Adaptation to climate change portal – Lake Victoria and Uganda

Select the application, you would like to get help about:

DATA AND INFORMATION

Access to near real-time data. Flood and drought indices. Climate forecast and climate change data.

DROUGHT ASSESSMENT

Locate and identify hazards, estimate impacts and provide risk assessment.

BASIN PLANNING

Create and evaluate basin plans. Linkage to water resource model.

REPORTING

User configured templates providing linkage to overview reports or bulletins. Specific templates for TDA/SAP, IWRM and WSP.

RDM TOOL

Robust Decision Making Tool

Data and Information application

User guide

DATA AND INFORMATION APPLICATION

1 Introduction and background

The Data and Information application is developed to ensure that any user will always have a basic data set available for planning related to water resource, drought or flood management.

The objective is to provide spatially distributed data in near real time for any focus area in the globe.

The available data is originating from a number of different data sources, which are all available in near real time and disseminated through the Data and Information application. The data relates to different climate variables, climate forecast data, climate change data, and drought related indices and flood related data.

The Data and Information application contains a number of different data types 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 through the Data and Information application in commonly used formats (netcdf file)

2 Quick guide for first time user

This section contains a brief introduction to the **Data and Information** application for first time users. For a more detailed description see the following sections. The specific data types are described in details in section 4.

2.1 Select data to view or analyse

Once you have logged in, the available data types are listed by choosing *Select* under the *Data* tab. Open this menu to select which data should be made available (this selection can be changed later on).

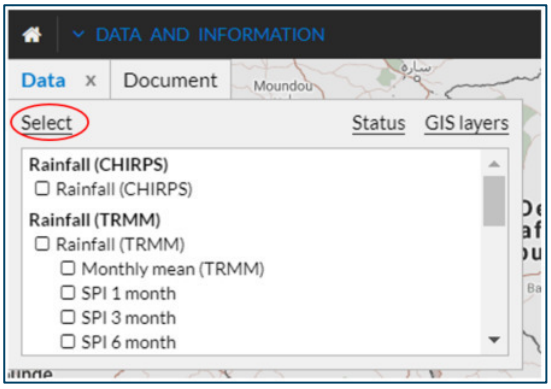


Figure 1 *Select* menu in the *Data* tab

The selected data will be available for viewing, download and analysis. Note that it's ONLY the data selected that is available for further processing.

See section 3.2 for a detailed description.

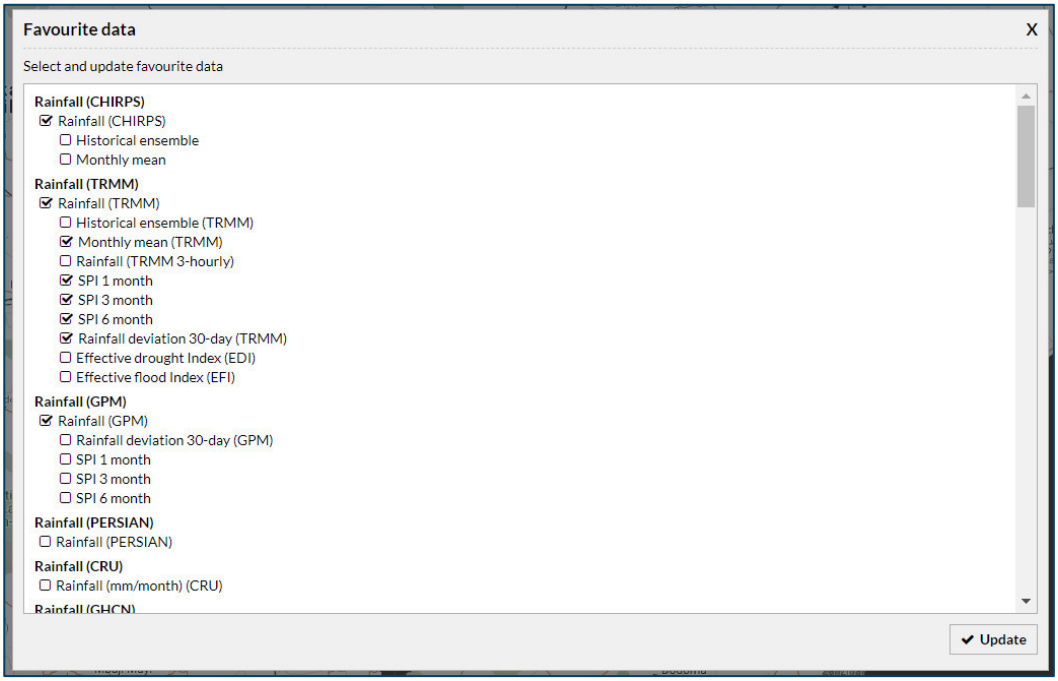


Figure 2 Selecting the data to work with in the *Select* dialog

2.2 View data

The selected data can be viewed from the *Layer* menu, which allows you to view each time step of a selected data type. See section 3.3 for more details.

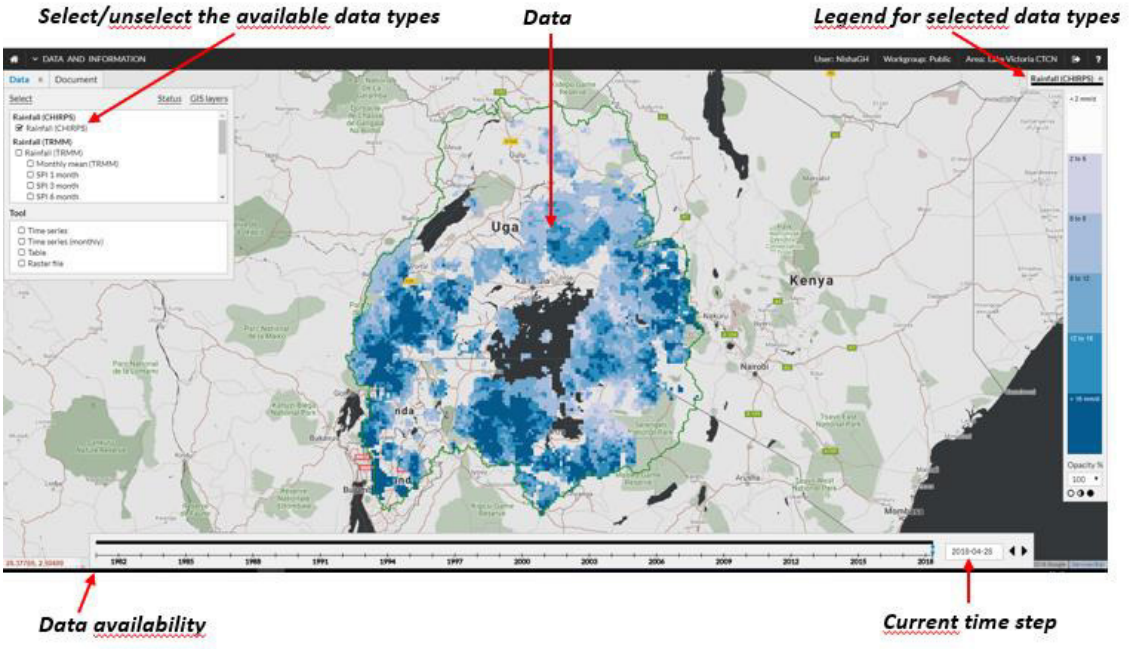


Figure 3 View data from the Layer menu

2.3 Download data as netcdf files

The tools menu is used to download and process the selected data. Use the tool called *Raster file* to download any of the available data files as a netcdf file. To download a data file:

- Select the layer you would like to download data from
- Select the *Raster File* under the *Tools* section
- Specify the period and press *Download*
- Then on the following dialog showing the file size, and the file name, press *Download.*

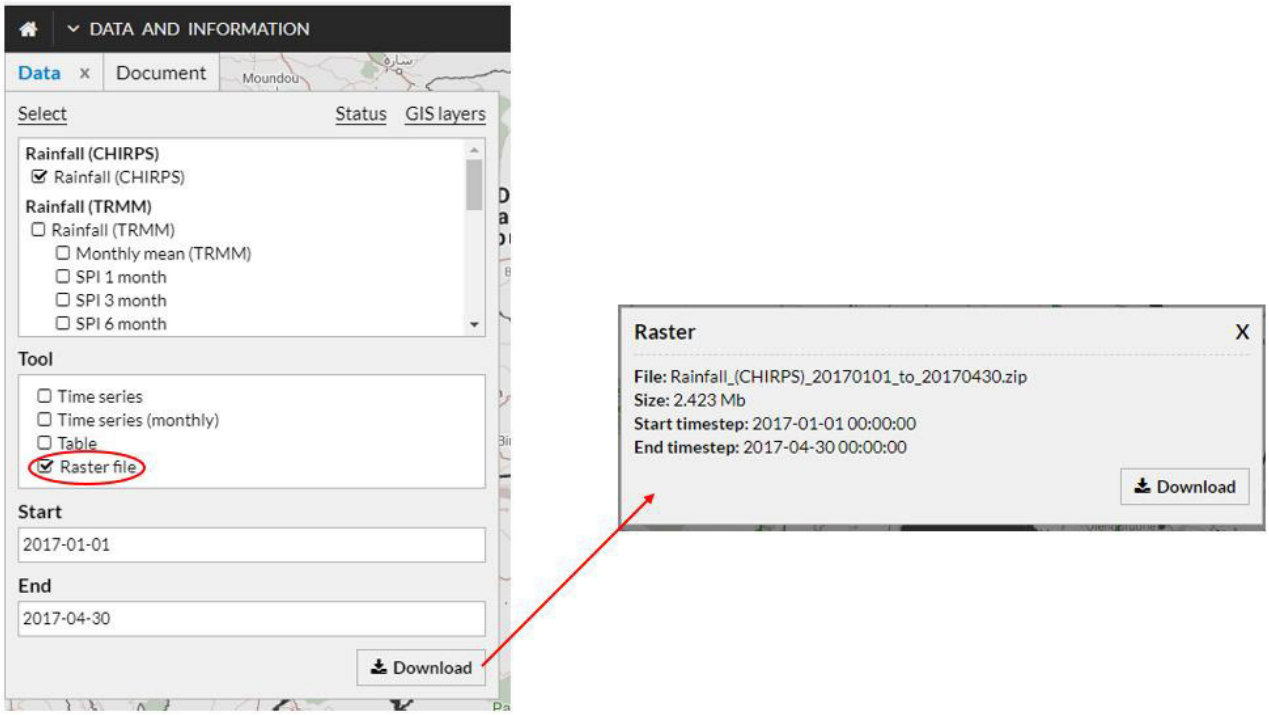


Figure 4 Download data as netcdf files

Note: the zip file contains the raster as .nc file, which can be open in most GIS tools. In addition, a legend file as .qml is associated to the .nc file. This legend file can be used in QGIS to load the default symbology.

2.4 View or download time series

The tools menu contains a number of different options for processing and analyzing the selected data types. Data could be extracted at different spatial resolutions from the entire focus area to point locations, and could be presented as time series, envelope plots or chart plots. See section 3.3.2 for details on the tools menu.

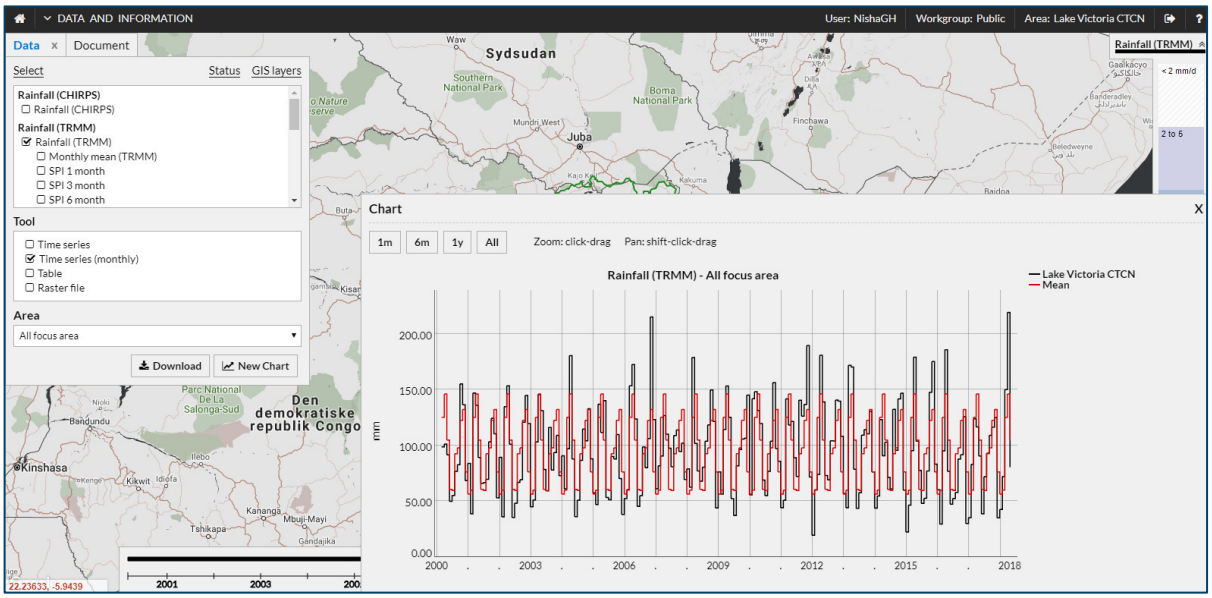


Figure 5 View or download time series

3 Functionality

This section contains a brief description of the functionalities currently available from the Data and Information application.

3.1 Info menu

The information menu allows the user to access the *User guide*, *Knowledge portal,* and *About*.

Figure 6 Information menu

3.1.1 User guide

Opens a pdf version of the user guide.

3.1.2 Knowledge portal

Here you can start discussions related to the portal.

3.1.3 About

Opens a short description of the system and contact information to the administrator.

3.2 Select

The *Select* menu is used to select the favourite data or the data available for viewing and analysis. The user selection is stored and will be used the next time the user logs in. The *Settings* dialog contains the following information:

- Overview of all available data in the Data and Information application (for the particular focus area)
- When clicking on a data type a brief description is displayed
- When selecting one or several data types and pressing *Update,* the selected data will be available for viewing and analysis, see section 3.3.

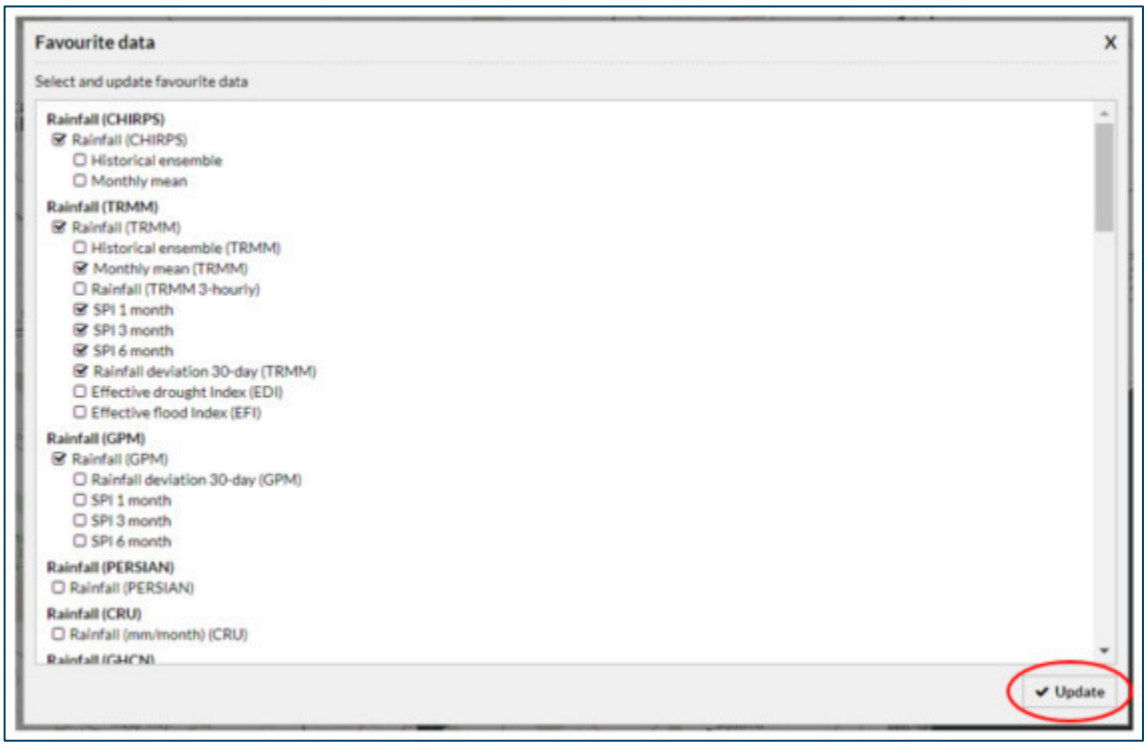


Figure 7 *Select* menu

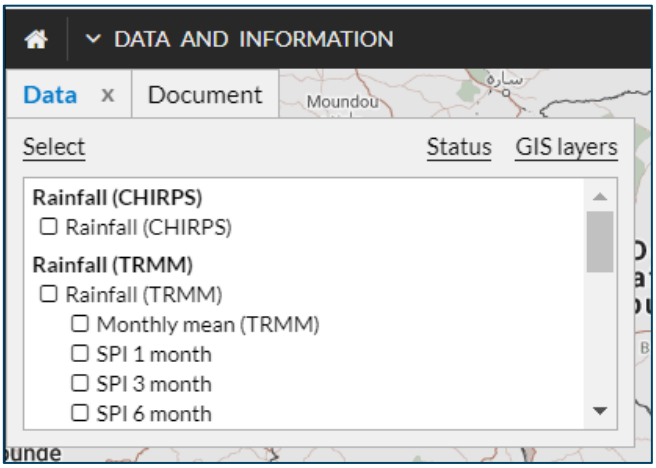


Figure 8 Available data in the *Data* menu is updated based on the selection in the *Select* dialog, see section 3.3 for more information.

3.3 Data menu

3.3.1 Layer visibility

The *Data* menu is used for viewing the data types selected in the *Select* dialog, see section 3.2. The following functionality and information is available:

- **List of available data types** (based on the selection in the *Select* dialog, see section 3.2)
    - Select or unselect a data type from the list

- When selecting a data type it appears on the map view showing the most recent time stamp

- **Legend** for the selected data type could be toggled on and off by clicking the two arrows in the top of the legend
- **Timeline** for the selected data type is shown at the bottom of the screen. Gaps in the time line denotes periods with missing data
    - Click within the time line to view the data at the specific time step
- **Current time step** is shown at the lower right part of the screen
    - Use the step forward or backwards buttons to change the time step

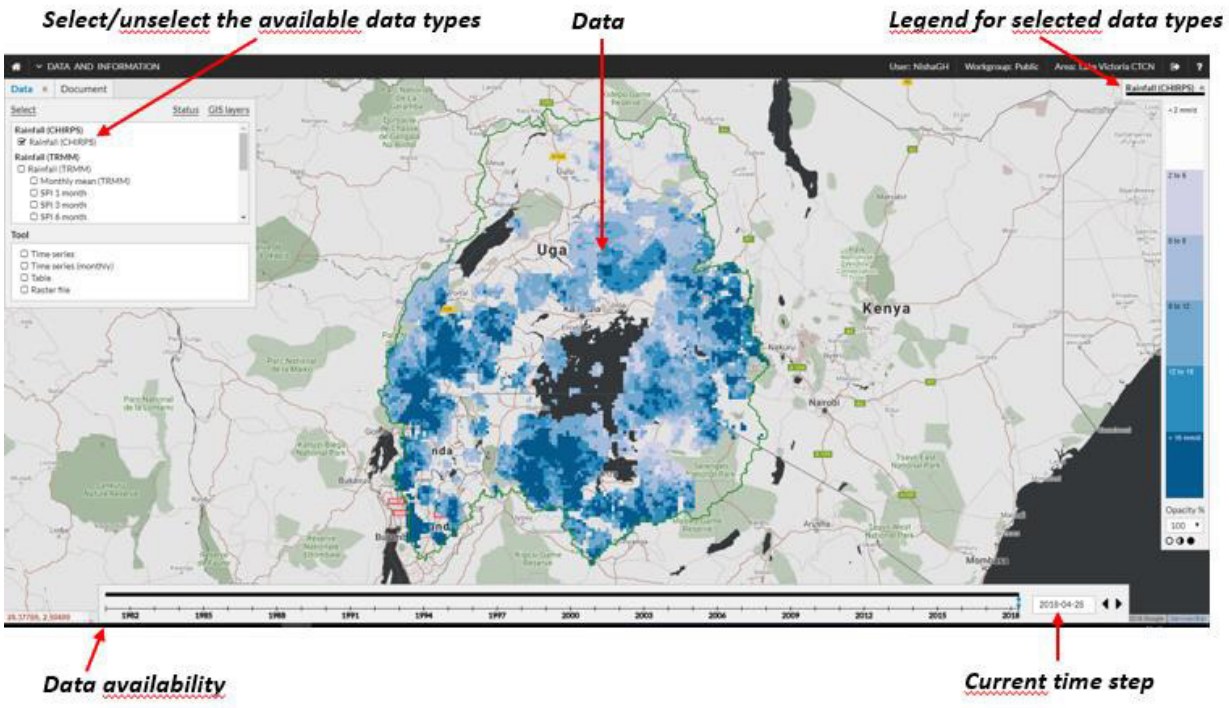
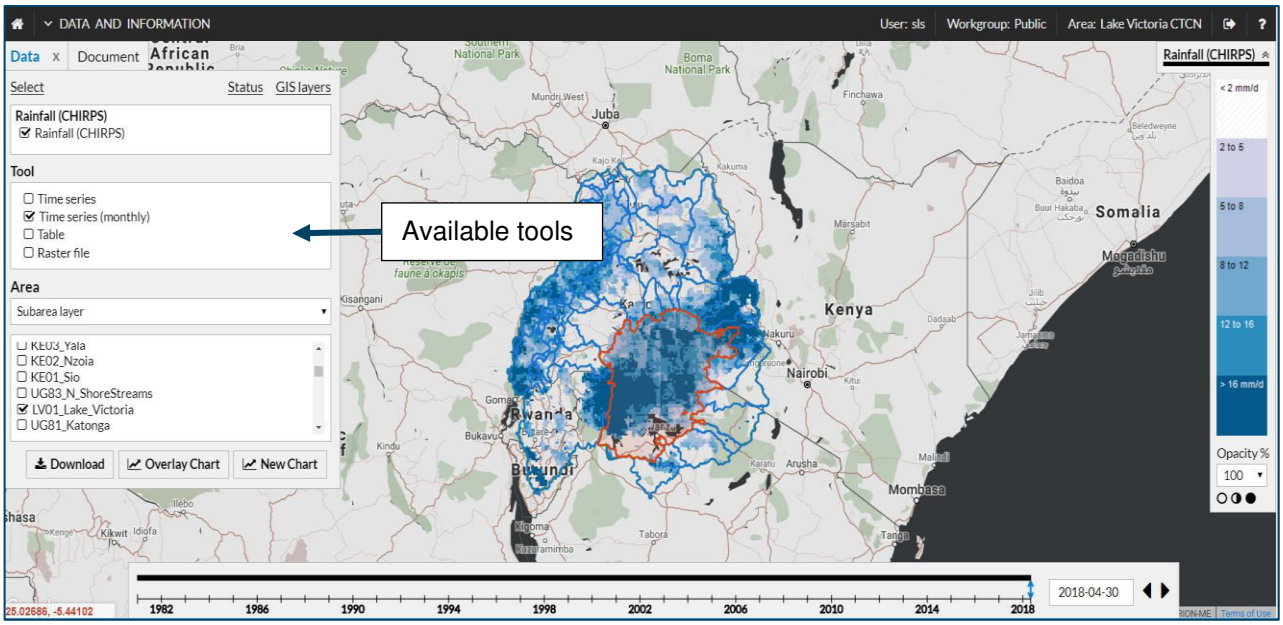


Figure 9 Overview of functionality in the *Data* menu

3.3.2 Tool functionality

The *Tools* menu opens below the data type selection, allowing the user to download data and perform a simple processing such as area-weighted time series.



