted WRC in developing a **baseline assessment and gap analysis** of droughts forecasting and management in Ghana. In addition, a **Climate vulnerability assessment** of the agricultural sector has been carried out. The outcomes of these assessments constitute the basis for developing a draft **Concept Note** for the Green Climate Fund. Please visit the CTCN project site[1] for access to all the project deliverables.

[1] CTCN project site https://www.ctc-n.org/technical-assistance/projects/improving-resiliency-crops-drought-through-strengthened-early-warning

1.2 Institutional setting

There are several state institutions and private organisations in Ghana that are involved directly or indirectly in drought management, from community level to national level. The following table presents the relevant institutions, mandates and technical state as regards drought management.

Institution	Mandate/Function	Technical state
Water Resources Commission (WRC)	- Coordinate relevant government policies in relation to them. - Assesses transboundary dimension of droughts and concerted management.	Regulate and manage the utilization of water resources.
Hydrological Services Department (HSD)	Embedded in the mandate of the line Ministry of Works and Housing which is "initiate and formulate policies, coordinate, budget, monitor and evaluate the provision of adequate, safe and affordable shelter, other landed properties, water resource management, provision of safe water, and the development of infrastructure facilities in the area of water, flood control systems, water related sanitation, drainage and coastal protection works and operational hydrology to ensure the efficiency of the sector."	- Consumer of meteorological information to produce hydrological forecasts of streamflows - Generates information for potable water service delivery and hydropower production. - Has capacity to produce seasonal forecast. Organizes workshops to disseminate seasonal forecast to stakeholders.
Ghana Meteorological Agency (GMet)	- Collect and provide localised, accurate and reliable meteorological data - Produce flood and drought forecasts to inform relevant agencies.	- Primary generator of drought information - Employs electronic media to transmit information which is limited. - Has capacity to produce information required. - Use of electronic and print media to disseminate drought information.
Directorate of Crop Services of MOFA	Develop and execute policies and strategies for the agriculture sector within the context of a coordinated national socio-economic growth and development agenda.	- Consumer of drought information - Transmits drought information to farmers.
Environmental Protection Agency (EPA)	- Regulate environmental issues in Ghana. - Enforce laws to safeguard the environment which support provision of agricultural lands and	- Consumer of drought information. - Facilitates platforms for drought and desertification management

	lands for development of housing facilities for people.	
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.	- Consumer of drought information. - Ensures that national development policy and planning account for disaster risk reduction including drought.
National Disaster Management Organisation (NADMO)	- Coordinate relief interventions of disaster affected communities and persons.	- Consumer of drought information. - Transmits drought information to regional, district and local authorities in regions and districts in the context of minimizing impacts on communities.
Ghana Irrigation Development Authority (GIDA)	Formulate, develop and implement irrigation and drainage plans for all year round agriculture production in Ghana.	- Consumer of drought information Provides technical assistance to farmers in the area of agricultural water management including soil and water conservation.

Table 1-1 National Institution, mandate and technical state in relation to drought management in Ghana

1.2.1 Responding to drought and emergency

The National Disaster Management Organisation (NADMO) is responsible for disaster response in Ghana. Awareness creation on disasters including drought is carried out by the staff at zonal level together with relevant technical institutions of district assemblies and regional coordinating councils including MOFA, Planning Officers and Information Service Department.

When drought takes disastrous proportions, NADMO steps in with relief items to alleviate the plight on the affected persons and communities. The relief items are mostly food related since farms are affected, impacting the food security of farmers. There have been instances where the World Food Programme (WFP) also participated in supporting government effort with food items.

Aside the distribution of relief items to affected persons, there are efforts to build resilience of farmers in food production systems through capacity building to improve soil moisture as well as soil fertility. Also, the Ghana Government has established a food buffer stock company to support measures towards food security in the event of crop failure.

Further, a riparian buffer zone policy was formulated to protect watersheds in 2013. Following, the Adaptation Fund project currently ongoing and implemented by EPA is supporting vulnerable communities to prepare micro watershed plans.

1.2.2 Existing coordination mechanism for drought management

NADMO is the institution responsible for managing disasters, to the extent that drought is a climate hazard and classified as such when it takes place. As part of the Africa Adaptation Project (AAP), the EPA facilitated broad-based participatory environmental planning and management. In this regard, platforms were set up for desertification and

drought control at four levels in the country notably national, regional, district and community levels. These are Environmental Management Committees (EMCs) on desertification and drought with the responsibility to implement the National Action Plan (NAP) activities at national, regional, district and community levels. The EMC is an interdisciplinary committee composed of 11 to 15 governmental and non-governmental institutions with the requisite expertise in the subject area. Whereas the national level representation is national in character, regional EMCs focused on the three regions of the north notably, Northern, Upper East and Upper West. At the regional level, the EMC is made of regional heads of departments and organizations, such as the EPA, Forestry Services Division, MOFA, Fire Service and Regional Planning and Coordinating Unit, and representatives of NGOs, CSOs, private sector, women organizations, District Assemblies and traditional local and regional authorities.

1.2.3 Related past and ongoing projects in Ghana

There are a number of ongoing and past projects of relevance for the CTCN and GCF assistance. The below table lists the relevant past and ongoing projects related to drought early warning and climate change adaptation.

