CTCN assistance in Uganda

Adaptation to climate change through improved information and planning tools for Lake Victoria

Deliverable 4 (activity 1.2) Technology specification report

Deliverable 5 (activity 1.2) Methodology for testing and demonstration

Report / Technical Note

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Prepared for UNEP

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Acronyms and Abbreviations

ASI	Agricultural Stress Index
CFS	Climate Forecast System
CGLS	Copernicus Global Land Service
CORDEX	Coordinated Regional Climate Downscaling Experiment
CTCN	Climate Technology Centre & Network
DHI	DHI - see more at www.dhigroup.com
EAC	East African Community
EDI	Effective Drought Index
GCF	Green Climate Fund
IUCEA	Inter-University Council for East Africa
JAXA	Japanese Aerospace Exploration Agency
LMCS	Land Monitoring Core Service
LVBC	Lake Victoria Basin Commission
LVEMP	Lake Victoria Environmental Management Project
MUST	Mbarara University of Science Technology
MWE CCD	Ministry of Water and Environment Climate Change Department
MWE SSD	Ministry of Water and Environment Support Services Department
MWE DWRM	Ministry of Water and Environment Directorate of Water Resources Management
NAPE	National Association of Professional Environmentalists
NASA	National Aeronautics and Space Administration
NBI	Nile Basin Initiative
NCEP	National Centers for Environmental Prediction
NDE	National Designated Entity
NDVI	Normalized Difference Vegetation Index
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NOAA	National Oceanic and Atmospheric Administration
MGLSD	Ministry of Gender Labour and Social Development
RAN	Resilient Africa Network
RCP	Radiative Concentration Pathway
SPI	Standardised Precipitation Index
STEPUP	STEPUP Standard Limited
SVI	Standardised vegetation index
SWI	Soil Water Index
TRMM	Tropical Rainfall Measuring Mission
UNCST	Uganda National Council for Science and Technology
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNMA	Uganda National Meteorology Authority
VCI	Vegetation Condition Index
WCRP	World Climate Research Programme
WRIS	Water Resources Information System

Technology specification & Methodology for testing and demonstration

This document contains the proposed technology implementation and a demonstration and testing plan through selected case studies. This output constitutes the deliverable under **Activity 1.2 Description of outcomes and identification of case studies** of the technical assistance.

The first chapter provides background to the Climate Technology Centre and Network (CTCN) technical assistance and case studies involved. The second and third chapters describe the technical specifications and methodology for demonstration and testing. The report concludes with the next steps towards the implementation stage of the assistance with a short description of Activity 2 and the expected inputs regarding gender mainstreaming within Activity 3 that is the capacity and dissemination part of the technical assistance.

1 Background

Upon a request by the Lake Victoria Basin Commission (LVBC), the CTCN funded technical assistance on "Adaptation to climate change through improved information and planning tools for Lake Victoria" was kicked off with a national workshop that was held at the Uganda National Council for Science and Technology (UNCST) in Kampala on the 15th of June 2017. The UNCST is the National Designated Entity (NDE) for Uganda. The list of attendees is available from the previously submitted deliverable "Minutes from the national workshop".

The objective of this technical assistance is to strengthen planning in the water resources and energy sectors in Uganda, at both long-term and seasonal timescales. The specific objectives of this technical assistance are to:

- Provide access to state-of-the-art ensemble climate projections, seasonal forecasts, and satellite-based historical data through a web based interface.
- Refine the existing impact model used for simulating hydrology and water use in the Lake Victoria basin in order to maximize the utility of the model for estimating climate impacts on the water and energy sectors.
- Provide guidelines for using ensemble projections of climate variables and other drivers in decision-making,
- Demonstrate the utility of the technologies and guidelines through applications to local case studies.
- Enable decision makers and stakeholders to use the transferred knowledge, practices and technologies through dissemination and outreach activities.

The technical assistance is being implemented through three main activities forming the scope of work and key deliverables: Activity 1 – Stakeholder outreach; Activity 2 – Data access, model refinement, and development of guidelines for decision support; and Activity 3 – Dissemination and outreach.

In **Activity 1.1 National workshop to introduce CTCN assistance and solicit feedback**, the technical assistance was presented to stakeholders involved in decision making or planning within the water or energy sector in Uganda. The stakeholders were selected by LVBC and the NDE based on their knowledge of national stakeholders of relevance for the CTCN assistance and in Activity 1.1 a national workshop to introduce CTCN assistance was organized and feedback solicited. The table below provides an overview (for more information view the minutes from the first national stakeholder workshop).

Table 1 List and overview of the applicant and stakeholders in Uganda.

Stakeholder	Role to support the implementation of the CTCN assistance
Lake Victoria Basin Commission (LVBC)	Main applicant assisting the implementer in the implementation of the CTCN supported technology. In addition, the LVBC will support this technical assistance in: 1. Requirements for needs assessment 2. QA and review of the proposed technologies 3. Review of the validation report Host for the national and regional workshops
Uganda National Council of Science and Technology (UNCST)	The Uganda National Council for Science and Technology was established in 1990 for the purpose of inter alia advising on and coordinating the formulation of national policy on all fields of science and technology, and for assisting in the promotion and development of indigenous science and technology. The Council cooperates closely with other organizations involved in scientific and technological activities. As NDE, the UNCST will assist the implementer in this technical assistance providing guidance and reviewing the relevant documents. UNCST will also be consulted and informed of the progress of the technical assistance.
Ministry of water and environment, Uganda (MWE)	Responsibility for setting national policies and standards, managing and regulating water resources and determining priorities for water development and management
Climate change department (CCD), MWE	Works with implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (KP)
Uganda National Meteorological Authority (UNMA)	UNMA Provides meteorological information since it collects, processs, archives and analyses meteorological data
National Environment Management Authority (NEMA)	NEMA's Development objective is to create, establish and maintain an efficient mechanism for sustainable environment and natural resources management at the national, district and community levels.
Ministry of Energy and Mineral development, Uganda	The Ministry carries out policy guidance in the development and exploitation of the energy and mineral resources.
Ministry of Gender, Labour and Social Development, Uganda (MGLSD)	Responsible for coordinating Gender Issues in Uganda
Mbarara University of Sciences and Technology (MUST)	Carries out water related research including impacts of climate change

Nile Basin Initiative (NBI)	Intergovernmental partnership of the 10 Nile Basin countries, and the highest decision and policy-making body of NBI is the Nile Council of Ministers (Nile-COM), comprised of Ministers in charge of Water Affairs in each NBI Member State. It is a forum for consultation and coordination among the Basin States for the sustainable management and development of the shared Nile Basin water and related resources.
Resilient Africa Network (RAN)	Partnership of 18 African universities in 13 countries led by Makerere University. RAN is a development lab under the Higher Education Solutions Network (HESN) in the office of Science and Technology (OST), USAID.
National Association of Professional Environmentalists (NAPE)	Organization that monitors government actions, conducts research, provides educational materials, develops science-based strategies, organizes affected communities, makes common cause with other civil society organisations and international organizations, and engages government officials at all levels.

Within Activity 1.1 the outcomes outlined in the objectives and a selection of case studies for testing have been consolidated through discussions held with stakeholders under Deliverables 2 and 3 namely, “Report on feedback and decision problems” and “Summary of identification of potential case studies for demonstration and testing of technologies”.

The next stage of the technical assistance is **Activity 2 Data access, model refinement, and development of guidelines for decision support** that refers to implementation the technological deliverables, along with the methodology for testing using a selection of case studies presented in the next chapter.

2 Selection of case studies

Relevant national programmes and initiatives were identified and discussed as part of the first national workshop, these are listed in Table 2. The national programmes and initiatives were used to frame the description of the case studies, to ensure the relevance of the case studies.

Table 2 Previous experience of projects in Uganda and the region, related to climate change in Lake Victoria as collected in the national workshop

Programme or project	Institution
Lake Victoria Environmental Management Project I and II (LVEMP-I and II)	EAC
Water Resources Information System (WRIS)	LVBC
National Water Resources Strategy for Uganda (2014)	MWE
"VicRes" project focusing on livelihood in Lake Victoria. Historical perspective of Climate Change (CC) / Policy implementation	IUCEA
Severe Weather Project WMO (Lake Victoria safety)	MNA
UK Metoffice climate model of Lake Victoria providing 24h forecast	MNA
Climate Change projections 20/50/100 years provided by MNA	MNA
Project for blending of satellite data with station data	MNA
Baseline and situation studies by MWE, focus on dropping water levels in Wamala/Rwizi catchments	MWE
Catchment Management Plans for Rwizi and Katonga, have some focus on Climate Change impact	MWE
Wetland coverage dataset for monitoring purposes	MWE
Project for incorporation of Climate Change into Catchment Management Plans	MWE
Nile Water Allocation Tool Study	NBI
Incorporation of Climate Change in NBI water resources model	NBI
Qualitative study of resilience of community against floods, drought and landslides; Community survey conducted	RAN
Training on gender mainstreaming emphasized within RAN activities	RAN

With approval by the LVBC and the UNCST, an evaluation of the relevance and effectiveness of the case studies has been established. The following criteria accounting for relevance to the technical assistance, accessibility to sufficient information and documentation and effective engagement of the stakeholder(s) involved have been established:

A. The outcome of the issue represented by the case study has a **significant environmental or socio-economic impact** on a local or regional scale.

B. **Climate change impacts are a critical factor** influencing the success or failure of the case study

C. The case study **addresses existing or future investments** related to the energy sector or water management within Uganda

D. **Possibility to evaluate the case study** using the water resources model established for impact assessment will be a great benefit

E. Is **in line with national climate change priority** sectors or plans

The case studies include, as per the technical assistance Response Plan, one case study focusing on a long-term planning problem (see Table 3 numbers 1 and 3), and another on a seasonal planning problem (Table 3 number 4 and 5)

Table 3 Description of case studies for demonstration of technology and tools

N	Title	Institution	Scope
1	Management and dissemination of climate information Link to: Adapting to climate change in Lake Victoria and WRIS	LVBC	**Objective:** Providing and testing the use of different types of climate information of relevance for the upcoming programme. **Output:** Web based portal providing access to climate information e.g. the latest regional climate projections and satellite based near real time and historical climate information**;** integration of climate change projections in the existing WRIS.
2	Establishment of regional water resource assessment model for decisions related to the water resource or energy sector Link to: LVEMP	LVBC MWE DWRM	**Objective:** Evaluate the existing water resource model and recommend refinements to make the model more useful for climate change impact assessment within the Lake Victoria Basin. **Output:** Refined model that can be used in the assessment of climate change impacts within the water resource and energy sectors in Uganda, and potentially the region. Climate change scenarios of interest and recommendations for future work.
3	Capacity and knowledge for decision making in a future climate Link to: National training and capacity programmes focussing on climate change mitigation	UNCST Stepup Standard Limited MUST RAN MGLSD NAPE	**Objective:** Embedding the data, tools and guidelines into the existing workflows and decision processes within relevant ministries and organisations in Uganda, collaboration with selected stakeholders supporting that the data is used actively in Uganda. **Output:** Web based portal providing access to climate data and indicators.
4	Water resource planning at national and regional level related to the water resources and energy sector Link to: National and regional programmes and studies	MWE DWRM LVBC NBI Ministry of Energy and Mineral Development	**Objective:** Evaluation of future investments related to water supply, irrigation scheme, hydropower, reservoirs and storage. Enable decision makers to evaluate the available water resource taking climate change projections into account and balance the requirements for the hydropower sector with the requirements from other sectors **Output:** Technology for utilizing the established water resource model for evaluation of plans and investments, without the requirement of having detailed knowledge of the specific model. Provide guidelines for improved climate resilient decisions. Support the existing national plans for the future energy production in Uganda with information and availability of tools supporting the national planning process.

N	Title	Institution	Scope
5	Providing data and interpretation of climate change data for management of agricultural impacts Link to: Existing activities or programmes	UNMA MWE CCD MWE DWRM MGLSD	**Objective:** Interpretation of specific data related to overview and monitoring of the current and upcoming climate for monitoring of the current status within the agricultural sector. **Output:** Application of drought indicators to monitor of the agricultural sector, enabling the user to identify areas where the current management practices result in impacts on the agricultural production.