When opening the *Tool*s menu a dialog with options for a) tool selection and b) tool configuration appears.

The available tools depend on the selected data layer.

Figure 10 Available tools will be displayed depending on the selected data layer

Tool raster file (download netcdf file)

The “Raster file” tool is used to download the selected data type as a netcdf file. To download the data file:

- Select the data type and select the “Raster file” tool
- Specify the time period to download data for
- Press the “Extract” button which will calculate the estimated file size and display this in a dialog
- Press “Download” to download the file as a netcdf file

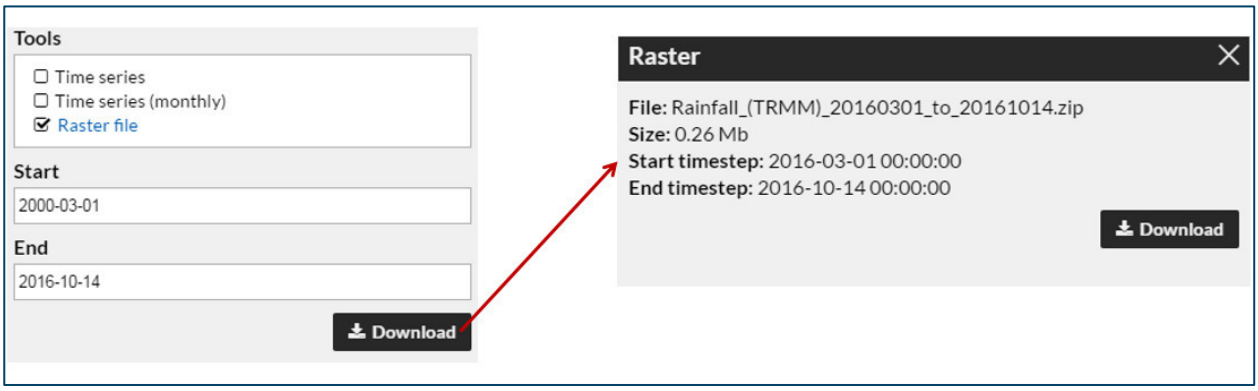


Figure 11 Specify the time period to download data for, click on Download and then a dialog with the estimated file size will appear.

Note: the zip file contains the raster as .nc file, which can be open in most GIS tools. In addition, a legend file as .qml is associated to the .nc file. This legend file can be used in QGIS to load the default symbology.

Tool area (time series and plotting tools)

The tools operate on different spatial resolutions – available options depend on the selected tools. The options are:

- **All focus area**. The tools produces an area weighted time series for the entire focus area.
- **User location**. Time series extracted at user specified locations (see following section for more details).
- **Subarea layer**. Time series processed as area weighted time series for a user specified subarea.
- **Point layer**. Time series processed as area weighted time series for a user specified point location.

Pressing the "**Download**" button downloads the data as a csv file. Pressing the "**Chart**" button displays a plot with the tool result.

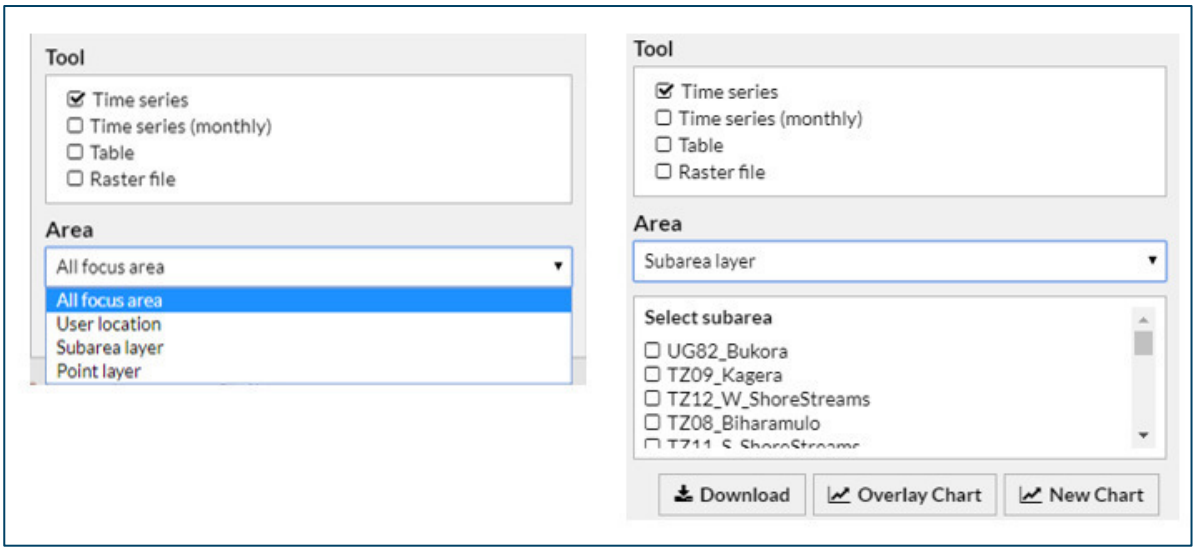


Figure 12 Tools are available at different spatial resolutions (options depend on the selected tool)

All focus area

Selecting the “All focus area” produces an area-weighted result of the data type for the entire focus area, see Figure 13 for an example with a time series tool. The time series plot is shown with area weighted data and long-term average data.

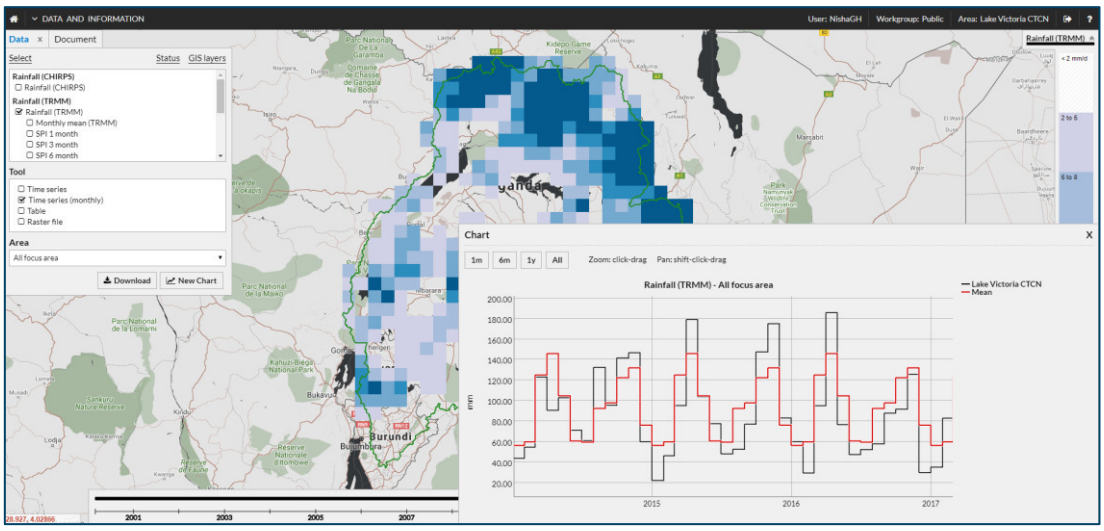


Figure 13 Area weighted plot for the entire focus area

Subarea layer

When selecting the “Subarea layer” a selection of the available subareas appears. Selecting a subarea will highlight the area on the map (or vice versa). Pressing “Chart” will produce a plot with the area weighted results, pressing “Download” will download the data.

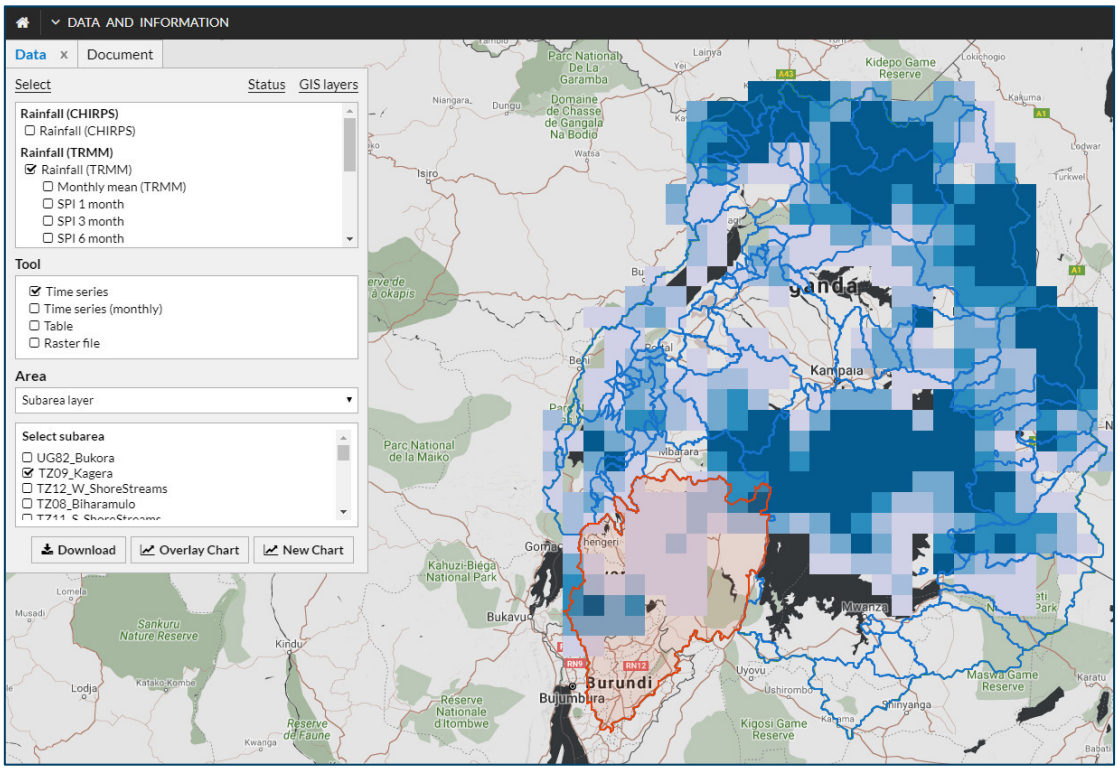


Figure 14 Subarea selection

Point layer

When selecting the "**Point layer**" a selection of the available locations appears. Selecting a point will highlight the location on the map. Pressing "**Chart**" will produce a plot with the area-weighted results, pressing "**Download**" will download the data.

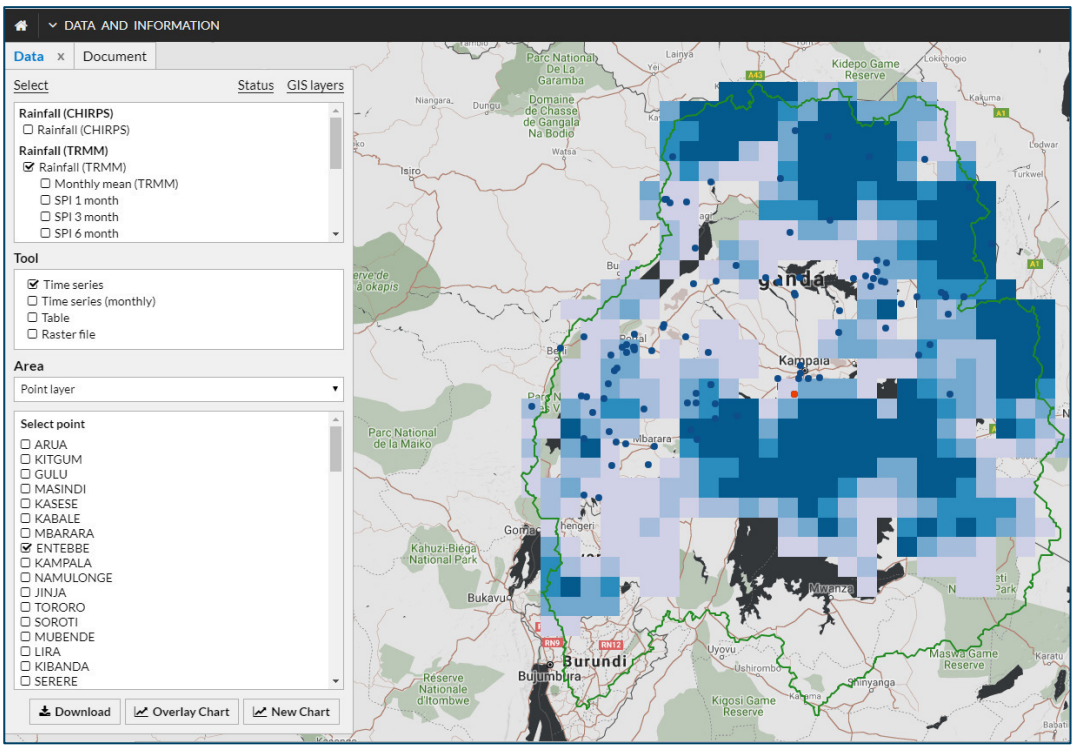


Figure 15 Point layer selection

User location

The "**user location**" allows the user to extract data from the data layer at user specified locations. The procedure is:

- Click on the map to define the location.
- The system will retrieve the data at the location.
- Several locations can be retrieved.
- Press the "Download" button to get the data

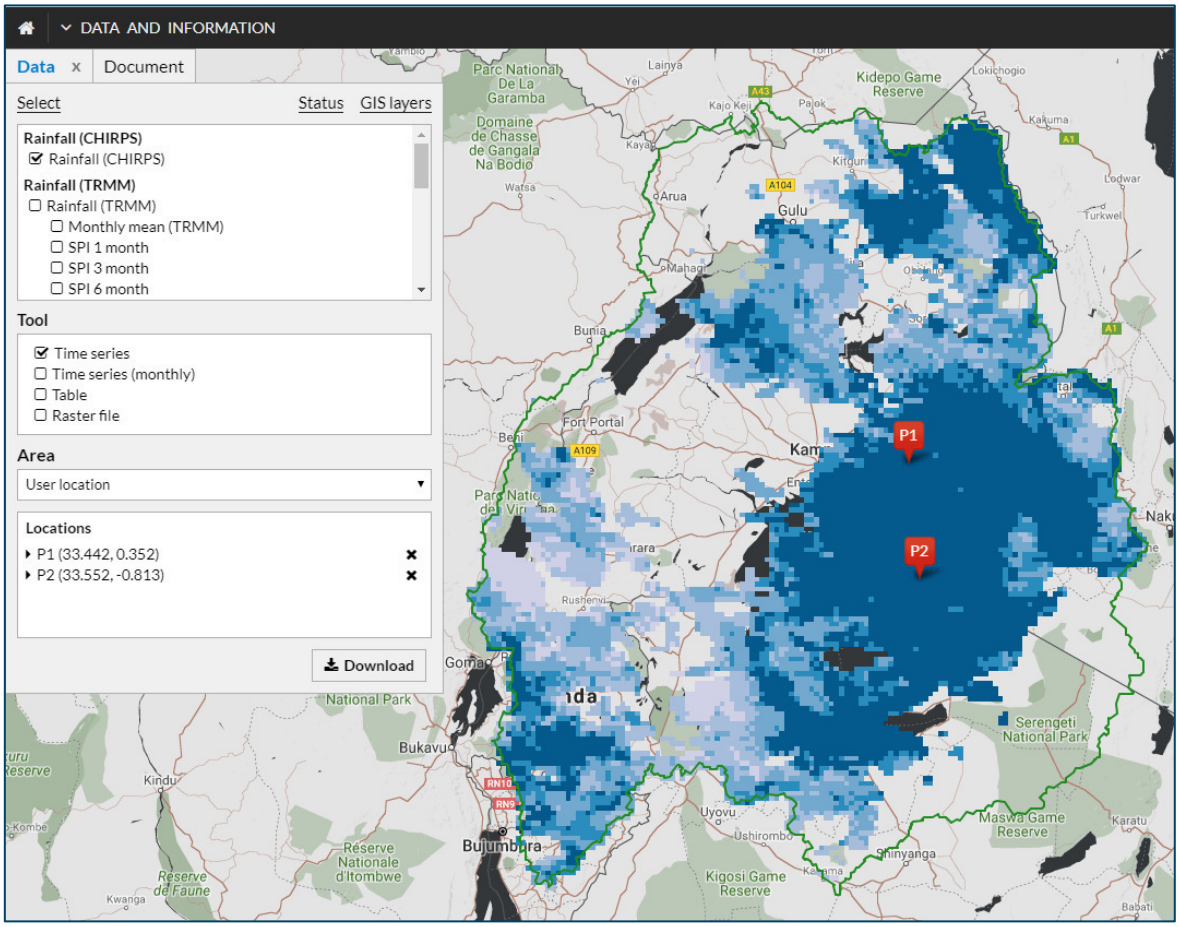


Figure 16 User location selection

Time series Tool

The time series tool produces an area weighted time series for the selected area. The time series uses the same temporal resolution as in the data file.

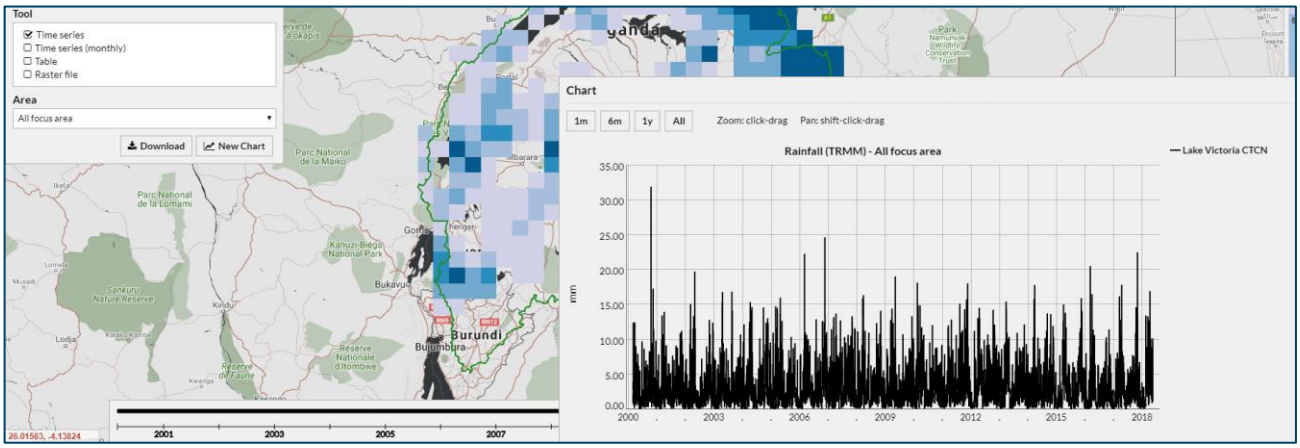


Figure 17 Output from Time series tool

Time series (monthly) Tool

The time series tool produces an area weighted time series for the selected area. The time series contains monthly accumulated values, and contains an item with the actual data (black) and an item with the long-term mean of each of the monthly time steps (red).

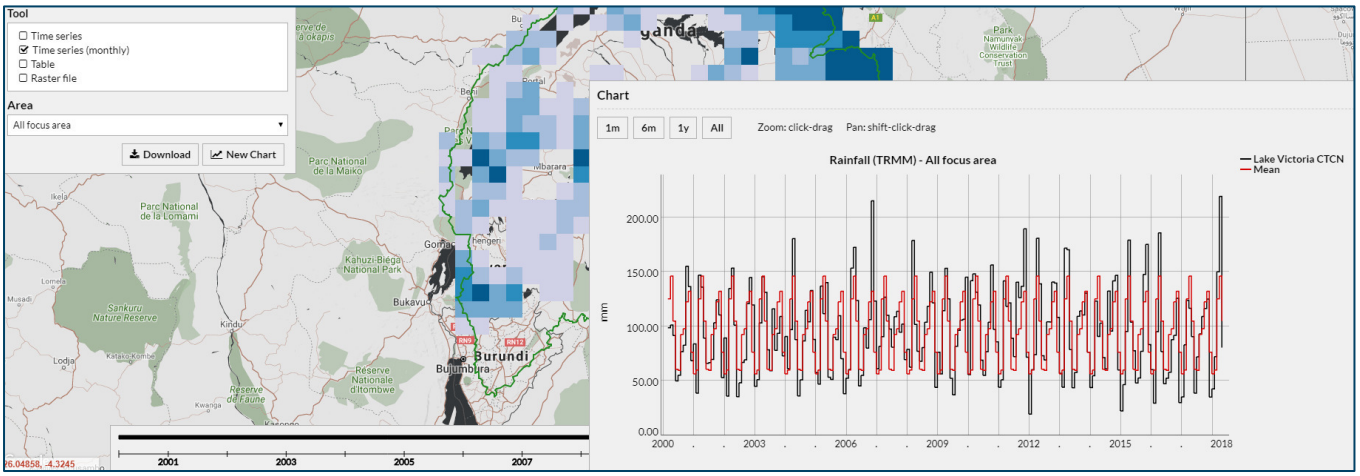


Figure 18 Output from Time series (Monthly) tool

Envelope plot Tool

This tool is only available for ensemble based data types, and produces a plot showing the median, 25 percentile and 75 percentile of the ensemble values.

