



CTCN assistance in Ghana

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



Lesson Learned Report



Report / Technical Note

May 2018



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Approved by

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CTCN assistance in Ghana

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

Lesson learned report

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Acronyms and Abbreviations

CSIR	Council for Scientific and Industrial Research
CTCN	Climate Technology Centre & Network
GCF	Green Climate Fund
DHI	DHI - see more at www.dhigoup.com
EPA	Environmental Protection Agency
EWS	Early Warning System
GIDA	Ghana Irrigation Development Authority
GMET	Ghana Meteorological Agency
GWCL	Ghana Water Company Limited
GWP	Global Water Partnership
HSD	Hydrological Services Department
IWMI	Internal Water Management Institute
MoF	Ministry of Finance
MOFA	Ministry of Food and Agriculture
MSW	Ministry of Sanitation and Water
NADMO	National Disaster Management Organisation
NDA	National Designated Authority
NIE	National Implementing Entity
UNEP	United Nations Environment Programme
UNEP-DHI	UNEP-DHI Partnership – Centre on Water and Environment
VRA	Volta River Authority
WRC	Water Resources Commission
WRI	Water research institute



1 Introduction and background to GCF and CTCN activities

1.1 Objectives

The technical assistance funded by GCF readiness funds and CTCN relates to **improving resiliency of crops to drought through strengthened early warning within Ghana**. The objective is to facilitate 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 the northern Ghana.

GCF Readiness funds have also been allocated to this CTCN technical assistance in order to investigate the potential up-scaling of this project to a large scale GCF project to be implemented at the national level.

1.2 Background

The 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 the 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 system. The findings have been described in the **Technology Validation report** delivered in January 2018.

National experts have also assisted WRC to develop a **baseline assessment and gap analysis** of the drought management and forecasting in Ghana. In addition, a **Climate vulnerability assessment** of the agricultural sector has also been carried out. These outcomes constitute a basis to develop a draft **Concept Note** for the Green Climate Fund.

Please visit the CTCN project site¹ 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>



1.3 Lesson learned

The current report highlights the lesson learned throughout the project, including the CTCN and the GCF readiness activities, from the following activities:

- **Stakeholder engagement (section 2)**
 - Key stakeholders have been actively engaged throughout the implementation of the CTCN and GCF readiness supported activities, and their feedback and input have been vital for the successful outcome of the activities.
 - Stakeholders have been actively engaged through four national workshops, one technical training as well as a long range of bilateral meetings with national and local stakeholders.
- **Drought Early Warning system (section 3)**
 - 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 lesson learned is mainly based on the technical training and the feedback received from the main applicant (WRC) during the technical review of the established Drought Early Warning System. The WRC will be the responsible organisation for the use and dissemination of the established system after the closure of the CTCN and GCF activities.
- **National experts – outcomes and lesson learned (section 4)**
 - The use of national experts is vital for a local anchoring and understanding of the issues and gaps which the developed Drought Early System is designed to target.
 - The information collected and compiled by the four national experts have proven critical and very valuable for the process of designing a concept and proposal for a full scale drought project with the intention of upscaling the implemented solution to the whole country.
 - The national experts have been able to engage and meet with additional stakeholders resulting in knowledge and information otherwise not collected as part of the CTCN and GCF activities.



2 Stakeholder engagement

Key stakeholders have been actively involved throughout the implementation of the GCF readiness and CTCN supported activities. During the GCF Readiness and CTCN activities the Ministry of Finance of Ghana (NDA), the Environmental Protection Agency (EPA), the Water Resources Commission (Executing Entity) with the technical assistance of UNEP-DHI have organised four national workshops in Accra (October 2016, October 2017, January 2018 and April 2018) where key stakeholders were invited to discuss the project results and lesson learned from the project. A technical training and a number of stakeholder consultations were conducted during the assistance as well. The lesson learned from each of the mentioned events are briefly described in the following sections.

2.1 National Workshop (26 October 2016)

The purpose of the national workshop was to i) Present the scope of the CTCN technical assistance to relevant national stakeholders, ii) Identify the current specific gaps related to drought forecasting and dissemination and the associated needs for including climate variability and climate change in dry season management in Ghana and iii) Update the inventory of past, existing, and planned similar activities and Ghana based on the participants' knowledge

2.1.1 Participating Institutions

All of the identified national organisations in Ghana related to drought management were invited to the workshop, and the following institutions participated in the workshop:

- Department of Earth Science, University of Ghana
- Environmental Protection Agency
- Ghana Meteorological Agency
- Ghana Irrigation Development Authority
- Global Water Partnership, Ghana
- Hydrological Services Department
- Ministry of Local Government and Rural Development
- National Disaster Management Organisation
- Ministry of Water Resources Works and Housing
- Ministry of Food and Agriculture
- Volta River Authority
- Water research institute
- Water Resources Commission, White Volta
- Water Resources Commission, Black Volta
- Water Resources Commission



2.1.2 Key outcomes from the national workshop

The workshop was very successful with participation of all the invited stakeholders except the Ministry of Food and Agriculture.

