CTCN assistance in Ghana

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

Needs assessment report (Deliverable 3 – activity 1.2)

Report / Technical Note

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

Needs Assessment report (Deliverable 3 – activity 1.2)

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CONTENTS

1 Background

The national workshop, held in Accra on the 26th of October, presented the scope and objectives with the CTCN assistance for a wide range of national stakeholders. The national workshop was followed by a number of stakeholder meetings aiming at further understanding and describing the needs and requirements for the assistance. The outcomes of the national workshop and additional stakeholder meetings is compiled into this needs assessment report describing the requirements for the CTCN assistance. The report addresses the current practices for dry season management in Ghana, gaps in the current practices, the typical challenges and risks, and results and outcomes from previous projects. Finally, the report will map out the specific needs and requirements for the outputs from the CTCN assistance.

1.1 Rationale and background for the CTCN assistance

Historical data indicates a climate signal for Ghana resulting in a rise in temperature and decrease in mean annual rainfall in most of the country. It is expected that this trend will continue over the coming decades. The economy of Ghana, which relies mainly on sectors such as agriculture, energy and water, is sensitive to climate change, thus climate change adaptation is critical for the future water management within these sectors. Due to the limited use of irrigation in Ghana, the majority of the agricultural areas are very vulnerable to changes related to the climatic conditions and increased frequency of flood and drought events (National Climate Change Adaptation Strategy, Ghana). The agricultural and water sectors were identified in the climate change technology needs assessments report (TNA) from 2013 as the main sectors in needs of adaptation technology for climate change.

The CTCN technical assistance relates to improving resiliency of crops to drought through strengthened early warning within Ghana. The objective of this technical assistance is to facilitate transfer and capacity building for climate change adaptation focusing on dry season management and planning. The proposed support will utilise existing knowledge and capacity and further develop and validate these for applications to local issues within Ghana.

2 Objectives and activities for the CTCN assistance

2.1 Objective and outcomes

Broadly, the objective of this technical assistance is to facilitate transfer and capacity building of technologies for climate change adaptation aligned with the Ghana National Climate Change Policy, the National Climate Change Adaptation Strategy (NCCAS) and the technology needs assessment report (TNA). The CTCN assistance will contribute to the fulfillment of these national strategies. More specifically, this CTCN technical assistance is designed to enhance the capacity of relevant local government agencies to address a number of drought related issues.

The specific objectives of this technical assistance are to:

- Enhance awareness and knowledge of spatially distributed drought issues within Ghana
- Increase the data accessibility of relevant near real-time satellite information

- Provide scientific based information for drought warning and forecasting within Ghana
- Enable decision makers and stakeholders to use the transferred knowledge, practices and technologies actively in the dry season planning

The overall contribution of the CTCN technical assistance will be the establishment of scientific based practices and building capacity for inclusion of impacts from climate change and climate variability into dry season management.

2.2 Activities within the CTCN assistance

The activities have been assigned into 3 main categories. The first activity consists of identifying the needs within relevant stakeholder groups and detail the required technology. The second activity focuses on adaptation of the existing technologies and validation within an assigned area in Ghana, while the third activity contains the technology transfer through workshops and training events in Ghana.

Each activity and the connected sub-activities are briefly described below, se section 6 for a more detailed description of the activities and the work plan.

2.2.1 Activity 1 - Stakeholder consultation

Aims at presenting the scope of the CTCN technical assistance to a wide range of stakeholders in Ghana and identify the needs for improved dry season management technologies. Contains the following sub-activities:

- Activity 1.1 – National workshop to identify priorities for the CTCN assistance
- Activity 1.2 – Needs assessment
- Activity 1.3 – Technology description

2.2.2 Activity 2 - Technology adjustment

This activity aims at developing the early warning and forecasting system and validating the use of it on a selected location within northern Ghana. Contains the following sub-activities:

- Activity 2.1 – Technology adaptation and development to local conditions
- Activity 2.2 - Technology validation

2.2.3 Activity 3 – Technology transfer and dissemination

This activity aims at ensuring the transfer of knowledge and technology to the local and regional stakeholders.

- Activity 3.1 – Second national workshop to create awareness and knowledge of the outcomes
- Activity 3.2 – Technical training
- Activity 3.3 – Outreach and dissemination

3 Partners and Stakeholders

3.1 Overview of partners and stakeholders

Drought management as well as impacts from drought events in Ghana involve directly or indirectly a multitude of stakeholders ranging from the population living in the drought affected areas to authorities or institutions responsible for advising and assisting the population.
For this particular CTCN technical assistance and based on the key activities as described in chapter 2 the key institutions that will be directly involved and thus considered as partners are:

- Ghana Water Resource Commission (WRC)
- Ghana Meteorological Agency (GMet)
- Ministry of Food and Agriculture (MOFA)

These institutions will work closely with DHI during the implementation of the CTCN technical assistance. Their given mandates and their main roles in the CTCN technical assistance are described below:

Ghana Water Resource Commission (WRC): The mandate of WRC is to "regulate and manage the utilization of the water resources and to co-ordinate relevant government policies". Their functions include:

- Propose integrated water resources management plans to guide the utilization, conservation, development and improvement of water resources;
- Initiate, control and co-ordinate activities connected with the development and utilization of water resources;
- Grant water rights;
- Collect, store and disseminate data or information on water resources;
- Engage water sector agencies to undertake scientific investigations, experiments or research into water resources;
- Monitor and evaluate programmes for the operation and maintenance of water resources;
- Advise the Government on any matter likely to have adverse effect on the water resources:
- Advise pollution control agencies in Ghana on matters concerning the management and control of pollution of water resources; and

Extreme events, such as drought, are not mentioned directly as part of the functions of WRC. However, the given mandate covers for drought situations with normally are taken into account when preparing IWRM plans, issuing of water rights and designing water resource monitoring system. Further, WRC can influence future water resource initiate e.g. in order to address drought events.