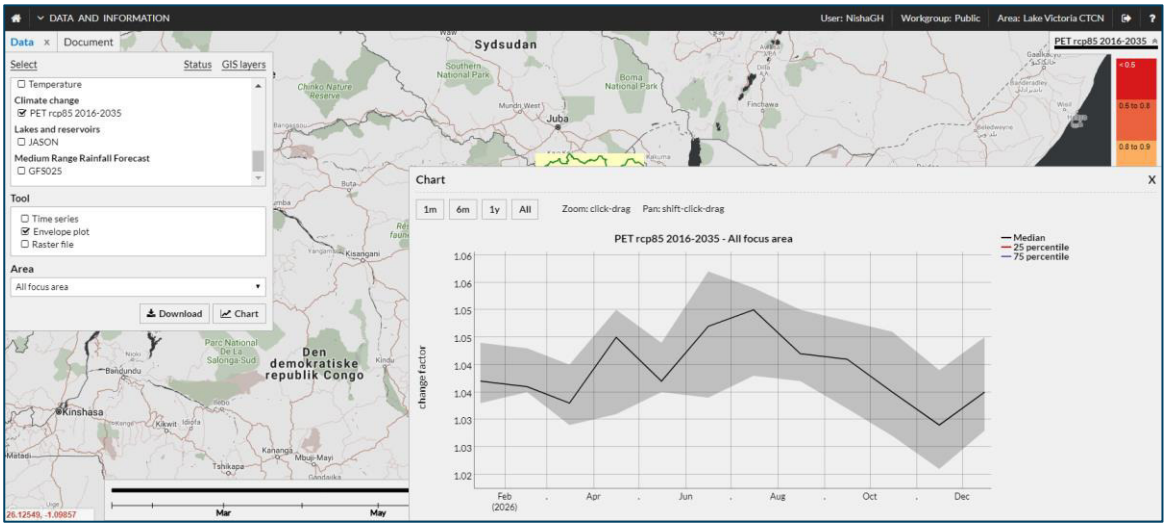


Figure 19 Output from Envelope tool

Column plot Tool

The column chart tool is only available for selected indices, and produces a plot showing the coverage, in percentage, of different drought or flood categories.

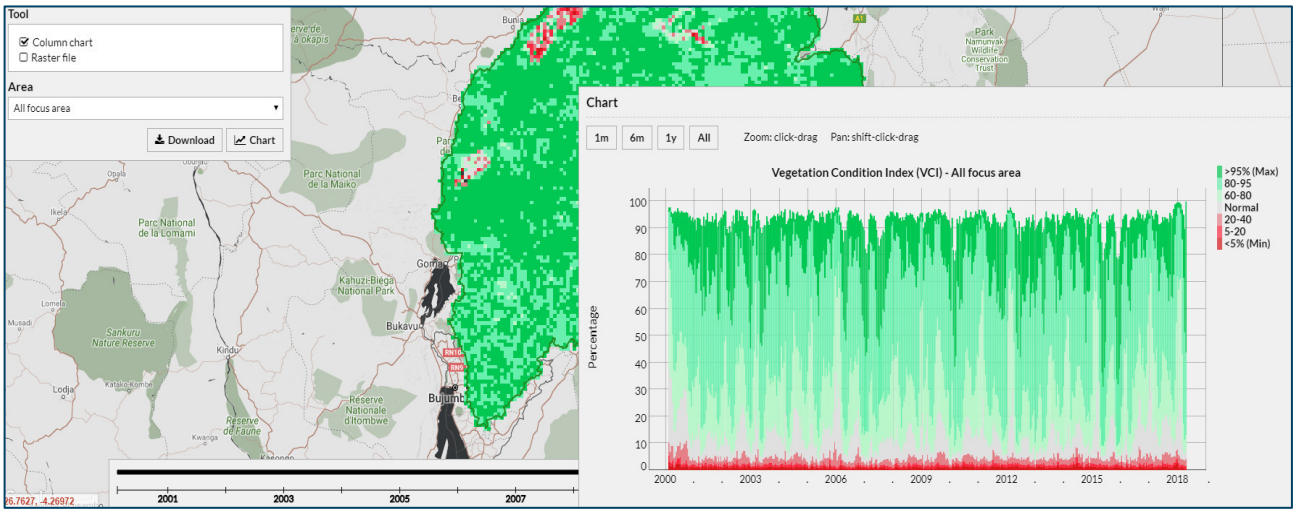


Figure 20 Output from "Column chart" tool

3.3.3 Tool tips

Tips are available for all layers and tools by clicking on the layer name or tool name, see Figure 21.

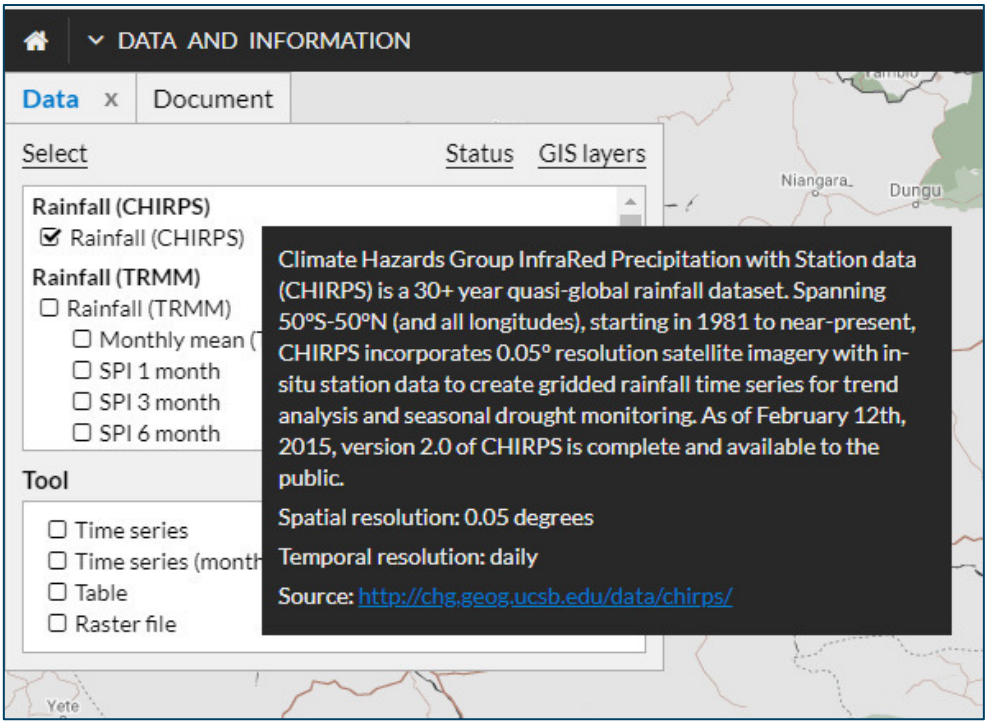


Figure 21 Tips displayed for a selected layer.

3.4 Document menu

The document menu opens a dialog listing the available documents associated with the particular focus area. The documents could be fact sheets with more information on specific data types, video showing the temporal and spatial change of a data type, custom made drought reports or other documents associated with the specific focus area.

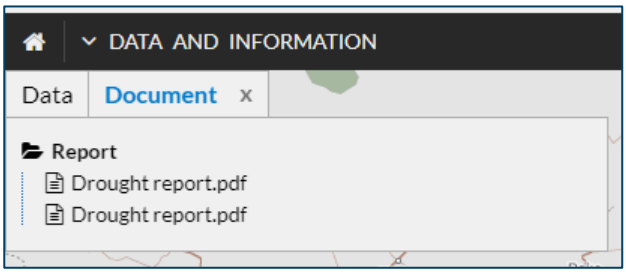
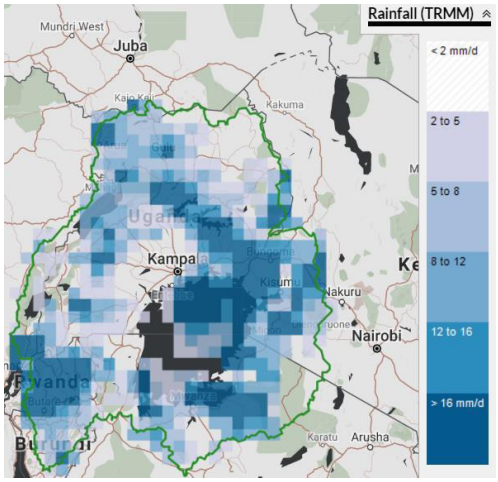


Figure 22 Document menu showing a list of available documents

4 Data description

This section contains a description of the available data sources in the Data and Information application.

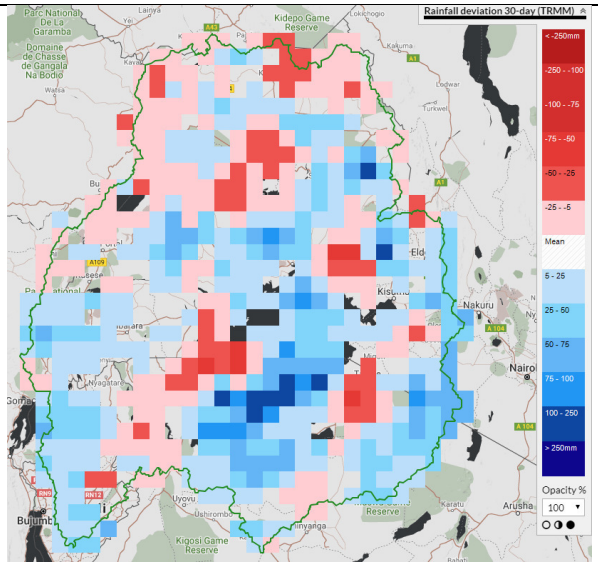
4.1 TRMM related data

Title	**Tropical Rainfall Measuring Mission (TRMM)**
Description	The Tropical Rainfall Measuring Mission (TRMM) is the first Earth Science mission dedicated to studying tropical and subtropical rainfall. The TRMM 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 complement of state-of-the-art instruments provide high accurate measurements. It measures precipitation that falls within 50 degrees north and 50 degrees south of the equator.
	INDICATOR USAGE
Index interpretation	TRMM is especially useful in cases where consistency in precipitation data is required over many years, such as is the case for hydrological design, flood risk assessment, 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
Source	http://trmm.gsfc.nasa.gov
Example of usage	Rainfall event across the focus area during the 6th of November 2017. 

	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 have been removed during the processing.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc
Data source	3B42RT (daily)

4.1.1 Rainfall deviation (30 days)

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.
Source	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.

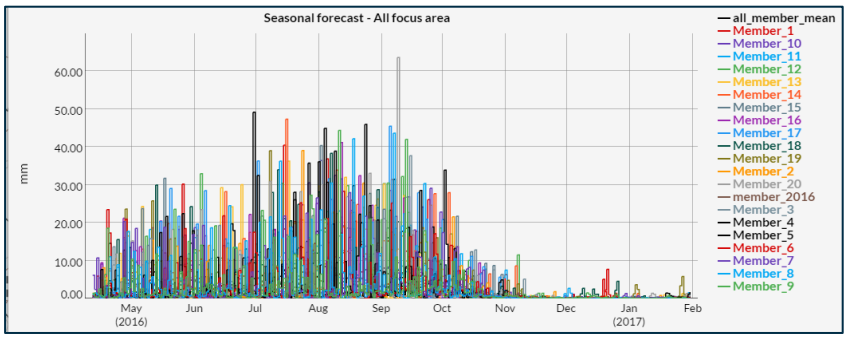
	
	INDICATOR CALCULATION
Data requirements and calculation	Based on daily TRMM rainfall and calculated as ∑TRMM - ∑TRMM$_{mean}$ for the last 30 days
Update Frequency	Daily
Related indices	
Data source	Based on TRMM data

4.1.2 Standardised Precipitation index (SPI)

Title	**Standardised Precipitation index (SPI)**
Description	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 used in research or operational mode in more than 70 countries.
	INDICATOR USAGE
Index interpretation	SPI is typically categorized using the following classification: > 2 — Extremely wet 1.5 to 2 — Very wet 1 to 1.5 — Moderately wet -1 to 1 — Near normal -1.5 to -1 — Moderately dry -2 to -1.5 — Severely dry < -2 — Extremely dry 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.
Spatial and temporal extent	From 50 degrees north to 50 degrees south of the equator. (Based on the TRMM data and the same values are applied) Available from 2000 to present.
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: resampled to daily rainfall product from 2000 to present (Based on the TRMM data and the same values are applied.)
Source	http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf
Example of usage	The following SPI products are available: • **SPI 1 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. • **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 have been removed during the processing.
Update Frequency	Daily
Related indices	SPI 1-month, SPI 3-month, etc
Data source	TRMM 3B42RT

4.2 Seasonal forecast

Title	**Seasonal forecast**
Description	The Climate Forecast System (CFS) version 2 is run by the Environmental Modeling Center at NCEP 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.
	INDICATOR USAGE
Index interpretation	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
Source	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. 
	INDICATOR CALCULATION
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

4.3 Climatology

Title	Climatology
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
Spatial and temporal resolution	Spatial resolution: 0.25 degree Temporal resolution: daily
Source	TRMM data
Example of usage	Ensemble members used as climate input for hydrological, water resource or crop models for evaluation of a future situation.
	INDICATOR CALCULATION
Data requirements and calculation	Climatology 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

4.4 Temperature

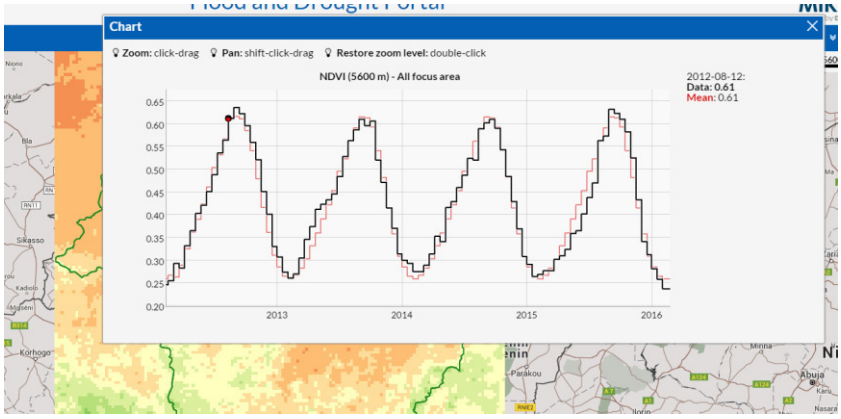
Title	Temperature
Description	The level-3 MODIS global Land Surface Temperature (LST) and Emissivity 8-day data are composed from the daily 1-kilometer LST product (MOD11C2) and stored on a 1-kilometer Sinusoidal grid as the average values of clear-sky LSTs during an 8-day period.
	INDICATOR USAGE
Index interpretation	Land surface temperature 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
Source	https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod11c2
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.
	INDICATOR CALCULATION
Data requirements and calculation	Download of MOD11C2 1 km 8-day product. Data resampled to 5 km resolution using a simple mean of the grid cells.
Update Frequency	8 days
Related indices	
Data source	MOD11C2 (8 day)

4.5 Vegetation (NDVI) related data

Title	**Normalized difference vegetation index (NDVI)**
Description	*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, 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.
	INDICATOR USAGE
Index interpretation	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

	<table><tr><td>< 0.1</td><td>Near zero vegetation such as barren area, rock, sand or snow</td></tr></table> **NDVI in itself is NOT a drought index, but could be used to detect changes in the vegetation pattern from year to year.**
Spatial and temporal extent	Global coverage Available from 2000 to present
Spatial and temporal resolution	Spatial resolution: from 5600 m to 250 m Temporal resolution: Updated every 16 days based on two daily passes. The value is based on the maximum value during the 16-day period.
Source	http://modis-land.gsfc.nasa.gov/vi.html and http://e4ftl01.cr.usgs.gov/MOLT/
Example of usage	Evaluation of vegetation growth. Used as source data for a number of vegetation indices. 
	INDICATOR CALCULATION
Data requirements and calculation	Converted to netcdf format
Update Frequency	16 days
Related indices	Vegetation based indices
Data source	Terra-MOD13C1 (5600 m)

4.5.1 NDVI deviation

<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

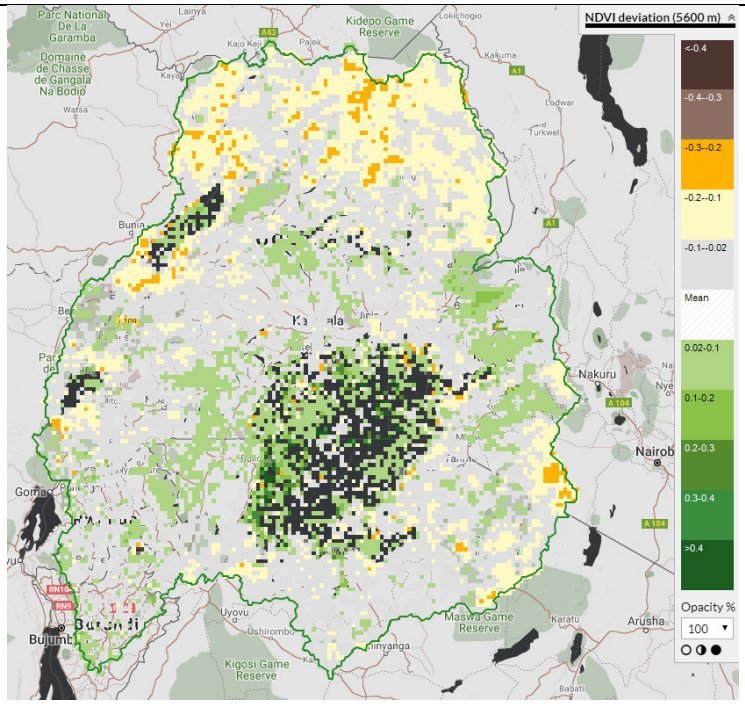
• When DEV_{NDVI} is negative, it indicates the below-normal vegetation condition/health and, therefore, suggests a prevailing drought situation.

• 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 and available since 2000</td></tr>
<tr><td>Spatial and temporal resolution</td><td>Spatial resolution: 5600 m to 250 m

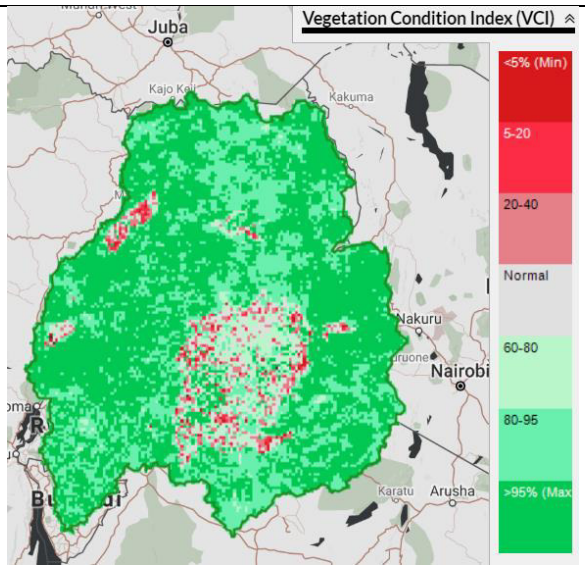
Temporal resolution: 16 days</td></tr>
<tr><td>Source</td><td>Based on the NDVI data</td></tr>
<tr><td>Example of usage</td><td>Location of areas with a vegetation growth below the long-term average.</td></tr>
</table>

	
	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 days
Related indices	Vegetation based indices
Data source	Based on the NDVI data

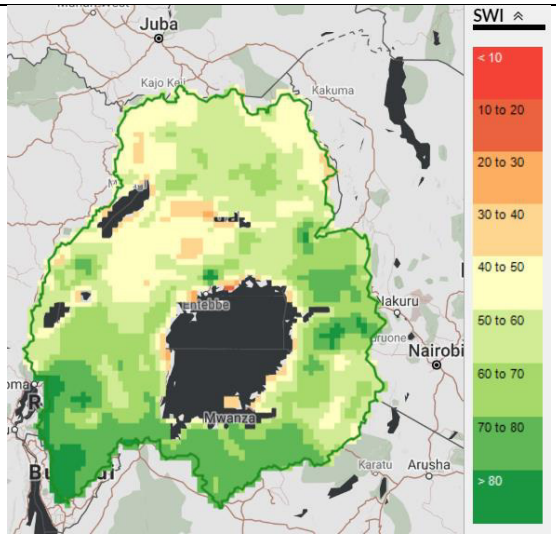
4.5.2 Vegetation condition index (VCI)

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:

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

Spatial extent	Global and available since 2000
Spatial and temporal resolution	Spatial resolution: 5600 m to 250 m Temporal resolution: 16 days
Source	Based on the NDVI data
Example of usage	
	INDICATOR CALCULATION
Data requirements and calculation	Vegetation condition index (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.
Update Frequency	16 days
Related indices	Vegetation based indices
Data source	Based on the NDVI data

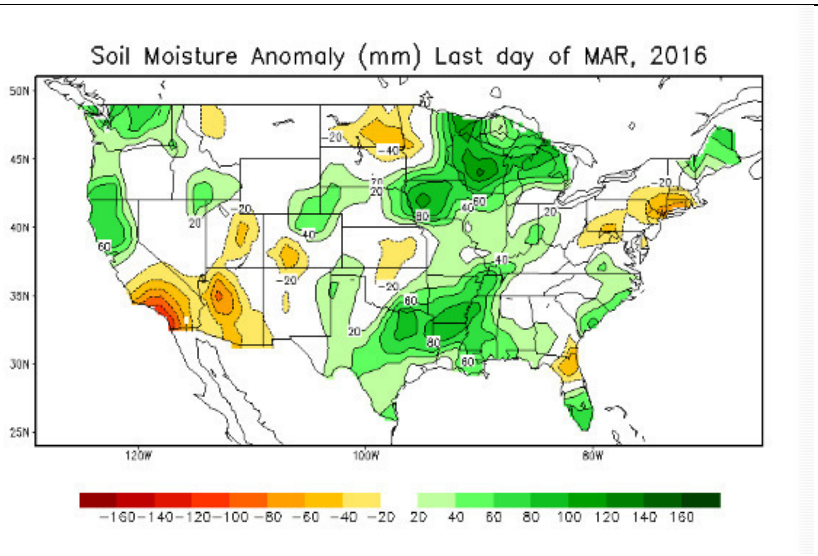
4.6 Soil moisture related data

Title	**Soil Moisture Index (SWI)**
Description	The soil water index (SWI) product contains daily synthesis of Soil Water Index derived from 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 soil water index across 0.5 to 1 meter of the topsoil.
	INDICATOR USAGE
Index interpretation	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: Spatial: 0.1 degree, Temporal: daily METOP-ASCAT satellite, from 2007 – present
Source	http://land.copernicus.vgt.vito.be/PDF/datapool/ and http://land.copernicus.eu/global/products/swi
Example of usage	
	INDICATOR CALCULATION
Data requirements and calculation	-