The key outcomes from the first national workshop were:

- **All participating institutions appreciated the CTCN initiative** and offered to support the technical assistance through possible future stakeholder meetings and through review of relevant project outputs.
- The workshop concluded that **drought is a very relevant topic to support in Ghana** as only few organisations and projects address drought management. Previous water resource management projects mainly focused on flooding although drought is often affecting more people over a longer time period compared to drought.
- The key stakeholders for the technical assistance will be:
 - Water Resources Commission as they are responsible for the overall water resource management in Ghana including the basin organisation in the Northern Ghana where the pilot area is likely to be located.
 - Department of Meteorology as they have experience with drought management and are currently providing seasonal forecast to different ministries.
 - Ministry of Food and Agriculture as they are the main organisation disseminating drought related information in Ghana via their regional and local structures.
- Follow-up meetings with some of the key stakeholders are to be arranged following the national workshop to further understand how the technical assistance results should embed into the current dissemination processes related to drought management in Ghana.

2.2 Stakeholder meetings

A number of meetings with relevant stakeholders in Accra and in the northern part of Ghana were initiated as part of the initial phase of the CTCN technical assistance. The following sections contains a brief description of the key outcomes from these meetings.

2.2.1 National focal point for Green Climate Fund

Accra, Ghana, 25th of October 2016

Name	Position
Mr. Frimpong Kwarteng-Amaning	Director of Real Sector Division, Ministry of Finance and Economic Planning
Mr. Foster Aboagye Gyamfi	Economics Officer, Natural Resources Environment and Climate Change Unit

The objective of the meeting was to discuss the opportunities for using the Green Climate Fund (GCF) to further upscale and secure the long-term sustainability of the assistance. The meeting was useful to understand the process of applying for GCF support in Ghana. The key outcomes were:

- GCF applications need to be submitted through an accredited entity in Ghana. For the CTCN assistance it would be relevant to use the Ministry of Environment as EPA is located within this ministry.
- The application is submitted to an advisory committee with the mandate of advising the national focal point (NDA) on the technical aspects of an application
- The GCF NDA is responsible for the final approval of any applications for GCF support within Ghana.

The CTCN assistance will further explore the opportunity for upscaling the project through GCF support.

2.2.2 Water Resources Commission, Regional office, White Volta

Bolgatanga, Ghana, 27th of October 2016

Name	Position	Email
Bob Alfa	Head of Water resources	philmantey@gmail.com
Aaron Aduna	Principal basin officer, White Volta	aaronaduna@yahoo.com

The Water Resources Commission (WRC) regional office, White Volta in Bolgatanga facilitated the stakeholder meetings in the upper east region. The Upper East region was selected as the piloting area as it is an area dominated by rain fed agriculture and thus prone to frequent drought events.

The WRC regional office is responsible for the overall water resource management in the region including water permitting for farmers and irrigation schemes. The WRC regional office in Bolgatanga will be an important stakeholder in facilitating the contact with local organisations and stakeholders in the region, as they have an extensive network among government and non-government organisations within the water and agriculture sector in the region.



Figure 2-1 Meeting at the Water Resources Commission, Regional office, White Volta in Bolgatanga

2.2.3 MOFA, regional office

Bolgatanga, Ghana, 27th of October 2016

The regional office of Ministry of Food and Agriculture (MOFA) in Bolgatanga is a key stakeholder in relation to drought management and dissemination of information to the farmers. The main outcomes from the meeting:

- The Upper east region of Ghana is a drought prone area, and drought management is important to secure the food productivity
- MOFA develops a crop calendar on a yearly basis to be used within the different districts to plan for the coming season. The crop calendar is modified to the local conditions within each of the districts.
- There are mainly rainfed agriculture in the Upper East region, but irrigation schemes are being introduced in certain areas of the region as well.
- The key challenges for MOFA relating to drought management are:
 - Drought tolerant crop varieties are needed to further improve the yield
 - Introduction of small scale irrigation to support the rainfed areas during drought periods
- MOFA is able to provide the following information for the CTCN assistance:
 - Rainfall data collected for the last 10 years
 - Food production data from the different districts
 - Marked prices of the main crops



Figure 2-2 Regional office of MOFA in Bolgatanga



2.2.4 EPA, Regional Office

Bolgatanga, Ghana, 27th of October 2016

Name	Position	Email
Asher Nkegbe	Regional director	ashernkegbe@yahoo.com

The regional office for the Environmental Protection Agency (EPA) serves a valuable role by collaborating with the local departments and organisations in relation to drought and climate change related issues. The regional office provides training and capacity building towards the regional departments and the farming organisations with respect to introduction of new crops and new techniques for improved farm management. The regional office is also involved in the development of the National Action Plan to combat drought.

2.2.5 GIDA, regional office

Bolgatanga, Ghana, 27th of October 2016

The regional office for Ghana Irrigation Development Authority (GIDA) is mainly involved in the design and construction of irrigation structures in the region. They have a minor role related to drought management as they do not manage the irrigation structures after construction. The regional office of GIDA will be kept informed through their main office in Ghana which will be invited to the upcoming workshops and trainings.