The specific roles of WRC in the CTCN technical assistance will be:

- Work closely with the DHI staff with respect to the overall planning of the CTCN technical assistance as well as with respect to the implementation.
- Coordination among national stakeholders including dissemination of outputs from the CTCN assistance
- Facilitating timely access to needed data and information produced by themselves or by other national entities.
- Linking the CTCN technical assistance to the actual pilot area including local stakeholders, which are likely to include: The local basin committee(s), farmers local network and water infrastructure operators.
- Assist in arranging stakeholder meetings at both central and local level.
- Provide expert views related to water resources and drought in Ghana.
- Collaborate with DHI on defining possible relevant post-project activities as well as identification of funding sources

- Discuss dissemination challenges with DHI and GMet in order to identify potential scope for improvements
- Key organisation for maintaining the long term sustainability of the outcomes

Ghana Meteorological Agency (GMet): GMet provides information on measured and predicted rainfall, evaporation, humidity, sunshine duration, wind speed/direction, temperature, cloud cover and solar radiation. GMet provides regular agro-meteorological bulletins, which can guide the farmers in their agricultural practices. Presently, the GMet does not prepare drought monitoring reports on a regularly basis nor do they use this information in predicting potential future drought situations.
GMA is presently providing weather forecasts to the farmers via departments under the Ministry of Food and Agriculture.

The specific roles of GMet under this CTCN technical assistance will be as follows:

- Provide DHI and WRC with detailed information on how the drought monitoring and drought forecasting is managed within GMet today.
- Inform DHI and WRC on the entities receiving drought monitoring reports and how these are used.
- Inform DHI and WRC on the present challenges in providing drought monitoring reports.
- Inform DHI and WRC on possible plans to improve drought monitoring and drought forecasting.
- Assess methodologies for drought monitoring and forecasting proposed by DHI.
- Receive training and integrating relevant new methodologies in the daily routines of GMet
- Discuss dissemination challenges with DHI and WRC in order to identify potential scope for improvements.

Ministry of Food and Agriculture:
The mandate of the Ministry of Food and Agriculture (MOFA) is the development and growth of agriculture in Ghana with the exception of the Cocoa-Coffee and Forestry sector. Its primary roles are the formulation of appropriate agricultural policies, planning & co-ordination, monitoring and evaluation within the overall national economic development.
MOFA has the following objectives:

- Improve agriculture productivity, incomes and employment opportunities;
- Establish effective agriculture -industry linkages; and
- Promote balanced regional development.

MOFA is divided into eight technical directorates as follows:

1. Crops Services
2. Agriculture Extension Services
3. Plant Protection and Regulatory Services
4. Agricultural Engineering Services
5. Animal Production
6. Veterinary Services
7. Fisheries
8. Women in Food and Agricultural Development

MOFA is represented by Agricultural Development Units at the regional as well as the district level.

The expected role of MOFA in the CTCN technical assistance is as follows:

- Main receiver of the information from the established drought early warning and forecasting system
- Describe present requirements with respect to weather forecasts and in particular drought forecasts.

- Describe existing applied disseminations systems targeting the farmers in Ghana and how these systems may be used for improved reporting on drought monitoring and drought warnings.
- Receive information from the established drought early warning and forecasting system for dissemination to relevant end users
- Assist in the dissemination of the results of the CTCN technical assistance both internally in MOFA and also towards the end users.

3.2 Other stakeholders

As drought is a cross-cutting phenomena the number of potential stakeholders for the CTCN technical assistance is high. Below, we have listed the immediate stakeholder that we believe may benefit from the CTCN technical assistance in form of lessons learnt or even by using the end-results:

Stakeholder	Stakes
Individual farmers and agricultural collectives	The farmers (males as well as females) will benefit on possible improvements on drought monitoring and warnings as they will be able to adapt their agricultural practices to the actual and predicted situations. For the farmer to benefit fully on possible improvements it is important that an efficient dissemination system is in place and that the farmers are trainined in receiving and responding to the notifications/warnings.
Water Infrastructure (Water Supply, Sanitation, Dams, Irrigation Schemes) Operators	Depending on the exact drought monitoring and warning tolls to be developed and applied the water infrastructure operators may also benefits from these tools e.g. for planning of possible restrictions in the use of water during dry/drought situations.
The Water Resource Commission for Black Volta & The Water Resource Commission for White Volta	These basin organisations are responsible for water resource management in their respective areas and will as such benefit from possible developed tools for monitoring and prediction of drought events in order for them to warn/guide the water users in the basins.
Regional Coordination Council(s) in the pilot area	As a regional authority the Coordination Council should be kept informed on possible planning and warning tools for drought that the population may benefit from. The Council may play a role in the implementation of possible new methodologies/tools within its area of jurisdiction.
Water Research Institute	Being a research institution within water resources in Ghana it is important that WRI are informed on possible developments made by the CTCN assistance and also that they have the possibility to give guidance when relevant.
Volta River Authority	Volta River Authority is the operator of the hydropower scheme at Akasombo Lake. The developed drought monitoring and warning tolls may be relevant for the planning and operation of the hydropower scheme.
Ministry of Environment, Science, Technology and Innovation (MESTI)	MESTI is the lead Ministry within Ghana when it concerns Climate Change. It is therefore important the