Project title	Duration	Stakeholder	Notes
Community Resilience and Early Warning	2014 - 2016	NADMO	Early warning system for flood and drought to be evaluated.
Enhancing resilience to climate and ecosystem changes, extreme value analysis	2012 - ongoing	GMET	
Water Climate and Development Programme	2011 - 2015	GWP	Climate change impact on water resource and indirectly on drought
Weather research and forecasting modelling	Ongoing	GMet	Opportunity to collaborate on the climate forecast part
Monitoring water availability for allocation taking into consideration drought	Ongoing	WRC	
Water Development and climate resilience project	Ongoing	GWP	
Integrated Drought Management Programme	Ongoing	GWP	Global project executed by GWP and WMO focusing on the policy aspects, but there are outcomes of relevance for the assistance
UNEP project Flood & Drought Management Tools	2014 to 2018	Global project with VBA as the key stakeholder in the region.	Outcomes related to drought management and data to be used.

Table 1-2 Key ongoing and past projects related to the CTCN and GCF assistance

1.3 Agriculture Sector Policy Interventions

The Government of Ghana identifies the agriculture sector as a possible vehicle for national economic growth and food security. There has been some government policy that leads to alleviate rural poverty, improve household food security and the nutritional status of individuals. The intension is that these can be achieved by improving the overall food availability and increase income earning opportunities in farming (Alessandro De Pinto et al., 2012).

Government has intensified research into impacts, vulnerability and adaptation of climate change on agriculture, human health and water resource systems as an immediate need. To minimise sensitivities to climate change, the Ghanaian economy is to be more diversified and agricultural technology optimised with regards to water usage through efficient irrigation and crop development as water resource stresses become acute in future.

Whilst some of these policy interventions will require some level of commitment on the side of Government, the benefits that will accrue through the flow of foreign direct investments, technology development and transfer and impact on sustainable development through poverty reduction, economic growth and good environmental stewardship are immense and could far outweigh the physical cost to Government.

There is also the need to involve policy makers to make them understand the complexities with which climate change affects the poor to enable them integrate policy interventions on climate change and mainstreamed into national development planning (Policy Advice Series No 13, 2012).

That notwithstanding, there are several policies that support Ghana's commitment to adapt to the impacts of climate change in the agriculture sector. These are briefly described in the following sections.

1.3.1 Food and Agriculture Sector Development Policy (FASDEP I) 2002

This was the first Food and Agriculture Sector Development Policy (FASDEP) developed. FASDEP I provided a framework for the implementation of strategies for the modernizing of the agricultural sector and making it a catalyst for rural transformation. The strategies in the policy were based on the Accelerated Agricultural Growth and Development Strategy (prepared in 1996), and were designed to forge linkages in the value chain.

Government's policy objective for the sector in 2017 (and the next four years) is to modernize agriculture, improve production efficiency, achieve food security and profitability of farmers, all aimed at significantly increasing agricultural productivity (GoG, 2017). This is under the "Planting for Food and Jobs" (PFJC) campaign by the current Government and aims to focus on maize, rice, soybean, sorghum and vegetables (Policy Brief 5, 2017).

Education, training and public awareness is crucial for the success of any Government policy intervention and for the sustenance of programmes that would be undertaken to adapt to the climate impacts for the agricultural sector.

1.3.2 Food and Agriculture Sector Development Policy (FASDEP II) 2007

Food and Agriculture Sector Development Policy (FASDEP) II policy is developed to guide the development and investment in the Ghanaian agricultural sector. It seeks to

enhance the environment for all categories of farmers, while targeting poor and risk prone and risk-averse producers. The policy also ensures consistency with national development objectives as specified in the Growth and Poverty Reduction Strategy II (GPRS II) which aims to achieve accelerated and sustainable shared growth, poverty reduction, gender equity, protection and empowerment of the vulnerable and excluded within a decentralised and democratic environment.

Early warning systems and emergency preparedness in the FASDEP II defined emergency preparedness as the assessment of the country's readiness to respond to the needs of victims of natural hazards and other calamities including climate change impacts. In the case of food it is the ability to provide food to affected persons in times of disaster. It recognizes the fact that poor weather (drought and floods) are the main natural causes of emergency food insecurity.

1.3.3 National Climate Change Adaptation Strategy (NCCAS) 2012

Ghana's National Climate Change Adaptation Strategy (NCCAS) is to ensure that climate change issues are adequately considered in national development planning and ensure a comprehensive and action-oriented response to national concern about impact of climate change and its associated disaster on individuals, communities and national development. The policy aims to reduce loss of life as well as the social, economic and environmental losses caused to communities and to a large extent possible ensure an added vulnerability to the Ghanaian economy attributed to the expected impacts of climate change on the entire society.

The basic goal of the strategy is to increase Ghana's resilience to climate change impacts through improved awareness, effective mainstreaming and consistent efforts to reduce vulnerability in natural and social systems.

1.3.4 National Climate Change Policy (NCCP) 2013

Ghana's integrated response to climate change is the National Climate Change Policy (NCCP). This policy provides well-defined strategies for dealing with the challenges of climate change. The policy incorporates current socio-economic setting of Ghana as well as the opportunities and benefits to response to climate change. The NCCP Phase I, presents policy analyses and gives the broad policy vision and objectives. The NCCP Phase II presents sector initiatives and programmes that have been identified in the form of Action Programmes for implementation.

For the agricultural sector, the policy provides the development of climate-resilient agriculture and food security systems as a means of enhancing agriculture production. This is to be achieved through planning for agriculture development with focus on increasing productivity and production whilst addressing climatic constraints. It also deals with the need for mainstreaming climate change and variability into food and agriculture development planning to ensure sustainability of achievements. Awareness creation, capacity building, improved training curricula and appropriate integration into existing processes has been identified as an effective way to mainstream climate change into the food and agricultural sector policies.