To assist in the assessment of the case study formulation and corroborate relevance to the targeted institutions/entities, we conducted a survey to find out data and reporting needs from participants to inform further the demonstration process by collecting information that is more detailed directly from the stakeholders. The survey is currently underway and presented in Appendix A.

3 Technical specifications

The following subchapters present the technical specifications of the data and tools developed as part of the technical assistance and thereafter tested using the case studies presented in the previous chapter (see Table 3). The deliverables build on ongoing efforts under the Global Environment Facility (GEF) funded Flood and Drought Management Tools project (for more information on the project please visit the project homepage at http://fdmt.iwlearn.org/en). These will be developed under **Activity 2.1 Implementation of technical components**, and the testing will be carried out under **Activity 2.2 Testing, demonstration and documentation**.

The introductory subchapter introduces the platforms that will be used to provide access to the deliverables: a web portal developed under this technical assistance and the existing LVBC Water Resources Information System (WRIS). It also explains which technical components will be embedded in the web portal and which will be supplied to the WRIS.

The subchapters that follow the introduction list and present the specifications of the technical components, namely:

- Data and information
- Reporting and bulletins
- Model refinements and planning
- Drought assessment
- Decision making guidelines

3.1 Introduction

To strengthen adaptation to climate change in the Lake Victoria basin in Uganda, a new web portal will be deployed making the data, information, tools and guidelines produced freely accessible online to all national stakeholders. The free web portal will be maintained by DHI for a number of years (2 to 3) after the technical assistance is finalized. Discussion with the applicant should follow to determine the possibility of a long term plan.

Between 2012 and 2015, the LVBC commissioned the development and implementation of a comprehensive Water Resources Information System (WRIS), which enables the monitoring of the environmental conditions in the Lake Victoria Basin based on shared information provided by the East African Community (EAC) Partner States.

Therefore, in parallel with the deployment of the web portal, the existing WRIS accessible to the applicant, the LVBC, will be strengthened with the inclusion of climate change data and information developed under this technical assistance.

Through the web portal, operational data will be delivered to tackle multiple thematic areas and decision making problems faced by the stakeholders of the water and energy sectors in Uganda. Whilst within the WRIS of the LVBC, static data consisting of climate change projections will be included to complement its current functionality (see Figure 1). The combined roles of the web portal and the WRIS provide a cohesive and complementing means to strengthening adaptation to climate change, by benefiting the stakeholders in Uganda and the LVBC.

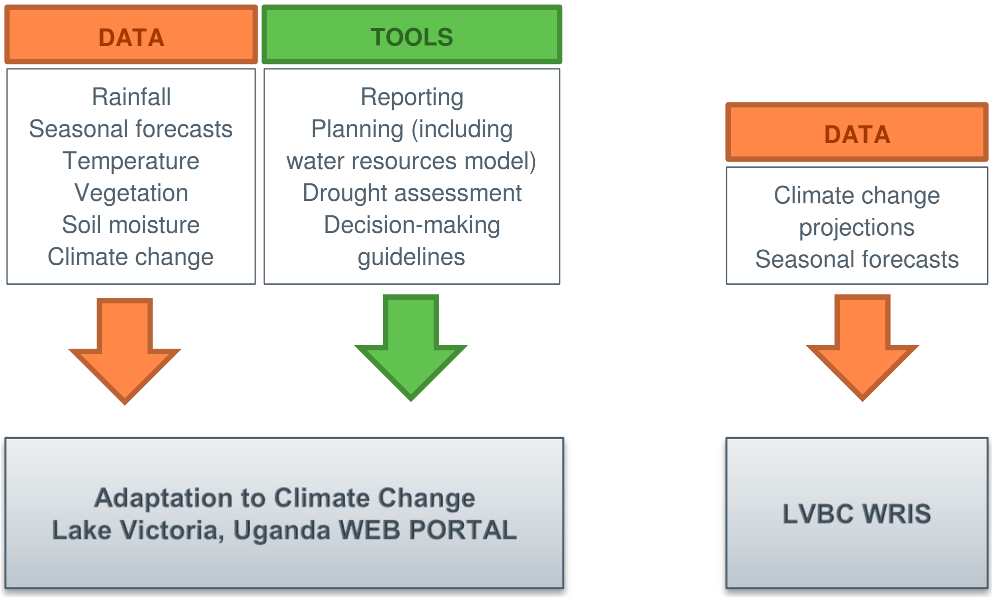


Figure 1 Representation of the integration of technology developed within the newly developed web portal and the existing LVBC WRIS.

The web portal titled ***Adaptation to Climate Change Lake Victoria, Uganda***, constitutes the platform provided by the technical assistance used to deliver embedded applications, namely:

- Data and information – application providing free access to near real time data and information of relevance for the CTCN assistance
- Reporting – application to support dissemination of reports or bulletins to stakeholders
- Planning – supporting basin planning through evaluation of existing and new investments, climate change and population pressure
- Drought assessment – supporting the identification of areas with drought hazard and evaluating the impact on vulnerable sectors or areas
- Decision making guidelines –supporting the decision process taking the uncertainty associated with climate change into consideration

The look and feel of the web portal we will deploy will be intuitive, user friendly and previous projects have been very well received according to our own experience within the Chao Phraya river basin in Thailand and the Volta river basin in Ghana.[1] Our focus is on adequate customization of the design, and together with the LVBC and UNCST, we will decide on the detailed aspects such as logos, title, homepage introductory and explanatory texts and reporting templates. Timely input from stakeholders will determine the depth of customization reached by assistance-end.

The backend of the web portal contains the programs developed for each tool and the following data processing workflow:

1. Data download

    a) Data is downloaded from the source server

[1] DHI has been implementing a GEF funded project between 2014 and 2018, for the technical development of a web-based Decision Support System (DSS) and the methodologies and tool based on well-tested and proven technology developed by DHI. The overall objective of the web based DSS is to facilitate the inclusion of information about floods, droughts and future scenarios water resources planning.

   b) Data is downloaded using an empty string as start and end date
   c) Entire data series is downloaded the first time
   d) Only new data is downloaded during the operational use

2. Data processing

   a) Downloaded data is converted to netcdf[2] format
   b) Data is saved in a time varying netcdf file
   c) Downloaded data is cropped to the user extent

3. Data statistics

   a) Statistic files for the data set are calculated
   b) Statistic files are updated every time the data is updated

4. Calculation of indices and indicators

   a) Indices and indicators calculated based on the updated data and the calculated statistics following their defined equations.

In turn, the ***Water Resources Information System*** (WRIS) is a platform that was designed and developed in close collaboration with the LVBC Secretariat and the technical water experts from each Partner State through workshops and training/testing sessions. It was developed under the auspices of the Lake Victoria Environmental Management Project II (LVEMP II), World Bank funded project (LVBC, 2014). It carries its own technology, backend functionality and technical specifications, and is today operational at the Secretariat. The climate change projections are static datasets developed under this technical assistance and will be loaded onto the WRIS, and a more detailed description of the data is included in the next chapter 3.2. A procedure to upload and keep seasonal forecasts updated will be outlined for use by the LVBC staff. It is envisioned, the LVBC staff managing the system follow this process particularly closely to ensure successful integration of the data in the system.

3.2 Data and information

In this subchapter, we list and describe the operational data and information to be embedded in the web portal as well as the static data to be loaded in the WRIS.

In the web portal, a data and information application will ensure that any user will always have a basic data set available for monitoring and for planning activities related to water resources or drought management. The purpose is to provide spatially distributed data for the Lake Victoria Basin area, in near real time, such as climate data, seasonal forecasts and a variety of indicators.

During the national workshop and subsequent analysis of the outcomes, we identified relevant types of data and information, which drove the selection of datasets relevant to the stakeholders, see summary in Table 4.

[2] NetCDF (Network Common Data Form) is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. For more check https://en.wikipedia.org/wiki/NetCDF

Table 4 Data and information to support the activities of water and energy sector stakeholders.

Activities	Dataset
Long term planning	Climate change projections
Short term water resources management	Near real time based on satellite or a combination of satellite and ground stations Rainfall deviation (30 days) Land surface temperature Ensemble forecast with several months lead time. Standardised Precipitation index (SPI)
Management of agricultural climate change impacts	Soil Water Index (SWI) SWI deviation SWI percentile SWI percentile change
Land degradation monitoring	Normalized Difference Vegetation Index (NDVI) NDVI anomaly NDVI deviation Vegetation condition index (VCI) Standardised vegetation index (SVI)
Wetland monitoring	Water body data set SWI can be used to monitor the state of wetland NDVI can be used to monitor vegetation changes related to the state of wetlands
Energy production and planning	Climatology Ensemble forecast with several months lead time Climate change data

We will obtain the original datasets from a number of different data sources, all available in near real time and free. We will then process the data to generate different climate variables; climate forecast data, climate change data, drought related indices and flood related data, having in common the following:

- Spatially distributed data (raster data visible on a map)
- Temporal resolution maintained in near real time (data is updated regularly)
- Short time delay (data is published with a maximum delay of 5 days)
- Available for download in commonly used formats (netcdf file)

The following sections contain a description of each of the datasets including origin, spatial and temporal resolution.

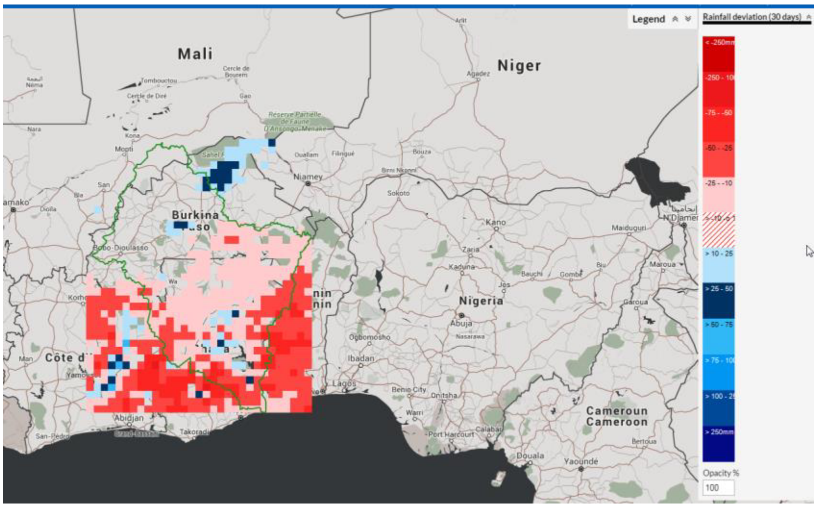
3.2.1 Rainfall related data

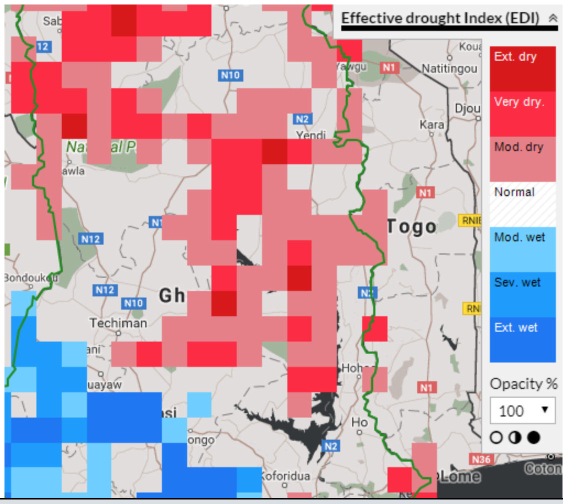
The Tropical Rainfall Measuring Mission (TRMM) is the first Earth Science mission dedicated to studying tropical and subtropical rainfall. It is a joint mission between the National Aeronautics and Space Administration (NASA) and Japanese Aerospace Exploration Agency (JAXA) dedicated to monitor rainfall in the tropics through microwave and visible infrared sensors, including the first space-borne rain radar. By use of a low-altitude orbit (350km), TRMM is complemented with state-of-the-art instruments providing high accurate measurements.

TRMM is especially useful in cases where consistency in precipitation data is required over many years, such as the case for hydrological design, flood risk assessment and water resources management.

Spatial extent	From 50 degrees north to 50 degrees south of the equator
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: resampled to daily rainfall product from 2000 to present
Reference	http://trmm.gsfc.nasa.gov
Data requirements and calculation	The original 3-hourly real-time rainfall data in mm/h from NASA is resampled to a daily product in mm/day, this daily product is then downloaded from the TRMM data provider and disseminated via the portal. Negative values are removed during the processing.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc
Data source	TRMM_3B42RT_Daily

Based on TRMM rainfall dataset we will generate the indicators presented in the following tables.