	MESTI is informed of the results of the CTCN technical assistance in order to able to coordinate it with other relevant climate change initiatives.
National Disaster Management Organisation	Being responsible for the disaster management in Ghana also means that NADMO should be informed on drought tools developed by the CTCN technical assistance. Such tools may be useful when NADMO monitors the risks of drought and the consequent food insecurity.
Ministry of Water Resources Work and Housing	Will be kept informed via the Water Resource Commission.
Ministry of Local Government and Rural Development	Will be kept informed via the Water Resource Commission. The actual direct contact with rural population in the pilot area will be made by MOFA. The Ministry of Local Government and Rural Development may be instrumental in dissemination potentially good lessons learnt to other geographical parts of Ghana.
Hydrological Services Department	The Hydrological Services Department is expected to provide hydrological ground data to support the information derived from earth observations. Guidance from HSD for the development of the drought monitoring and warning tools are also expected to increase the effectiveness of the tools.
Global Water Partnership (Ghana)	GWP is collecting and sharing water resource management experiences among water users and water managers and as such the results of the CTCN technical assistance shall also be shared with GWP.
Environmental Protection Agency	The developed tools may be relevant for EPA when monitoring/managing e.g. wetland.
Department of Earth Science, University of Ghana	DES is presently involved in research projects related to water resources in Norther Ghana and may as such benefit from the results of the CTCN technical assistance.
Ghana Irrigation Development Authority	IDA is responsible for the design and contraction of irrigations schemes while the actual operation of the same schemes is the responsibility of the respective water user associations (WUA) . IDA may assist in providing links to relevant WUAs in the pilot area.
Ministry of Women and Gender	The ministry will be kept informed of the result of the CTCN technical assistance. See also comments related to individual farmers.
Savanna Accelerated Development Authority	The organization will be kept informed of the results of the CTCN technical assistance.
Centre for Remote Sensing and Geographic Information Services	The centre will be kept informed of the results of the CTCN technical assistance.

3.3 Institutional structure related to drought management

The present CTCN technical assistance focusing on resilience to drought relates closely to the following policies/plans guiding the socio-economic development in Ghana:

- The National Climate Change Policy (NCCP) 2014
- Food and Agriculture Sector Development Policy (FASDEP) II 2009-2015
- National Action Programme to Combat Drought and Desertification
- National Climate Change Policy – Action Programme for Implementation 2015-2020

Above policies and plans all encourage the development and use of new technologies in order to adapt to climate change. The present CTCN technical assistance is thus contributing to the already agreed policies and plans in Ghana.

Overall, the Ministry of Environment, Science, Technology and Information (MESTI) is in charge of overseeing and securing that the climate change policies and plans are implemented in Ghana. The actual implementation of the activities related to food security is the responsibility of MOFA. In this context, MOFA has recently issued a working paper with the title “National Climate-Smart Agriculture and Food Security Action Plan of Ghana (2016-2020)”. This plan is specifically mentioning the generation and use of seasonal weather forecasts (by GMet) in order to improve resilience in the cropping system and adaptation in the livestock production. The plan also encourage the use of mass media channels, especially radio and television to reach farming communities. As such, the CTCN technical assistance can to a large extent be seen as contributing directly to the proposed National Climate-Smart Agriculture and Food Security Action Plan.

According to the proposed plan the Environment and Climate Change Unit under the Directorate of Crops Services within MOFA shall be responsible for the implementation of the “climate-smart and food security actions”. At the decentralized level, the Department of Agriculture of the Metropolitan, Municipal and District Assemblies (MMDAs) shall support the on-the-ground activities according to plan.

The CTCN technical assistance will during the early part of 2017 take contact to MOFA in order to make final agreements on the actual involvement of MOFA and its structures at regional, district and local level.

As agreed during the initial workshop in October 2016 the CTCN technical assistance will to the largest extent possible work within the existing institutional framework in Ghana in order to support ongoing initiatives.

3.4 Related past and ongoing projects in Ghana

There are a number of ongoing and past projects of relevance for the CTCN assistance. The key projects will as part of activity 2 “Technology adaptation/adjustment” be examined for knowledge or outcomes to be utilized or further developed within the CTCN assistance. The below table lists the relevant past and ongoing projects.

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	Ghana Meteorological Agency	
WACDEP	2011 - 2015	GWP	Climate change impact on water resource and indirectly on drought
Weather research and forecasting modelling	Ongoing	Ghana Meteorological Agency	Opportunity to collaborate on the climate forecast part
Monitoring water availability for allocation taking into consideration drought	Ongoing	Water Resources Commission	
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.

4 Activities carried out during the Initial Phase of the CTCN assistance

4.1 National workshop

The national workshop was held at the Water Resources Commission in Accra on 26th October 2016. Minutes of the workshop are available as deliverable 2 of the CTCN assistance.

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 flooding.

- It was agreed that the pilot area will be located in the Northern part of Ghana where drought is more often experienced compared to the Central and Southern Ghana.
- There is a scope for improving the existing drought monitoring and forecasting methodologies in Ghana based on latest Earth Observation technologies.
- The main activities of the CTCN technical assistance is likely to be focused towards improved drought forecasting (in terms of timeliness, quality, and format).
- The dissemination aspects – including how to reach female farmers – needs to be investigated via consultations with the Ministry of Food and Agriculture as dissemination of drought warnings to the farmers are their responsibility.
- 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.
    - Ghana Meteorological Agency 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.
- It is important that the outcomes from the technical assistance supports the existing dissemination processes e.g. dissemination from ministries to farmers and related organisations.
- There will be a need for follow-up meetings with some of the key stakeholders within the coming months to further understand how the technical assistance results should embed into the current dissemination processes related to drought management in Ghana.

4.2 Meetings with stakeholders

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

4.2.1 National focal point for Green Climate Fund

Accra, Ghana, 25th of October 2016

Name	Position	Email
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.

4.2.2 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.