2.2.6 CREW project at NADMO, Accra

Accra, Ghana, 28th of October 2016

Name	Position	Email
Philip Mantey	Technical advisor CREW	philmantey@gmail.com

The Community Resilience through Early Warning project (CREW, <https://crewghana.wordpress.com/>) is working on risk mapping and disaster risk reduction for both floods and drought taking local indicators into account. The project ends in 2016, and the outcomes will be available at the time of the project closure. The project has developed a web based portal looking at drought risk factors, based on rainfall only. This part might be highly relevant for the CTCN assistance and will be evaluated further.

2.2.7 Danish Embassy, Accra

Accra, Ghana, 28th of October 2016

Name	Position	Email
Tove Degnbol	Ambassador	tovdeg@um.dk
Jacob Kahl Jepsen	Head of Trade	jajeps@um.dk



The Danish Embassy is responsible for coordinating the Danish foreign aid in Ghana, which previously did support several climate change adaptation projects in Ghana. The Embassy is currently supporting the Climate Innovation Center in Ghana, which could be a relevant stakeholder.

2.2.8 National Disaster Management Organisation (NADMO)

Accra, Ghana, 27th of January 2017

Name	Position
Mr. Gavivina Yao Tamakeo	Chief Disaster Officer
Fred Akatur	PACO
Kofi Osei	PACO
Benjamin Larbi	IT specialist

NADMO is responsible for the coordination, management, dissemination and planning when an event turns into an emergency (defined as an event that the local organisations are not able to cope and adapt to). NADMO coordinates the disaster operation with relevant organisations as WRC, Meteorological Department, MOFA and Hydrological Service department. NADMO has by law the power to mobilize emergency relief and aid in case of an emergency.

NADMO relies on information from the other key agencies with respect to identification of a drought emergency. There are no drought categories defined in Ghana, but a system of red, yellow and green alert categories is used (without a formal definition of the categories). There is a need for a more specific definition of drought alert levels and linkage between alert categories and action plans.

The CREW project (UNDP) located within the premises of NADMO is developing an early warning system for both floods and droughts, which will be handed over to NADMO in the early part of 2017. The CREW system provides a link with 10 pilot centres, providing near real time information of flood and drought status. A request for more detailed information on the CREW outcomes have been submitted to the team leader of this UNDP funded project.

2.2.9 Ghana Meteorological Agency

Accra, Ghana 30th of January 2017

Name	Position	Email
Juati Ayilari-naa	Director Synoptic meteorology and forecasting	a.juati@meteo.gov.gh



The Ghana Meteorological Agency (GMET) is responsible for forwarding relevant meteorological information to MOFA regarding:

- Climate patterns
- Rainfall monitoring within each of the districts (10-day rainfall)
- Rainfall forecast for the coming season
 - Seasonal forecast issued each year in February (with 3 month lead time)
 - Focus on the forecast of dry spells and monthly accumulated rainfall

GMET interfaces with MOFA on climate data and information but does not provide drought warnings or information as such, as MOFA is responsible for impact and risk assessment based on the delivered data from GMET.

MOFA then disseminates information to the farmers via the extension officers.

GMET is currently not using drought indices to evaluate how the current rainfall relates to previous years, but relies mainly on comparison of rainfall amounts.

GMET has just initiated a project focussing on utilising satellite based data for bio-physical parameters which will enable them to evaluate the climate impact on the vegetation.

2.3 Second National Workshop (26 October 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 purpose of the workshop was to:

- Present the Technical outputs from the CTCN and GCF activities
 - Presentation of the drought early warning system
 - Provide feedback from the technical training which took place during the two previous days
- Overview the scheduled Green Climate Fund readiness activities
 - Overview and status of the remaining activities
 - Status on the GCF concept note
- Provide input to the GCF concept note on the institutional part
 - What is the current institutional and technical state of drought management and forecasting in Ghana?
 - What are the technical and institutional requirements or needs for improving drought-related services in Ghana?
- Provide input to the GCF concept note related to the technical activities



- Identify relevant technical services currently lacking for strengthening the national water resources and drought planning with respect to food security. The identified services are to be implemented in the full-scale GCF project.
- Identify relevant technical services targeting and supporting local level climate resilient solutions. The identified services are to be implemented as part of the full-scale GCF project.

2.3.1 Participating Institutions

The following institutions participated in the workshop:

- Department of Earth Science, University of Ghana
- Environmental Protection Agency
- Ghana Meteorological Agency
- Ghana Irrigation Development Authority
- Global Water Partnership, Ghana
- Hydrological Services Department
- National Disaster Management Organisation
- Ministry of Water Resources Works and Housing
- Ministry of Food and Agriculture
- Ministry of Finance
- Water Resources Commission, White Volta
- Water Resources Commission

2.3.2 Key outcomes from the workshop

The workshop was very successful with participation of all the invited stakeholders. The key outcomes from the national workshop were:

- 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 engagement in the process of further developing and distributing the developed Drought Early Warning System among the stakeholders.
- The developed web based portal for drought management and early warning is an important step for strengthening the national capacity.
- The GCF concept note will be an important process for collecting and describing the current state and the gaps with respect to drought management within Ghana.