Title	**Rainfall deviation (30 days)**
Description	Deviation of accumulated rainfall from the long term mean within the last 30 days. Calculated based on the TRMM rainfall where the long term mean is based on TRMM data since 2000.
	INDICATOR USAGE
Index interpretation	Used to locate areas with rainfall surplus or deficit within the last 30 days.
Spatial extent	As TRMM data
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: Updated daily as TRMM rainfall gets updated.
Reference	Processed based on TRMM data
Example of usage	Illustrates the how the accumulated rainfall deviates from the mean accumulation within a given area. Used to locate areas with rainfall surplus or deficit across the last 30 days. 
	INDICATOR CALCULATION
Data requirements and calculation	Based on daily TRMM rainfall and calculated as $\sum TRMM - \sum TRMM_{mean}$ for the last 30 days
Update Frequency	Daily updated in the web portal
Related indices	-
Data source	Based on TRMM data

Title	Effective Drought Index (EDI)
Description	The Effective Drought Index (EDI) was developed by Byun and Wilhite (1999) as a measure that considers daily water accumulation with a weighting function for time passage. More information is available via http://om.ciheam.org/om/pdf/a95/00801330.pdf
	INDICATOR USAGE
Index interpretation	Used to locate areas that are very dry to very wet as a measure of drought. The "drought range" of the EDI indicates the following: extreme drought at EDI = -2, severe drought at -2.0 < EDI = -1.5 moderate drought at -1.5 < EDI = -1.0. Near normal conditions are indicated by -1.0 < EDI = 1.0
Spatial extent	As TRMM data
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: Updated daily as TRMM rainfall gets updated.
Reference	Hi-Ryong Byun and Donald A. Wilhite, Objective Quantification of Drought Severity and Duration, 1999. http://journals.ametsoc.org/doi/full/10.1175/1520-0442%281999%29012%3C2747%3AOQODSA%3E2.0.CO%3B2
Example of usage	Example of the EDI coverage for Ghana: 
	INDICATOR CALCULATION
Data requirements and calculation	Based on daily TRMM rainfall and calculated for the last 30 days as: EDI = Deviation(PE)/Std(PE) Where PE is :

	$$P_{E_i} = \sum_{N=1}^{D}\left[\frac{\sum_{m=1}^{N} P_m}{N}\right]$$
Update Frequency	Daily
Related indices	-
Data source	Based on TRMM data

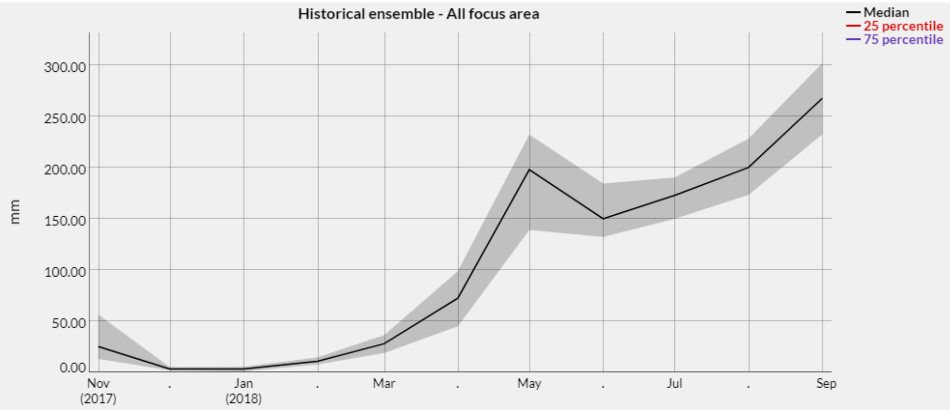
<table>
<tr><th>Title</th><th>Standardised Precipitation index (SPI)</th></tr>
<tr><td>Description</td><td>The SPI is based on the probability of precipitation for any time scale. The probability of observed precipitation is then transformed into an index. It is being used in research or operational mode in more than 70 countries. More information is available via http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf</td></tr>
<tr><td></td><td>INDICATOR USAGE</td></tr>
<tr><td>Index interpretation</td><td>SPI is typically categorized using the following classification:
<table>
<tr><td>> 2</td><td>Extremely wet</td></tr>
<tr><td>1.5 to 2</td><td>Very wet</td></tr>
<tr><td>1 to 1.5</td><td>Moderately wet</td></tr>
<tr><td>-1 to 1</td><td>Near normal</td></tr>
<tr><td>-1.5 to -1</td><td>Moderately dry</td></tr>
<tr><td>-2 to -1.5</td><td>Severely dry</td></tr>
<tr><td>< -2</td><td>Extremely dry</td></tr>
</table>

A drought event occurs any time the SPI is continuously negative and reaches an intensity of -1.0 or less. The event ends when the SPI becomes positive. Each drought event, therefore, has a duration defined by its beginning and end, and an intensity for each month that the event continues. The positive sum of the SPI for all the months within a drought event can be termed the drought's “magnitude”.

Because the SPI is normalized, wetter and drier climates can be represented in the same way; thus, wet periods can also be monitored using the SPI. However, it must be stressed that the SPI is not suitable for climate change analysis because temperature is not an input parameter.</td></tr>
<tr><td>Spatial extent</td><td>As TRMM data</td></tr>
<tr><td>Spatial and temporal resolution</td><td>Spatial resolution: 0.25 degree

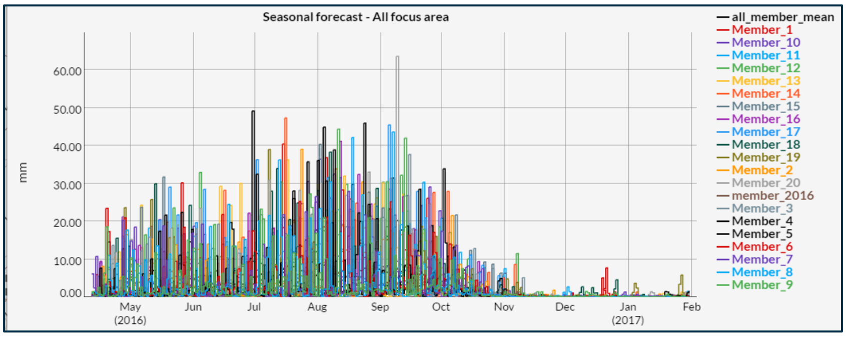
Temporal resolution: Updated daily as TRMM rainfall gets updated.</td></tr>
<tr><td>Reference</td><td>http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf</td></tr>
<tr><td>Example of usage</td><td>The following SPI products are available:
SPI -month: the one-month SPI provides a comparison of the precipitation over a specific one month period with the precipitation totals from the same period for all the years included in the historical record. 1-month SPI reflects relatively short-term conditions, its application can be related closely with short-term soil moisture and crop stress, especially during the growing season.
SPI 3-month: the three-month SPI provides a comparison of the precipitation over a specific 3-month period with the precipitation totals from the same 3-month period for all the years included in the historical record. A 3-month SPI reflects short- and medium-term moisture conditions and provides a seasonal estimation of precipitation.</td></tr>
</table>

	• **SPI 6-month**: the 6-month SPI compares the precipitation for that period with the same 6-month period over the historical record. The 6-month SPI indicates medium-term trends in precipitation.
	INDICATOR CALCULATION
Data requirements and calculation	The original 3-hourly real-time rainfall data in mm/h from NASA is resampled to daily product in mm/day. Negative values are removed during the processing.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc
Data source	TRMM 3B42RT

Title	**Climatology or historical ensembles**
Description	Climatology or historical ensembles is a way to generate ensembles based on the historical rainfall to be used as a "prediction" of how the future rainfall will evolve. Climatology is very useful if forecasted rainfall is not available or the skill of the forecasted rainfall is poor.
	INDICATOR USAGE
Index interpretation	Provides ensemble input of forecasted rainfall based on the historical observations.
Spatial extent	From 50 degrees north to 50 degrees south of the equator (similar to TRMM data)
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: daily
Reference	TRMM data
Example of usage	Ensemble members used as climate input for hydrological, water resource or crop models for evaluation of a future situation. These can also be used to produce statistical monthly envelope charts as shown below. 
	INDICATOR CALCULATION
Data requirements and calculation	Based on TRMM data from 2000 until today. Climatology is yearly time series of the historical TRMM rainfall.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc. based on forecasted rainfall
Data source	TRMM data

3.2.2 Seasonal forecasts

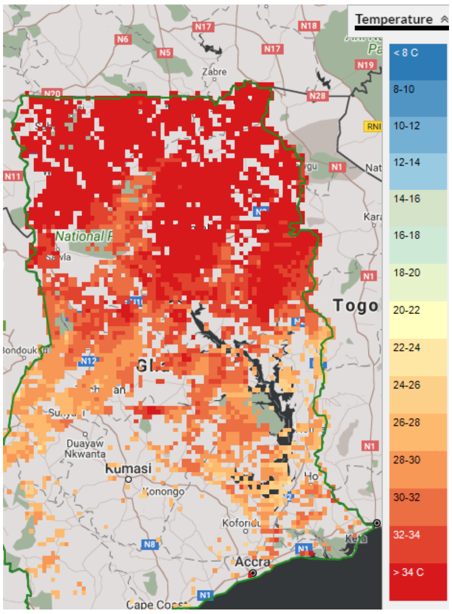
The Climate Forecast System (CFS) version 2 is run by the Environmental Modeling Center at National Centers for Environmental Prediction (NCEP), National Oceanic and Atmospheric Administration (NOAA) and became operational in March 2011. It is a fully coupled model representing the interaction between the Earth's atmosphere, oceans and land. The variables available include precipitation and surface temperature. The forecast data is made available in a form of an ensemble forecast with several months lead time and provides ensemble input of forecasted rainfall.

Spatial extent	Global coverage (Longitude Range: 180W to 180E, and Latitude Range: 90S to 90N)
Spatial and temporal resolution	Spatial resolution: 1 degree Temporal resolution: daily
Reference	http://cfs.ncep.noaa.gov/
Example of usage	Ensemble members used as climate input for hydrological, water resource or crop models for evaluation of a future situation. 
Data requirements and calculation	The computation consists of construction of the 20-member ensemble forecast. The original product is resampled from 6-hourly to daily.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc. based on forecasted rainfall
Data source	NCEP CFS v2

3.2.3 Temperature

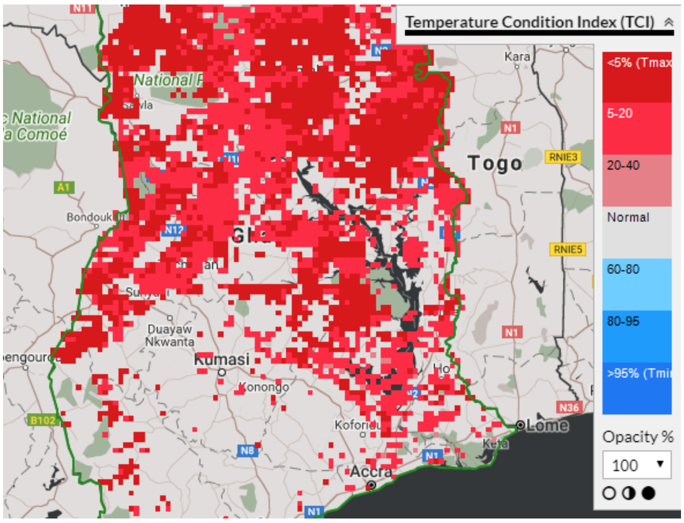
The level-3 MODIS[3] global Land Surface Temperature (LST) and Emissivity 8-day data (MOD11A2) are composed from the daily 1-kilometer LST product (MOD11A1) and stored on a 1-kilometer Sinusoidal grid as the average values of clear-sky LSTs during an 8-day period.[4]

LST and especially the change in temperature over time is a valuable indicator for climate change and drought events.

Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 1 km but resampled to 5 km Temporal resolution: 8 day product from 2000 to present
Reference	https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod11a2
Example of usage	Temperature in itself is NOT an index, but could be used to detect changes in the temperature pattern from year to year. 
Data requirements and calculation	Download of MOD11A2 1 km 8 day product. Data resampled to 5 km resolution using a simple mean of the grid cells.
Update Frequency	8 day
Data source	MOD11A2

[3] The Moderate Resolution Imaging Spectroradiometer

[4] https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod11a2

Title	**Temperature condition index (TCI)**
Description	TCI is estimated relative to the maximum and minimum temperatures and modified to reflect different vegetation responses to temperature.
	INDICATOR USAGE
Index interpretation	Used to determine stress on vegetation caused by temperatures and excessive wetness.
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 5 km Temporal resolution: 8 daily
Reference	Daytime land surface temperature based on the 1 km MOD11C2 product. https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod11c2
Example of usage	Example of the TCI coverage over Ghana: 
	INDICATOR CALCULATION
Data requirements and calculation	TCI is calculated as: 100*(Tmax - T)/(Tmax - Tmin)
Update Frequency	8 days
Related indices	-
Data source	MOD11C2

3.2.4 Vegetation related data

The Normalized Difference Vegetation Index (NDVI) is used as an index of vegetation health and density.

NDVI = (λNIR – λred) / (λNIR + λred)

where: *λNIR* and *λred* are the reflectance in the NIR and red bands, respectively.

MODIS vegetation indices are produced on 16-day intervals and at multiple spatial resolutions. NDVI is closely correlated to vegetation canopy greenness, a composite property of leaf area, chlorophyll and canopy structure, and could be used as a base data set for monitoring of crop and vegetation status.

It varies between -1 and +1. Strong correlation with leaf area index and biomass

NDVI in itself does not reflect drought or non-drought conditions, but could be used to detect vegetation cover.

NDVI values	Vegetation condition
0.1 to 0.7	Vegetated land
> 0.5	Dense vegetation
< 0.1	Near zero vegetation such as barren area, rock, sand or snow

NDVI in itself is NOT a drought index, but could be used to detect changes in the vegetation pattern from year to year. , used as source data for a number of vegetation indices.

Spatial and temporal extent	Global coverage
Spatial and temporal resolution	Spatial resolution: from 5600 m to 250 m Temporal resolution: Updated every 16 day based on two daily passes. The value is based on the maximum value during the 16 day period (Available from 2000 to present)
Reference	http://modis-land.gsfc.nasa.gov/vi.html and http://e4ftl01.cr.usgs.gov/MOLT/
Data requirements and calculation	Converted to netcdf format
Update Frequency	16 day
Related indices	Vegetation based indices
Data source	Terra-MOD13C1 (5600 m)

The following tables define the indicators we will calculate based on the NDVI dataset.

<table>
<tr><td>Title</td><td>NDVI deviation</td></tr>
<tr><td>Description</td><td>NDVI deviation is calculated as the deviation from the long-term mean. It expresses the current vegetation growth compared to the long term mean for the same period.</td></tr>
<tr><td></td><td>INDICATOR USAGE</td></tr>
<tr><td>Index interpretation</td><td>NDVI deviation could be used to define a drought as it is defined as the difference between the NDVI for the current time step and the long term mean NDVI for the same month.

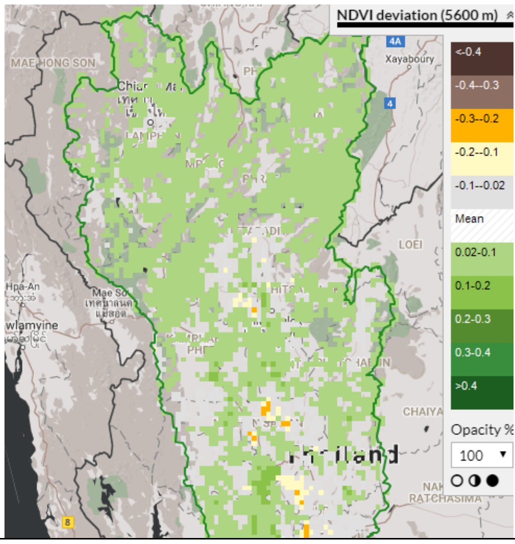
$DEV_{NDVI} = NDVI_i - NDVI_{mean,m}$

Where: $NDVI_i$: NDVI for the current time step and $NDVI_{mean,m}$: Long term mean NDVI for the same month

• When DEV_{NDVI} is negative, it indicates the below-normal vegetation condition/health and, therefore, suggests a prevailing drought situation.
• The greater the negative departure the greater the magnitude of a drought.

The limitation is that the deviation from the mean does not take into account the variability in the vegetation within the region. Hence a negative DEV_{NDVI} could be caused by a different crop type.

<table>
<tr><th>DEV_{NDVI} values</th><th>Condition</th></tr>
<tr><td><= 0.2</td><td>Severe drought (extremely dry)</td></tr>
<tr><td>-0.05 to -0.2</td><td>Drought (moderately dry)</td></tr>
<tr><td>-0.05 to 0.1</td><td>Near normal</td></tr>
<tr><td>> 0.1</td><td>Above optimal (extremely wet)</td></tr>
</table></td></tr>
<tr><td>Spatial extent</td><td>Global coverage</td></tr>
<tr><td>Spatial and temporal resolution</td><td>Spatial resolution: 5600 m to 250 m
Temporal resolution: 16 day</td></tr>
<tr><td>Reference</td><td>Processed based on the NDVI data</td></tr>
<tr><td>Example of usage</td><td>Location of areas with a vegetation growth below the long term average.


</td></tr>
</table>

	INDICATOR CALCULATION
Data requirements and calculation	$DEV_{NDVI} = NDVI_i – NDVI_{mean,m}$ Where: $NDVI_i$: NDVI for the current time step and $NDVI_{mean,m}$: Long term mean NDVI for the same month
Update Frequency	16 day
Related indices	Vegetation based indices
Data source	Based on the NDVI data

Title	**Vegetation condition index (VCI)**
Description	Vegetation condition index (VCI) shows how close the NDVI of the current month is to the minimum NDVI calculated from the long term record.
	INDICATOR USAGE
Index interpretation	VCI values reflects the following: (see table below)
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 5600 m to 250 m Temporal resolution: 16-day
Reference	Kogan, F. N. F. Remote sensing of weather impacts on vegetation in non-homogeneous areas. International Journal of Remote Sensing 1990, 11, 1405–1419.
	INDICATOR CALCULATION
Data requirements and calculation	VCI shows how close the NDVI of the current month is to the minimum NDVI calculated from the long term record. $VCI_J = \frac{(NDVI_J - NDVI_{min})}{(NDVI_{max} - NDVI_{min})} * 100$ Where: $NDVI_{min}$ and $NDVI_{max}$ are calculated for the same month from a long term record.

VCI values	Condition
50 to 100 %	Optimal or above normal conditions
35 to 50%	Fair vegetation condition
0 to 35%	Severe drought (local trigger values apply)
0%	Extremely dry and equal to the long term minimum

Update Frequency	16 day
Related indices	Vegetation based indices
Data source	Based on the NDVI data

Title	**Standardised vegetation index (SVI)**
Description	SVI is NDVI normalized for each pixel on the basis of the maximum statistical range over the historical record.
	INDICATOR USAGE
Index interpretation	<table><tr><th>SVI values</th><th>Condition</th></tr><tr><td>0 to 0.05</td><td>Very poor conditions</td></tr><tr><td>0.05 to 0.25</td><td>Poor conditions</td></tr><tr><td>0.25 to 0.75</td><td>Average conditions</td></tr><tr><td>0.75 to 0.95</td><td>Good conditions</td></tr><tr><td>0.95 to 1</td><td>Very good conditions</td></tr></table> Zero is the baseline condition where the NDVI is lower than all possible NDVI values for that period in other years.
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 5600 m to 250 m Temporal resolution: 16-day
Reference	Processed based on the NDVI data
	INDICATOR CALCULATION
Data requirements and calculation	SVI is NDVI normalized for each pixel on the basis of the maximum statistical range over the historical record. Low SVI values indicate poor vegetation condition that could be the result of climate conditions. The SVI is based on a z score. The z score is a deviation from the mean in units of standard deviation.
Update Frequency	16 day
Related indices	Vegetation based indices
Data source	Based on the NDVI data

Title	**Vegetation health index (VHI)**
Description	VHI is combination of vegetation condition index (VCI) and temperature condition index (TCI).
	INDICATOR USAGE
Index interpretation	The following classification is used for drought related vegetation stress: < 10 Extreme drought 10 to 20 Severe drought 20 to 30 Moderate drought 30 to 40 Mild drought 40 to 100 No drought
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 5600 m to 250 m Temporal resolution: 16 day
Reference	Processed based on the NDVI data
	INDICATOR CALCULATION
Data requirements and calculation	Calculated as: VHI = 0.5 * VCI + 0.5 * TCI
Update Frequency	16 day
Related indices	Vegetation based indices
Data source	Based on the NDVI data

Title	**Agricultural Stress Index (ASI)**
Description	The ASI is an index based on the integration of the Vegetation Health Index (VHI) in two dimensions that are critical in the assessment of a drought event in agriculture: temporal and spatial.
	INDICATOR USAGE
Index interpretation	Provides the combination of the intensity and duration of dry periods occurring during the crop cycle and spatial extent.
Spatial extent	Global and available since 2000
Spatial and temporal resolution	Spatial resolution: 1 km Temporal resolution: 16-day
Reference	Based on the VHI data
	INDICATOR CALCULATION
Data requirements and calculation	The first step of the ASI calculation is a temporal averaging of the VHI at pixel level. The second step determines the spatial extent of drought events by calculating the percentage of pixels in arable areas with a VHI value below 35 percent (this value was identified as a critical threshold in assessing the extent of drought in previous research by Kogan, 1995). Finally, each administrative area is classified according to its percentage of affected area to facilitate the quick interpretation of results by analysts.
Update Frequency	16-day
Related indices	Vegetation based indices
Data source	http://www.fao.org/giews/earthobservation/asis/index_1.jsp

3.2.5 Soil moisture related data

The Soil water index (SWI) product contains daily synthesis of SWI derived from Advanced Scatterometer Surface Soil Moisture (ASCAT SSM) data at 25 km resolution (then resampled to 0.1 degree).

The SWI algorithm, originally developed at Vienna University of Technology (TU Wien) and later improved by other research groups, uses an infiltration model describing the relation between surface soil moisture and profile soil moisture as a function of time. The algorithm is based on a two-layer water balance model.

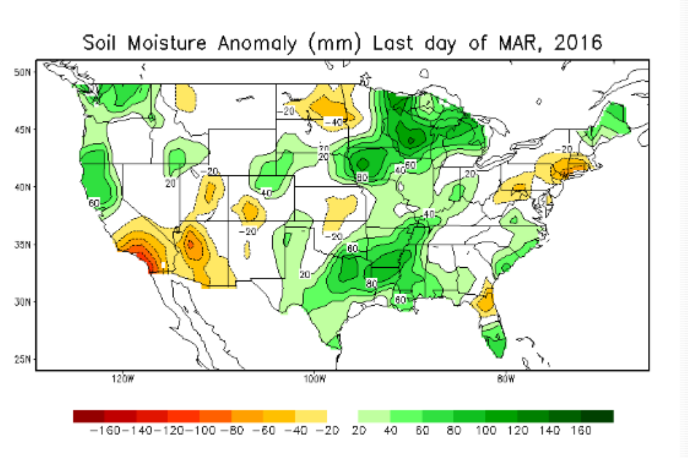
The data value used are using the largest characteristic time length giving the deepest penetration within the soil layers, and the values represent an average SWI across 0.5 to 1 meter of the topsoil.