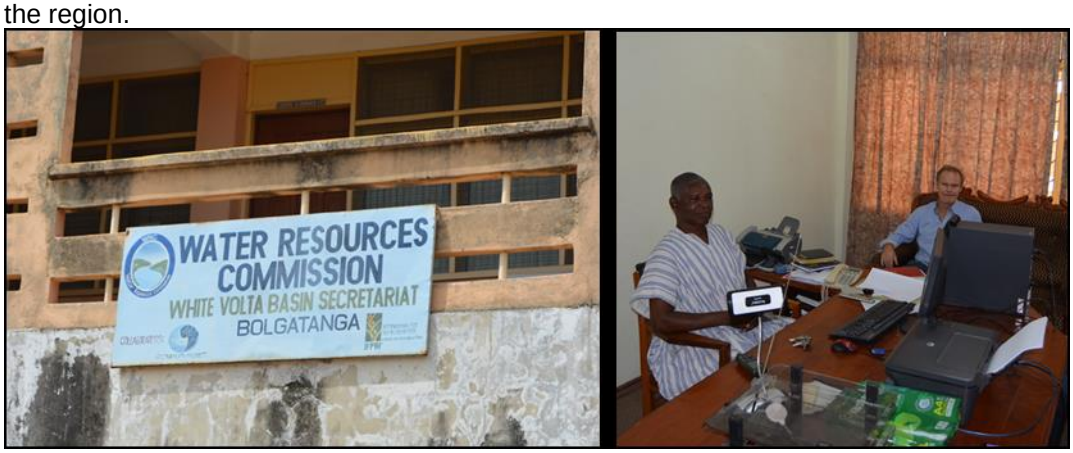

Figure 4-1 Meeting at the Water Resources Commission, Regional office, White Volta in Bolgatanga

4.2.3 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
- There are 3 crop seasons in the region with May to October as the main season (major crop), November to February (mainly vegetable) and March to May (mainly maize).
- 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 4-2 Regional office of MOFA in Bolgatanga

4.2.4 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 and desertification.

Figure 4-3 EPA regional office in Bolgatanga

4.2.5 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.

4.2.6 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 during the late part of 2016. They have 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.

4.2.7 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.

5 Needs Assessment

The CTCN assistance is based on a national request followed by a response plan detailing the technical response to the national request. The objective of this needs assessment activity is to further strengthen the scope of the national request by including the prioritized gaps and requirements from a number of bilateral stakeholder meetings and a national workshop.

5.1 Methodology applied for the assessment

The methodology for the needs assessment is based on communication and discussion with a number of stakeholders within Ghana of relevance for drought management. This is achieved through:

- National workshop with the key national stakeholders on October 26th in Accra
- Bilateral meetings with national stakeholders in Accra
- Bilateral meetings with local stakeholders in the northern region of Ghana (Upper East region)

The outcomes from the needs assessment is detailed in section 5.4 (describing how the assistance will support the gaps and requirements) and in section 6 (describing the proposed work plan and outcomes).

5.2 Existing practices related to drought management in Ghana

The existing practices related to drought management are based on the collected knowledge from the stakeholder meetings and the national workshop. The knowledge will be further extended as the CTCN assistance develops with additional meetings in order to get a more detailed understanding of the current practices and gaps.

The **Ghana Meteorological Agency (GMet)** is the organisation with the responsibilities for the technical areas related to climate induced drought and they are currently providing seasonal weather forecast to relevant end users via departments under the Ministry of Food and Agriculture. The current seasonal weather forecast is used actively in the norther regions and is based on a locally adjusted weather forecast from the global NOAA CFS model. The seasonal forecast for the coming 12 months is developed every March and updated in June based on the performance during the past months. GMet disseminates the seasonal forecast to MOFA who is responsible for the further dissemination to the local users and organisations. Currently, GMet does not disseminate other drought related information or data, but the plan is to expand the current service with drought indices and additional drought specific information.

Ministry of Food and Agriculture (MOFA) is responsible for the formulation of appropriate agricultural policies, planning & co-ordination, monitoring and evaluation within the overall national economic development. In relation to drought management they have an important role as the organisation providing information from the central ministries to the local and regional offices and organisations. Currently this information is related to the weather information received from GMet and guidance as well as support to the agricultural sector in relation to farming and irrigation practices, e.g. when to plant which crop (this part will be further explored during planned meetings with MOFA in Q1 2017). MOFA does not provide drought forecast or warnings to the agricultural sector in the form or risk maps or drought specific indices relating the current or forecasted drought situation to a risk for the farmers' crop production.

The **Environmental Protection Agency (EPA)** serves the role of guiding the agricultural sector with respect to drought tolerant crops or farming practices increasing the water efficiency within the sector. This relates both to events caused by climate variability but also for the long term changes imposed by climate change. EPA provides an important role in linking the technical aspects behind drought assessment and warning with the practical implementation at the farmers' level.

5.3 Challenges and gaps

The main challenges and gaps related to drought management in Ghana as observed through the stakeholder consultations in Accra and in the Upper East region are:

- **Drought issue** - There is a frequent and real drought issue in the northern parts of Ghana due to an increase in the observed hot spells with limited rainfall. If these events coincide, with the sowing time for the major crop types it will have a serious impact on the crop yield and the economic return to the farmers. Currently, the farmers apply a practice of planting their crops over a period of 3 to 4 weeks to reduce the risk of losing all their crops in case that a series drought event occurs during the critical early growth phase.
- **Climate change** will alter the areas impacted by drought and it is expected that the southern regions will see increased drought events. This increases the need for awareness and adaptation to the issue on a national scale.

- **Reliable near real-time observations are missing** in some parts of Ghana which makes it difficult to overview the current conditions and predict how drought events will evolve. The issues are mainly related to the cost of new equipment and the maintenance of these. There will be a scope for using the latest Earth Observation technologies as this method could be used to supplement the current observation stations.

- **Dissemination of information to farmers** – the Ghana Meteorological Department provides a seasonal forecast with recommendations for the farmers. This information is disseminated to the agricultural sector through MOFA, but the observations in the Upper East district is that organisations do not always receive this information, and they seem to rely to a large extent on the general weather information broadcasted by radio ortelevision.