1.3.5 Medium Term Agriculture Sector Investment Plan (METASIP I (2014-2017) & II (2011-2015))

The Medium Term Agriculture Sector Investment Plan (METASIP) was to implement the objectives outlined in the FASDEP II. The plan was based on FASDEP II objectives with a target for agriculture sector GDP growth of at least 6% annually and government expenditure allocation of at least 10% of the national budget within the plan period, (MoFA, 2011 report). These targets are in conformity with the agricultural performance targets, which meet the standards of both national and international Institutions. The objectives of METASIP, in line with the objectives of FASDEP II are as follows: Securing food security and emergency preparedness; improve growth in incomes; increase competitiveness and enhanced integration into domestic and international markets; sustain management of land and environment; science and technology applied in food and agriculture development and improve institutional coordination, (FASDEP II; 2007) which it believes can help support climate vulnerability interventions in the agriculture sector.

2 Strategic context for a national scale deployment of the drought early warning technology

Ghana's agriculture and food production systems are based on exploitation of natural resources, with extensive crop and livestock production systems, rain-fed agriculture, hunting, and fishing. Climate change, in addition to non-climate drivers such as soil degradation, land tenure arrangements and poor technology, is expected to have significant impacts on these resource dependent sectors, and consequently food security.

To contain climate change including drought there is the need to take actions that would enable the country to achieve sustainable development. These include broad actions to strengthen the capacity of the vulnerable groups to cope with climate variability, such as improving human resources, strengthening institutional systems, providing food security and putting public finances on a sound footing. Furthermore, actions are needed to ensure that natural resources most sensitive to climate variability and change, such as land systems are sustainably managed (Climate Change Adaptation and Mitigation, 2008).

It is important to ensure information and data flow on climate change, including the quality of data, access to data and gathering including sharing and translation of that data. The research needs on climate change are significant, starting with the pressing need for better projections on possible impacts, backed by effective knowledge systems to inform strategy, planning and practice.

Particularly for the agriculture sector it is important to build and strengthen capacity of local farmers to increase agricultural productivity and awareness of climate issues whilst strengthening the capacity of extension officers in new farming technologies in order to enhance their support for farmers. Promoting the cultivation of crops and rearing of animals is key in adapting to harsh climatic conditions. There is also the need to train trainers to promote post-harvest technologies to minimize losses of farm produce.

For drought early warning activities, there is the need to promote the development of modern information management systems for data collection, processing and dissemination of information and to encourage evidence-based decision making.

2.1 Context (Activities carried out through the Readiness Program)

2.1.1 Developed drought early warning technology

The overall objective of the CTCN technical assistance implemented through the GCF readiness programme is the development and implementation of a drought early warning system facilitating the provision of timely and effective information related to the water and agriculture sectors allowing these sectors to take actions to mitigate impacts of upcoming droughts. The established drought early warning system is a web-based system allowing relevant stakeholders to utilize the system without the installation of any software. The technical design of the system is based on the feedback from the national workshop and the stakeholder consultation meetings during the initial part of the technical assistance.

The drought early warning system enables decision makers and stakeholders to use the transferred knowledge, practices and technologies actively in the dry season planning. The solution focuses on improving the adaptation to upcoming drought events by supporting elements within the risk management part of the drought management

process. The crisis management or the response to an already occurred drought event or disaster will not as such be included in the outcomes of the CTCN assistance. The drought early warning system is described in details in the deliverable "Technology description and user guide"[2].