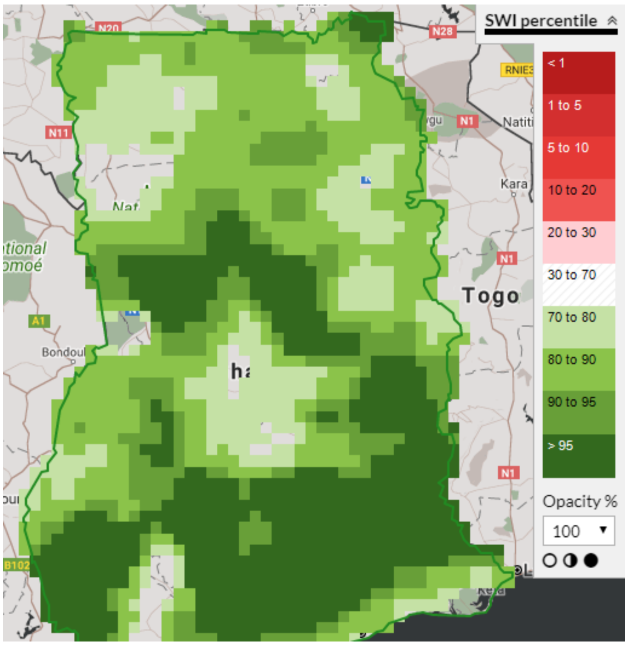
SWI is used as an indicator for the water availability in the upper part of the root zone.

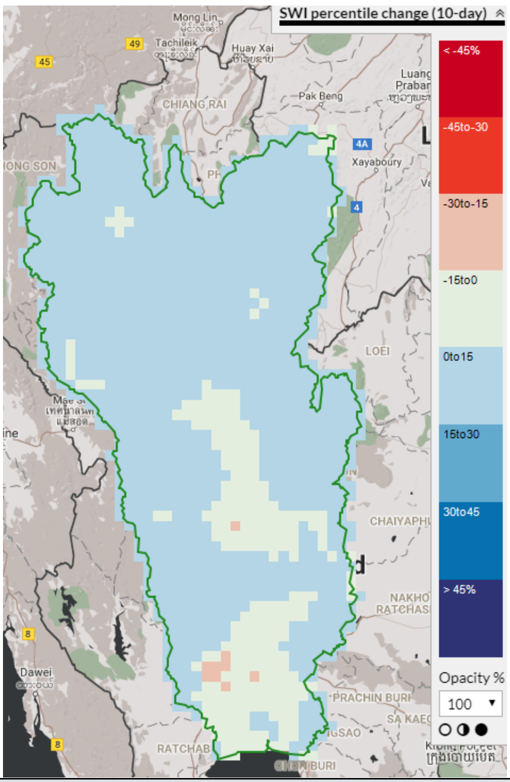
SWI in itself is NOT a drought index, but could be used to detect changes in the soil moisture pattern from year to year.

Spatial extent	Global
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: daily METOP-ASCAT satellite, from 2007 – present
Reference	http://land.copernicus.vgt.vito.be/PDF/datapool/ and http://land.copernicus.eu/global/products/swi
Update Frequency	Daily
Related indices	Soil moisture based indices

The following tables define indicators based on the SWI included in the web portal.

Title	**SWI deviation**
Description	SWI deviation is calculated as the deviation from the long-term mean. It expresses the current soil moisture compared to the long term mean for the same period.
	INDICATOR USAGE
Index interpretation	SWI deviation could be used to define areas with unexpected low water availability in the root zone as it is defined as the difference between the SWI for the current time step and the long term mean SWI for the same period. $DEV_{SWII} = SWI_i - SWI_{mean,m}$ Where: SWI_i : SWI for the current time step and $SWI_{mean,m}$: Long term mean SWI for the same month When DEV_{SWI} is negative, it indicates the below-normal water availability and, therefore, suggests a prevailing drought situation. The greater the negative departure the greater the magnitude of a potential drought.
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: Daily or 10 daily
Reference	Processed based on SWI data
Example of usage	Example of how a SWI anomaly map from the Climate Prediction Centre (http://www.cpc.ncep.noaa.gov) 
	INDICATOR CALCULATION
Data requirements and calculation	$DEV_{SWII} = SWI_i - SWI_{mean,m}$ where: SWI_i : SWI for the current time step and $SWI_{mean,m}$: Long term mean SWI for the same month(from 2007 to present)
Update Frequency	Daily or 10 daily
Data source	Based on SWI data

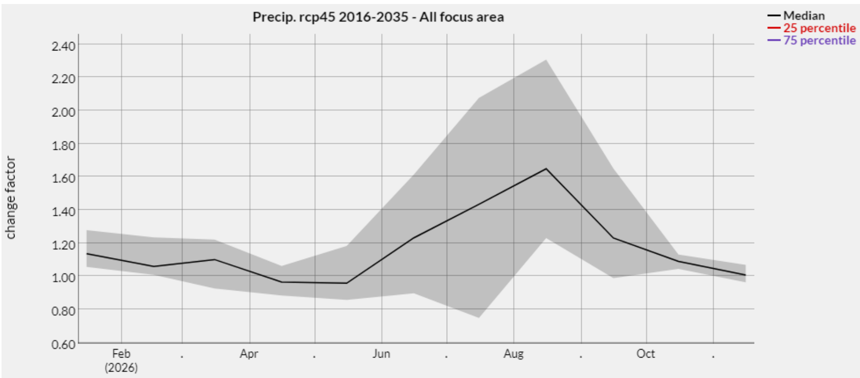
Title	**SWI percentile**
Description	SWI percentile expresses the percentage of soil moisture that is equal or below a certain amount for each year in the entire record.
	INDICATOR USAGE
Index interpretation	A drought or water scarcity is often defined when the soil moisture percentile drops below 30 or 20 %.
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: daily or 10 daily
Reference	Processed based on SWI data
Example of usage	Example of SWI percentile map 
	INDICATOR CALCULATION
Data requirements and calculation	Calculated as the percentile value for the same period as the observed data (based on data from 2007 to present).
Update Frequency	Daily or 10 daily
Data source	Based on SWI data

Title	**SWI percentile change**
Description	Change in soil moisture percentile is used to evaluate the trend over a given period and locate areas where the soil moisture is increasing or decreasing. The SWI percentile is calculated for 1 week, 2 week and 1 month change.
	INDICATOR USAGE
Index interpretation	Positive values indicate an increase in soil moisture across the period while negative values indicate a decrease in soil moisture across the period.
Spatial extent	Global coverage
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: Daily or 10 daily
Reference	Processed based on SWI data
Example of usage	Example of SWI percentile change (10 days) showing areas where the soil is getting wetter or dryer over the last month. 
	INDICATOR CALCULATION
Data requirements and calculation	Calculated as the change in percentile value.
Update Frequency	Daily or 10 daily
Data source	Based on SWI data

3.2.6 Climate change data

Coordinated Regional Climate Downscaling Experiment (CORDEX) is a World Climate Research Programme (WCRP) project with the goal to produce coordinated sets of regional downscaled climate projections worldwide, i.e. for each continent a model domain was defined to run a set of Regional Climate Models (RCMs). The initiative responsible for the generation of RCMs for Africa is called CORDEX Africa. The RCMs are driven by the new generation radiative concentration pathway (RCP) scenarios at a horizontal resolution of 0.44 degree.

The RCM outputs are processed into so-called delta change factors for monthly mean rainfall in order to indicate projected changes in monthly mean rainfall. The factors represent for each month the ratio between the average in the control model run (1986-2005) and the projection model run (2081-2100). Changes are estimated for the medium radiation forcing scenario RCP4.5 and the extreme radiation forcing scenario RCP8.5.

Spatial extent	Global
Spatial and temporal resolution	Spatial resolution: 0.44 degree Temporal resolution: resampled to monthly METOP-ASCAT satellite, from 2007 – present
Reference	https://esg-dn1.nsc.liu.se/search/esgf-liu/ (ESGF Data Node)
Example of usage	Monthly envelope chart of precipitation delta change factors showing expected increase or decrease in precipitation over a certain basin. 
Update Frequency	Static dataset
Related indices	-

Based on the delta change factors we will calculate the climate change projection series for the Lake Victoria basin of precipitation. These time series will be named and identified after the carbon dioxide emissions scenarios and the projection time period:

- Precip. rcp45 2016-2035
- Precip. rcp85 2016-2035
- Precip. rcp45 2081-2100
- Precip. rcp85 2081-2100

Based on the precipitation datasets listed, we will generate an index expressing the number of dry days per month for each RCP scenario and projection time period. Finally, alongside precipitation, the datasets for the Lake Victoria basin of temperature and potential evapotranspiration will also be generated and named:

- PET rcp45 2016-2035
- PET rcp85 2016-2035
- PET rcp45 2081-2100
- PET rcp85 2081-2100
- TEMP rcp45 2016-2035
- TEMP rcp85 2016-2035
- TEMP rcp85 2081-2100
- TEMP rcp45 2081-2100

This dataset is static and will be made available through the web portal, applied in the water resources model (precipitation and evapotranspiration), as well as included in the WRIS for Lake Victoria basin.

3.2.7 Water body data

The Water body data produced by the Copernicus Global Land Service (CGLS) is a component of the Land Monitoring Core Service (LMCS) of Copernicus, the European Earth Observation programme. With this dataset it is possible to detect areas covered by inland water along the year providing the maximum and the minimum extent of the water surface as well as the seasonal dynamics.

Spatial extent	Global
Spatial and temporal resolution	Spatial resolution: 300 m Temporal resolution: 10 day composite product. PROV-B sensor, from January 2014 – present
Reference	http://land.copernicus.eu/global/products/wb
Update Frequency	10 days
Related indices	-

3.3 Reporting and bulletins

In this subchapter, we describe a reporting application the stakeholders and the LVBC can use to disseminate the data and information presented in chapter 3.2. Dissemination in the form of reports or bulletins is critical in relation to planning as this enables the decision or policy makers to disseminate the actual plans or the background for the decision process to stakeholders.

Not only is it necessary for data to be freely accessible to the Lake Victoria stakeholders via the online web portal, supplementing this access to data with a tool to compile reports using templates relevant to the stakeholders will add value to the data and increase its usage and ultimately applicability.

With this reporting tool, users will be able to select between a number of default reports, or develop their own reports based on their specific requirements. The reporting application is based on reporting templates in the form of Word documents containing a number of tags, where the user is able to specify which type of content the reporting application should replace the tags with.

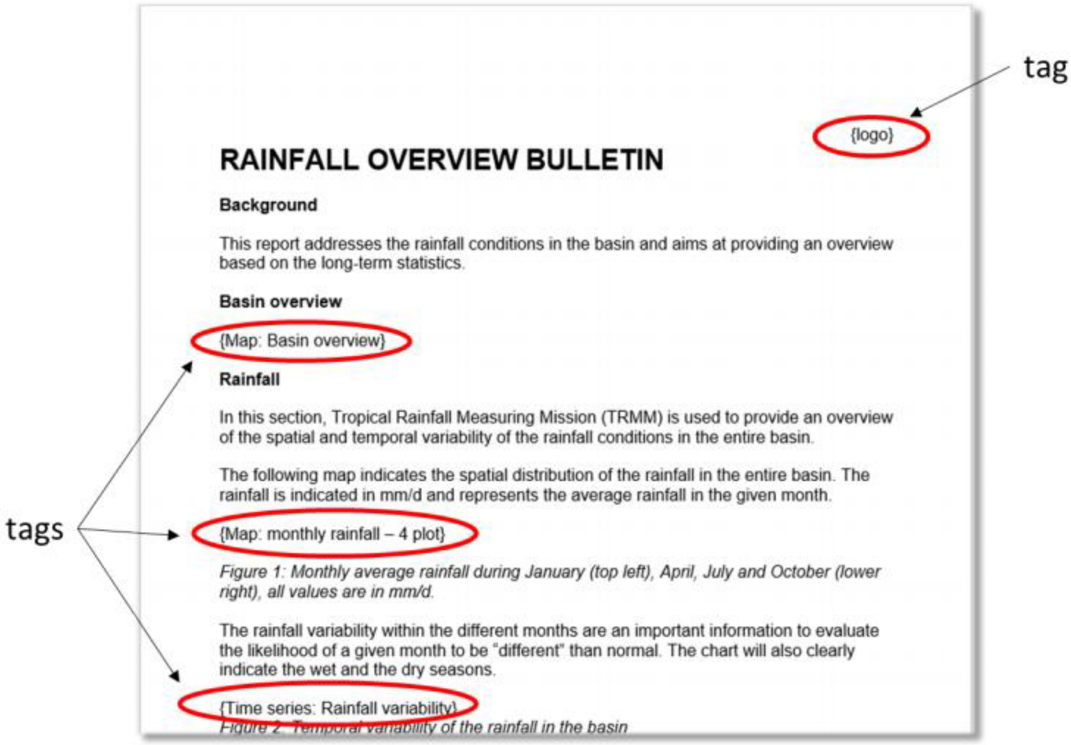


Figure 2 Example of a report with tags.