- 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.
- The NDA will work towards submitting one proposal from Ghana for a full size GCF funded project focussing on increased food security based on a combination of the existing concept notes.

2.4 Technical training (October 2017)

The objective of the training was to train the participants in the use of the Drought Early Warning and Forecasting system developed as part of the technical Assistance to Ghana.

Key organisations, carefully selected by the main applicant (WRC), have been invited to take part of this two-day technical training that took place at the head quarter of the Water Resources Commission in Accra.

2.4.1 Key components in the training

The training was developed so the participants would be introduced to relevant modules with an increased complexity and understanding of drought management and early warning.

The modules constituting the training was:

- **Impact and causes:** Identification of prioritised impacts and their underlying causes from drought in Ghana.
- **Assessing drought state through indicators:** Identification of indicators and the required data for assessing the state of drought in Ghana.
- **Data and Information:** Knowledge and understanding of available data to be used for drought assessment.
- **Drought Indicators:** Capacity and knowledge to use key indicators for drought assessment in Ghana.
- **Early warning:** Practical understanding on application of drought early warning in Ghana in Ghana.
- **Reporting:** dissemination of the relevant information via a drought report. This facility enables users to submit automated e-mails containing a link to an updated drought report from within the developed system.

2.4.2 Key outcome

The key outcomes of the training was:

- **Strengthen capacity:** one of the main outcome of the training has been the capacity building in drought assessment and early warning topics. Various topics have been addressed a scientific approach and applied to the context in northern Ghana



- **Test and validation of the Drought Early Warning System for a large panel of users:** This training session have been an opportunity to test the DEWS on a large panel of users. Feedback from the participants has been collected during the training.
- **Constitution of a core team of experts among key organisations:** This training session has also been an opportunity to start a momentum in using the system. All participants have been advised to communicate among their respective organisations the use of the DEWS. WRC, as the anchor point, will support the organisations willing to use this system.

2.5 Final National Workshop (18 April 2018)

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

2.5.1 Attendance

The following institutions participated in the workshop:

- Coalition of NGOs in Water and Sanitation (CONIWAS)
- Council for Scientific and Industrial Research, Water Research Institute (CSIR-WRI)
- Environmental Protection Agency (EPA)
- Ghana Meteorological Agency (GMet)
- Ghana Irrigation Development Authority (GIDA)
- Global Water Partnership, Ghana (GWP)
- Hydrological Services Department (HSD)
- Internal Water Management Institute (IWMI)
- National Disaster Management Organisation (NADMO)
- UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI)
- University of Ghana (UG)
- Volta River Authority (VRA)
- Water Resources Commission (WRC)

2.5.2 Key outcomes from the workshop

The workshop was very successful with participation of all the invited stakeholders. The key outcomes from the national workshop were:



- All the key national stakeholders were presented with the outcomes from the CTCN and GCF funded activities being implemented from October 2016 to April 2018.
- The participants acknowledged the importance of drought in Ghana.
- 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 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.

The implementing agencies would like to thank all the involved stakeholders for their actively and engaged commitment to the process and we will be looking forward to further collaboration in future projects.



3 Drought Early Warning system

3.1 Background

The overall objective of the CTCN/GCF assistance 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 Web-based drought early warning and forecasting portal covers the following main topics:

- Issue analysis allowing stakeholders to identify and discuss the underlying causes behind drought events in Ghana.
- Web-based drought early warning and forecasting portal providing access to the technical functionalities, and enable stakeholders to view and download data and information;
- Data and information to avail near real-time satellite products related to drought warning and forecasting, and provide the required data input for the drought warning and forecasting system
- Risk management components supporting the risk-based drought management through drought early warning and detection for increased adaptation and preparedness to upcoming drought events
- Dissemination relating to how the technical information is conveyed from the web-based system to the end-users in form of reports, messages or warnings.

3.2 Testing and validation

The testing and validation was done by a national expert from the Water Resources Commission. The details of the testing is available in the deliverable “Review report from main applicant”.

3.2.1 Review comments by WRC

Major institutions in the country stand to benefit from the full operation of the online portal.



Firstly, it is accessible to all, provided individuals apply for accounts, a very easy process. Also, the online nature of the portal allows for accessibility from all over the country.

The system stands to benefit organizations and individuals working in the area of forecasting, agricultural productivity in terms of efficiency and effective farming practices since they can access quality and readily available data as and when needed. It will also help to know when signs of disaster due to environmental factors becomes glaring and how to mitigate them or perhaps reduce to a minimum the effect natural disasters can have. It does not however remove the rigorous effort required to analyse and process data for better management.