Update Frequency	Daily
Related indices	Soil moisture based indices
Data source	

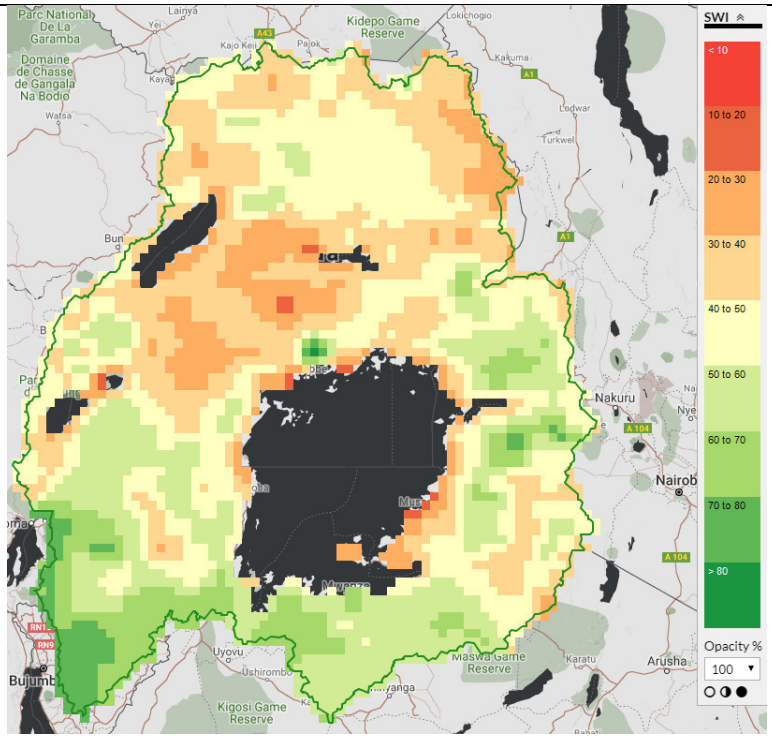
4.6.1 SWI deviation

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 DEVSWI 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
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: Daily or 10 daily
Source	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	Based on SWI and requires SWI data from 2007 to present to make a reliable estimate of the long-term mean.
Update Frequency	Daily or 10 daily
Related indices	
Data source	Based on SWI data

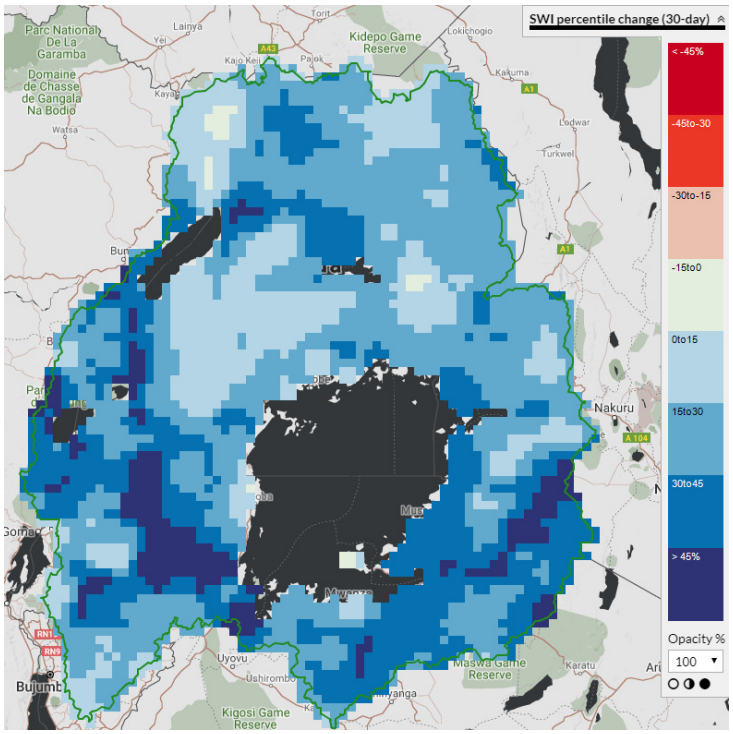
4.6.2 SWI percentile

Title	**SWI percentile**
Description	SWI percentile expresses
	INDICATOR USAGE
Index interpretation	A drought or water scarcity is often defined when the soil moisture percentile drops below 30 or 20 %.
Spatial extent	As SWI data
Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: daily or 10 daily
Source	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
Related indices	
Data source	Based on SWI data

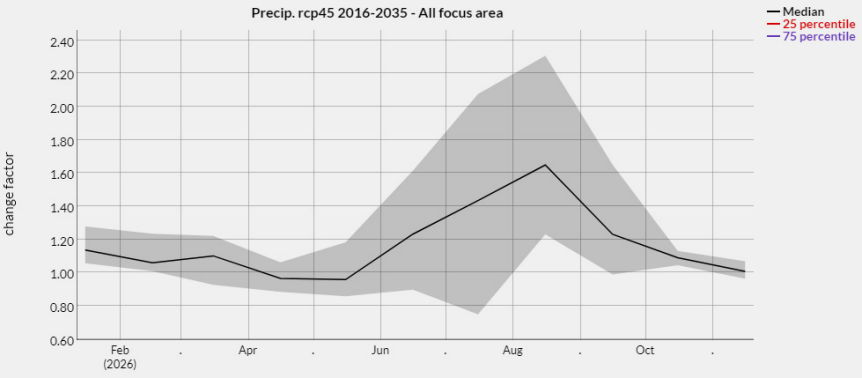
4.6.3 SWI percentile change

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 weeks 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

Spatial and temporal resolution	Spatial resolution: 0.1 degree Temporal resolution: Daily or 10 daily
Source	Based on SWI data
Example of usage	Example of SWI percentile change (1 month) 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
Related indices	
Data source	Based on SWI data

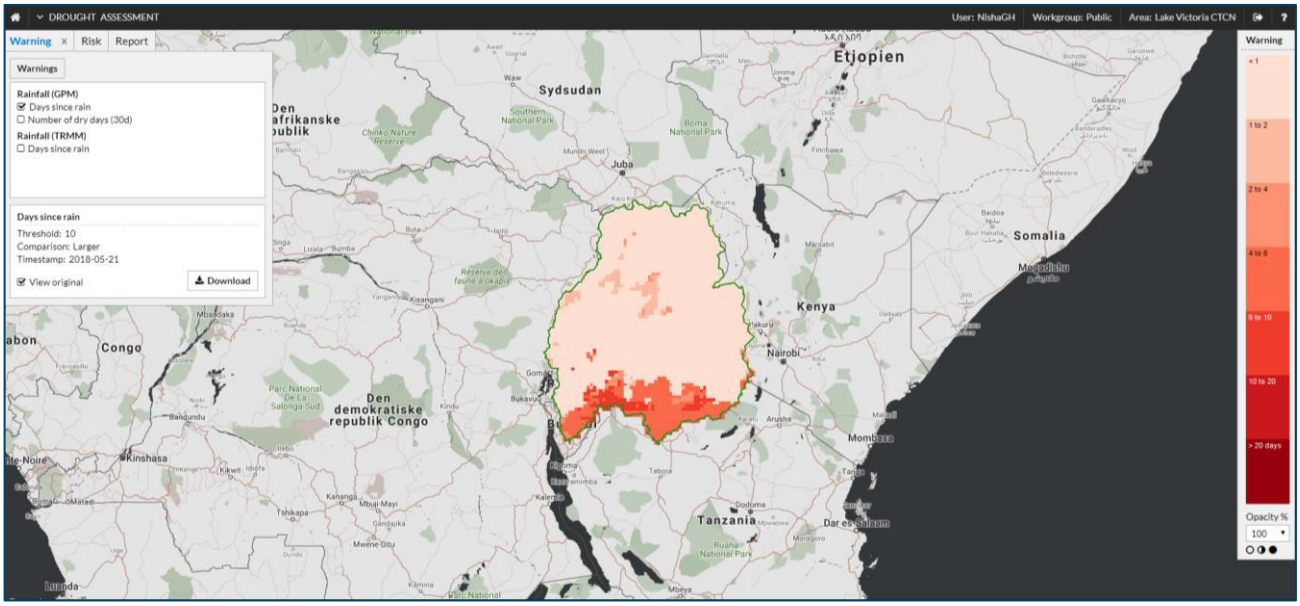
4.7 Climate change data

Title	**Delta change factors**
Description	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.
	INDICATOR USAGE
Index interpretation	Precipitation and PET delta change factors are multiplied by the baseline conditions. Temperature delta change factors are added to the baseline conditions.
Spatial extent	Global
Spatial and temporal resolution	Spatial resolution: 0.44 degree Temporal resolution: resampled to monthly METOP-ASCAT satellite, from 2007 – present
Source	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. 
	INDICATOR CALCULATION
Data requirements and calculation	-
Update Frequency	Static dataset
Related indices	-
Data source	CORDEX

Drought Assessment application

User guide



DROUGHT ASSESSMENT

1 Background

1.1 Drought early warning system

Drought early warning systems are an important component of the risk management part of the drought management process as highlighted in Figure 1. It provides an identification of a current or upcoming hazards and provides an assessment of the associated risk related to the hazards.

The main objective of a drought early warning system is to detect when and if a drought hazard might occur and the location and severity of the hazard. Drought warnings could be expressed based on the hazard itself or on the associated risk towards specific vulnerable sectors or areas.

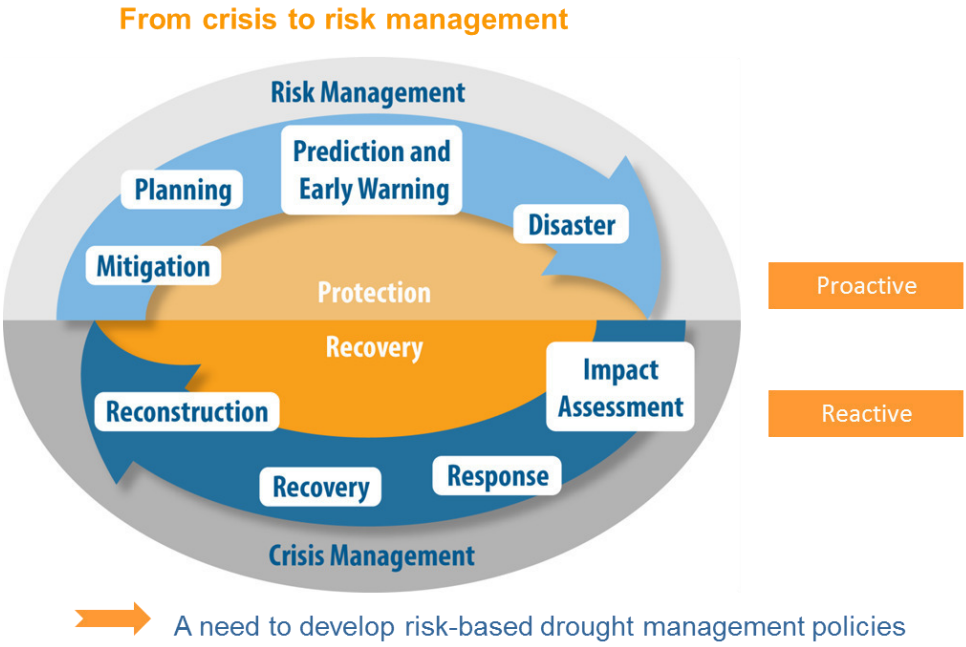


Figure 1 Drought management (adapted from [2])

1.2 Risk assessment

The identification of the timing and location of a drought event is the first step in a drought assessment or drought management process. The impact assessment aims at quantifying how the identified hazards affects specific areas or sectors exposed to this hazard.

The vulnerability analysis provides a mean for analysing the causes behind the drought impact and the priority of these causes. This is an important step for increasing the effectiveness of drought risk management as it provides the means for drought interventions or mitigations measures to be targeted specifically against the underlying causes for the drought impact.

The risk is expressed based on the vulnerability towards the impact from a specific hazard, or as the likelihood of harm, loss or disaster for a specific drought related hazard (see illustration in Figure 2).

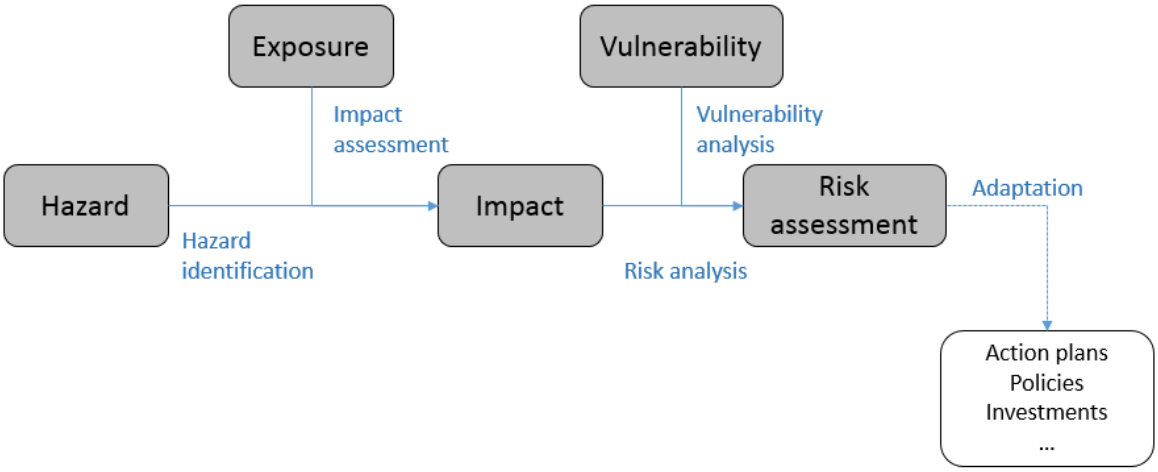


Figure 2 Risk assessment workflow

1.2.1 Hazard identification

The identification of the timing and location of a drought event is the first step in a drought assessment or drought management process. It is typically based on different types of drought indices each representing the state of a specific drought related issue at different times. Drought indices could cover the entire spectrum of drought types: meteorological, agricultural and hydrological drought (see Figure 3).

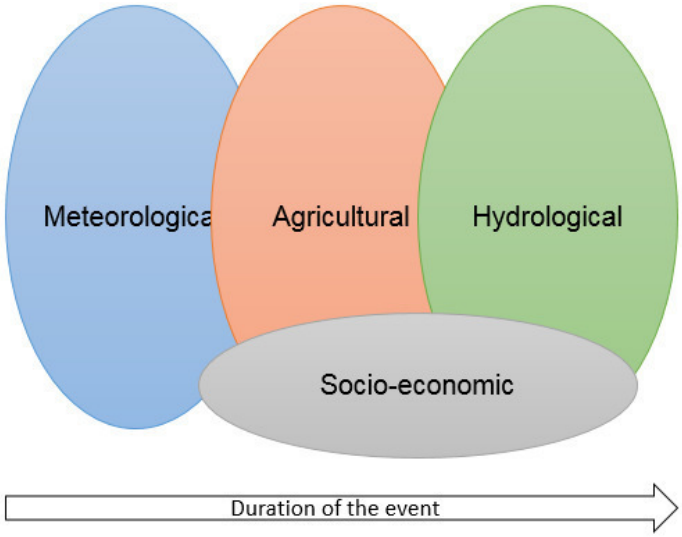


Figure 3 Different types of drought

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

Examples of drought indices:

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

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

1.3 Exposure

The exposure to drought relates to the identification of sectors or areas particularly sensitive to drought through impacts or consequences such as reduced crop yield, livestock losses, socio-economic impacts or reservoir depletion. Examples of areas exposed to drought could be rainfed agricultural areas or urban areas relying on surface water resources. The exposure would often be illustrated in the form of GIS shape files or raster maps delineating areas of specific exposure.

1.4 Hazard categories

In order to express the severity of the drought hazard, drought categories are often used to classify the severity and impact of the hazard. The classification for drought categories could be inspired from the US drought monitor system using drought categories from D0 (abnormally dry) to D5 (Exceptional drought) (for more information see Figure 4).

Category	Description	Impact
Normal	Normal	*Normal conditions*
D0	Abnormally Dry	*Short-term dryness some water deficit*
D1	Moderate Drought	*Some damage to crops*
D2	Severe Drought	*Crop or pasture losses likely; water shortages common*
D3	Extreme Drought	*Major crop/pasture losses; widespread water shortages*
D4	Exceptional Drought	*Exceptional and widespread crop/pasture losses*

Source: U.S. Drought Monitor Classification Scheme

Figure 4 Drought classification scheme (source: [3])

1.5 Impact assessment

The impact assessment aims at quantifying how the identified hazards affects specific areas or sectors exposed to this hazard. The outcome will describe how specific drought related hazards impact e.g. the agricultural production or the water supply. Impact could be expressed in terms of direct losses, or changes but also in terms of hazard or drought categories within a specific exposed area.

A typical way to illustrate the drought impact is through the use of drought categories where the areas within specific drought categories are calculated and presented in tables. The impact would be divided into exposed categories, e.g. rainfed areas, urban areas etc. The correlation between drought categories and specific impacts would often be assessed through a regression analysis looking at the correlation between past drought events and the impact.

1.6 Risk analysis

The risk will be expressed based on the vulnerability towards the impact from a specific hazard, or as the likelihood of harm, loss or disaster for a specific drought related hazard.

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

Risk is often expressed as hazard x vulnerability.

2 Quick guide for first time user

This section contains a brief introduction for first time users. For a more detailed description, see the following sections.

2.1 Access to the Drought Assessment app

The Drought assessment app is accessible from the landing page by clicking on the “Drought assessment” icon.

2.2 Main content

The Drought assessment app is a map based application, which has two main menus:

- Warning
- Risk

2.2.1 Drought Warning

The warning page allows the user to select a specific layer and apply a threshold value to highlight the areas that are affected by a specific hazard.

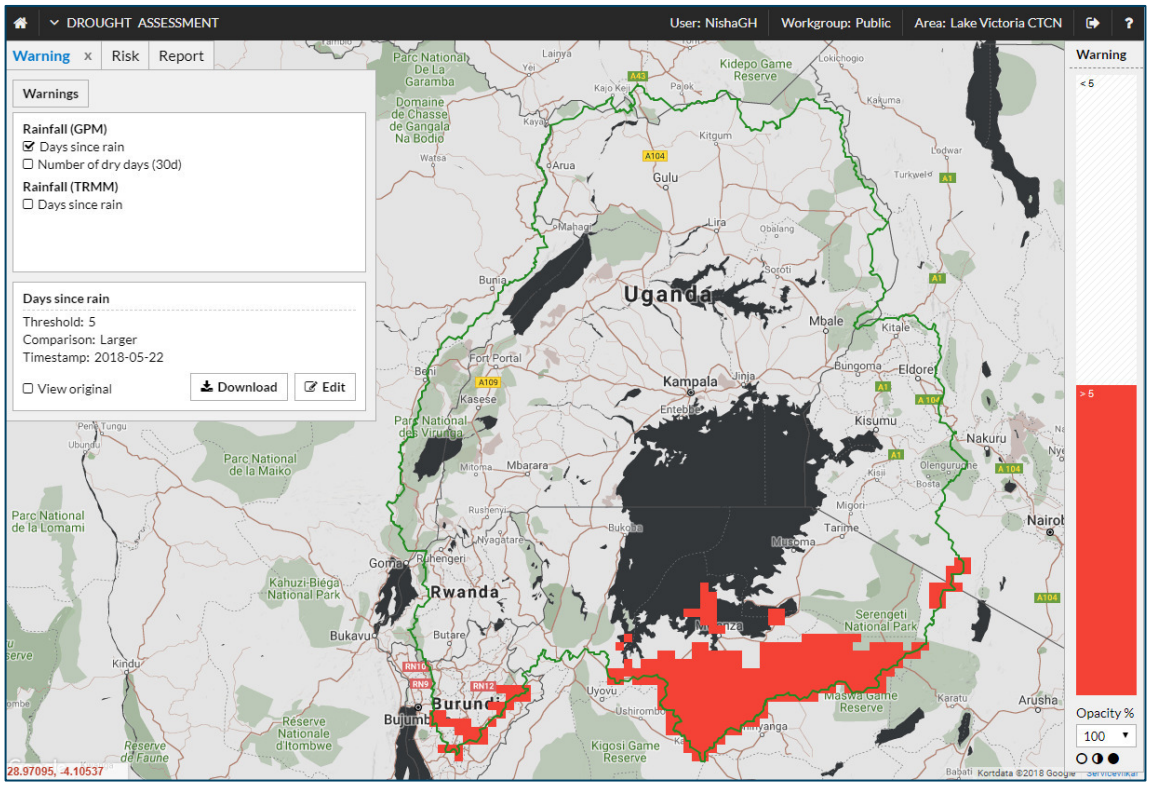
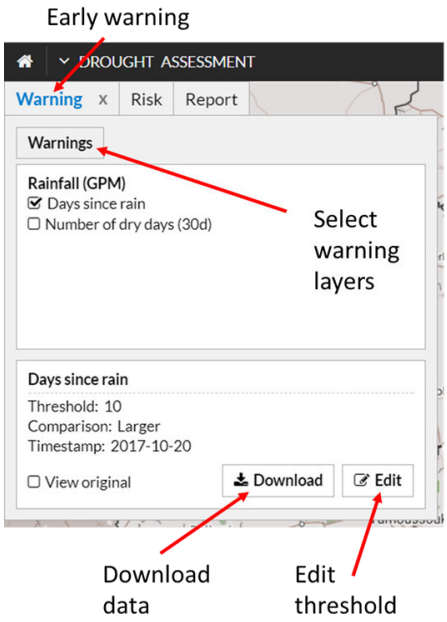


Figure 5 Warning page of the drought assessment app

Warnings: The selection of layer is done by clicking on the Warning button. The selected layers will then appear in the tree view. It is always possible to edit them later.

Edit: This is to edit the user-defined warning level. The Edit button is used to edit the threshold vale as well as the comparison type to be applied on the hazard. The map is instantaneously updated.

View original: this allows the user to view on the map the original hazard layer without applying any warning level.



2.2.2 Drought Risk

The drought risk page provides an interface to assess risk based on hazards and vulnerability. The main output of this page is a map with overlaid hazard and vulnerability.