The tool works with template reports containing the overall framework of the report and is able to insert objects in the form of images, text, chart or tables at user specified locations and converting the template report into a final report containing for example tables with the latest climate information, drought hazards or other information from portal.

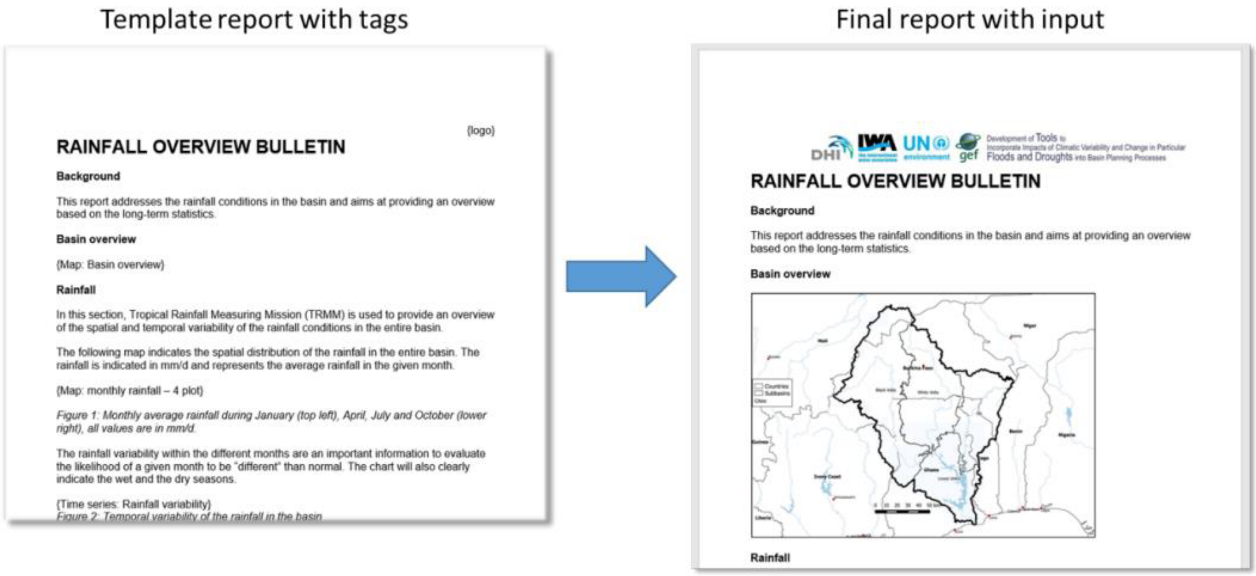


Figure 3 Template report with tags and final report with input in the form of images, chart or text replacing the tags.

3.4 Model refinements and planning

Water resource models are useful for the assessment of water resource management and infrastructure plans, and have gained acceptance for evaluating impacts within the hydrological setting of Lake Victoria. The CTCN assistance will evaluate the existing water resource models used at Lake Victoria and select the model that is best suited for evaluating the impact of the water resources, hydropower generation from management options, climate changes and population pressure on the lake.

Based on the available information and experience from a range of projects involving the LVBC, the NBI and national ministries in Uganda we have decided to utilize an existing MIKE HYDRO Basin model[5] developed over a long period of time by multiple stakeholders and used for evaluation of climate pressure on Lake Victoria (UNEP, 2013) and for development of investment plans in Uganda (MWE DWRM, 2013).

Access to the refined water resources model will be given to the stakeholders via a planning application on the technical assistance web portal, which will make the model license independent and freely available. The following subchapters detail further our approach.

3.4.1 Water resources model used for impact assessment on Lake Victoria

The CTCN assistance is to be based on the currently available information and experience from past projects, and the approach is to evaluate the existing water resources models used within Lake Victoria and select the best model to achieve the objectives of the CTCN assistance. The selected model will be refined and updated after consultation with LVBC and other stakeholders ensuring that the assistance objectives as well as the requirements from LVBC are integrated into the model refinement. The final model would have the potential to be the central water resource model for assessment of

[5] MIKE HYDRO Basin is a physical and conceptual model system for catchments, rivers and floodplains, applied to Integrated Water Resources Management, Water resources assessment, Water allocation, Reservoir operation and other types of analysis, planning and management model studies (MIKE Powered by DHI, 2017)

climate change impacts within the water resource and energy sectors in Uganda, and potentially the region.

Therefore, based on our experience and our assessment, it has been found that the best model for the LVBC to achieve the objectives of the CTCN assistance, is the one developed through the Nile Basin Adaptation to Water Stress project (DHI and Met Office, 2013) carried out for UNEP and the NBI. Within the context of this work, a water resources model was established of the whole Nile Basin, the NBI and the MWE DWRM were part of the stakeholders involved in the model development. This model will, as part of the CTCN assistance and in close collaboration with LVBC, be further refined and will be made available for LVBC as part of the CTCN assistance.

The water resources model was developed with the objective of having a state of the art tool being able to describe the water resources within the Lake Victoria itself (rainfall and evaporation) as well as the key components from the surrounding catchments. Refinement will entail updating with the latest information regarding hydropower production, and will be used as the key tool for evaluating the impact from water management options, investments and climate change.

The model itself will not be used directly by the LVBC, but through a planning application, conceptualized to use model based planning for decision makers who do not need prior modelling knowledge. The detailed model development is documented in DHI and Met Office (2013), UNEP (2013) and MWE DWRM (2013).

The technical workflow involved in the refinement of the model is the following:

- Model domain reduced
- Verification of calibration due to domain reduction implemented
- Adding existing hydropower plants to the water resources model;
- Inventory of planned hydropower investments and adding these to the model;
- Preparation of the catchment shapefile and a spreadsheet with an inventory of existing water users;
- Upload of the model into the planning application and establishment of the baseline plan.

To assist in verifying the performance of the refined model, specific investigations regarding the lake hydrology will be carried out:

- 3-hourly TRMM data is now available in Lake Victoria (see chapter 3.2). We will use this data to evaluate if we are able to capture the daily rainfall variation over the lake with particular considerations on day/night variations;
- CHIRPS[6] data corrected with ground measurements is also available, a comparison between both datasets will be carried out;
- Lake versus basin water balance will be carried out;
- Comparison with the most recent research regarding impact of climate change on Lake Victoria following the findings of Thiery, W. et al. (2016), focusing on increasing hazardous weather extremes over the lake behind the thousands of accidents and deaths of fishermen due to night-time thunderstorms.

[6] Climate Hazards Group InfraRed Precipitation with Station

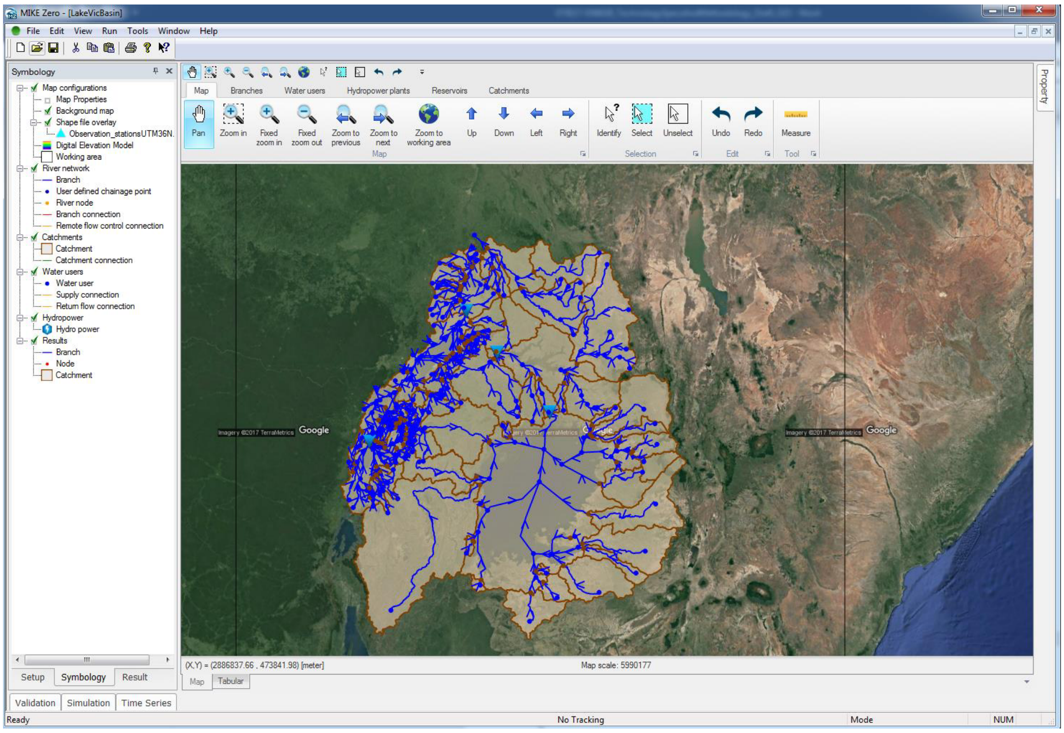


Figure 4 Screenshot of the MIKE HYDRO BASIN model user interface for the Lake Victoria Basin displaying water network branches in blue and subcatchment polygons in brown over a satellite background map

3.4.2 Planning application

The planning application will be embedded in the web portal deployed within this technical assistance. It targets decision makers without any modelling expertise, and the overall concept is to utilize the refined water resources model, for evaluation of plans by stakeholders in the water and energy sectors. Use of the planning application rests on the concepts itemized below and further schematized in Figure 5:

- Investments: these are investments decision makers want to implement within a specific plan; investments are limited to water supply, irrigation schemes, other types of water supply, hydropower, reservoirs and storage;. investments are described as water user nodes in the water resources model, or as hydropower or reservoir nodes.

- External factors: these are climate change and population growth; the external factors influence the model in different ways as they impact either the climate or the water demand simulated.

- Plans: a plan is a collection of investments and external factors combined into a plan or scenario; each plan is represented by a set of inputs to the model.

- Indicators: planning results are all indicators derived from the model result files, i.e. actual model results will not be shown but only indicator values.

- Strategies: weighting system attributed to indicators expressing different policy and strategic focuses.

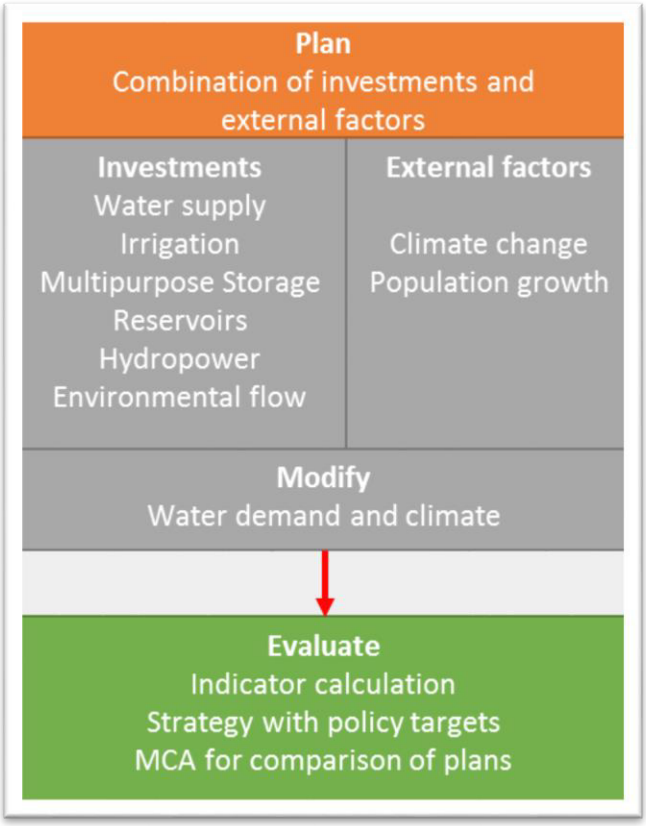


Figure 5 Overall concept of and key components of the planning application.

The technical workflow for the planning application is explained using a step-by-step description as follows:

Step 0: Log on to the web portal and enter the planning application

Step 1: Upload of the Lake Victoria water resources model and describes the baseline

Step 2: The baseline condition is established in the backend and made available for the user

Step 3: User defines a number of investments to be included.