The system can be incorporated into the work flow of many organizations such as the Water Resources Commission, Ministry of Food and Agriculture (especially the work of the extension offices in the various districts), Environmental Protection Agency (EPA), Meteorological Services, Hydrological Services Department, Ghana Irrigation development Authorities (GIDA), Ghana Meteorological Services (GMet), NGOs etc.

The system will also be beneficial to research activities in the country. Access to data required for investigation will be made less stressful and easily available for all. The additional charts and plots will help to enhance and speed up the decision making process. The satellite data can also help fill in the gaps of missing data, which is a phenomenon common to the manual collection of data, and the gaps created by insufficient ground stations.

GIS layers in both vector and raster files formats are also available for easy downloading to be used in other GIS software (ArcGIS, QGIS) for further analysis and the provisioning of further informative maps. This is however limited to advance users of the portal.

3.3 Initial use of the system

The developed drought early warning system will be anchored within the WRC, who will be responsible for further outreach, support and dissemination to relevant stakeholders within Ghana.

The WRC will use the system to generate information and dissemination to relevant national agencies in Ghana, which will be able to further refine and validate the information with the tools available and further push the information to the end users.

The developed drought early warning system can be used to certify other products that are already used operationally in Ghana, providing additional support for areas that are not mostly covered in such developments because they do not fall directly in the basin.

The water resource commission can use the reports generated in the system in informing institutions of impending drought events. NADMO and MOFA can then further inform farmers on the best resistant crops to grow in other to minimize the lost and make the most of the environmental conditions available. NADMO can also evaluate and encourage relocation of the farmers to suitable sites. Some agriculture activities can be allowed in the designated buffer zones when the worse conditions present itself all because information is made known ahead of the events.

GMET and HSD can use the tool to also evaluate results from other products and supplement the data they receive from the limited available stations.

3.4 Indicators

The main objective of a drought early warning system is to detect when and if a drought hazard might occur and the location and severity of the hazard. Drought warnings could be expressed based on the hazard itself or on the associated risk towards specific vulnerable sectors or areas. A key element in any drought early warning systems are the use of indicators expressing the state of a specific hazard. Drought indicators represents the state of a specific drought related issue at different times. Drought indices could cover the entire spectrum of drought types: meteorological, agricultural and hydrological drought (see below figure).

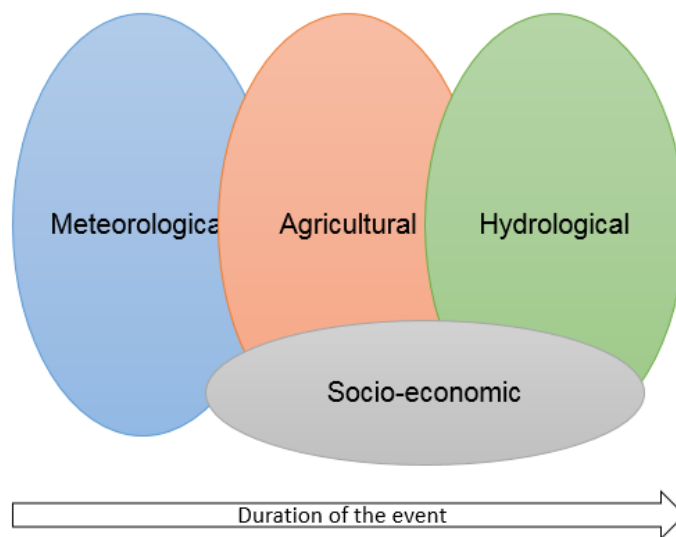


Figure 3-1 Different types of drought indices

An example could be climate based drought indices describing the state of meteorological drought. The specific drought indices to be included should be based on locally accepted indices as well as scientific sound and validated indices.

Examples of drought indices:

- Rainfall deviation expressed through the standardized precipitation index (SPI),
- Crop related drought hazard described through the vegetation condition index (VCI).

The key requirement is that the indices should represent the current or future state, hence should be available in close to real time or as forecasted values. Spatially distributed indices are often a requirement as well, as the location of the drought hazard is critical. Exceptions would be indices related to specific locations as reservoirs, lakes, rivers etc.

The developed Drought Early Warning System contains a long list of drought indices which could be applied through the use of the system. The drought indicators are described in more detail in the deliverable “Technology description and User guide”.



3.4.1 Gender relevant indicators

The developed Drought Early Warning system provides a risk based assessment of the drought impact within Ghana. The risk will be expressed based on the vulnerability towards the impact from a specific hazard, or as the likelihood of harm, loss or disaster for a specific drought related hazard.

Risk is defined as the likelihood of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions (UN-ISDR, 2009, EC, 2011). The risk analysis will identify areas or groups at different risk levels, which will be the targets for the following adaptation or mitigation planning.