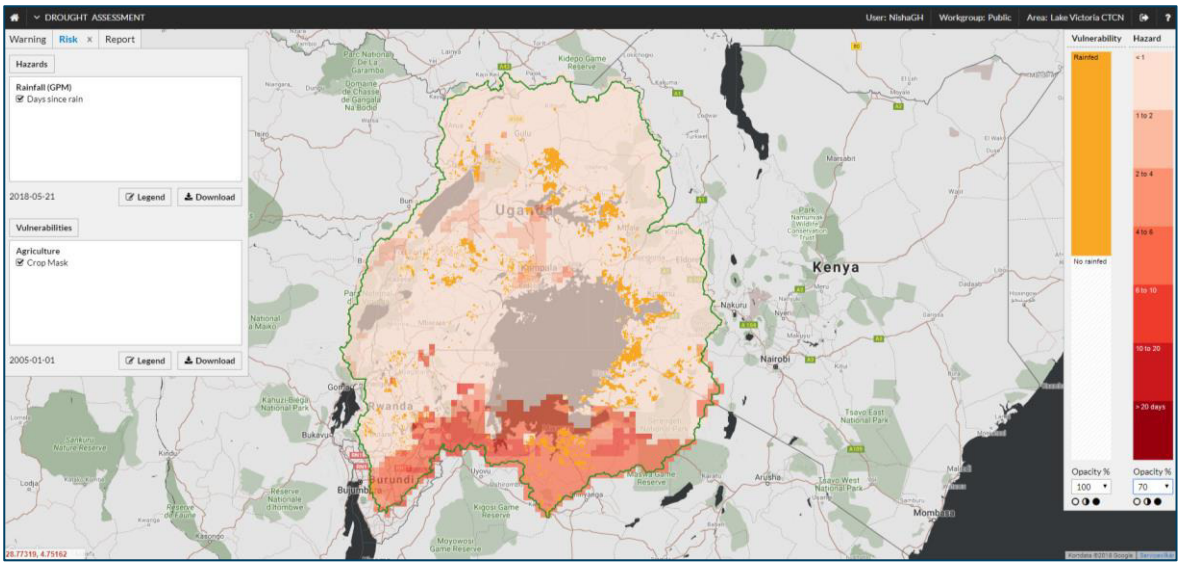


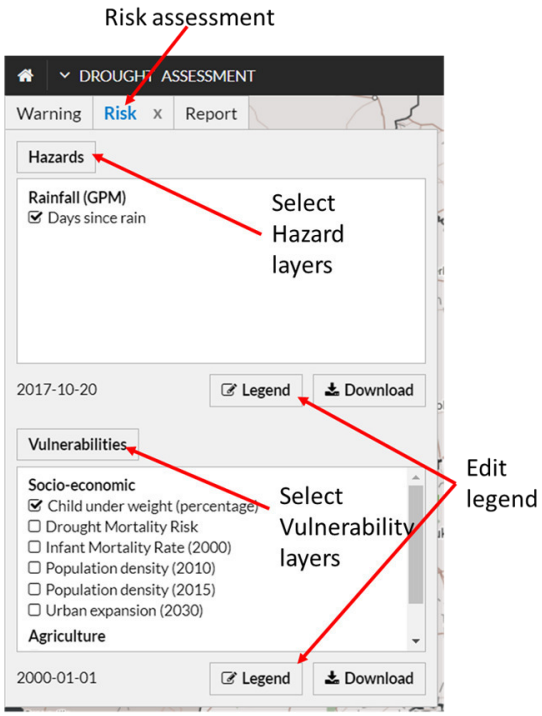
Figure 6 Drought risk page of the Drought Assessment application

Hazards:

- **Layer**: layers for the hazard can be selected from a list.
- **Legend**: the user is able to edit the color code and values in the legend

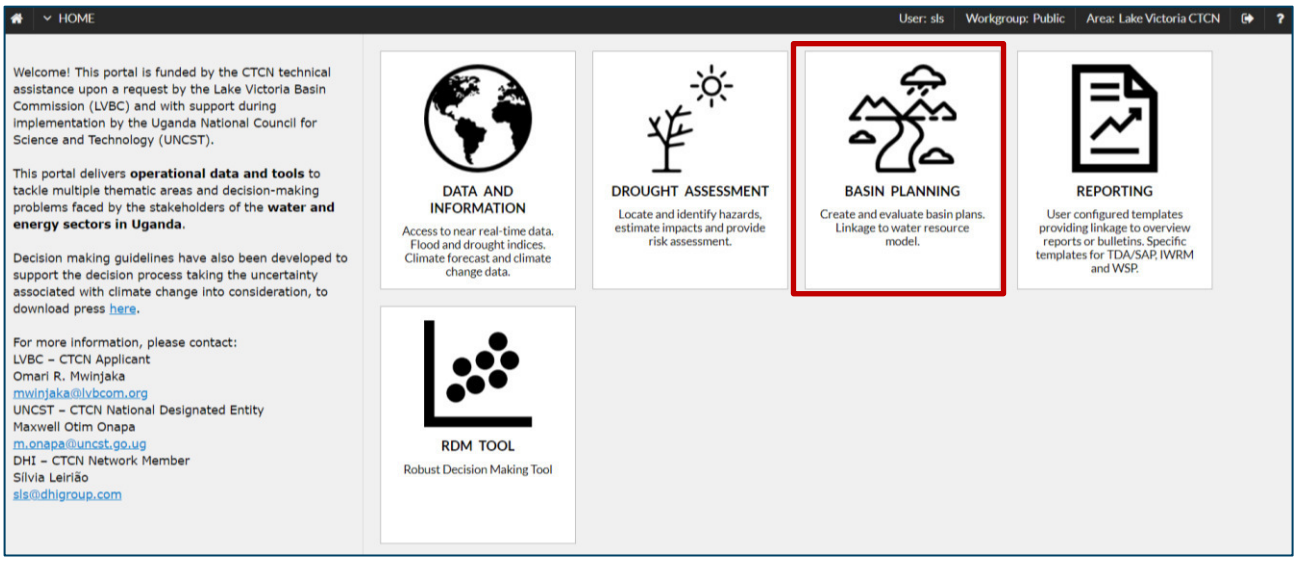
Vulnerabilities:

- **Layer**: layers for the vulnerabilities can be selected from a list.
- **Legend**: the user is able to edit the color code and values in the legend



Basin Planning application

User guide



BASIN PLANNING APPLICATION

1 Introduction and background

The planning application is 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 listed below:

- 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.

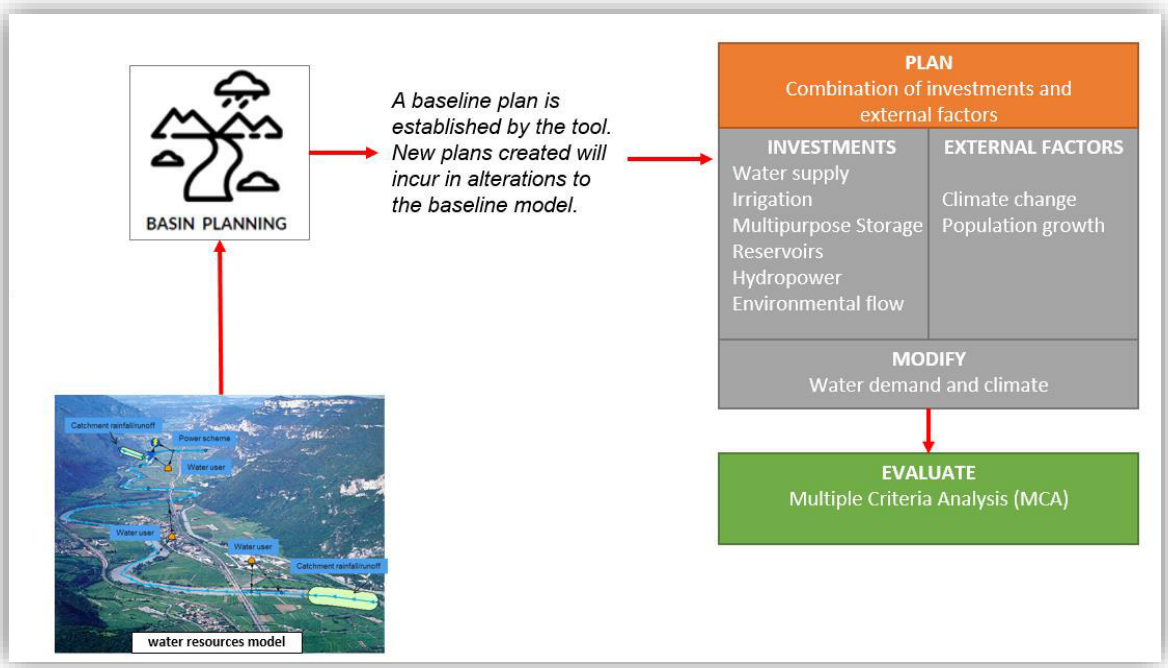


Figure 1 Overall concept of and key components of the planning application.

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

Step 1: Upload of the Lake Victoria water resources model was carried out.

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.
- 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.

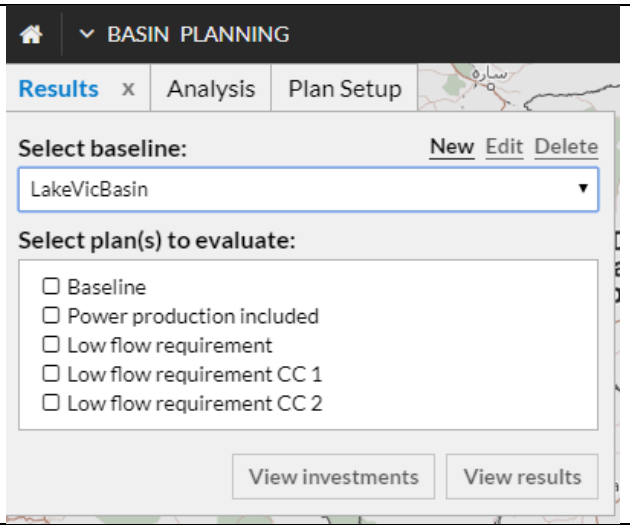
Step 7: User selects reporting

- 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.

2 Quick guide for first time user

This section contains a brief introduction for first time users. For a more detailed description, see the following sections.

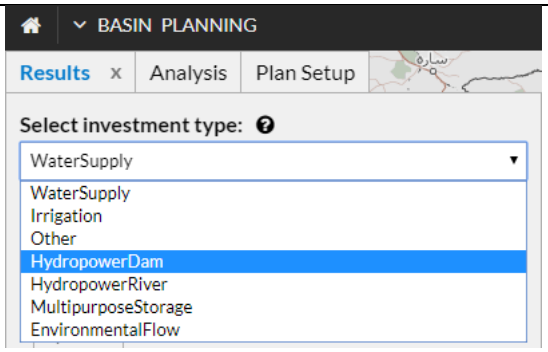
1	**Viewing the Baseline conditions**
1.1	**Select the plan** When you enter the Basin Planning application tool, there are four main tabs, and the user lands at the “Results” tab. In it there are two options: Select model: here the user will find there is one model to be used according to your username (the dropdown list is there to make allowance for the existence of future models). Select plans to evaluate: there are five different plans to evaluate.

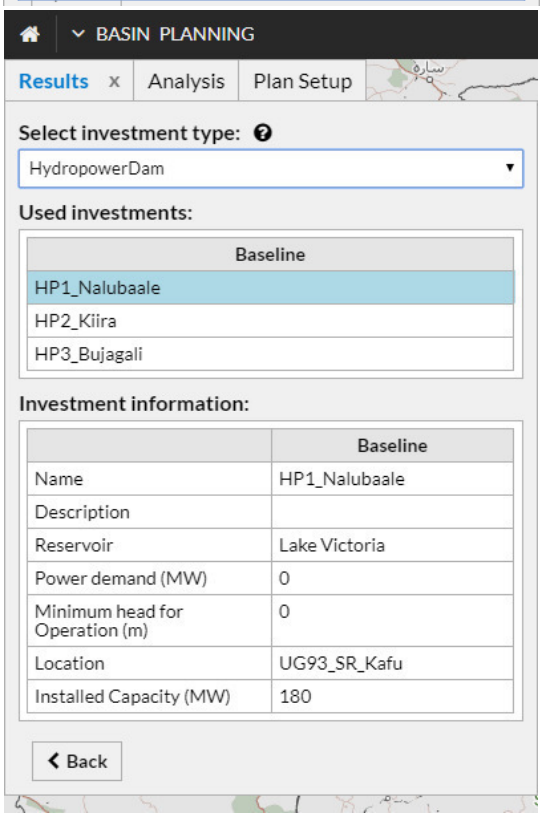


1.2 Viewing investments

Select the Baseline plan and click on “View investments”. Please take note of the different investment types available at the moment in the planning application:

- Please go through the list and take note of any questions regarding the different investment types.
- Choose HydropowerDam from the list and see the existing investments in the Baseline plan.

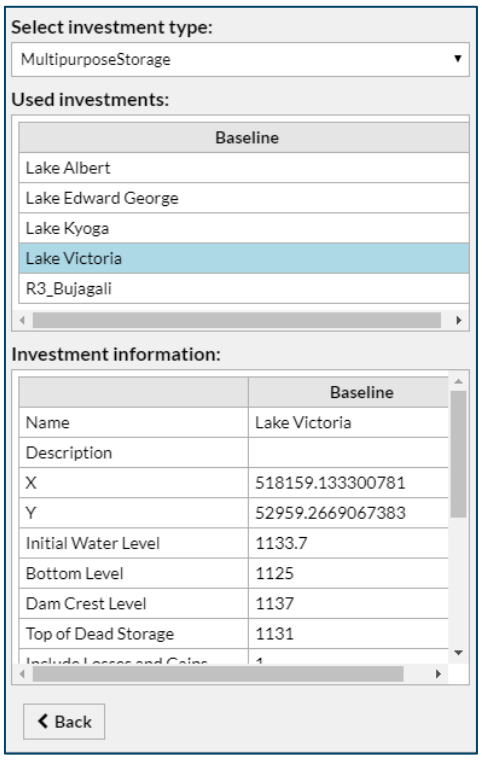




MultipurposeStorage investments and Lake Victoria

Please select MultipurposeStorage investment type from the list. Observe the different investments available.

- Choose Lake Victoria from the list and observe the investment information
- Next, please have a look at the rest of the MultipurposeStorage investments..



WaterSupply and Irrigation

Please select Irrigation investment type from the list. Why is it that the list is empty? Because the baseline conditions have no water supply nor irrigation investments.

1.3 Viewing results

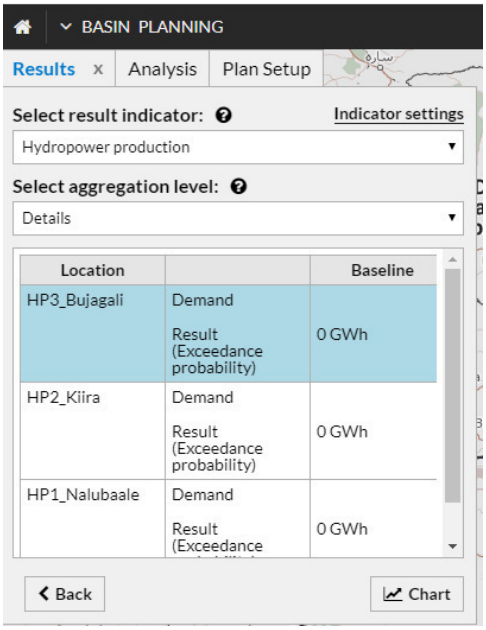
To view results from the baseline plan there are two options available:

Select result indicator: here you have a selection of the available indicators for the baseline plan.

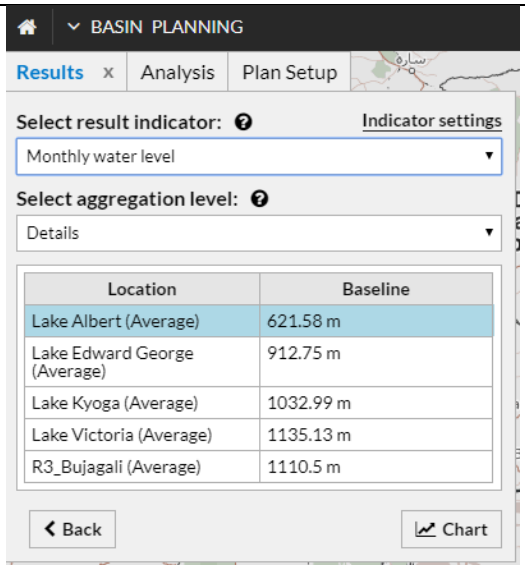
Select aggregation level: for each indicator there are different levels of aggregation available. By default the following:

Summary level: this level of aggregation represents the whole focus area
Details level: this level allows viewing results at investment level
Catchment level: this level of aggregation represents a summary at the catchment level

- Please choose Hydropower production as an indicator, and Details as the level. View the table and click the Chart button.



- Please choose Monthly water level and observe the different results. Are these results possible according to your experience?
- Is it possible to aggregate based on Summary (whole area) or Catchments? Why not? Because for this indicator it would not make sense to add up different water levels at different dam locations.

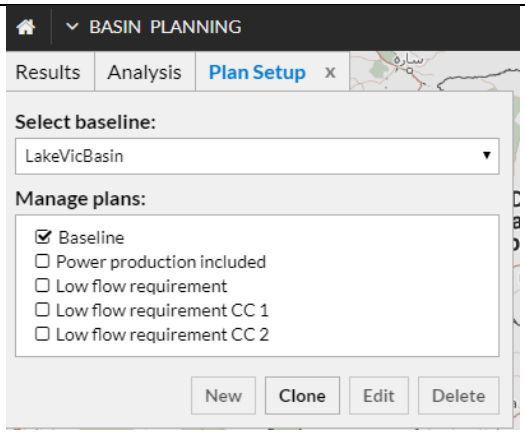


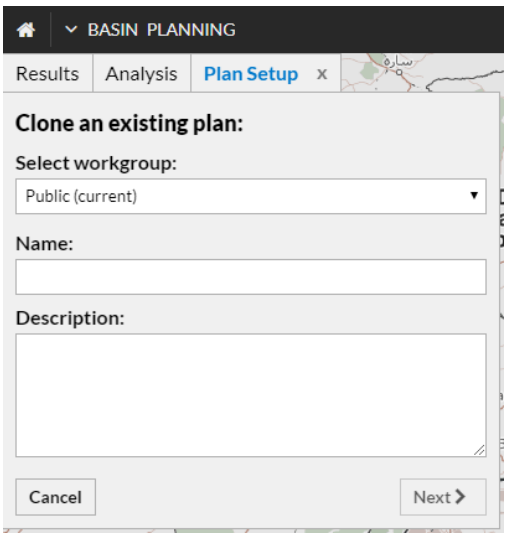
2 Setting up a new Plan based on the Baseline plan

2.1 To create a plan of your own that is departing from the baseline conditions established for your area, please go to the "Plan Setup" tab, and tick on the Baseline plan.

Click the Clone button.

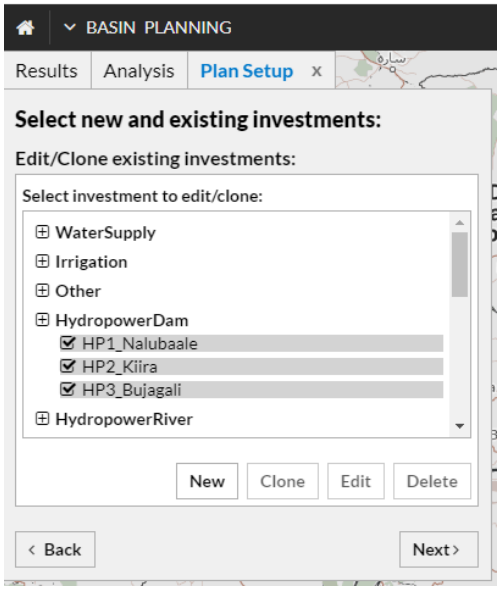
- Select workgroup
- Provide a Name and Description, where the user should state a summary of what the plan will include.
- Click Next.





2.2 When the user clones a plan, the user is making a copy of the original. Then the user is given the opportunity to add or remove investments, except for two types: HydropowerDam and MultipurposeStorage. This is because it is not allowed to remove hydropower plants or reservoirs from your baseline conditions.

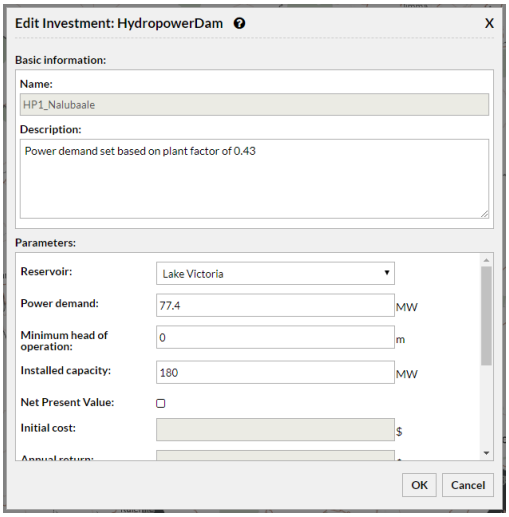
Therefore, it is very important that you capture correctly these two types of elements in your Baseline condition.



2.3 **Editing an investment**

Select each of the HydropowerDam investments one by one, and specify a value of "Target power"

- First click on the name of the investment then click the Edit button
- Find the target power parameter and change the zero value to the amount of MW you find appropriate.
- When finished editing the three power schemes press Next.
- Please observe the interaction as you click, between the map view and the table with the investments list.

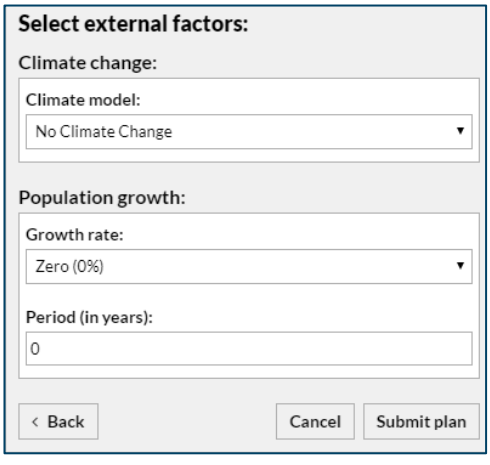


2.4 **Selecting an external factor**

The final step of the plan setup is choosing whether you want to include the effect of climate change and/or population growth.

- Look at the options of climate model, do these look familiar?
- Where is the data coming from and what is the impact in the Baseline conditions if you add climate change to your clone?

For the time being leave these options unchanged and click "Submit plan".



3 Water Supply and Irrigation planning

In this exercise, different possible future **Investments** can be included in a new plan (e.g.: hydropower schemes, irrigation scheme rehabilitation projects and potable water supply projects). We will focus on:

1. "Water Supply"
2. "Irrigation"

There is also the "Other" investment type which is there to cover other types of demand the user would like to include in a plan, but that does not fall within irrigation schemes or potable water supply schemes. For each investment the following information will be required: Basic information and Parameter information.