- **Drought indices are currently not used** in Ghana as the information is based on rainfall information only. There is a scope for increasing the knowledge and capacity for using drought indices as one of the key parameters for identification of drought impacted areas.

- **Institutional responsibility for drought management** and their respective roles within the key ministries seems not clearly defined, or is not visible for the CTCN assistance at this stage.

- **National focus on drought** is not visible due to the fact that the t impact is limited to the northern regions, and as the drought events are not seen as natural events occurring with a certain frequency. Drought spells have been seen in the northern part of Ghana for many years, but as they are expected to increase in frequency and duration it is critical to increase awareness on drought management on a national scale.

The challenges and gaps related to drought management are based on the available information and the meetings and workshops conducted during the initial phase of the assistance. The knowledge will be further extended as the technical assistance develops during the year 2017.

5.4 How the CTCN assistance can support the gaps and requirements

As of now drought is a common event in the northern regions of Ghana, and the regional organisations and local farmers are adapting but they are facing a number of challenges, which reduces the efficiency of the current drought management. The CTCN assistance aims at supporting the gaps and requirements within the following areas:

- **Data and information** is critical for any type of assessment and one of the current gaps are the lack of near real time ground stations providing relevant information for drought management. Within this area there is a clear scope for improving the existing drought monitoring and forecasting through the use of the latest Earth Observation technologies as it enables near real time data and information on a national scale of key data sources for drought observation and management.

- **Drought identification** is typically based on a number of drought indices, which relates the value of different data types with the state of the drought. A drought index could be expressed as the rainfall deviation from the long term mean in a

specific month, or as other statistical measures providing information regarding how the current state is compared to what was expected. Drought indices are currently not used in Ghana and this is one of the key parameters to improve the drought observation and forecasting.

- **Drought forecasting** is based on weather forecast and the ability to analyse how the future situation impacts the agriculture sector. There is already a lot of knowledge within the Ghana Meteorological Agency but there is a scope for linking this information closer to drought management through forecast of drought indices or impacts within the agriculture sector.

- **Impact on crops** is critical for the farmers and the CTCN assistance will provide technology using some of the available FAO tools for crop requirement and yield to provide information regarding the crop impact for expected drought impacts.

- **Dissemination format** or the way technical information is provided to the end user is important for how the information is perceived. The CTCN assistance will help to design the dissemination so it specifically targets the vulnerable groups within the agriculture and water sector.

- **Access to relevant and updated information** can have a great impact on an emerging drought situation as stakeholders and farmers are able to react faster and thereby increase the adaptation to an upcoming situation. The use of web solutions are already well established in Ghana and should be used as a key tool for dissemination of key information in a drought management process.

The CTCN assistance will support the gaps and challenges through a web based drought early warning and forecasting portal allowing key stakeholders to access relevant data and information for drought detection, warning, forecasting and dissemination. The web based portal will be targeted towards the Ghana Meteorological Agency (GMet) and Ministry of Food and Agriculture (MOFA) as they are the key ministries responsible for drought management. The web based portal will be public and could be accessed by a range of national, regional or local organisations as well. The criteria though is that the CTCN assistance should embed into the existing dissemination process without creating a new one, hence it is critical that the CTCN assistance strengthens and supports the ongoing dissemination processes within Ghana thought MOFA.

5.4.1 Ideas for the technical description

The detailed technical description for how the CTCN assistance will support the gaps and challenges will be described in the next deliverable (Technology specification report for activity 1.3), but in order to get an understanding of how the technical solution might look like some of the key components are drafted in the following section.

Data and information will be the key focus as this is the basic requirements for making the drought early warning and forecasting portal. Due to the limited amount of station data then the initial focus will be on using satellite and earth observation products combined with model based weather forecast and climate change products. Depending on the availability of station data these might be included as well. Figure 5-1 shows a schematic description of a process where the web based drought early warning portal gets updated with the latest satellite and climate forecast data, which gets processed and used for calculation of a number of drought indices. The data will then be available for the user in near real time (maximum delay of a few days from the actual observation). The specific datatypes and drought indices to make available will be decided in close collaboration with WRC, GMet and MOFA.

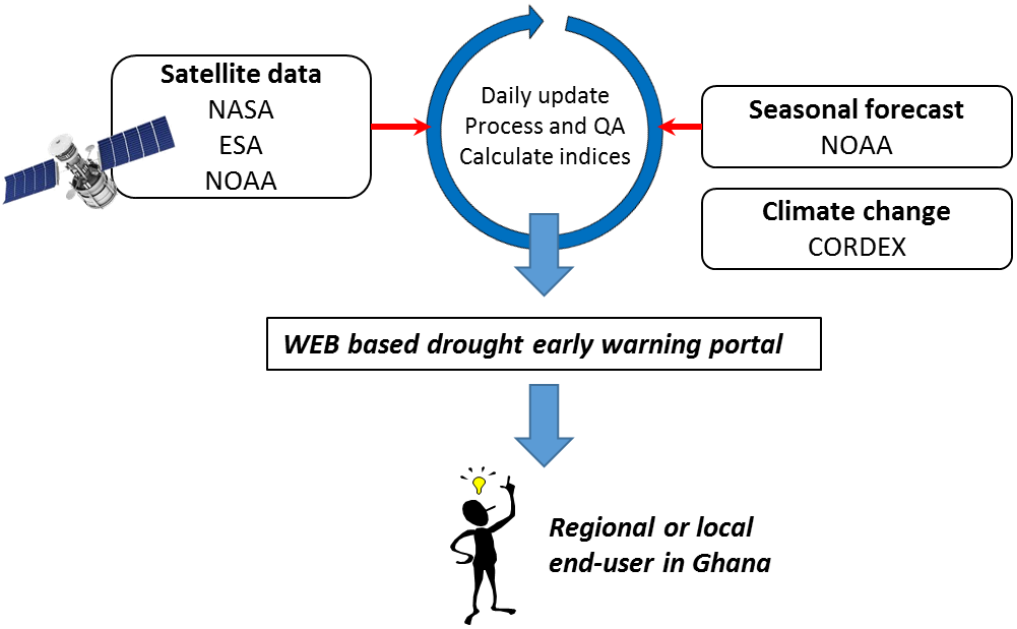

Figure 5-1 Schematic description of how a web portal could be updated with satellite based data, climate forecast and climate change data