Gender relevant indicators are used to express the drought risk towards vulnerable groups in Ghana. Examples of gender relevant indicators used in the developed system are:

- **Child under weight (percentage):** Percentage of children, under the age of 5, who are underweight (year period: 1990-2002)
- **Drought Mortality Risk:** Global Drought Mortality Risks and Distribution is a 2.5 minute grid of global drought mortality risks. Gridded Population of the World, Version 3 (GPWv3) data provide a baseline estimation of population per grid cell from which to estimate potential mortality risks due to drought hazard. Mortality loss estimates per hazard event are calculated using regional, hazard-specific mortality records of the Emergency Events Database (EM-DAT) that span the 20 years between 1981 and 2000.
- **Gross Domestic Product:** In the distributed global GDP dataset sub-national GRP and national GDP data are allocated to approximately 1km grid cells in proportion to the population residing in that cell. The method also distinguishes between rural and urban population, assuming the latter to have a higher GDP per capita.
- **Infant Mortality Rate (2000):** Infant mortality rate, adjusted to the year 2000, in deaths per 10,000 live births.
- **Population density (2010):** estimate of population density for the years 2010 based on counts consistent with national censuses and population registers, as raster data to facilitate data integration.
- **Population density (2015)** estimate of population density for the years 2015 based on counts consistent with national censuses and population registers, as raster data to facilitate data integration.
- **Population density (2020)** estimate of population density for the years 2020 based on counts consistent with national censuses and population registers, as raster data to facilitate data integration.

The above mentioned gender relevant indicators are the indicators available at the time of the implementation of the assistance. In case of further upscaling of the system within Ghana additional focus will be made towards identification of additional gender relevant indicators.



4 National experts – outcomes and lesson learned

National expertise is vital for the success of the CTCN assistance and the GCF readiness and preparatory support, and national consultancy services were included to cover the following aspects:

- Climate vulnerability assessment of the agricultural sector with focus on the food production based on existing references;
- Baseline assessment on the current institutional and technical state of drought management and forecasting in Ghana;
- Gap analysis describing the necessary technical and institutional capacity required for improving drought related services in Ghana;
- Relevant technical services targeting and supporting local level climate resilient solutions

The following sections contains a brief summary of some of the key outcomes and lesson learned from the services conducted by the national experts.

4.1 Vulnerability of the agricultural sector in Ghana

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. Having effective agricultural policies will not only improve food security but will also contribute synergistically to carbon sequestration, enhanced conservation and biodiversity, improved quality of soil and water, protection of the watershed, healthier natural ecosystems as well as socio-economic stability.

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.

Research on climate change in Ghana is often project-driven, short-term and uncoordinated. There is often limited research in climatology and meteorology as well as the down-scaling of models and scenarios. In addition, more information is needed on what works for local people, based on research that is informed by their views and participation.

There is also the need to establish meaningful dialogues between climate scientists and the users of knowledge and offer accessible and relevant resources to stakeholders concerned with sustainable development. This requires high-level and well- structured interactions and feedbacks to provide policymakers with the evidence they need to formulate valid policies and guide implementation.

Ghana has a vast body of traditional knowledge on how to soften the impacts of an adverse climate that needs to be tapped, documented and analysed. Traditional knowledge has been critical in conserving natural resources, protecting the environment,



making farming decisions, predicting weather, managing health and coping with extreme climate variability. It is important to document indigenous knowledge into early warning systems and research and to establish its potential for scaling up.

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 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.

As discussed, it is important to note that Ghana cannot continue with business as usual without taken climate change issues into consideration. Neither can the country consider climate change as an added cost and therefore continue to suffer the massive impacts of climate related droughts and floods, water stress and impacts on agricultural productivity.

4.2 Baseline assessment on the current institutional and technical state of drought management and forecasting in Ghana

A number of projects on drought management have been implemented in Ghana. The following sections presents the projects, achievements and lessons learned in the implementation of projects/programmes where issues of drought were addressed.

4.2.1 The Africa Adaptation Programme (AAP)

The AAP was implemented in Ghana from 2010 to 2012, led by MESTI and its allied agency, EPA. The project aimed at developing capacity and identifying financing options for mainstreaming climate change adaptation into plans, policies and programmes at national and subnational levels. The 5 outputs are the following: (i) Dynamic, long-term planning mechanisms to cope with the inherent uncertainties of climate change introduced; (ii) Leadership and institutional frameworks to manage climate change risks and opportunities in an integrated manner at the local and national levels strengthened; (iii) Climate-resilient policies and measures implemented in priority sectors implemented; (iv) Financing options to meet national adaptation costs expanded at the local, national, sub-regional and regional levels; (v) Knowledge on adjusting national development processes to fully incorporate climate change risks and opportunities generated and shared across all levels. The project provided some insight into risks related to climate hazards such as floods and droughts using cases from five pilot districts. Key achievements were the following: (a) Mainstreaming of climate change and Disaster Risk Reduction (DRR) into Medium and Long Terms Development Planning, building capacity of 170 district assemblies while providing technical backstopping using mainstreaming Guide; (b) The Mentoring and Coaching Initiative that supported improvement of knowledge and skills of key stakeholders involving 32 mentors and mentees in Ghana. Also 2 committees and a volunteer Group to oversee water resources management along Osubin River at Begoro in the Eastern Region; (c) In respect of Early Warning System, some hardware and software for Early Warning System were provided at the Ghana Meteorological Agency, enabling flood and drought hazard mapping in 5 Pilot Districts in Ghana while providing NADMO with a methodology tools for effective disaster risk reduction (DRR) communication in the districts; (d) On knowledge management, the



project contributed to the following: (1) Supported a study on Indigenous Knowledge (IK) on climate change in six (6) districts and subsequently developed an Indigenous Knowledge Atlas on changes in climate in the 6 studied districts. (2) Supported the development of a 19 series “Policy Advisory Series” document on climate change and a Guide for Mainstreaming Climate Change and Disaster Risk into national development policies and planning (3) Supported the development of a well-resourced website to serve as an online encyclopedia on AAP activities.