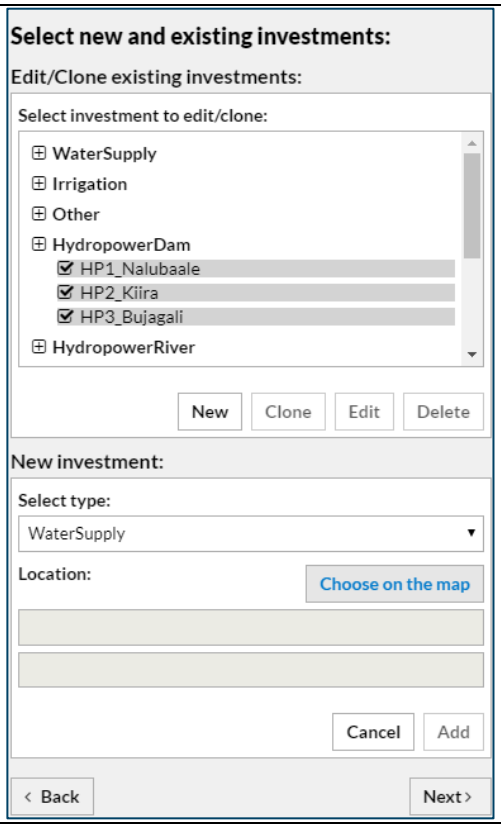
3.1 Clone the Baseline plan

To start, go to Plan Setup and Clone the Baseline plan. Attribute a Name and a meaningful Description.

Press Next.

3.2 Create a new WaterSupply investment

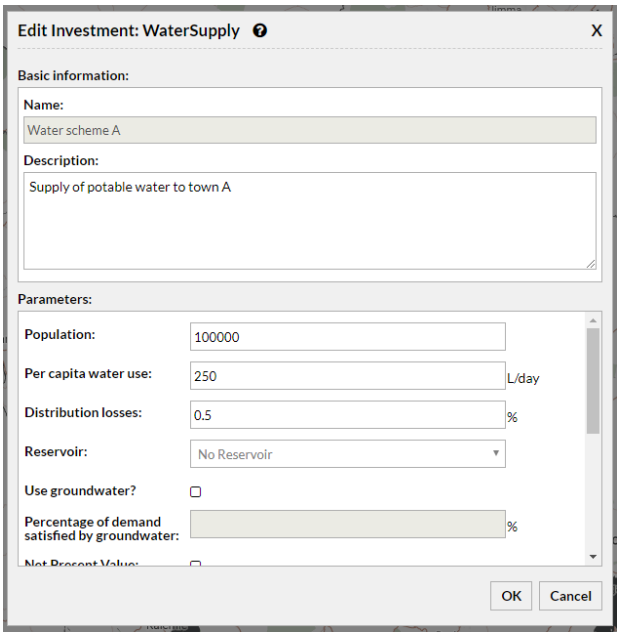
- Click New.
- Choose WaterSupply from the list and then click on the "Choose on the map" button.
- Click on the map, approximately on top of the location where the new water supply scheme will be in place to supply a certain town. Make sure you always click inside the catchment boundaries. Do you see the red star on the map?
- Please click Add.



Add the Basic information and then go through the Parameters.

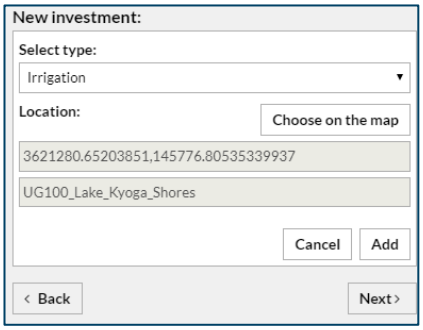
- Enter the values as shown in the right-hand side or enter your own information brought for testing.
- Click OK.

This user is not expected to use any groundwater resources, but it would be possible to choose a fraction of groundwater if that was the case.



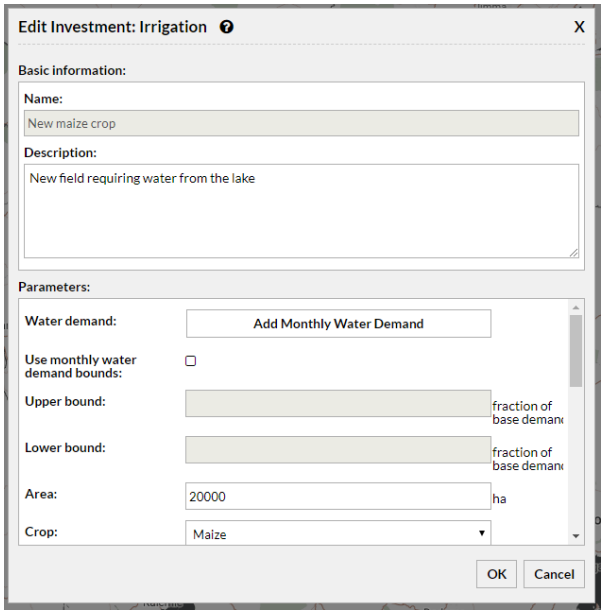
3.3 Make a new Irrigation investment

- Please click New.
- Choose Irrigation from the list and then click on the “Choose on the map” button.
- Click within the catchment of your choice for a location of your new irrigation scheme.
- And click the Add button.



Add the Basic information and then go through the Parameters. As of now, there is no irrigation model attached to the planning application. Therefore, the information you choose in Area and Crop type is only informative. Therefore, the user is asked to add the water demand explicitly.

- Enter the values as shown in the right-hand side or enter your own information for testing.
- Click OK.



3.4 Press Next and Submit your new plan.

4 Analysis

The different plans can be evaluated by comparing key **Indicator** results, as well as by running a simple **MultiCriteria Analysis (MCA)** and comparing the MCA results. The MCA score matrix needs to include concerns / priorities of different stakeholders in the basin. These stakeholder inputs are specified as importance criteria in a **Strategy**. In this exercise, you will evaluate the new investments by comparing the plans and running the analysis.

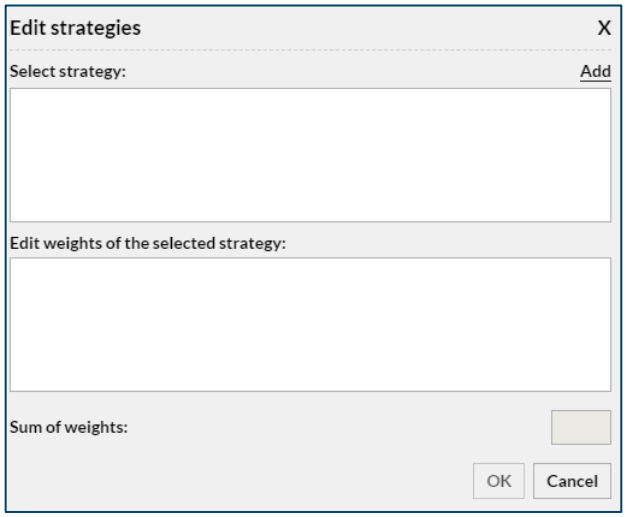
The application calculates an MCA score for the whole area based on a MCA approach. **Indicator results** are grouped according to the type of indicator and the results are normalized across plans.

The output from the normalization is afterwards combined with the strategy weights, which in turned are summed up to produce the final score, per plan and per strategy.

4.1 Strategies

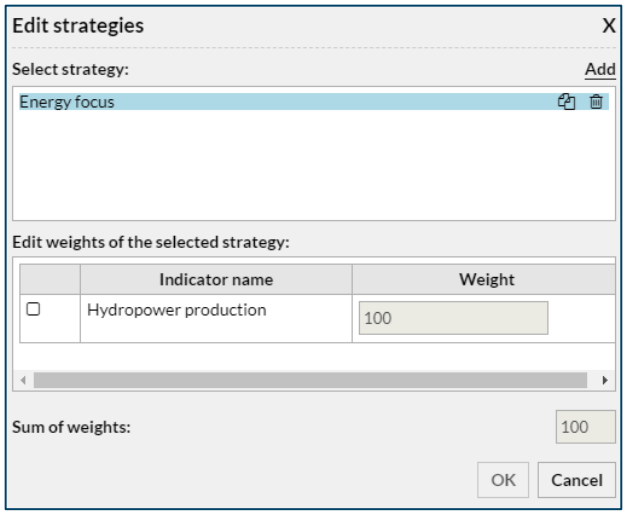
The first step in the Analysis workflow is create strategies to be used in the analysis.

- Please press “Edit Strategies”.
- To create a strategy press Add.
- Tick on the Indicators you would like to add to the strategy and attribute a weight. Please note the weights should add up to 100%.



Create a strategy with one indicator only focusing on energy production. This means that the plan with the highest energy production, according to this strategy, should score the highest in the analysis:

- Name the strategy “Energy focus”.
- Enter the description of what this strategy represents.
- Give the total weight of 100.



4.2

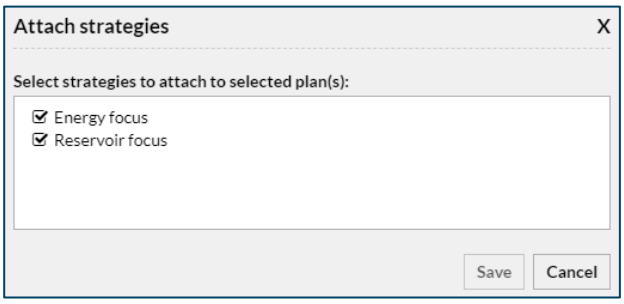
Next create a new strategy based on two indicators Hydropower production and Reservoir status. Attribute your own weighting scheme.

4.3 Attach one or more Strategies to the Plans

To carry out an Analysis the user needs to attach strategies to the minimum of two Plans. Additionally, this attachment must be consistent. This means that a strategy based on an indicator of water supply, cannot be attached to a plan without any water supply investments.

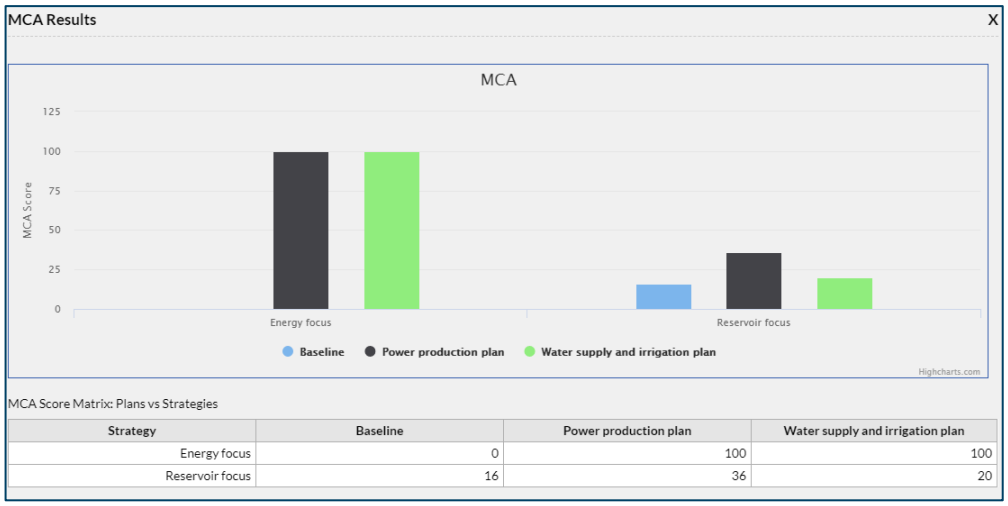
- Tick on the minimum number of two plans and press “Attach strategies”.
- Tick on the strategies and click Save.

You are now ready to complete the Analysis by clicking “View results”.



4.4

The final score is a weighted sum of indicators, where the weights have been previously defined to reflect priorities or concerns in the basin. Focus can be given to development, or environmental sustainability. Which plan scores highest when compared across each one of your strategies?



MCA Score Matrix: Plans vs Strategies

Strategy	Baseline	Power production plan	Water supply and irrigation plan
Energy focus	0	100	100
Reservoir focus	16	36	20

3 Functionality

This section contains a description of the functionalities.

3.1 Results

There are different types of investments available in the Planning application:

- WaterSupply represents potable water production schemes; the water demand is calculated by specifying the population and consumption per capita.
- Irrigation represents agricultural irrigation schemes; a water demand for the crop must be specified.
- EnvironmentalFlow can be used to represent water demand needed for the environment, should you have environmental flow calculations for your catchment your catchment you insert this type of investment in your plan and set the water demand to match the result from your analysis.
- Other type of water demand, represents water demand that does not fall within any of the categories above (for e.g. industrial, livestock, etc.)
- HydropowerDam represents hydropower plants located at a dam; it requires an installed capacity and the power demand and it will return energy produced.
- HydropowerRiver represents run-of-river hydropower schemes; this type of investment requires water demand and it will return water supplied.
- MultipurposeStorage is the investment type that can be used to represent reservoirs and storage (lakes, etc.) within your catchment.

The indicators constitute the different criteria based on which the plans will be evaluated. It is therefore important that stakeholders understand the meaning of the indicators and their variation across plans. Indicators should be well defined and should not be redundant. Indicators should also be mutually independent, meaning they do not convey information about each other such that one does not change the assessment of the other.

There are currently five indicators available:

- Annual energy production produced by hydropower schemes (GWh); this is directly dependent on the water level at the dam where the turbines are located.

  Hydroelectric power produced is calculated from the following formula:

  $$P = \Delta h(Q) \times Q \times \varepsilon(\Delta h) \times g \times \rho_{water}$$

  where P is the power generated, Δh is the effective head (difference) [L], Q is the discharge/release through turbine(s) [L3/T], ε is the machine (power) efficiency [-], g is the gravitational constant [L/T2] and ρwater is the density of water [M/L3]. The effective head difference is obtained by:

  $$\Delta h(Q) = h_{reservoir} - h_{tailwater}(Q) - h_{conveyance}(Q)$$

  $$h_{tailwater} = \max(h_{tailwater}(Q), h_{downstream\_reservoir})$$

  $$h_{tailwater}(Q) = h_{reservoir\_bottom\_level}$$

$$\Delta h_{conveyance} = 0$$

$$\varepsilon(\Delta h) = 0.86$$

- Annual reliability of supply either as the magnitude of the supply given a certain demand (m3/s), or as a fraction of demand supplied at a chosen level of probability of exceedance (%).

  The annual simulated water supply to users is calculated for each of the years of available data, where the hypothetical percentage of water supplied to meet a demand, at the 90% reliability of supply, is calculated to be equal to a certain percentage for e.g. 70%. Expressed differently, this means that for 9 out of every 10 years (i.e. 90% risk level) this water user would always receive 70 % or more of their required demand.

- Groundwater sustainability index as a comparison of the total groundwater recharge of the basin to the total abstraction from groundwater on an annual basis (%). The following equation is used:

  Annual GW Sustainability (%) = 100 x (1 – (Abstractions / Recharge))

- Net Present Value is a measurement of profit calculated by subtracting the present value of costs (including initial cost) from the present values of benefits over a period (user specified currency).

- Reservoir status is an indicator providing water level, reservoir downstream release and storage over time (m, m^3/s and m^3 respectively).

- Reservoir status probability indicator uses the same reservoir downstream release and storage as the previous but provides results as duration curves.

Results can be visualized at three different aggregation levels by default:

- **Details** returns the indicator values of individual investments.
- **Catchments** returns the indicator values summed up per catchment.
- **Summary** returns the indicator values of investment types summed up for the whole focus area.

The user can add aggregation levels by uploading the corresponding shapefiles when creating the baseline plan.

3.2 Analysis

Based on a Multi Criteria Analysis (MCA) approach, providing a structured framework for comparing a number of plans across strategies. The workflow involved in carrying the analysis is as follows:

1. Define strategies
2. Define weights
3. Calculate relative scoring
4. Combine the weights and scores for each of the options to derive and overall value for that strategy per plan
5. Analyze the overall score for each plan
6. Conduct a sensitivity analysis

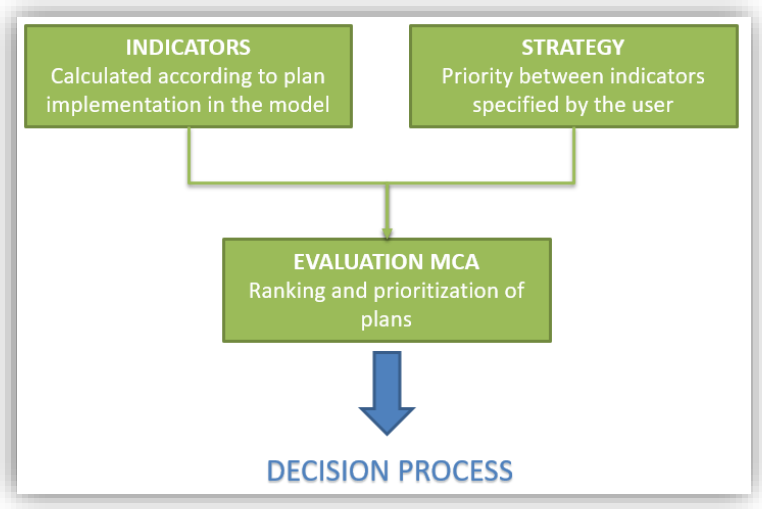


Figure 2 Analysis stage of the planning application workflow.

1. Define Strategies

The MCA score matrix needs to include concerns / priorities of different stakeholders in the basin. These stakeholder inputs are specified as importance criteria in a Strategy.

Strategies can have different focuses: for example domestic water supply can be given first priority, followed by livestock (other), hydropower and irrigation.

The indicators constitute the different criteria based on which the plans will be evaluated.

2. Define weights for each indicator

Choose which indicators to use as criteria and attribute weights.

Consensus should be reached; however, it is important to record disagreement to carry out a sensitivity analysis at a later stage.

3. Calculate relative scoring

The relative score needs to be calculated for the indicators results of each plan. Two calculations can take place to calculate a relative score:

- Higher value preferable 100*(X-Xmin)/(Xmax-Xmin)
- Lower value preferable 100*(Xmax-X)/(Xmax-Xmin)

4. Combine weights and scores

Weights and scores for each of the indicator results are multiplied.

Total weighted score of each plan is obtained by adding up all indicator weighted relative scores.

5. Analysis results

The final result per plan and per strategy, allows a ranking and prioritization of each plan under the weighting scheme carried by each strategy.

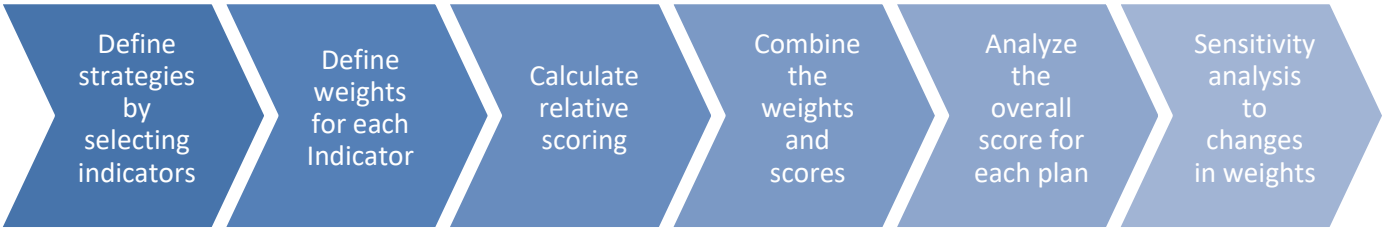
The plan scoring the highest total relative weighted score can be ranked as the most preferred plan.

The ranked list of plans combines indicator results on the same relative scale, thus reflecting overall plan preference.

6. Sensitivity analysis

The weighting of indicators can be altered.

This can be done by cloning a strategy and editing it according to the new strategic goal, or by adjusting upon recognition of associated uncertainty and conflicting objectives of multiple stakeholders.

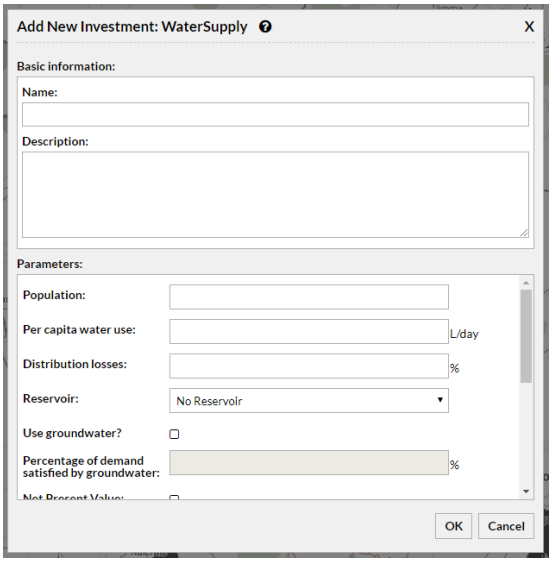


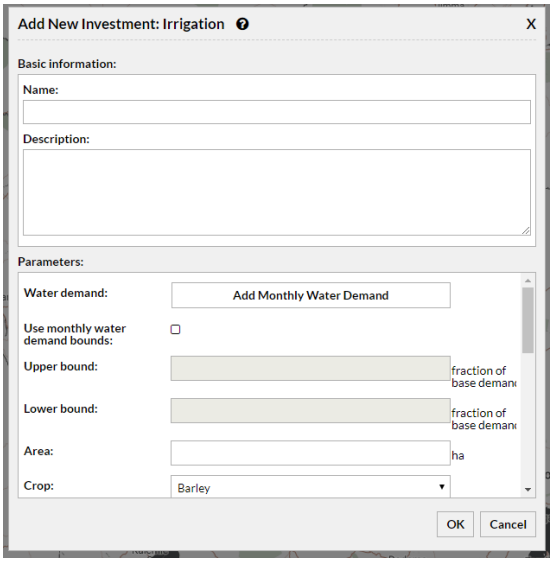
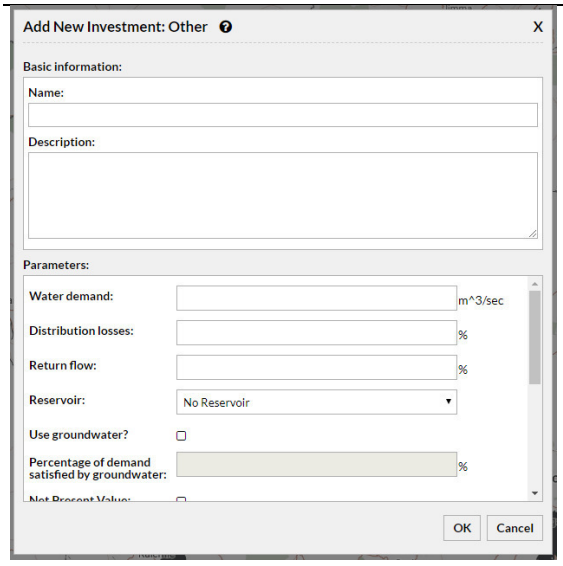
3.3 Plan Setup

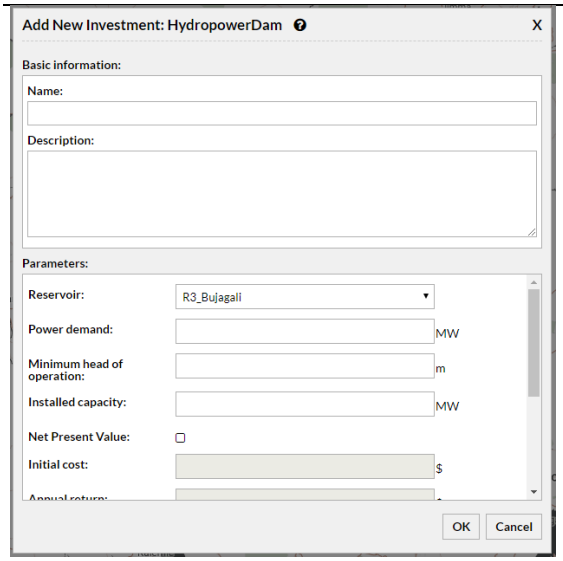
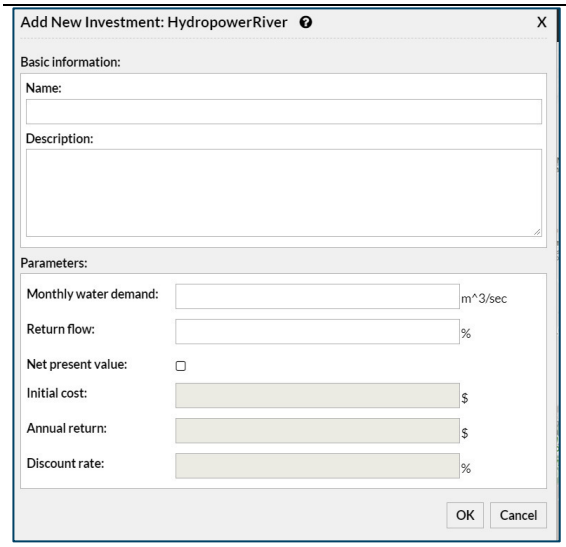
Setting up new plans or editing existing ones, is done in the Plan Setup section of the Planning Application.