The web-based drought early warning and forecasting portal will be the key outcome of the CTCN assistance and will serve several purposes for the end-users in Ghana with respect to drought management; i) a data and information provider, ii) location of drought impacted areas, iii) provide warnings for future drought events and iv) as one of the key dissemination tools supporting the existing dissemination process at MOFA. Figure 5-2 illustrates some of the basic components in a web solution allowing the user to view different data types, plot data as maps or time series and download data for further analysis. It will also include an assessment part providing the actual identification of drought impacted areas and a dissemination part for automated reporting of drought impacts and warnings of future events. The detailed design will follow in the deliverable connected to activity 1.3.

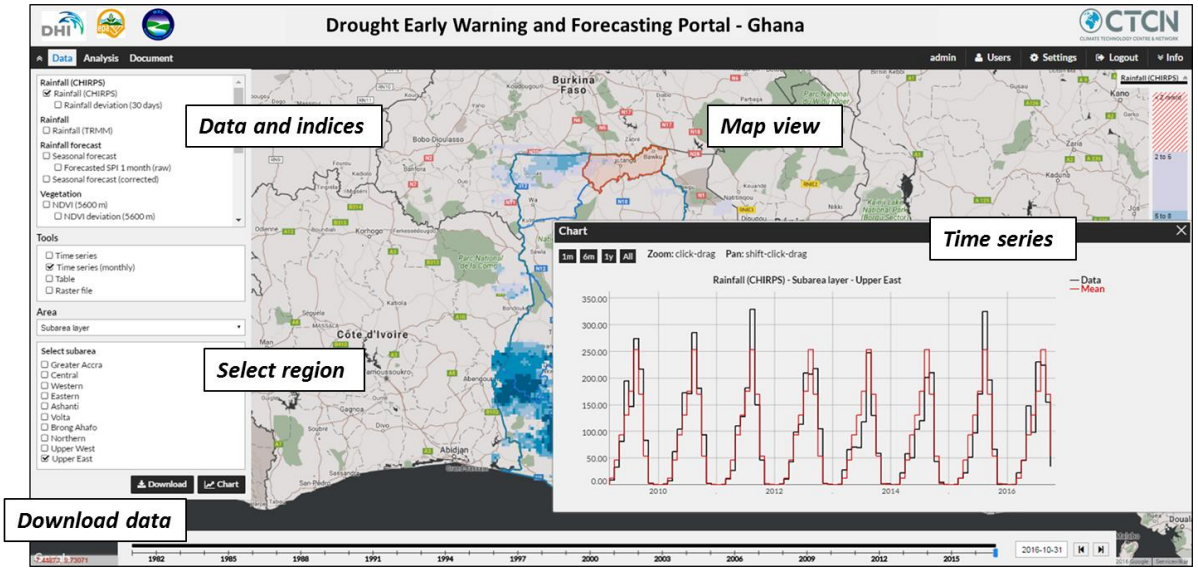

Figure 5-2 Illustration of web based interface for drought early warning and forecasting portal

Climate forecast will be another key focus area which the technical part of the CTCN assistance will have to look at. The proposed solution is to take advantage of some of the freely available climate forecast models and downscale the results to the conditions within Ghana. This will allow for forecast of rainfall within an upcoming season but also evaluation of specific drought indices as the Standardised Precipitation Index (SPI) which is a commonly used drought index. Figure 5-3 illustrates how a forecasted SPI value could be presented in a web solution.

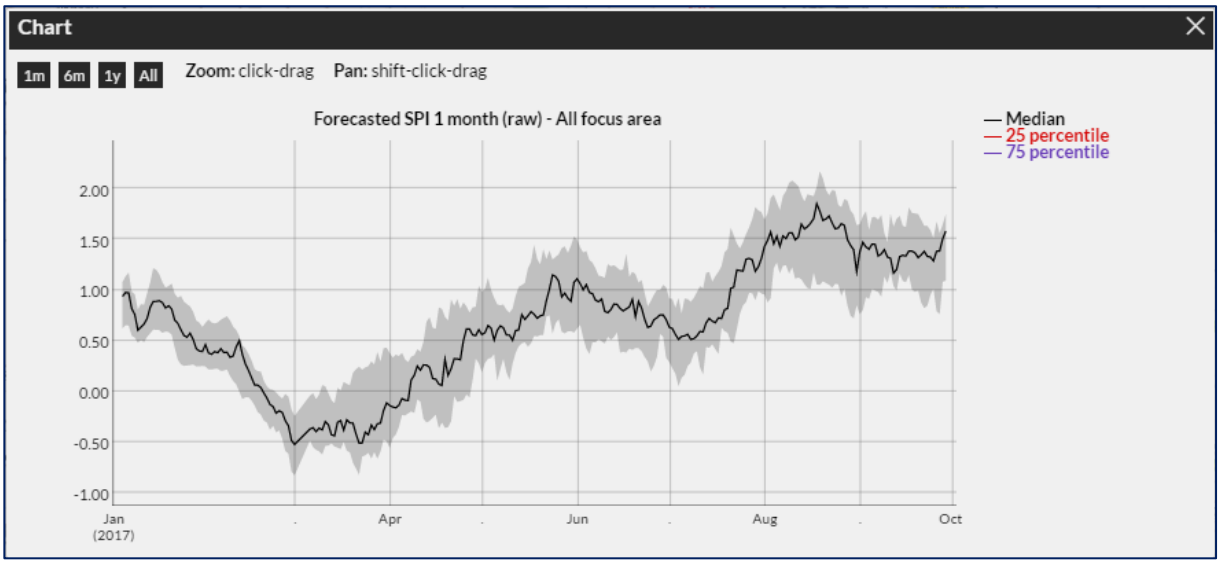

Figure 5-3 Example of forecasted SPI (1 month) for Ghana based on a 20 member forecast (DHI)

There are a number of other requirements to the technical outcome which will be detailed within activity 1.3, this includes drought identification, the use of crop tools as AquaCrop, downscaling technique for the climate forecast, the use of climate change data and the reporting and dissemination part.