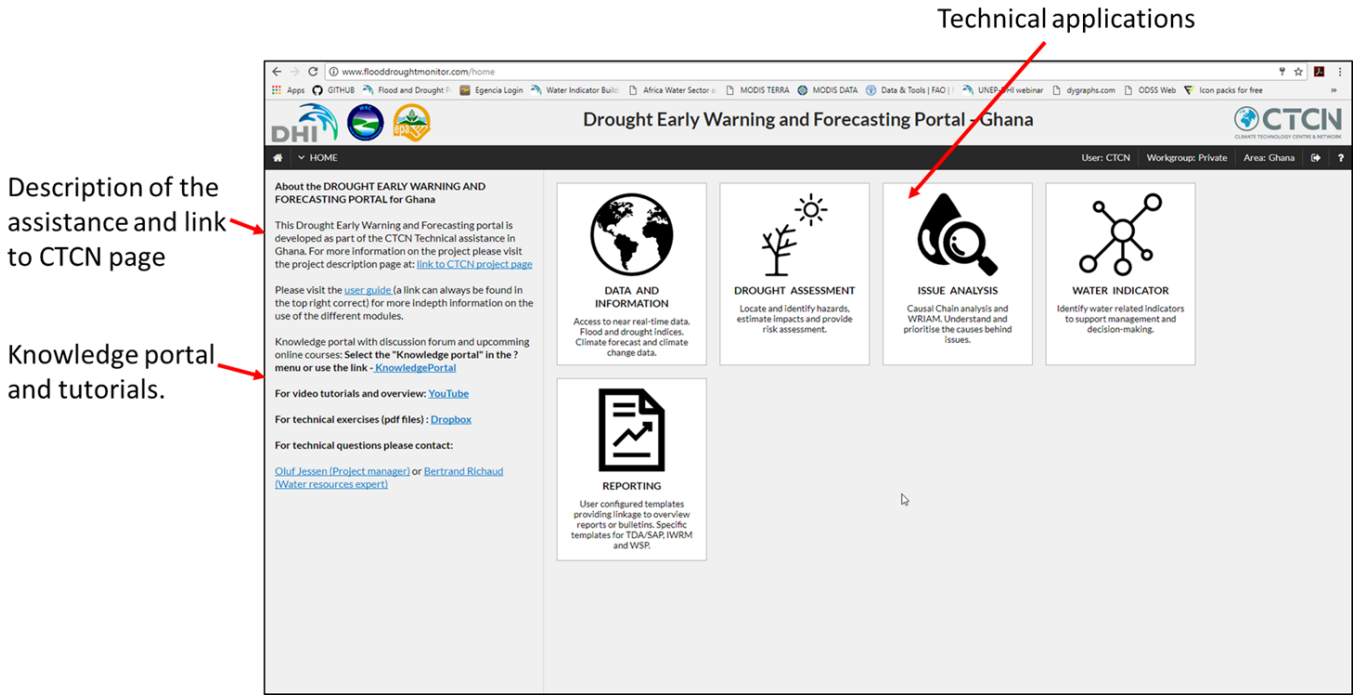

Figure 2-1 The Drought Early Warning and Forecasting Portal developed as part of the CTCN assistance (www.flooddroughtmonitor.com)

2.1.2 Outcomes from the second national workshop, October 2017

The second national workshop marked the finalisation of technical development within the GCF/CTCN funded technical assistance on "Improving resiliency of crops to drought through strengthening early warning". The workshop was held at the Water Resources Commission in Accra, Ghana on October 26th, 2017.

The national workshop took place over a full day and provided an overview of the technical outputs from the CTCN and the upcoming GCF activities, but was also an important workshop for defining the scope of the proposed GCF full size project.

The key outcomes from the national workshop are:

- *There is a strong engagement in the process of further developing and distributing the developed drought early warning portal among the stakeholders*
- *The developed web based portal for drought management and early warning is an important step for strengthening the national capacity*

[2] All deliverables are available on the site https://www.ctc-n.org/technical-assistance/projects/improving-resiliency-crops-drought-through-strengthened-early-warning

- *The Water Resources Commission will be the anchoring stakeholder for the technology and will ensure that all stakeholders are kept updated and involved after the closure of the CTCN assistance*

2.1.3 Outcomes from the Final national workshop, April 2018

The **Final workshop** marked the official end of the GCF readiness activities presents the final outcomes of the GCF readiness activities and look towards a potential GCF full scale project implemented with UN Environment as the accredited implementing entity for GCF projects.

The **expected outputs** of the workshop was (1) knowledge of the key outcomes of the GCF Readiness fund activities within the key national organisations (2) national acceptance of the draft concept note for a future up-scaled GCF project and (3) agreement on the next steps in the application process.

The workshop was very successful with participation of all the invited stakeholders, some of the key outcomes from the national workshop related to the future sustainability was:

- The participants acknowledged the importance of drought in Ghana and the need for technology supporting the staff at the key organisations related to drought management and early warning.
- There is a strong interest and support for future activities aiming at strengthening the national capacity and knowledge to handle and plan for future impacts related to climate variability and climate change
- The participants acknowledge that future activities should not be limited to drought management but extended to management of dry spells or water scarcity in general with specific focus on climate resilient solutions for the water management and food production in Ghana.
- The participants supports the appointment of UN Environment as the Accredited Entity for supporting Ghana in the application of a full size GCF funded project with the title “Improving resilience of food security and water management to climate variability and change”
- The participants supports the decision of submitting a concept note for GCF funding using the Simplified Approval Process as suggested by UN Environment. The selected process limits the budget to 10 mio. USD but increases the likelihood of a successful project application.

2.2 Obstacles and gaps in project implementation

2.2.1 Institutional gaps and barriers

The historical approach to agricultural development in Ghana has focused on increasing productivity, with limited attention to the potential impacts of climate change. Drought management is primarily reactive, with the National Disaster Management Organisation (NADMO) coordinating relief services in the event of a disaster – including droughts. In contrast, a proactive approach to drought management is a cross-cutting exercise, requiring input from experts in a variety of fields, including hydro meteorological, agricultural, livestock, water resources and socio-economic services.

A gap analysis[3] on drought-risk management and early warnings in Ghana and a Capacity Needs Assessment[4] of the Ghana Meteorological Agency (GMET) revealed several barriers to building the resilience of the agricultural sector to the impacts of climate change. These include limited:

- Institutional and technical capacity in the Ghana Meteorological Agency (GMET) to produce reliable observation and forecasting data for drought-risk assessment and early warning systems;
- Capacity within government institutions for the collection, analysis and transfer of climate information and adaptation technologies to inform drought-risk management and dry season planning;
- Collaboration between research institutions for the enhancement of climate information services;
- Awareness of best practices for drought management and climate change adaptation; and
- Definition of roles and coordination between technical institutions involved in the monitoring process at both the national and local levels.

2.2.2 Technical gaps

At the stakeholder consultations towards preparation of this present report, some issues raised were consistent with the concerns contained in the inception workshop report of the Community Resilience through Early Warning (CREW) project held in 2013[5]. The relevant technical issues that hinder generation of drought information and dissemination have been noted as follows:

- The meteorological and hydrological services operate two systems of forecasts for droughts that are not integrated.
- There was need to agree on definition of drought, taking into account its severity to trigger early response.
- There is need to automate hydrological and meteorological data generation and collection systems.

The infrastructure provides basis for measurement of the parameters and collection of data needed to scientifically establish drought occurrence. In Ghana, meteorological and hydrological services departments lack modern observation and research infrastructure to carry out climate monitoring which undermines data reliability. There is an urgent need to upgrade and automate the observation networks to guarantee viable drought risk profiling using measured and collected quality data as well as geospatial data. Limited equipment limits monitoring of drought occurrence and impacts.