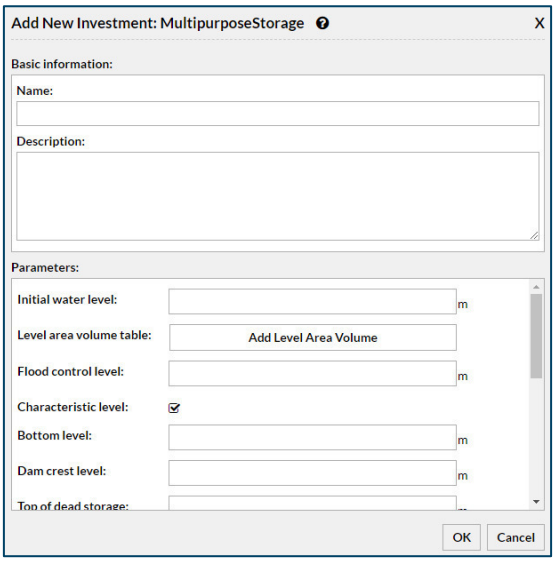
Firstly the user decides which investments are maintained and/or which investments need to be newly created. It is possible to add new investments and each investment type requires different parameters; below is a guide per investment type, for all the basic information is needed:

Basic information is where to attribute a meaningful **Name** to the plan as well as a **Description** stating a summary of key plan information including sources/references and aims.

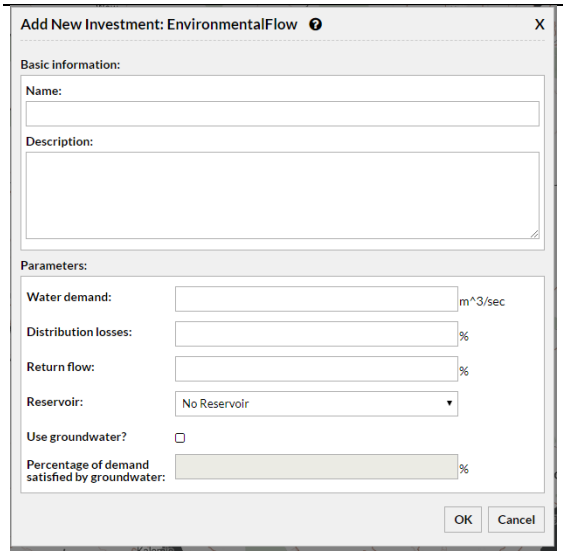
	Investment specific parameters
	**Population** is the number of people to be supplied by the scheme. **Per capita water use** is the estimated water use per day per capita. **Distribution losses** is the percentage of water that is lost while being conveyed from the production site to the users. **Reservoir** provides the option to set the source of water for the investment, it can either draw from an existing reservoir/storage or if "No Reservoir" is chosen it will withdraw from the river. **Use groundwater?** is a tick box used to activate/deactivate the parameter needed in case the investment uses groundwater as a source; if the model in the back end does not have this facility, this option will not be used. **Percentage of demand satisfied by groundwater** defines how much of the water demand is to be satisfied from the catchment groundwater source

	Net Present Value is a tick box used to activate/deactivate the parameters needed to apply the formula used to calculate this indicator: **Initial cost** of the investment specified by the user as the cost for the start year; **Annual return** is the expected annual benefit from the investment; and **Discount rate** is the annual discount rate which is kept constant.
	**Water demand** is the water needed for irrigation every month derived by the user. **Use monthly water demand bounds** is a multiplying factor to be used only in case results are needed for the RDM tool. **Area** is the area of the field in hectares. **Crop** is a dropdown list with different crop types to choose from. **Distribution losses** is the percentage of water that is lost while being conveyed from the source to the user. **Return flow** is the percentage of water that is estimated to be unconsumed and returned to the river system. **Reservoir** provides the option to set the source of water for the investment, it can either draw from an existing reservoir/storage or if “No Reservoir” is chosen it will withdraw from the river. **Use groundwater?** is a tick box used to activate/deactivate the parameter needed in case the investment uses groundwater as a source; if the model in the back end does not have this facility, this option will not be used. **Percentage of demand satisfied by groundwater** defines how much of the water demand is to be satisfied from the catchment groundwater source
	**Water demand** is the water needed for irrigation derived by the user. **Distribution losses** is the percentage of water that is lost while being conveyed from the source to the user. **Return flow** is the percentage of water that is estimated to be unconsumed and returned to the river system. **Reservoir** provides the option to set the source of water for the investment, it can either draw from an existing reservoir/storage or if “No Reservoir” is chosen it will withdraw from the river. **Use groundwater?** is a tick box used to activate/deactivate the parameter needed in case the investment uses groundwater as a source; if the model in the back end does not have this facility, this option will not be used.

	Percentage of demand satisfied by groundwater defines how much of the water demand is to be satisfied from the catchment groundwater source
	**Reservoir** is a dropdown list to choose which dam the hydropower plant will be located at and drawing water from. **Power demand** is the estimated target power the turbines should aim to produce. **Minimum head of operation** is the required minimum water level at the dam below which no energy will be produced. **Installed capacity** is the total production capacity of the turbines.
	**Water demand** is the water needed for irrigation derived by the user. **Return flow** is the percentage of water that is estimated to be unconsumed and returned to the river system.

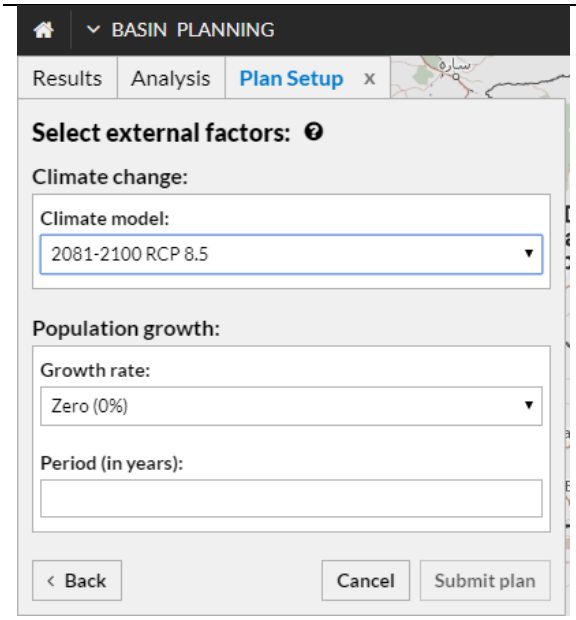


Initial water level is used to define the initial status of the water level in the reservoir.
Bottom level is the bottom of the Reservoir
Dam crest level is the highest water level in the Reservoir before spill occurs.
Top of dead storage is the minimum level from which water can be utilized. If the water level is below this zone water can only be lost due to evaporation or bottom infiltration.
Flood Control Level is the level above which water is released for flood control purposes.
Level area volume table allows the user to fill in a table with defining the available area and volume for water as a function of the level.
Include Losses and Gains is a tick box used to activate/deactivate the parameters required to simulate atmospheric losses and gains from the water storage such as **Evaporation** and **Precipitation**, as well as **Infiltration** losses through the reservoir bottom.



Water demand is the water needed for irrigation derived by the user.
Distribution losses is the percentage of water that is lost while being conveyed from the source to the user.
Return flow is the percentage of water that is estimated to be unconsumed and returned to the river system.
Reservoir provides the option to set the source of water for the investment, it can either draw from an existing reservoir/storage or if “No Reservoir” is chosen it will withdraw from the river.

After defining the investments constituting the plan, the user can choose to add external factors.



Climate change

This external factor influences the rainfall-runoff model in the back end, by replacing the climate dataset from the baseline conditions, with a dataset corresponding to the climate change projection scenario chosen from the drop-down list. If the model in the back end does not have rainfall-runoff functionality then this external factor will be disabled.

Population growth

This external factor influences WaterSupply investment type, by altering the population parameter to a projection depending on a growth rate and total period. The calculation is done by the following formula:

$$Pop_{future} = Pop \times (1 + Growth\_rate)^{Period}$$

4 Final remarks

The focus of the Basin Planning application and its use in the Lake Victoria basin and Uganda is dependent on the **underlying model which focuses on the impact at catchment and national level** and will not provide a feasibility study of local impact of specific development options.

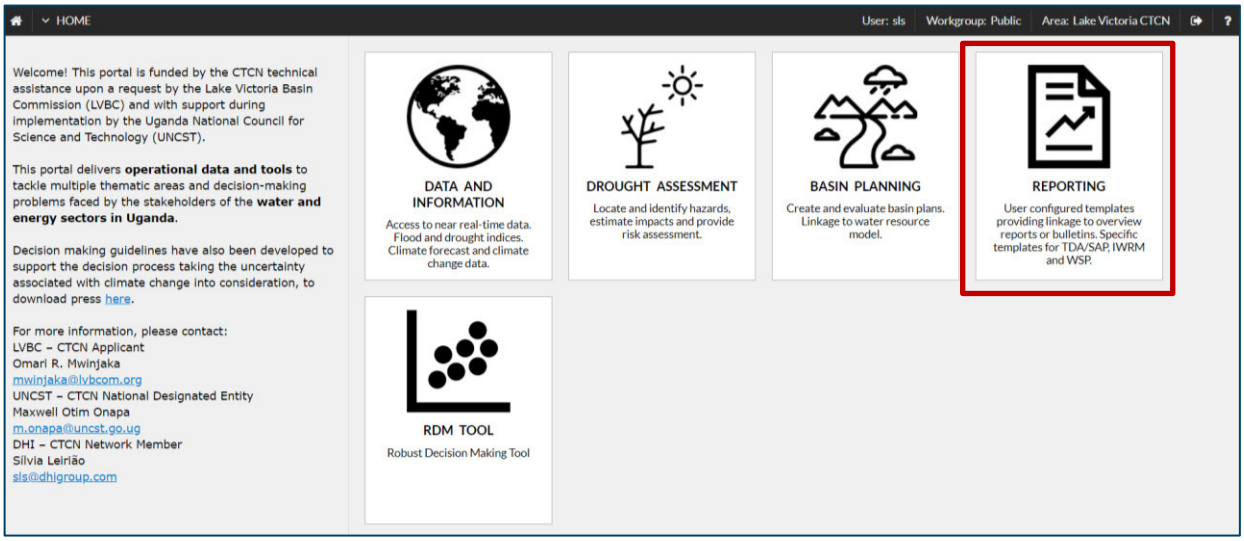
It is designed to allow users to analyse the **trade-off between different water uses in development plans**, for example hydropower versus potable water supply investments, considering how much water abstraction is needed and the availability of water resources in the basin.

Investments **should be placed where there would be water available** for that specific usage, so that the underlying model can take that consumptive use into account.

Different plans must be evaluated against the **same indicators** and should be evaluated based on the **same climate change scenario**.

Reporting application

User guide



REPORTING APPLICATION

1 Introduction and background

Dissemination in the form of reports or bulletins are 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. The content and format of the dissemination depends to a large extent on the specific content of the decision and the intended receiver of the report or bulletin. In some cases the reports or bulletins needs to be very detailed with technical content and in other cases it should highlight the key issues using non-technical terms. For this reason the reporting application is based on a process allowing the user to select between a number of default reports, or develop their own reports based on the specific requirements.

The reporting application is based on reporting templates (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. Currently the tags could be replaced with images, text, charts or tables.

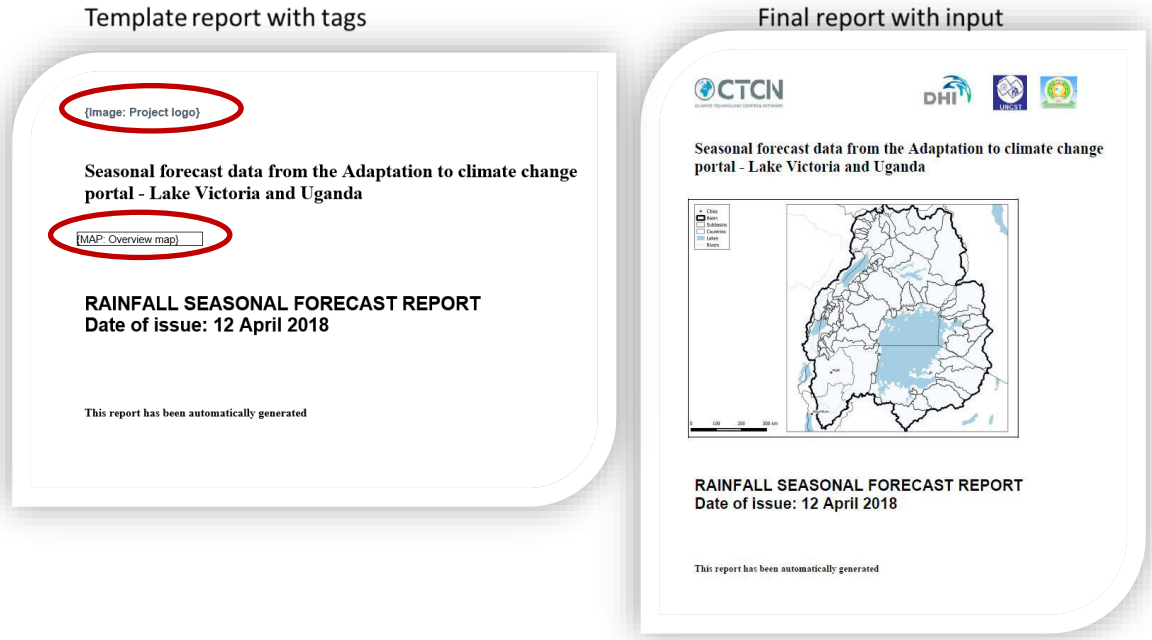


Figure 1-1 Template report with tags and final report with input in the form of images, chart or text replacing the tags

1.1 Template reports and tags

Template reports are one of the key features in the reporting application. A template report is a Word document (docx file) containing the overall framework of the report. The reporting application is able to insert objects in the form of images, text, chart or tables at user specified locations in the template report, and converting the template report into a final report containing for example tables with the latest climate information, drought hazards or other information from the Flood and Drought Portal.

The location of the inserted objects (images, text, chart or tables) are specified by adding tags in the report, where a tag is specified by brackets (start and end bracket) with a text in between, e.g. “{this is a reporting tag}”. See Figure 1-2 for an example of a reporting template with reporting tags.

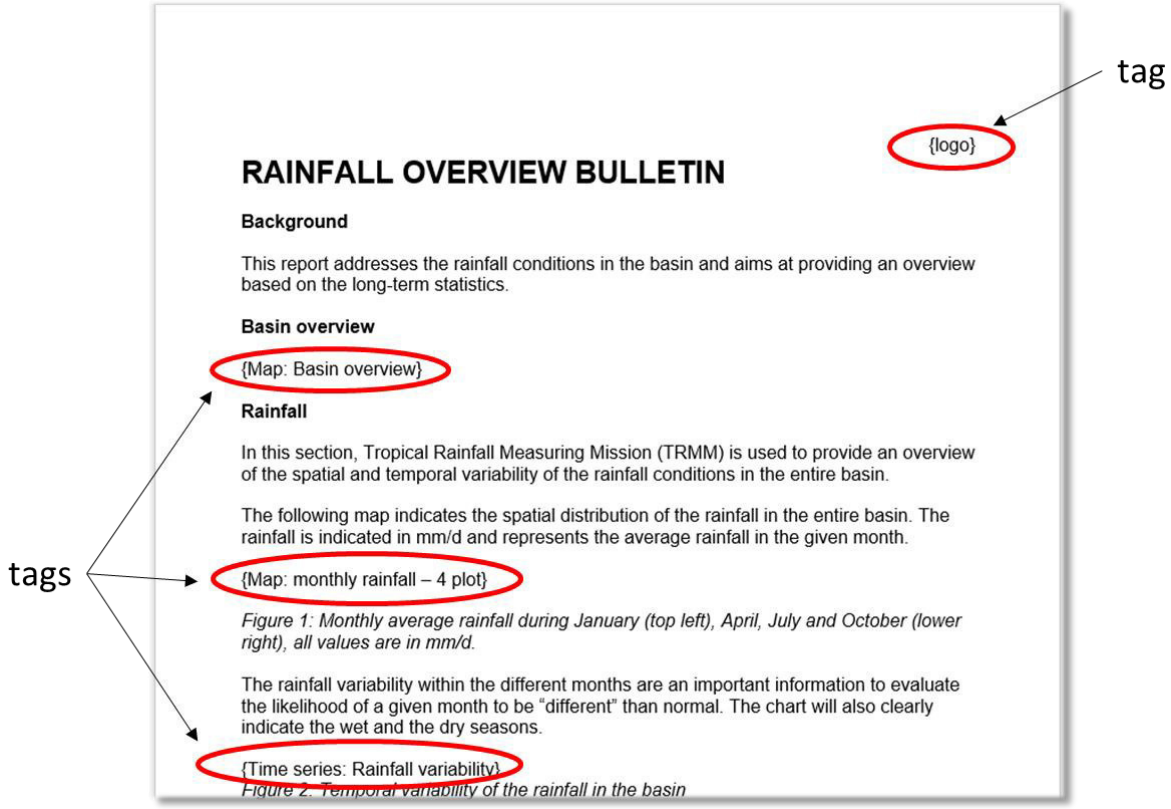


Figure 1-2 Example of a template reports with reporting tags

When loading the reporting template into the reporting application, all tags are listed and the user is able to specify what the reporting application should insert instead of each tag (images, text, chart or tables). See Figure 1-3 for an example.

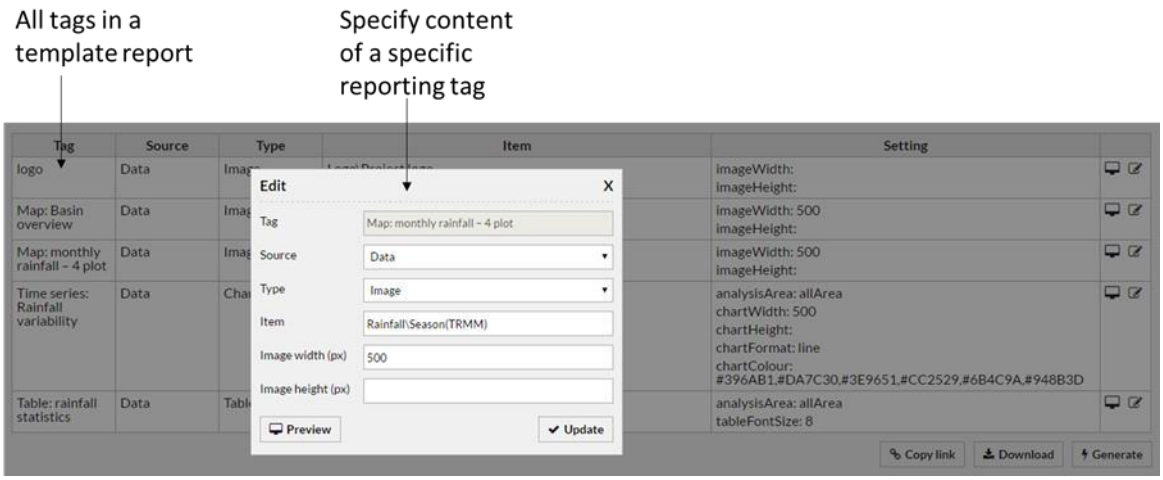


Figure 1-3 Example of how tags are converted to reporting objects within the reporting application

1.2 Automated reporting

Another feature of the reporting application is the ability of generating reports automatically based on a user-defined schedule. Reports will be generated automatically – without any user action – based on the latest data available. A notification email will also be sent to all the recipients of the report. The email will contain a link to download the latest version of the report.

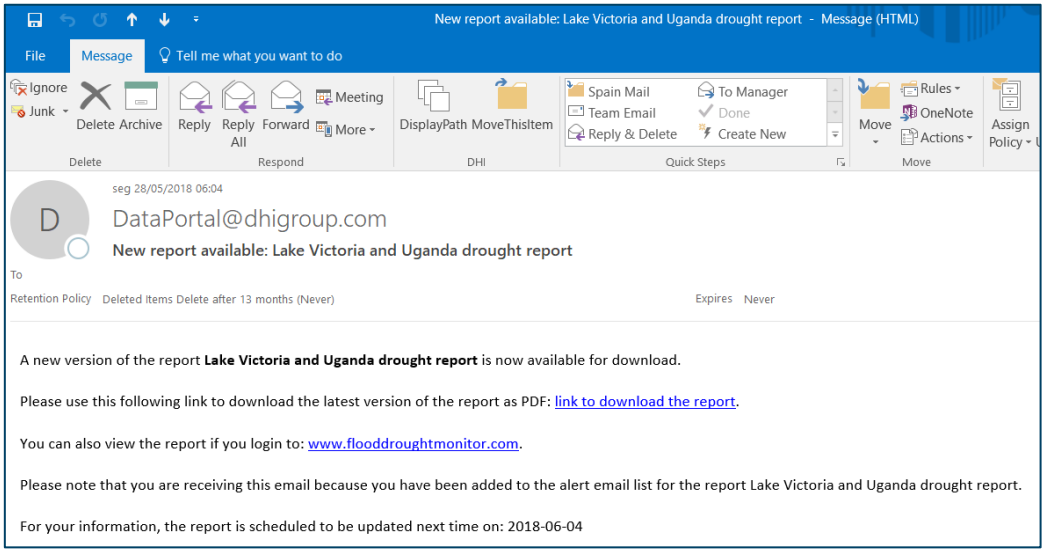


Figure 1-4 Example of an email notification when a new report has been generated.