- List appears with existing investments, all investments in the baseline case should be editable.
- User is presented with dialog for adding new investments, added by clicking on the map followed by typing of parameters. When a new investment is added it appears on the map and in an overview list.

Step 4: User defines a number of external factors to be included.

- Climate change factor will be implemented through change factor multiplication on climate files.
- Population growth is implemented by choosing the percentage of annual growth within the investment horizon year.

Step 5: The user makes a new Plan with the new investments and external factors from steps 3 and 4.

- The baseline model is cloned and the alterations implemented in the backend.

- The clone is a scenario model which represents the New Plan.
- The scenario model is executed.
- All the available indicators are calculated and the indicator results are stored.
- The scenario model and the model results are deleted (not to be used any more)
- User receives an email, as the plan is available.

Step 6: User evaluates the plan, selects which indicators to use and defines strategies

- When clicking on a plan the existing investments can be examined and are also shown on the map.
- Indicator results are presented as tables, charts and on the map.
- The user is able to change the indicator configuration and the results presentation will be updated.
- The user creates strategies with weighting systems to evaluate the New Plan.

Step 7: User selects reporting

- Once evaluation of the plan is done, the user can prepare reports and export them. The reporting part will be done through the web portal, see chapter 3.3.

3.5 Drought assessment

Droughts are typically classified in four different categories: meteorological, agricultural, hydrological, or socioeconomic. Meteorological drought is defined as deviation of rainfall compared to normal conditions. Agriculture drought occurs when the sustainability of the crop development is affected, leading to reduced crop yields. Definitions of hydrological drought are often referring to hydrological condition of the surface hydrology, which could be a period when streamflow has fallen below a given threshold. The last category of droughts is the societal and economic impacts.

All these definitions encompass the concept of water scarcity where water availability is insufficient to meet water demand. Water availability is closely connected to rainfall, but also to changes in land use, water quality, legislation etc. However it is important to bear in mind that water shortages related to drought must be considered as relative and not as absolute conditions.

Defining a drought condition relates to identifying the beginning, length and degree of severity of the drought. One of the issues with defining a drought event is that at its beginning, the duration and severity of the drought will be unknown.

The main tools for defining a drought event are different drought indices, as they can help identifying when a drought is starting and the severity. There are many existing indices, all developed and used for different purposes. It should be noted that no drought index is perfect for all situations, and in most cases, several indices will be used to evaluate a drought event.

The objective with drought assessment implementation is to provide the Lake Victoria Basin decision makers in Uganda as well as the LVBC with information to improve the planning and managing for drought with respect to operational and long term strategic planning.

Through this technical assistance, the calculation of different indices, such as the Standardized Precipitation Index (SPI) amongst others described in chapter 3.3, will be carried out for the Lake Victoria Basin area, and access provided through the web portal. Along with the indices, we will add an assessment application to set up warning thresholds for each index and carry out a risk assessment by combining the indices with different socio-economic indicators available.

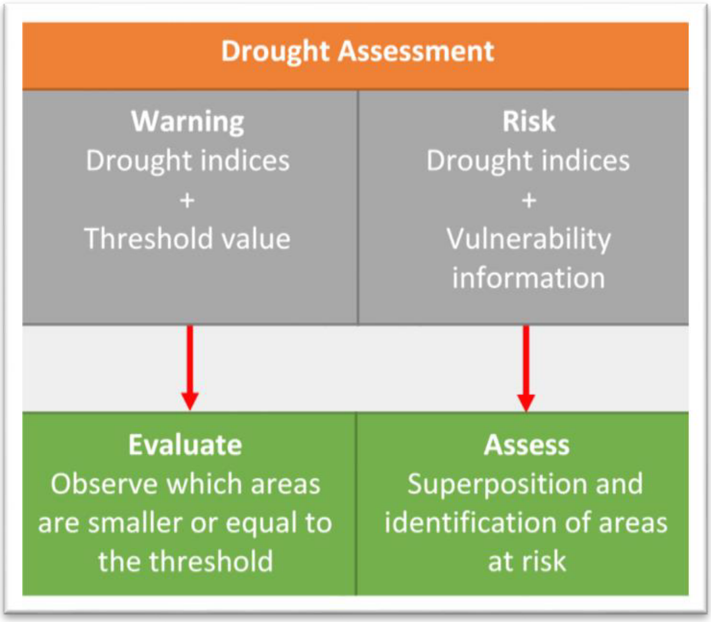


Figure 6 Overall concept of and key components of the drought assessment application.

The technical workflow is explained using a step-by-step description next.

Step 0: Log on to the web portal and enter the drought assessment application

Step 1: The user configures a warning, based on the data and information application, a set of index datasets will be available for choosing:

- ASI latest value
- Number days with EDI value less than -1 (30d)
- Consecutive days with EDI value less -1
- Days with VCI less than 20 (30d)
- Days with VHI less than 30 (30d)

Step 2: Select threshold values for the indices selected, thus configuring a warning.

Step 3: Based on visual analysis, the user observes how the indices perform over the Lake Victoria basin area, considering the thresholds defined.

Step 4: The user configures a risk assessment, by combining the indices with socio economic data available for the basin, constituting measures of vulnerability to the impacts of drought. The expected types of information, still being collected that will be available are:

- Child under weight (percentage); Drought Mortality Risk; Flood Mortality Risk; Infant Mortality Rate (2000)
- Gross Domestic Product;
- Population density; Urban expansion;
- Irrigated Area; Pasture

Step 5: The user is presented with a superposition of the hazardous areas and the vulnerability information on the web portal map, allowing the identification of locations at risk.

3.6 Decision making guidelines

This deliverable consists of a document providing guidance on how to use data, models, and other tools in decision-making processes. No technology will be delivered, so the document constitutes the technology deliverable in itself.

The guidelines are based on the robust decision making methodology (Bryant & Lempert, 2010; Lempert, 2013), which has been developed to assist decision making in situations characterized by considerable uncertainty about future conditions. In this methodology, technical specialists work together with stakeholders to develop plausible scenarios of future conditions in which proposed policy, infrastructure, or other alternatives are likely to fail. These scenarios are then used to develop planning alternatives that are less likely to fail, with the goal of identifying a so-called "robust" alternative.

The robust decision making methodology develops a scenario in which proposed alternatives may fail through the following steps:

- A simulation model is developed for each policy or infrastructure alternative.
- Each simulation is run many times using an ensemble of model inputs.
    - The ensemble of model inputs is used to characterize the full range of uncertainty associated with important drivers affecting the performance of alternatives.
    - Examples may include climate projections, demographic projections, or projections of economic factors. This creates a database of model runs where each run represents a particular set of assumptions about future conditions.
- A statistical analysis of the resulting database of indicators is then used to identify a subset of the input ensemble that results in unacceptable indicator values.
- This subset is then used to define a scenario (which may be a single scenario or a subset of the original ensemble) that is used to test and refine alternatives.

For example, a robust decision making analysis for a hydropower planning authority would begin by developing a simulation for each planning alternative under consideration (new facilities, new operating rules, new energy contracts, etc.). Then, the analysis would run an ensemble simulation for each alternative with different assumptions about climate, energy demand, and other water demands incorporated in each ensemble member. The analysis would then compute indicators of interest from each model run, such as the economic benefit of hydropower or the extent to which other water demands are met. The subset of ensemble members in which each alternative fails would then be used to develop one or more "failure" scenarios. The "failure" scenarios would then be used to define an alternative that is "robust" to uncertainty, either by selecting one of the original alternatives that performs best across the failure scenarios, or by developing a new alternative.

The robust methodology is useful for engaging stakeholders in a decision making process. Implementation requires thresholds defining acceptable performance for each indicator, which are identified in consultation with stakeholders. The focus on identifying conditions in which an alternative is likely to fail provides an opportunity to engage stakeholders with future scenarios that they might not consider otherwise. Finally, the methodology does not weight different future scenarios but simply asks stakeholders to consider all possible futures that may result in unacceptable outcomes. For this reason, it does not rely on probabilistic estimates of future conditions that may be controversial with stakeholder groups having different expectations of the future.

The robust decision making methodology makes use of ensemble climate information and impact modelling, both of which are components of the CTCN assistance. Therefore, at the conclusion of this technical assistance, many of the technical tools and data needed to implement the methodology will be in place. Furthermore, the planning application being implemented as part of the current assistance provides a resource for creating and testing infrastructure alternatives that could also be incorporated into a robust decision making workflow. A small case study application will be developed in consultation with local stakeholders and will be used to demonstrate the methodology in the guidelines.

4 Methodology for testing and demonstration

In this chapter we present the methodology for testing of the deliverables described in chapter 3 Technical Specifications. This activity will test developments taking place in Activity 2.1 on case studies related to long-term and seasonal time scale planning.

4.1 Objectives

The purpose of the testing will be to ensure that the outcomes of the technical assistance are relevant and their utility demonstrated for decision-making processes of the participating stakeholders.

The steps in the testing and demonstration phase will be as follows:

- Identify outcomes to be validated;
- Meetings with the stakeholders to allow the institutions to further assess and nominate participants in validation outlined in the work plan;
- Collect information to be used for the validation e.g. planned interventions, scenarios, observed data or historical information, reporting templates;
- Validation of data and information, remotely and via working sessions outlined in the work plan;
- Demonstration using case studies, for an assessment of how the outcomes from the CTCN assistance correlates with the actual processes and reporting of stakeholders;
- Adjustment of the CTCN outcomes aiming at refining the data, tools and guidelines provided.

4.2 Validation and demonstration of technical components

This process will ensure that the developed technology provides outcomes that can represent the actual conditions in the basin, and therefore be used for decisions aiming at increasing the adaptation capacity towards climate change.

Validation of the outcomes will mainly be done on historical data, hence evaluating how the system is able to reproduce events which have already occurred. It will depend on the successful collection of information from the stakeholders. The following table presents how each of the technical components will be validated and with what purpose.

Table 5 Validation process of technical assistance components

Outcome	Means of validation	Purpose
Data and information	Compare climate variable values with historic information in the form of records of precipitation, evaporation and temperature. Main focus on the Lake Victoria itself and the basin. Sending weekly infosheets containing descriptions of selected data types	Ensure that the most appropriate datasets are included as part of the CTCN assistance and assess different datasets deviation. Ensure stakeholders are exposed to the data and start using it early on, and maintaining regular communication as a way to

Outcome	Means of validation	Purpose
	with attached spreadsheets with time series produced.	encourage further stakeholder engagement and use of the datasets.
Reporting and bulletins	Setup of reports by stakeholders using their own reporting templates.	Ensure the dissemination of the data and information provided by the technical assistance is done in the most useful format.
Model refinements and planning	Evaluate performance of the planning application with the refined model by the LVBC and potentially other relevant stakeholders. Uploading of climate change projections to the WRIS.	Ensure that relevant scenarios are tested and verify applicability and ease of use of the planning application developed. Ensure extended functionality of the current WRIS by including climate change datasets for the basin.
Drought assessment	Compare indicator values with occurrence of drought for impacted areas or recorded droughts. Evaluate the need for adjustment of the selected indices.	Ensure that the most appropriate indices are used for drought hazard identification.
Decision making guidelines	Work with stakeholders to identify appropriate decision making problem. Test decision making methodology in consultation with stakeholders using small case study.	Ensure that decision making guidelines are useful for real-world applications.

In parallel with the validation of the outcomes, demonstration of their application will be done through the case studies introduced in chapter 2. Next, we present how each case study (CS) will be used in the demonstration of the components described under the Technical Specifications as well as the requirements needed in each case to allow demonstration to succeed.

CS1 Management and dissemination of climate information

Link to: Adapting to climate change in Lake Victoria and WRIS

Platform: web portal and WRIS

Technology/Tool: Data and information and Reporting application

Requirements: Response to data and reporting needs questionnaire; Supplying data reporting examples and establishment of reports; Collaboration with current WRIS operators at LVBC.