6 Proposed Work Schedule of the CTCN support

The proposed work schedule covers the activities and outcomes from the assistance. The prioritized gaps and requirements collected, as part of the needs assessment activity does not require any significant change to the initial work schedule. It is expected that the initial work plan and budget will be followed.

6.1 Activities

The activities are divided into three main categories, each with their own activity heading. The content of each of the sub-activities and the expected outcome is briefly described in the following sections.

6.1.1 Activity 1.1 – National workshop to identify priorities for the CTCN assistance

The national workshop marked the initiation of the CTCN funded technical and was held at the Water Resources Commission in Accra, Ghana on October 26th, 2016.

The workshop was scheduled for a full day, in which participants from various institutions came together for a presentation of the scope and content of the CTCN technical assistance and for discussions of how the outcomes could be further tailored to benefit the water and agricultural sector in Ghana. The content and outcome of the workshop is described in the minutes of workshop (deliverable 2).

6.1.2 Activity 1.2 – Needs assessment

The objective with this activity is to compile the findings and understanding from the workshop and stakeholder meetings during the initial phase of the assistance into a more detailed description of the requirements for the CTCN assistance. The main outcome is the present Needs Assessment Peport.

6.1.3 Activity 1.3 – Technology description

This activities focused on delivering a clear description on the technical content of the CTCN assistance in the form of the Technology specification report. The technical description will be based on the outcomes from the national workshop and the needs assessment report which will lead to a more detailed description of the proposed technology in a technology specification report. This also includes specifications for how the developed technology should be tested and validated before being transferred to the end users, as technical use cases to validate the functionality, and specifications for an in-situ validation on a selected location in northern Ghana.

6.1.4 Activity 2.1 – Technology adjustment and development to local conditions

This activity contains the development of all the technical components and especially the main outcome which is a web-based drought early warning and forecasting system aims at providing timely and correct information to relevant stakeholders related to the current and projected drought status.

The technical activities will relate to the following specific areas:

Web-based data and information portal aiming at providing near real-time information and data required for drought monitoring and forecasting. The data sources will include rainfall, temperature, vegetation cover, water availability in the root zone, forecasted rainfall (seasonal forecast), climate change factors and a number of relevant drought indices derived from these data sources. The drought indices will be included to compare the current situation against historical records. Example of indices to be included will be standardized precipitation index, anomaly and deviation index. All data sources will be spatially distributed and updated in near real time. In normal operation, the time lag from when the data is available at the source and when it is available at the portal will be maximum a few days, thus operating in near real-time. The web-based portal from where data can be visualised and accessed will be the central information platform for the early warning and forecasting system.

Web-based early warning and forecasting system aiming at providing timely and correct information related to the current and projected drought status. The early warning and forecasting system will be the key technology in the CTCN assistance, as it will make use of the available near real-time data in the data portal to provide analysis of the current and projected drought status and impact in Ghana. The assessment of the current drought status will be based on near real-time data and associated drought indices. Climate, vegetation and soil moisture impacts will be assessed using predefined drought categories. The drought assessment will be prepared for dissemination to relevant

stakeholders within Ghana. In addition, the forecasted drought status (for the coming 2 to 4 months) will be assessed based on the seasonal forecast and will be used to predict climate impacts as well as the estimated crop yield and impact on selected crops in Ghana. The long term drought assessment (decades) will be built upon results from the latest climate models where results such as changes in number of dry days, extreme events and rainfall pattern will be made available for assessment of the expected long term changes in drought spells. The early warning and forecasting system will be a web-based system and closely linked to the data and information portal.

Dissemination technologies to present the outputs from the early warning and forecasting system are a key component of the CTCN assistance. The dissemination tools will be targeted towards the different potential end users in Ghana.

The first outcome of the activity will be a description for how the CTCN outcomes should be tested and validated (Methodology for validation and testing).

The second outcome will be a first version of the drought early warning and forecasting system for QA and testing by WRC, GMet and MOFA.

6.1.5 Activity 2.2 - Technology validation

The objective of this activity is to ensure validated outcomes are produced in a correct and timely manner and their dissemination can support the relevant stakeholders. There will be a close collaboration with the regional office for the Water Resources Commission, Regional office in Bolgatanga as this area will be used to validate the outcomes of the system. The area is often affected by serious drought spells and the historic information available from this area will be used to ensure that the drought system is able to produce timely and correct results. Selected stakeholders in the region will as well be used to shape the dissemination part of the assistance. There will be three outcomes from this activity i) Review report from main applicant describing giving the review and feedback on the first version of the drought early warning system, ii) Technology validation report describing how the system performs compared to the actual situation in the northern part of Ghana and iii) first version of a user guide.

6.1.6 Activity 3.1 – Second national workshop to create awareness and knowledge of the outcomes

A second national workshop will be held with relevant stakeholders and organisations in Ghana with the aim of creating awareness and knowledge of the technology transfer. The workshop will include a maximum of 15 participants for a duration of 1 day. At the workshop, the validation case will be presented in details in order to provide in-depth information on the use and benefits of the technologies. A summary report describing the key outcomes of the workshop will be produced. The outcome of the workshop will be described in a summary report.