In the current practice, there appears to be competition and duplication of effort between GMET and NADMO where both institutions produce drought information using two separate platforms. GMET is the primary source of drought information but appears to

[3] UNDP. 2011. Mainstreaming Drought Risk Management – A primer.

[4] CTCN. 2016. Ghana Meteorological Agency Needs Assessment Report.

[5] Community Resilience through Early Warning, UNDP, http://www.gh.undp.org/content/ghana/en/home/operations/projects/environment_and_energy/crew.html

operate in isolation such that the platform in use is not linked to NADMO's. It is noted that drought information produced by NADMO is expected to trigger government intervention towards provision of relief items to affected persons. If linked, then drought information arising from GMET will trigger anticipation and possible rallying of support with relief items to persons to be affected which NADMO is expected to coordinate. During the stakeholder consultations for the present process, the need to integrate the two platforms was strongly advocated for and currently a major concern.

Drought monitoring and early warning products should be tailored to suit the needs of end-users. This will foster incorporation of the information obtained in the operational decision making. As a result, it is important to ascertain the different stakeholders at national, regional and district levels including farmers and their drought information needs or required services. For example, agriculture including crops and livestock sub-sectors may require information on the onset and end of the rainy/dry season and the distribution of rainfall to identify the optimal timing of planting, livestock destocking or restocking, supplementary feeding and pasture rotations. However, during consultations, some farmers noted that extension services information only focused on crops sub-sector to the detriment of others. Often, the water sector is more interested in changes in streamflow and reservoir level thus informing water resources planning for hydropower generation, irrigation and industrial or domestic uses.

Usability of drought products by different stakeholders must be reviewed continually to improve communication and feedback mechanisms between the producers and users of information.

2.2.3 Financial obstacles

Given the current economic situation in Ghana, the contribution of funds by international donors or other funding agencies are essential for a successful implementation of climate change related interventions. Without the investments the livelihoods of the population in Ghana that are reliant on the agricultural sector are at risk to the threats of climate change. It is expected that impacts of climate change and climate vulnerability will affect a large part of the country in the coming years. The agricultural sector in Ghana is already largely reliant on foreign funding, with ~65% of total public expenditure in support of food and agriculture funded by external sources including the World Bank, USAID and the European Union[6]. The need for external funding is compounded by the current state of the Ghanaian economy. Despite a period of rapid economic growth over the last two decades graduating Ghana to lower middle-income status, the country's economy has seen a decline in growth over the past five years[7]. Increasing debt, high inflation and currency depreciation have contributed to the deterioration of the economy, leading to a current account deficit of -7.5%[8] and a debt-to-GDP ratio of 73.9%[9]. Further challenges to Ghana's economic outlook include inflated domestic financing costs, technical problems in the oil and gas sectors, energy problems related to state-owned enterprises and continued weak commodity prices[10]. These factors result in an unfavourable fiscal climate

[6] FAO. 2014. Analysis of Public Expenditure in Support of the Food and Agriculture Sector in Ghana, 2006-2012: A preliminary assessment. Technical notes series, MAFAP, by Ghins, L., Rome.

[7] IMF Survey – 2016 – Ghana: The Bumpy Road to Economic Recovery. Available at: www.imf.org/.

[8] World Bank – 2015 – Current account balance (% of GDP). Available at: http://data.worldbank.org/.

[9] http://www.tradingeconomics.com/ghana/government-debt-to-gdp

[10] World Bank – 2017 – Ghana Country Overview. Available at: http://www.worldbank.org/en/country/ghana/overview.

for the Ghanaian government to secure loan financing for large-scale investments into innovative climate change adaptation measures.

3 Roadmap for transfer of technology, national scale up and project expansion

3.1 Sustainability plan for the current drought early warning technology

The sustainability plan for the current drought early warning technology is based on the following recommendations:

- **Responsible agency**: The Water Resources Commission (WRC) will be the anchoring stakeholder for the technology and will ensure that all relevant stakeholders are kept updated and involved after the closure of the CTCN assistance. UNEP-DHI will support WRC through e-mail and Skype to solve any questions or issues that may arise after the closure of the assistance.
- **National stakeholders**: The relevant national stakeholders where identified during the implementation of the assistance, and the majority of them have been actively engaged in the technical training and workshops. WRC will be responsible for the dissemination of information and follow up on the engagement and use of the technology by the stakeholders after the closure of the assistance. Additional stakeholders approaching WRC or UNEP-DHI will be granted access to the drought early warning portal, the associated user guides and technical descriptions.
- **Technical capacity and training**: The technical capacity for active use of the drought early warning technology is currently present in Ghana, as a number of agencies participated in the technical training. WRC will be the “champion” for the national agencies and will address immediate needs for further training. It is anticipated that further training and capacity building will be required at a later stage to maintain the technical capacity and knowledge to use the system. This issue is to be addressed in future projects as it will require external funding.
- **National coverage**: The current drought early warning technology covers the entire country but is only validated against the conditions in the upper east region of Ghana. In order for the technology to be applied on a national scale, the drought early warning technology needs to be validated against the entire country and especially the southern part, due to different climatic conditions. Recommendations for validation against the conditions within the entire country should be addressed in future projects, and are addressed in the proposed upscaling through a GCF funded project.
- **National institutional strengthening**: The long term sustainability of the drought early warning technology will depend on future institutional strengthening. This includes the creation of a clear mandate for drought management and planning within the national agencies as well as a coordination of the national drought platforms between GMET and NADMO. Both recommendations are addressed in the proposed upscaling through a GCF funded project.
- **Embed into national drought management**: It is essential to embed the drought early warning technology into the national drought management to

ensure the long term sustainability. This is not possible at the moment due to required institutional strengthening and most importantly the need for national validation and testing of the technology. This adds further importance to the recommendation for national coverage and institutional strengthening. Both issues are to be addressed in future projects, and are addressed in the proposed upscaling through a GCF funded project.