4.2.2 The Community Resilience through Early Warning (CREW) Project

The Community Resilience through Early Warning (CREW) is a project developed from the conclusions of The African Adaptation Programme in Ghana. It was implemented from 2013 to 2015 by NADMO through collaboration with GMet, HSD, target Metropolitan, Municipal and District Assemblies and MOFA. Specifically, it provided drought risk maps for 10 pilot districts, selected in each of the 10 regions of Ghana. In the pilot districts, hotspots (communities) were identified for more in depth risk profiling and mapping (hazard, vulnerability and risks).

4.2.3 Africa Risk Capacity (ARC) Project

The Africa Risk Capacity is an African initiative that seeks to commit countries to insure against climate related disasters such as drought. It is implemented by the Real Sector Division of Ministry of Finance in collaboration with other institutions such as NADMO, GMet, MOFA, Ghana Statistical Service, HSD, and GIDA. Presently, processes are ongoing to acquire the necessary data to be able to generate thresholds and determine the amount to pay as Premium. There is a platform which has two inbuilt components; (i) Early warning component; and (ii) Response mechanism inbuilt.

4.3 Gap analysis describing the necessary technical and institutional capacity required for improving drought related services in Ghana

Gaps analysis on drought risk management and early warning in Ghana has been carried out as part of the CTCN and GCF activities. Unequivocally, information on drought risk is limited backed by weak institutional coordination mechanism. The current thinking and practice is reactive and a proactive approach to drought risk management is necessary. It will focus on upstream engagements using modern technology towards preparedness and planning for drought. The gaps are clear and provide opportunities for streamlining activities while enhancing collaboration among institutions involved with generation of drought information. Also, the analysis provides perspectives for improved drought management and early warning, employing effective channels of communicating products to end-users. Institutions need to step up their game in drought information services delivery and management while farmers and other end-users lie in wait for the key messages to inform their farming practices. Further, water service providers also anticipate this level of information in order to plan for the entire season. Also, it will be useful to provide mechanisms for feedbacks so as to help improve on institutional performance.



4.3.1 Recommendations

The recommendations are made following analysis of the gaps in the existing institutional and technical state of drought information generation and dissemination to relevant stakeholders.

Institutional Coordination and Cooperation

Some of the recommendations are worth addressing at national level and others at regional and district levels.

National level

There are opportunities to implement drought or dry spell related information generation and dissemination by setting up 10 regional centres of information to accompany districts and communities. This will help devolve operations from the national level to the regional level and thereby consolidate the engagements while reducing the dependency on national office.

The meetings of the GMet, Crops Services Directorate of MOFA and NADMO following the release of weather information and seasonal forecasting should include the Animal Production Directorate of MOFA to bring to focus dimensions of livestock raising so as not to skew information to farmers.

The key stakeholders including GMet, MOFA, NADMO, MOFA, WRC, EPA should take steps to select one institution that will be responsible to coordinate the interventions of dry spells and related information generation and dissemination, while identifying the roles of the other institutions towards ensuring that facilities provided under the project are maintained and operations sustained. There is a structure for managing floods and same can be adopted or adapted for drought management.

Drought management and forecasting towards enhancing food security will require data exchange. Therefore, it will be useful to make arrangements and data sharing protocols to guide and regulate institutional conduct.

Regional/District level

Engaging AEAs for drought information dissemination from national level should bring the aspect of livestock raising and the required associated elements such as fodder production, restocking and destocking to strengthen the social capital and livelihoods of households in rural settings.

MOFA has engaged civil society in drought information dissemination in other projects implemented in the past. Therefore, opportunity exists to engage civil society and NGOs, educational institutions and the private sector while defining the roles and responsibilities of partners' in drought management.

Capacity Development

Some of the recommendations are worth addressing at national level and others at regional and district levels. As such, they will be considered in that context.

National level

Where regional and district levels operations are strengthened, it will be useful to develop Manual assisted systems to support and guide the Officers of MOFA and NADMO.



There are existing platforms for data and information exchange at NADMO, HSD and GMet. GMet and HSD platforms (servers) are connected enabling information exchange at the click of a button. It is expected that GMet and NADMO will also be connected to ensure data harvest and analysis on its platform, enabling production of products and services and transmitted to different stakeholders.

The Institutional Needs Assessments of GMet and HSD suggest the need to automate and upgrade some of the weather stations and at the same time, increasing the density to ensure drought or dry spell indicators are characterised appropriately, using viable data such that the outcome information will be reliable.