6.1.7 Activity 3.2 – Technical training

Technical training (2-day) for selected staff within the key organizations (maximum 5 organisations and a total of 15 participants) will be organised with the objective of providing detailed knowledge and capacity in using the transferred technologies in Ghana on an ongoing basis. Five organizations to send trainees to this workshops will be selected by the implementers together with the main applicant. All training material will be made available to the trainees for further use after the training. In addition, a short

summary report with outcomes of the training will be produced. This report will identify key areas where further capacity building is required.

6.1.8 Activity 3.3 – Outreach and dissemination

The outreach and dissemination part aims at providing awareness and knowledge of the technology to relevant organizations. This activity includes:

Presentations for key Ghana institutes and relevant partners through separate meetings (maximum of 3 meetings). The CTCN contractor will organize and attend the meetings and will report the outcome of these meetings to the main applicant. The minutes will be published in the lesson-learned report.

Presentation of the technologies for VBA and ECOWAS as they are the relevant bodies for the Volta basin and the West Africa Union. The CTCN contractor will organize and attend up to 2 meetings with relevant regional organisations. The CTCN contractor will report the outcome of these meetings to the main applicant, and the minutes will be published in the lesson-learned report.

Lesson-learned report from the validation case and the initial use of the system in Ghana (maximum of 30 pages). This also includes description and design of gender relevant indicators, and identifying at-risk groups and recommendations to improve gender-sensitive drought planning. The report will be submitted to the main applicant.

Roadmap documentation describing recommendations for transfer of the technology and scaling up within future projects (maximum of 20 pages).

Dissemination of reports, materials and tools to all relevant stakeholders. This will be done through the main applicant, where the CTCN contractor will make the required documents and tools available.

Evaluate funding options through regional partnerships and opportunities for post response interventions. This will be reported in the roadmap document.

6.2 Work plan

The work plan for each of the activities are shown in Table 6-1. The work plan is shown in weeks from the start of the assistance (August 31, 2016).

Activity	**Weeks**											
Weeks since 1 August 2016	4	9	13	17	22	26	31	36	40	44	49	52
	Year 2016				Year 2017							
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1 Stakeholder consultation												
1.1 National workshop to identify priorities for the CTCN assistance												
1.2 Needs assessment												

1.3 Technology description												
2 Implementation												
2.1 Technology adjustment and development												
2.2 Technology validation												
3 Technology transfer												
3.1 Second national workshop to create awareness and knowledge of the outcomes												
3.2 Technical training												
3.3 Outreach and dissemination												

Table 6-1 Work plan

6.3 Deliverables and outcomes

The key outcome from the CTCN assistance will be a web-based drought assessment and early warning portal supporting the following components:

- Data accessibility. Web-based technology allowing the stakeholders to access near real-time satellite-based data for Ghana. The available data will be related to climate (rainfall and temperature), crop and soil moisture conditions. The aim is 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.
- Climate forecasting. Climate forecasting is a key product for assessing the evolution of a drought in the coming season. Existing seasonal forecast products and associated skills within Ghana will be explored, and a near real-time product will be made available through the mentioned web-based data portal.
- Climate change. The latest climate change results will be evaluated and included in the data portal.
- Early warning. An early drought warning system facilitates the provision of timely and effective information related to the water and agriculture sectors allowing these sectors to take actions to mitigate impacts of the upcoming drought. The available data will be used by the national stakeholders for establishing a web-based drought early warning system on a seasonal scale and a drought forecasting system on the long-term scale.
- Early warning communication. Tools for disseminating warnings and forecasts will be evaluated in close cooperation with the local stakeholders.

All the mentioned technologies will be made freely available for the stakeholders and will not be associated with any license or maintenance cost.

The specific deliverables and the delivery dates are shown in Table 6-2.

Deliverable	Delivery date
List of stakeholders (activity 1.1)	4th November 2016
Minutes from national workshop (activity 1.1)	4th November 2016
Needs assessment report (activity 1.2)	2nd December 2016
Technology specification report (activity 1.3)	13th February 2017
Methodology for validation and testing (activity 2.1)	13th February 2017
First version of the system for QA and testing by the main applicant (activity 2.1)	30th April 2017
Review report from main applicant (activity 2.2)	1st June 2017
Technology validation report (activity 2.2)	1st July 2017
Technology description and user guide (activity 2.2)	1st July 2017
Summary report of the second national workshop (activity 3.1)	15th August 2017
Technical training material (activity 3.2)	15th August 2017
Summary report of the technical training (activity 3.2)	15th August 2017
Lesson learned and recommendation report (activity 3.3)	31st August 2017
Roadmap documentation in transfer of technology and scale up (activity 3.3)	31st August 2017

Table 6-2 Deliverables and delivery date

6.4 Meetings and workshops

The following meetings and workshops will be conducted as part of the CTCN assistance:

- National workshop. Conducted with 20 participants on October 26, 2016
- Stakeholder meetings during initial phase of the assistance. A number of stakeholder meetings have been conducted in Accra and in the northern part of Ghana (see section 4.2).
- Stakeholder meetings (February 2017) to further understand and detail the needs for the technical solution.
- National workshop (August 2017) to create awareness and knowledge of the outcomes
- Technical training (August 2017) to develop capacity to use the outcome as a tool for the national drought management
- Outreach and dissemination (August 2017) with national and regional organisations for dissemination of the outcomes.

6.5 Training and capacity building

A technical training (2-day) for selected staff within the key organizations (maximum 5 organisations and a total of 15 participants) will be organised with the objective of providing detailed knowledge and capacity in using the transferred technologies in Ghana on an ongoing basis. Five organizations to send trainees to this workshops will be selected by the implementers together with the main applicant. All training material will be made available to the trainees for further use after the training.