- **Maintenance**: The established web based drought early warning technology will be hosted through the implementing agency, UNEP-DHI, and maintained in operational mode for at least 3 years after the closure of the current CTCN and GCF funded activities. The situation and the need for additional funding for maintaining the drought early warning technology after the 3 year period will be assessed at a later stage. The issue will be addressed in the proposed GCF funded project, but it is recommended to look for additional funding in case the proposed GCF project is not implemented.

- **Financial resources**: The sustainability of the technology in the short term, 1 to 3 years, is secured through the outcomes of the assistance as there are technical capacity and knowledge to use the system for the northern part of Ghana. Financial resources will be needed to ensure national coverage and to address the issues related to institutional strengthening and training. The most likely sources will be donor funds through future project applications. UNEP-DHI and WRC will both be active in pursuing additional funding opportunities to address the sustainability requirements. The immediate funding opportunity is the proposed GCF funded project.

- **Upscaling and further support**: The implementing agency, UNEP-DHI, will actively engage in a process for upscaling the current technology and provide funds for further anchoring the drought early warning system within Ghana through an application for a full scale GCF funded project. The application for funding through a GCF funded project is currently seen as the best option for additional funding to ensure long term sustainability, as this will address the issues related to the institutional strengthening, national coverage, technical training and cost for hosting the web solution after the 3 year period.

3.2 Reccomendations to overcome gaps

The identified key recommendations to overcome gaps related to sustainability, upscaling and active use of the drought early warning technology are briefly described below. Further details are added to the recommendations in the following sections:

- **Institutional strengthening and training**
    - Institutional strengthening resulting in a clear national mandate for drought management.
    - For future projects there should be established an active and engaged project steering committee which will be able to advise and direct the project with respect to issues directed towards the national governance structure.
    - Training and capacity building beyond the current level to ensure a long term sustainability of the established drought early warning technology.

- The developed web based portal for drought management and early warning is an important step for strengthening the national capacity, and future projects should build on the outcomes of the CTCN and GCF assistance.

- **Technical and financial capacity needs**

  - Align technical solutions at different agencies ensuring that tools and platforms are aligned and compatible, allowing for information and decisions to be embedded across national agencies.

  - Upscale technology to national level as the current drought early warning technology is only validated for the Upper East region of Ghana. It should be noted that the established drought early warning portal covers the entire country, but the results in the southern part of the country are not validated against ground date.

  - Improve the data availability for drought management at national level. This mainly relates to improved hydro-meteorological measurements, but also to the use of new technologies and data types as satellite based data.

  - Improving the capacity and knowledge gaps for climate and hazard data collection, transmission and processing. This relates to the collection, quality assurance and management of data in general, and moving from paper based to digital based data storage and management.

  - Extending the local knowledge of satellite data and performing additional validation and ground proofing on the use of satellite data for drought management in Ghana. It is anticipated that a large part of the current ground observations will be replaced in the future by remotely observed data sources from satellites, drones, airplanes etc.

  - Future activities should not be limited to drought management but extended to management of dry spells or water scarcity in general, with specific focus on climate resilient solutions for water management and food production in Ghana.

  - Identify financial sources to cover the maintenance after the 3 year period covered by the assistance. The current CTCN/GCF assistance will maintain the technology in operational state for the coming 3 years, and additional funding will be required after that period.

  - Identify financial resources for upscaling of the current technology. WRC and UNEP-DHI are actively engaged in the process of identifying and pursuing future funding opportunities for upscaling the current technology.

  - Actively pursue the application of a full size GCF funded project with the title “Building climate resilience of the agriculture sector in Ghana through improved climate information and early warning services”. The stakeholders support and recommend the appointment of UN Environment as the Accredited Entity for the application. The stakeholders supports the decision of submitting a concept note for GCF funding using the Simplified Approval Process as suggested by UN Environment. The selected process limits the budget to 10 mio. USD.

- **Dissemination and stakeholder engagement**
    - Capacity building and training are vital for a successful implementation of a drought early warning system. An important lesson learned is that activities related to capacity building and training should be increased and that it is important to have capacity building events not only with technical staff but as well on management level.
    - Prioritise the linkage between national level planning and local level implementation of drought measures as this is a key focus area in Ghana.
    - Stakeholder analysis based on extensive consultations with key stakeholders are required in the initial phase of the project to identify and address potential issues and conflicts.
    - Establish linkage between climate scientists, the national agencies and the local farmers.

Further details are added in the following sections.

3.2.1 Recommendations for the required institutional strengthening and training

Drought is multi-faceted and requires different disciplines to combine efforts at characterizing it. Therefore, harmonizing perspectives is a pre-requisite and preferably should be performed and facilitated through a champion institution or a range of well trained and coordinated experts with a clear and precise mandate for drought management on national and local level.

Coordination

The institutional setting for drought risk management is currently not well defined. NADMO was established to coordinate relief services in the event of disasters including drought, and disaster risk management, particularly relating to drought is gaining grounds in the country, taking into account a proactive approach of preparedness and planning prior to its occurrence. NADMO is currently reviewing the Act that set it up to include disaster risk reduction which will seek to embrace the proactive approach to risk management, as coordination is missing in the current practice. Clearly, the multiplicity of drought indicators requires experts in different fields, recognising that drought monitoring is a cross-cutting exercise and does not necessary fall under the sole mandate of meteorological or hydrological agencies, but also relies on agricultural, livestock, water resources and socio-economic services. Therefore, roles of the various technical institutions involved in the monitoring process must be clearly defined and coordination mechanism established at both the national and local levels.