Regional/District level

The information on drought disseminated to communities is good. However, planning with it and documenting at community level is critical and MOFA Officers are enjoined to provide support in guiding farmers to maximize use of the drought information so received. This effort could inform bottom-up approach to district assembly level planning to inform the District Medium Term Development Plan preparation.

The AEAs and NADMO Officers should endeavor to document feedback received from communities and local farmers or FBOs on the weather information or drought disseminated towards improving forecasts and relevance.

The occurrence of drought requires implementation of the Buffer Zone Policy to support farmers at practicing water conservation strategies.



5 Lesson learned

The technical assistance funded by GCF readiness funds and CTCN relates to **improving resiliency of crops to drought through strengthened early warning within Ghana**. The objective is to facilitate 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 the northern Ghana.

The lesson learned during the CTCN and GCF funded activities originates from feedback received during stakeholder meetings and workshops, implementation of the developed Drought Early Warning System and information collected by the four national experts.

5.1 Stakeholder engagement

There have been four national workshops in Accra (October 2016, October 2017, January 2018 and April 2018) as well as a technical training (October 2017) and a long range of meetings with stakeholders in Accra and in the Upper East region of Ghana. The key lesson learned messages from the stakeholder meetings are:

- The CTCN and GCF initiative is greatly appreciated by the national stakeholders and the engagement and support throughout the process have been very valuable from all relevant agencies in Ghana
- Large number of organisations participated in the organised meetings and workshops and the discussions and feedback received during the meetings have proven very valuable for the final outcome.
- Drought is currently a serious issue in the northern part of Ghana but the experience from the stakeholders is that even the southern part of the country are experiencing impacts from drought affecting the food security and cropping patterns. The expectation is that the impact will increase over the coming years and decades.
- Its recommended that the CTCN and GCF activities are followed by a full size project where the developed solutions are up-scaled to national level.
- Availability of hydromet data is one of the key constrains for drought management in Ghana. This barrier could be mitigated through upgrading the existing hydromet network combined with an increased use and knowledge of how satellite based data could be used within drought management.
- The development and implementation of a web based platform requires that the infrastructure with respect to mobile data exist within the country. This is an area which is growing very rapidly and during the project implementation period feedbacks on the use of an web based platform was positive. This makes it much easier to disseminate information and provide access to new users therefore its recommended to maintain the focus on web based solutions in future projects.



5.2 Implementation of Drought Early Warning system

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 lesson learned is mainly based on the technical training and the feedback received from the main applicant (WRC) during the technical review of the established Drought Early Warning System. The WRC will be the responsible organisation for the use and dissemination of the established system after the closure of the CTCN and GCF activities.

The main lessons learned related to the established Drought Early system are:

- Access to near real time satellite based data and indices provides great value and a strong supplement to existing data from ground stations. There is a need for further 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.
- The design of the implemented Drought Early Warning System is web based which proves a great advantage in Ghana due to the rather good mobile data connection in the country and the easy in which the stakeholders are able to connect to the system. The use of a web based system reduces the need for purchase of IT equipment and removes the dependency of local IT resources. It's recommended to base future drought system on a web based technology as well.
- The dissemination of drought information from national to local level is a key requirement in Ghana, and a requirement that the current CTCN and GCF activities have not completely achieved. The implemented Drought Early Warning System is mainly supporting the national agencies and they are then responsible for further dissemination to regional and local level. For future activities its recommended to 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. This recommendation should be adopted by future full size drought related projects in Ghana.
- The technical level of the implemented Drought Early Warning System have been discussed during the implementation of the system, and the lessons learned is that the active engagement and involvement of key national agencies is very important. For future drought projects its recommended to involve key agencies in the design through focus on actual cases at the different agencies, as this will enable identification of the required functionality to an even higher degree than what was possible during the current CTCN and GCF activities.
- Capacity building and training is vital for a successful implementation of such a system, and an important lesson learned is that these activities should be increased and that its important to have capacity building events not only with the technical staff but as well on management level to ensure the buy-in and long term sustainability of the implemented system.



5.3 Information collected by national experts

The use of national experts is vital for a local anchoring and understanding of the issues and gaps which the developed Drought Early System is designed to target. The main lessons learned from the information collected by the national experts are:

- The information collected and compiled by the four national experts have proven critical and very valuable for the process of designing a concept and proposal for a full scale drought project with the intention of upscaling the implemented solution to the whole country.
- The national experts have been able to engage and meet with additional stakeholders resulting in knowledge and information otherwise not collected as part of the CTCN and GCF activities.
- The implemented Drought Early Warning System was tested and validated in the Upper East region of Ghana, and the use of the national experts proved valuable in order to get access to required data for testing and validating the implemented system in the pilot area.
- The procurement and follow up on national experts during the periods where the implementing experts were abroad proved to be a challenge and recommendations for future projects will be to assign a designed local person in charge of the day to day operation and feedback to the national experts as this potentially could make the process more efficient.