Outcomes of demonstration:

- User experience of the web portal
- Understanding and applicability of climate data types
- Adequacy of indicators

- Verification of data format
- Download of seasonal forecasts from the web portal and integrate into the WRIS
- Outline a procedure to keep the seasonal forecasts up to date
- Integration of climate change projections in the existing WRIS

CS2 Establishment of regional water resources assessment model for decisions related to the water resource or energy sector

Link to: LVEMP

Platform: web portal and WRIS

Technology/Tool: Lake Victoria basin Model and climate change projections

Requirements: Response to data and reporting needs questionnaire; Discussion of baseline model and climate change scenarios of interest described; Collaboration with current WRIS operators at LVBC.

Outcomes of demonstration:

- Refined model reviewed by LVBC;
- Climate change scenarios of interest selected.

CS3 Capacity and knowledge for decision making in a future climate

Link to: National training and capacity programmes focussing on climate change mitigation

Platform: web portal

Technology/Tool: Data and information and Reporting application

Requirements: Response to data and reporting needs questionnaire; Decision making processes identified; key trainees identified, supplying reporting examples and establishment of reports.

Outcomes of demonstration:

- User experience of the web portal
- Understanding and applicability of climate data types
- Adequacy of climate data and indicators made available for usage;
- Verification of data format
- Potential synergy with existing programmes and ongoing activities at MNA and MWE DRWM, namely climate change projection project, catchment management plans and baseline and situation assessment studies.

CS4 Water resource planning at national and regional level related to the water resources and energy sector

Link to: National and regional programmes and studies

Platform: web portal

Technology/Tool: Planning application and Decision making guidelines

Requirements: Response to data and reporting needs questionnaire; List of water use investments with detailed information for different planning parameters required; Planning scenarios that need to be tested.

Outcomes of demonstration:

- Relevant implementation of planning alternatives via the planning application, assess potential for further usage within organization.
- Linkage with the National Water Resources Strategy for Uganda
- Applicability of guidelines produced.

CS5 Providing data and interpretation of climate change data for management of agricultural impacts

Link to: Existing activities or programmes from MNA and MWE namely

Platform: web portal

Technology/Tool: Data application and Drought assessment application

Requirements: Response to data and reporting needs questionnaire; Study areas and detailed description of specific drought hazard; identification of most appropriate indicators and establishment of reports.

Outcomes of Demonstration:

- Application of drought indicators to monitor the agricultural sector
- Identification of areas and setup monitoring strategy using the web portal.

4.3 Work plan for Activities 2 and 3

The following actions for engagement and preparation leading up to and including the technical training and workshop activities are planned:

Meetings with targeted institutions in Uganda – end of January/February 2018 – meetings in preparation for testing and demonstration as well as training in the end of April/May. These will be done by us at stakeholders' offices, and does not require attendance by LVBC. The selection of meetings will depend on the availability of specific organisations and the available resources within the CTCN assistance.

Working session at UNCST – mid March 2018 – with LVBC staff, UNCST and potentially relevant stakeholders focusing on testing and demonstration.

Technical training and national workshop in Uganda – end of April 2018 / mid May 2018 – 2 days with selected trainees followed by 3rd day (mostly morning session) with stakeholders to share outcomes from the technical assistance. Duration to be programmed based on findings of previous sessions.

A proposed technical training plan is introduced next revolving around working sessions with different interest groups to be conducted by our team. It is envisioned that with the UNCST collaboration, we will be able to find a suitable venue where participants can work together and focus on the training at hand.

A tentative agenda for the training and workshop activities is presented in Table 6 and Table 7.

Table 6 Proposed agenda for the technical training

DAY 1		
Time	**WORK SESSION 1 LVBC MWE NBI**	**WORK SESSION 2 UNCST NAPE MUST RAN UNMA MWE**
09.00 – 09.30	Registration	
09.30 – 10.40	Welcome and presentation of the work sessions	
09.40 – 10.00	Presentation of participants	
10.00 – 10.45	Overview of key features and capabilities of the web portal. This includes what type of outputs is produced and how to be interpreted.	
10.45 – 11.00	Break & Away into sessions	
11.00 – 11.45	DATA & INFORMATION	DATA & INFORMATION
11:45 – 12:30	Exercises	Exercises
12:30 – 13:30	Lunch	
13:30 – 14:30	DATA & INFORMATION	REPORTING
14:30 – 14:45	Break	
14:45 – 15:30	Intro to PLANNING	Exercises
15.30 – 16.00	Discussion and wrap up	

DAY 2		
Time	**WORK SESSION 1 LVBC MWE NBI**	**WORK SESSION 2 UNCST NAPE MUST RAN UNMA MWE**
09.00 – 09.45	Re-cap Day 1	Re-cap Day 1
09.45 – 11.00	PLANNING	DATA & INFORMATION
11:00 – 11.15	Break	
11.15 – 11.45	Exercises	Exercises
11:45 – 12:30	Exercises	DROUGHT
12:30 – 13:30	Lunch	
13:30 – 14:30	DECISION	Exercises
14:30 – 14:45	Break	
14:45 – 15:30	Exercises	Exercises
15.30 – 16.00	Discussion and wrap up	

Table 7 Proposed agenda for the final workshop

Time	Title	Responsible
09.00 – 09.15	Welcome and presentation of the objective with the workshop	Host
09.15 – 09.45	Presentation of decision case by one of the local stakeholders. The decision case will be used throughout the day as an example • Type of decision to be made • Objectives, constrains and uncertainties • Current decision workflow • Types of data and output used in the decision case	Local stakeholder
09.45 – 10.00	Q&A	
10.00 – 10.45	Overview of key features and capabilities of the web portal. This includes what type of outputs are produced and how these need to be interpreted.	DHI
10.45 – 11.00	Q&A	
11:00 – 11.15	Break	
11.15 – 11.45	Exercise 1: use of web portal functionality in relation to the decision case	Local stakeholder / DHI
11:45 – 12:30	Exercise 2: use of web portal functionality in relation to the decision case	Local stakeholder / DHI
12:30 – 13:30	Lunch	
13:30 – 14:30	Assisted role-play focusing on use of tools for decision making. The exercise shall attempt to portray a real-life situation, based on the presented case, where participants will be able to identify a number of management and/or development options. Pre-made output from will be used in the exercise.	DHI
14:30 – 14:45	Q&A	
14:45 – 15:30	Discussion on how the web portal could be used in the decision process focusing on the operational use and sustainability of the portal.	All
15:30 – 15:45	Break	
15:45 – 16:30	Wrap up	Host

All workshop material and developed content will be compiled and disseminated to all participants.

In the following page, we present the proposed scheduling for the work plan above, currently under discussion with LVBC and UNCST.

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

DHI UNCST

2018

JANUARY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

MARCH

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

MAY

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

IMPORTANT DATES

FEBRUARY 5 - 9

Meetings at stakeholders offices in preparation of testing

FEBRUARY 15

First version of the tools for testing Deliverable 2.1

Mid-MARCH ?

Testing working session at UNCST

MARCH 31

Review and comments from LVBC

End APRIL **OR** Mid MAY ?

Technical training & National workshop

APRIL 30

Testing and demonstration report & user guide Deliverable 2.2

MAY 31

Summary report of training and workshop Deliverables 3.1 & 3.2

National Holidays in UG / KN / DK

5 Next steps

This deliverable brings Activity 1 to completion, next lies Activity 2 which encompasses the delivery of technical outputs and validation on specific use cases:

- Activity 2.1 refers to the implementation of technical components, including setting up the web portal, data access, Impact assessment model refinements, and guidelines for decision-making.
- Activity 2.2 will test developments taking place in Activity 2.1 on relevant case studies. After testing, the new developments will be documented in order to support dissemination activities, including the elaboration of a summary of feedbacks from LVBC on Activity 2.1, and a user guide.

The next deliverables of the above activities following this report are: the first draft version of the technical components by 15th of February 2018, the Technology testing and demonstration report, the final version of the technical components, and Documentation and user guide report by the end of April 2018.

Activity 3 Dissemination and outreach, will help stakeholders make use of the different components through a second national workshop and technical training. Summary reports of the events and all training materials will be delivered and disseminated, and a Roadmap elaborated with recommendations for regional transfer of the technology and scaling up within future projects.

The input by our gender expert is programmed within the scope of Activity 3, the next subchapter provides details on the expected scope of work.

5.1 Gender mainstreaming

Gender considerations will be taken as part of the national workshop and subsequent training events to ensure gender equality within the capacity and dissemination part of the technical assistance. In order to fulfil this, our team integrates a gender expert whose scope of work is:

1. Participate in the workshop of Activity 3.1 and training of Activity 3.2 by reporting on/tracking the gender mainstreaming relevant indicators of the Monitoring and Evaluation Plan within Activity 3.4 and briefly assessing the performance in light of gender mainstreaming.
2. Contribute to the CTCN Impact description in light of gender mainstreaming within a climate change adaptation technical assistance

The team's gender expert will participate in the above activities, and during the first day observe, follow the activities and apply gender gap assessment of the working sessions with participants.

Following the first day's work sessions, the team's gender expert will then relay on the other team members the findings and discuss the necessary tools to be implemented directly over the course of the second and third days of the training and workshop activities.

Finally, reporting and lessons learned will be integrated into the dissemination and reporting tasks of the technical assistance following 3.1 and 3.2 deliverables.

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APPENDIX A

Reporting and data needs survey

CLIMATE TECHNOLOGY CENTRE & NETWORK

Adaptation to climate change through improved information and planning tools for Lake Victoria - CTCN Technical Assistance

Climate data and reporting needs

Your answers to these 10 questions will inform the data and tools being implemented within this technical assistance, as well as the case studies used in validation.

OK

1. Which sector do you belong to?

- ○ Water sector
- ○ Energy sector

Other (please specify)

2. Tick from the following list if the activities apply to you.

- ☐ I compile raw climate data
- ☐ I compile processed basin scale information
- ☐ I read indicators regarding drought
- ☐ I read indicators regarding floods
- ☐ I use short term weather forecasts
- ☐ I use climate change projections for catchment rainfall
- ☐ I use tables and time series plots of meteorological parameters
- ☐ I use spatially distributed maps in my reports
- ☐ I produce meteorological and hydrological maps
- ☐ I produce maps of basin characteristics

Other (please specify)

3. What type of instruments do you use the most and how often?

	Daily	Weekly	Monthly	Annually	N/A
Strategic Action Plans	○	○	○	○	○
Weather forecasts	○	○	○	○	○
Climate change projections	○	○	○	○	○
Catchment Management Plans	○	○	○	○	○
GIS maps of biophysical basin characteristics	○	○	○	○	○
Socio-economic indicators	○	○	○	○	○

Other (please specify)

4. If you could get a report based on the last 24 hours which data should be included and in which format (reports, short technical notes, maps, raw data)?

5. What information on a short term basis (if any) do you think should be communicated to other members of your team and in which format (reports, maps, etc.)?

6. Are you currently getting the information you require from other sections and/or directorates or do you need other support?

7. Is there any specific information that you are required to provide to different processes, sections or directorates?

Type of information	
Frequency (daily/weekly/monthly)	
Format (reports/notes/maps/raw data/etc.)	

8. On a scale from Irrelevant to Indispensable, please rate how important each type of data is to your daily tasks and reporting you need to do. Also, tick on if you have access to it currently.

	Irrelevant	Relevant	Indispensable	Available
Near real time rainfall	☐	☐	☐	☐
Monitored lake water level (remote sensing)	☐	☐	☐	☐
Drought indicators	☐	☐	☐	☐
Flood indicators	☐	☐	☐	☐
Seasonal weather forecast	☐	☐	☐	☐
Comparisons of indicators against specific thresholds	☐	☐	☐	☐
Water balance information (simulated flows from hydrological models)	☐	☐	☐	☐
Projected water demands and demographic information	☐	☐	☐	☐
Vegetation cover	☐	☐	☐	☐
Climate characterization (Precipitation index, evaporation, temperature etc.)	☐	☐	☐	☐
Crop water requirements	☐	☐	☐	☐

Other (please specify)

9. Please rate in terms of relevance, the thematic working session(s) useful to your work in climate change adaptation you would like to see in a workshop event.

	Irrelevant	Relevant	Indispensable	N/A
Accessing the climate change data, interpreting plots and downloading	○	○	○	○
How to use drought assessment tools	○	○	○	○
Using a Planning tool with a baseline hydrological model	○	○	○	○
How to produce an automatic report using all data available	○	○	○	○
Application of decision making guidelines	○	○	○	○

Other (please specify)

10. Demographics information, please choose from below.

○ Male

○ Female

DONE