Further, setting up of Environmental Management Committees (EMCs) with consideration of desertification is quite broad and risks relegating the issues of drought to the background. It should be noted that at the heart of drought management is water and that water tends to assume a central role, taking note of its state in each of the sectors. Therefore, bringing the issues of drought under the umbrella of water resources to facilitate stakeholder coordination is worth considering.

Strengthening scientific and technical capacity for drought risk management

Capacity and knowledge gaps in climate/hazard data collection and processing should be identified and an enabling policy and institutional environment established to bridge gaps.

The drought risk management process starts with the meteorological agency, which should therefore demonstrate capacity for weather monitoring, collection, mapping out, processing, analysing and storing all forms of meteorological data. It should have access to advanced forecasting technologies and modern equipment to measure and transmit. Further, the technical capacity to operate them is key and GMET acknowledges that new staff is needed to augment their service delivery and support operations of the agency. Capacity building and technical capacity are required in order to catch up and match the capacity requirements to generate and produce drought risk information.

Also, lessons from the Sustainable Land and Water Management (SLWM) initiative indicate that community members and farmers need drought risk reduction knowledge and skills in order to proactively address the menace of drought.

Recommendations for the required institutional strengthening and training

The key recommendations related to the required institutional strengthening and training are:

- The current institutional setting related to drought management and forecasting is not clearly defined and should be addressed. The roles of the various technical institutions involved in the monitoring process must be clearly defined and a coordination mechanism established at both the national and local levels. Therefore, bringing the issues of drought under the umbrella of water resources to facilitate stakeholder coordination is worth considering.

- There might be a need for a “champion” office or commission with the responsibility of addressing and driving the process related to especially the proactive part of drought management (planning). There should be a clear and direct linkage to some of the current key agencies related to drought management such as WRC, GMET, NADMO and MOFA.

- Setting up of Environmental Management Committees (EMCs) with consideration of desertification is quite broad and risks relegating the issues of drought to the background. A more specific focus on drought is proposed within these settings.

- Technical capacity related to weather forecasting, numerical modelling, data and information management etc. needs to be strengthened and improved through training and capacity building events. The details of the recommendations will have to be specified at the time of future projects as the requirements will change over time.

- Stronger linkage between the academic environment and the implementing agencies to strengthen the active implementation of new technologies and methods in Ghana e.g. use of satellite based data sources, more efficient monitoring or data management techniques. This could be done through workshops or engagement of research staff at national agencies.

3.2.2 Recommendations for the required technical and financial capacity needs

The recommendations for the required technical and financial capacity are direct outcomes of the workshops initiated as part of the assistance and the stakeholder consultations during the entire length of the assistance.

Technical capacity needs

The key issues related to the technical capacity needs relates to i) availability of data and information, ii) alignment of technical solutions and iii) linkage between national agencies and local level implementation of drought measures.

The availability of data and information is a key concern as the current observation network at GMET is inadequate for a detailed an updated description of the drought status within Ghana. Updating the observation network includes the procurement of costly equipment related to rainfall stations, weather radar, river discharge stations, water quality sampling etc. There is an urgent need to upgrade and automate the observation networks to guarantee viable drought risk profiling using measured and collected quality data as well as geospatial data. Limited equipment is an obstacle to monitoring of drought occurrence and impacts. An update of the current observation network will be costly and, in order for it to be sustained, an extensive package of training and maintenance will have to be allocated on a yearly basis, as the use of efficiency of the equipment otherwise will degrade over time.

The alignment of the technical systems used at different national agencies, mainly GMET and NADMO, are currently a limiting factor for the dissemination and sharing of information between agencies and coordination of efforts for mitigating future drought events. If linked, then drought information arising from GMET will trigger anticipation and possible rallying of support with relief items to persons to be affected which NADMO is expected to coordinate. During the stakeholder consultations for the present process, the need to integrate the two platforms was strongly advocated for and currently a major concern.

Drought monitoring and early warning products should be tailored to suit the needs of end-users. As a result, it is important to ascertain the different stakeholders at national, regional and district levels including farmers and their drought information needs or required services. Usability of drought products by different stakeholders must be reviewed continually to improve communication and feedback mechanisms between the producers and users of information.

Financial capacity needs

The contribution of funds by international donors or other funding agencies is essential for further upscaling the drought early warning technology, as well as for implementing the listed recommendations related to institutional strengthening and further capacity building and training. One of the key recommendations is to actively identify and pursue funding opportunities for implementation of the identified recommendations.

Currently, a GCF concept note is being developed (June 2018) with the objective of upscaling the outcomes from the CTCN and GCF readiness activities to a national project. This process involved the GCF focal point in Ghana (Mr. Frimpong Kwateng-Amaning, Director of the Real Sector, Ministry of Finance of the Republic of Ghana), WRC and the technical committee associated with the NDA in Ghana. The GCF concept note is finalised by UNEP-DHI with the assistance of experts from the C4 Ecosolutions group.

Recommendations for the required technical and financial capacity needs

The key recommendations related to the required technical and financial capacity needs are:

- New technology applying data sources available at less cost in close to near real time as remotely sensed data should be used more actively to extent the local

knowledge of drought throughout the country. The linkage to research communities and experts is vital for using the latest technology and methods maintaining a cost effective observation system with less need for on the ground maintenance and service. It is anticipated that a large part of the current ground observations in the future will be replaced by remotely observed data sources from satellites, drones, airplanes etc.

- Alignment of technical tools and platforms across agencies should have a high priority in future projects and activities related to drought management. If a clear mandate for drought management is put in place then any alignment and coordination of technical tools and platforms would be easier to facilitate.

- Regarding the financial resources then one of the key recommendations will be to identify funding opportunities to support the long term sustainability and further development of the drought early warning technology in Ghana. The most obvious funding sources are international donor organisations, as UNDP, the World Bank and UN Environment are active in Ghana.

3.2.3 Recommendations for the dissemination and stakeholder engagement processes

The ability to introduce new technologies and maintain the capacity of the local experts within the area of drought management in Ghana depends on the adaptation of new research and methods by national agencies and private sectors. A central component is the research environment in Ghana and the linkage between the research institutes, the national agencies and the private sector. There is a need to promote the collaboration and inclusion of research initiatives into climate change and water related initiatives through awareness raising events and workshops focussing on the collaboration between the sectors. The focus should be on strengthening the collaboration and awareness to ensure that research initiatives in Ghana are linked with future action plans and initiatives.

Usability of drought products by different stakeholders must be reviewed continually to improve communication and feedback mechanisms between the producers and users of information. One of recommended approaches is the use of mobile based services linking water resources and drought management at national level with guidance and implementation of drought resilient measures at local level. Examples could be a mobile based service enabling farmers to get guidance on when to plant a specific crop: the advice would be based on tools on national level and tools with climate forecast and crop models will provide guidance to farmers. Another example could be farmers taking pictures of their crop and the application will then guide the farmer on drought measures for coping with dry spells etc.

Proper dissemination of information as well as linkage between national and local level will have a key impact on the stakeholder engagement at all levels.

Recommendations for the required dissemination and stakeholder engagement processes

- Establish linkage between climate scientists, the national agencies and the farmers. This is a key component to ensure the long term sustainability of the drought early warning technology, and ensure the use of more cost effective methods and tools.

- Prioritise the focus on the linkage between national level planning and local level implementation of drought measures as this is a key focus area in Ghana. Tools

based on crowd sourcing methods could be recommended as the use of mobile phone are increasing rapidly even in very remote areas in Ghana.

- Stakeholder analysis based on extensive consultations with key stakeholders are required in the initial phase of the project to identify and address potential issues and conflicts with the project.

3.3 Upscaling possibilities through a GCF funded full scale project

In collaboration with the GCF focal point in Ghana (Mr. Frimpong Kwateng-Amaning, Director of the Real Sector, Ministry of Finance of the Republic of Ghana) a GCF concept note is developed (June 2018) with the objective of upscaling the outcomes from the CTCN and GCF readiness activities to a national project.

The proposed project will build on GCF readiness programme activities to elicit a paradigm shift in Ghana's approach to water and drought management. This will be achieved by: i) building institutional capacity for water and drought management; ii) enhancing hydro meteorological service delivery systems; iii) creating linkages between farmers and national institutions; and iv) improving knowledge management frameworks.

The proposed project will build on GCF readiness programme activities. This will be achieved by building on existing institutional structures to strengthen the national capacity for drought management and planning, with a focus on improving food production and water management under future climate scenarios. The proposed project components and their associated activities are outlined below.

Component 1: Capacity building, *Output 1: Strengthened institutional capacity for national water and drought management under future climate scenarios.*

Component 2: Technology Transfer, *Output 2: Strengthened technical capacity of regional and national policymakers, technical officers and local communities for climate-resilient water and drought management.*

Component 3: Climate Information Based Planning, *Output 3: Improved transfer of climate information between various levels of government and vulnerable farming communities to support local level planning for food production.*

Component 4: Knowledge Management, *Output 4: Improved knowledge management frameworks for the collection and maintenance of national and regional information on climate change adaptation practices.*

The proposed GCF funded activities are actively pursued by UNEP-DHI and the milestone will be as follows i) development of GCF concept note for the simplified approval process within GCF (July 2018), ii) approval and feedback from the national technical committee at the NDA office in Ghana (July 2018), iii) submission of GCF concept note by August 2018.

3.4 UNCCD collaboration

UNEP-DHI is actively engaged with (United Nations Convention to Combat Desertification) UNCCD in the development of a Drought Toolbox supporting the initiatives within the mandate of UNCCD.

Parties at COP 13 requested the secretariat and other UNCCD institutions and bodies to implement a drought initiative which proposes concrete action on drought preparedness systems to boost the resilience of people, communities and ecosystems against droughts. The toolbox is designed to provide drought stakeholders with easy access to tools, case studies and other resources to support the design of National Drought Policy Plans.

If this initiative materialises then one of the intentions would be to use Ghana as a country for validation and testing of the developed Drought toolbox, as the proposed UNCCD Drought Toolbox will be based on the drought early warning system developed as part of the CTCN and GCF funded activities. This activity could potentially further strengthen the existing technology not only in Ghana but also make it available on a global scale.

3.5 Regional and national activities

UNEP-DHI and DHI is actively engaged in a number of activities in the region which could support the future strengthening and upscaling of the technology, such as:

- Ongoing project with ECOWAS supporting water related indicators in the region
- Climate change training in Senegal where the developed technology for drought management might be applied
- Discussions with GWP (Burkina Faso office) on collaboration within the Integrated Drought Management Programme

There will be an active commitment to pursue opportunities which could further strengthen the transfer of technology and national scale up related to drought management and drought early warning in Ghana through these activities.

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