2 Quick guide for first time user

This section contains a brief introduction for first time users. For a more detailed description, see the following sections.

This section explains how to use one of the default reporting templates built in to the system. For description on how to make a new report or upload user specific content, please refer to the following sections.

2.1 Open the reporting application

The reporting application is available from the landing page of the Flood and Drought Portal, see Figure 2-1. The reporting application will use the workgroup concept to determine which reports are available for viewing, editing and download.

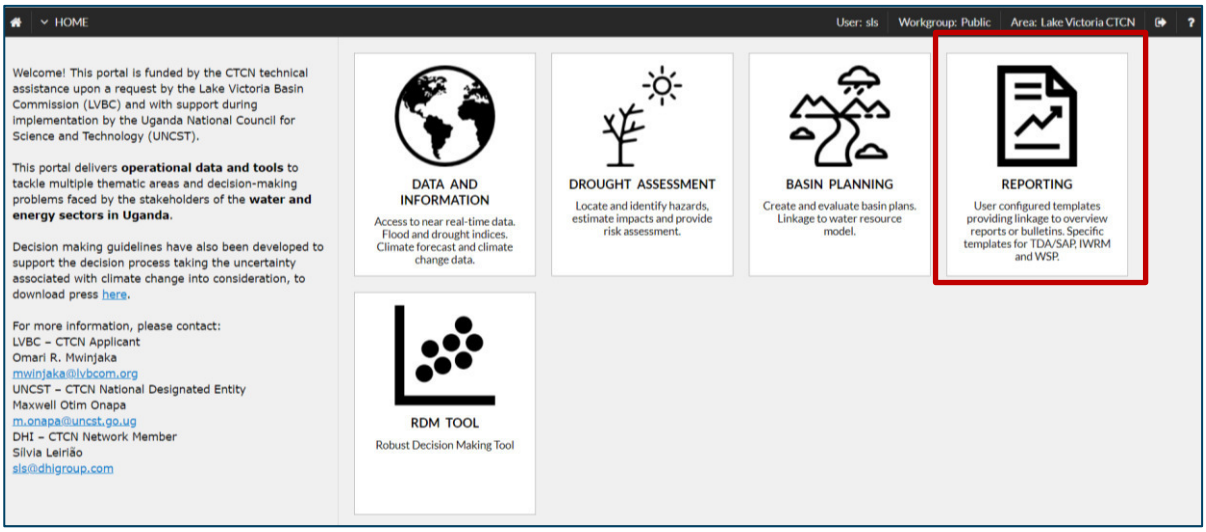


Figure 2-1 Open the reporting application from the landing page

2.2 Default reporting templates

The reporting application contains a number of built in default reporting templates enabling the user generate reports with a default content without having to develop their own Word based template. The default templates could also be used as a starting point for a user defined report.

The default reporting templates are accessed through the “Open” menu, where the all the default templates are marked with a “*” in from of the name, see Figure 2-2. Please note the following:

- Default reporting templates are all developed by the system and are available as read-only templates (user needs to clone the template to use them).
- The report generate option is disabled

In order to use a default reporting template within a specific basin please follow the following procedure:

- Select a default reporting template (through the “Open” menu”)
- Clone the reporting template
    - Specify a name for the cloned version
    - Specify the workgroup for the cloned version of the report
    - Update the description if needed
- Press “Clone” to copy the default reporting template.

After the reporting template is cloned the “Generate” option will be enabled and the user can generate the report for this specific basin. The report will be populated with updated content and can be viewed after the “Generate” option is executed.

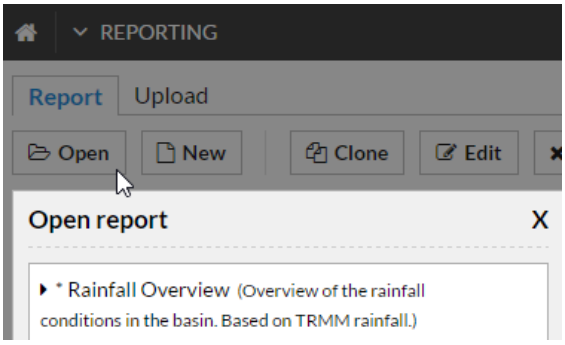
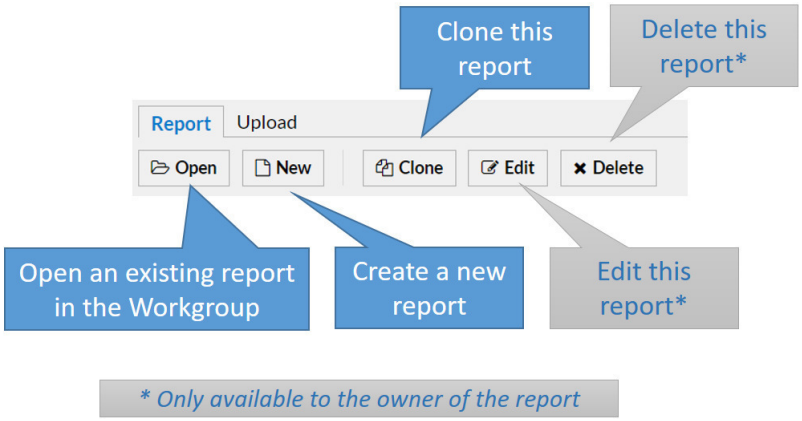
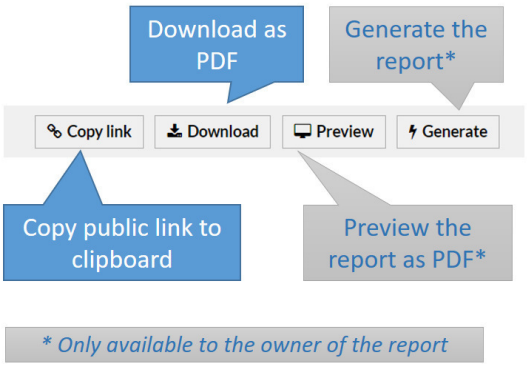


Figure 2-2 Default reporting templates

Main option to manage the reports are as follow:



When working with a report, there are a few options available:



2.3 View or edit content

When opening a report with editing rights, refer to user workgroup, all the content of the reporting template will be editable. When pressing the edit button ( ) an Edit dialog is opened and the user is able to specify the content for the specific tag. Pressing the preview button ( ) enables the user to preview the content of the specific tag.

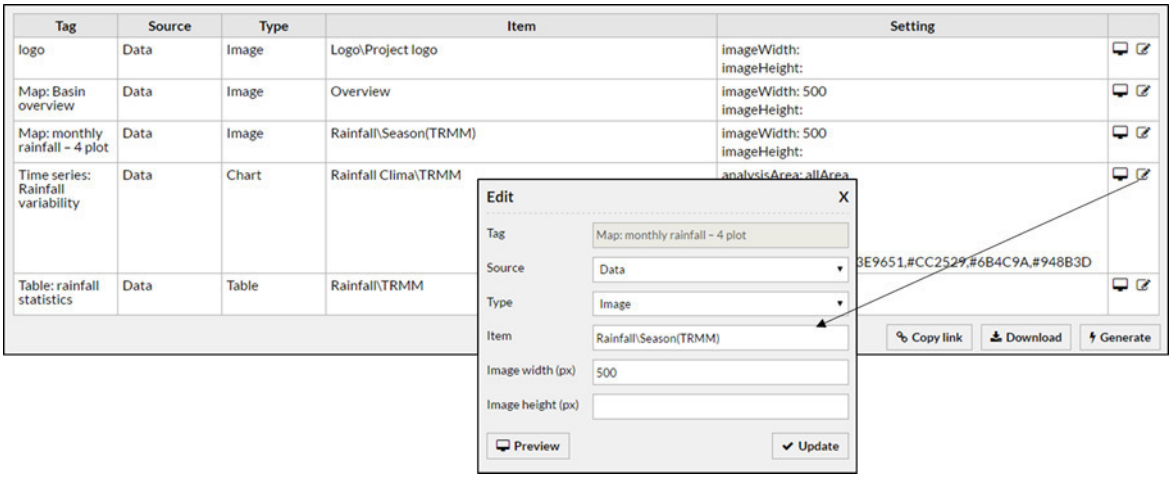


Figure 2-3 Edit reporting content

2.4 Generate report

The “Generate” menu generates the report by inserting all the user specified content into the reporting template and converting the report to pdf format. A dialog will appear at the end of the process allowing the user to download the generated report.

2.5 Download report

The “Download” menu enables the user to download an already generated report. Note that the report is not updated when using this option.

2.6 Copy link to report

The “Copy link” function provides a link to report. The link is automatically copied to the clipboard and can be used to access the generated report. The link can be used to share the report. Note: it is not needed to login to the Portal to access the report via this link.

3 Functionality

This section contains a description of the functionalities.

3.1 Open report

The “Open” menu enables an overview of all accessible reports, based on the workgroup concept.

3.2 New report

The “New” menu enables the user to generate a new report. The following input are required:

- **Report title**: Report title as it will appear in the system
- **Description**: Short description of the report.
- **Template**: Report template in Word format (docx format). The reporting template should contain tags in the form of brackets with a text e.g. ” {this is a reporting tag}”
- **Update frequency (optional)**: The frequency for automated update of the reports in weeks. The minimum time between two reports will be one day. No report will be generated automatically if left blank.
- **Alert email (optional)**: Email addresses to be notified when updated report has been generated based on the frequency. Several email addresses can be specified. No report will be generated automatically if left blank.

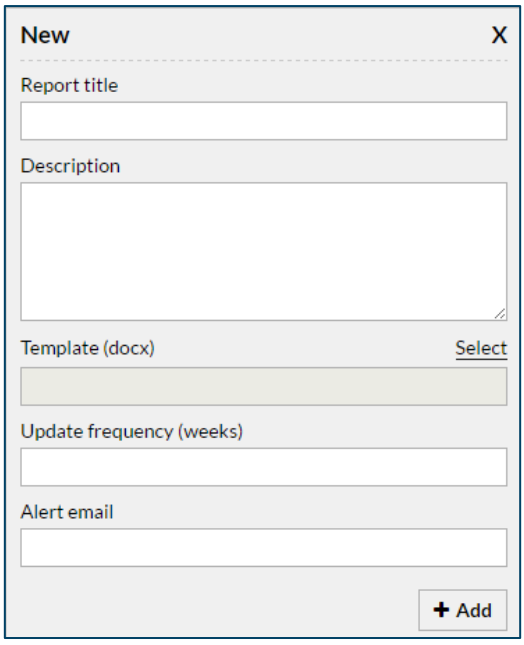


Figure 3-1 New report

When pressing the “Add” button a new reporting template will be generated and the list of the tags in the report template will be listed. The user should then specify the content of each of the tags before generating the report.

3.2.1 Default report templates

All reports marked with a "*" in front of the name are default report templates. The reporting application contains a number of built in default reporting templates enabling the user to generate reports with a default content without having to develop their own Word based template. The default templates could also be used as a starting point for a user defined report.

The default reporting templates are accessed through the "Open" menu, where the all the default templates are marked with a "*" in from of the name, see Figure 2-2. Please note the following:

- Default reporting templates are all developed by the system and are available as read only templates (user needs to clone the template to use them).
- The report generate option is disables

In order to use a default reporting template within a specific basin please follow the following procedure:

- Select a default reporting template (through the "Open" menu")
- Clone the reporting template
    - Specify a name for the cloned version
    - Specify the workgroup for the cloned version of the report
    - Update the description if needed
- Press "Clone" to copy the default reporting template.

After the reporting template is cloned the "Generate" option will be enables and the user can now generate the report for this specific basin. The report will be populated with updated content and can be viewed after the "Generate" option is executed.

3.2.2 New report template

It is possible to create a new template as a Report template in Word format (docx format). The reporting template should contain tags in the form of brackets with a text e.g. "{this is a reporting tag}"

For maps, it is recommended to add a frame around the text, this frame will then be adjusted around the map added as picture to the Word document. The best way is actually to create a one cell table, inside which the picture will be added, see below an example. Please note that a negative left indent will be give better result.

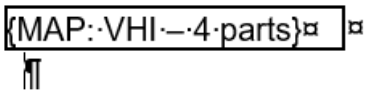


Figure 3-2 Tags to be used as a map placeholder

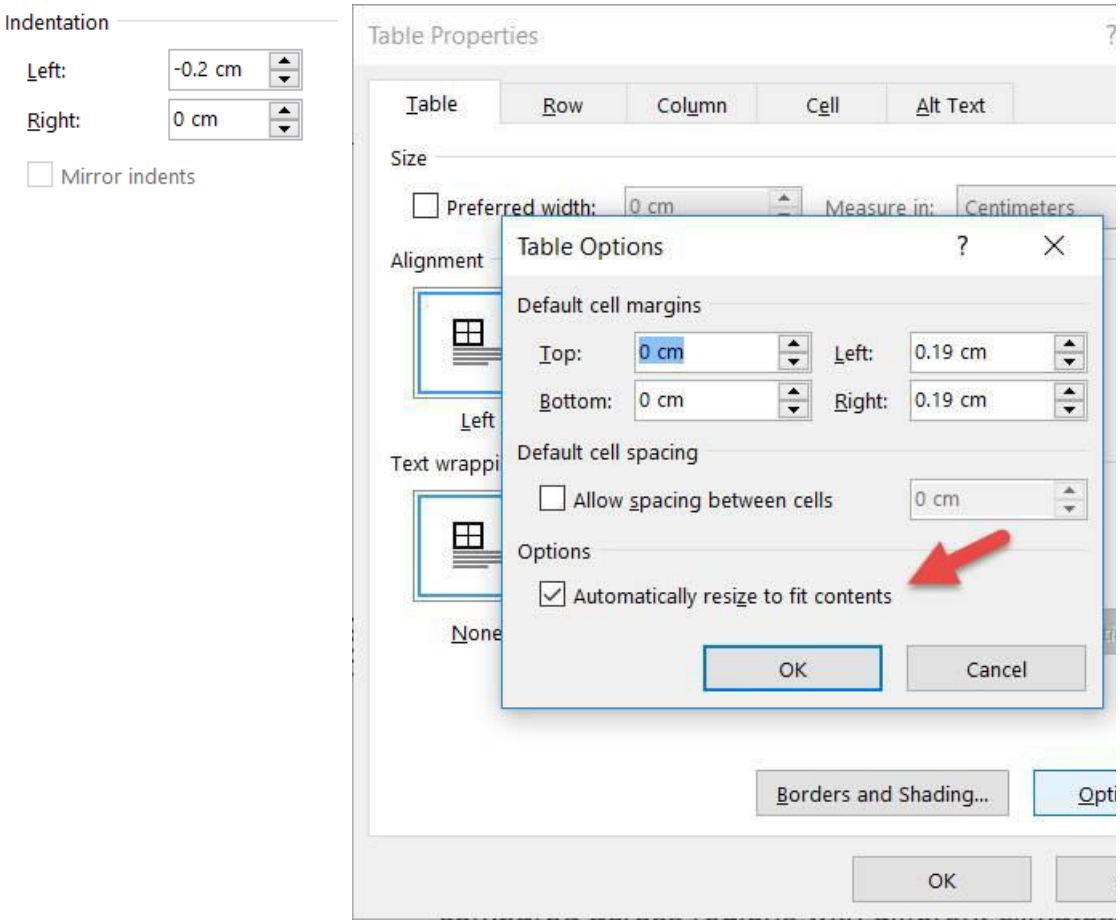


Figure 3-3 Properties of the table

3.3 Clone report

The “Clone” menu creates a copy of a report and saves it in a new user specified name. Note that the user has the option of selecting the workgroup for the cloned report.

3.4 Edit report

The “Edit” menu enables the user to change or edit the report title, the description, change the reporting.

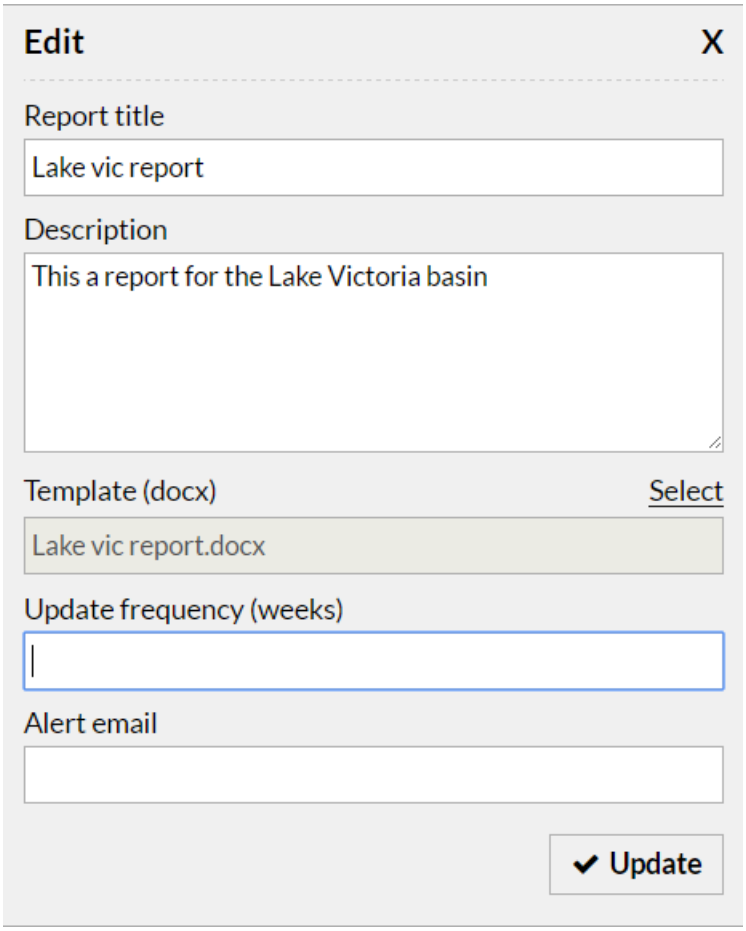


Figure 3-4 Edit dialog

3.5 Delete report

The “Delete” menu deletes the current report. Please note that the template and all the settings will be deleted from the system. The “Delete” menu is only enabled if the user is the author of the current report.

3.6 Edit or preview reporting tags

When opening a report with editing rights, refer to user workgroup, all the content of the reporting template will be editable. When pressing the edit button ( ) an Edit dialog is opened and the user is able to specify the content for the specific tag. Pressing the preview button ( ) enables the user to pre-view the content of the specific tag.

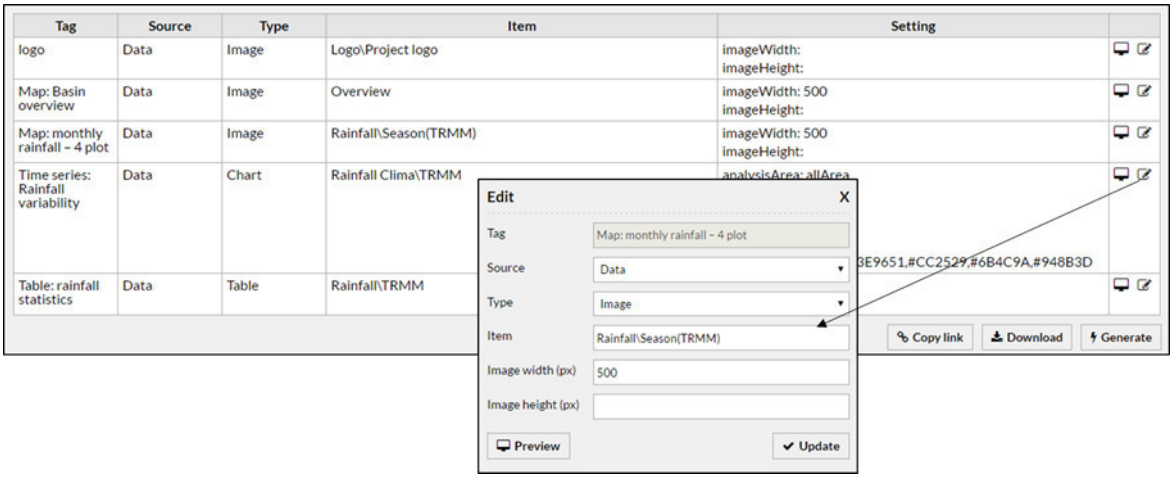


Figure 3-5 Edit reporting content

3.7 Generate report

The “Generate” menu creates the report based on template file and the user input for each of the reporting tags. The final report is converted to pdf format and will be available for download or through a link. The “Generate” option is used when a user needs to update the content of the report.

3.8 Download report

The “Download” menu enables the user to download already generated reports. Please note that this menu only downloads the existing report with the current content, the content of the report is not updated.

3.9 Copy link

The “Copy link” function copies a url or link to the latest generated report. The link could be used when submitting an email providing a link to the latest generated report. Pasting the link into any internet explorer would provide access to the report.

3.10 Upload reporting content

The user is able to upload content into the system, which could be a specific logo or a description within a txt file. The upload function is enables by selecting “Upload” tab.

Figure 3-6 Upload tab

User uploaded items could be in the form of images (*.png files), chart (*.csv file), tables (*.csv files) or text (*.txt files). The procedure for uploading an item and making it available for a reporting tag is explained below, see also Figure 3-7.

Procedure for uploading an item and making it available for a reporting tag:

- Select the “Upload” tab
- Press “New” and specify the information for the item to upload
    - **Item**: Name for the item as it will appear for the user
    - **Description**: Description as it will appear for the user
    - **Type**: Select the type of item to upload. Please note that the system will NOT validate the uploaded images or csv files and errors might occur if a file type is specified with a wrong extension type.
    - **File**: Browse and select the file to upload
- The uploaded item will now appear in the list of uploaded items
    - Note that an uploaded item can be deleted, edited or cloned by the user
- When editing a tag in a reporting template all user uploaded items are available by selecting the source type “Upload”.
- Selecting an item within the source type “Upload” adds the uploaded item to the specific reporting tag.

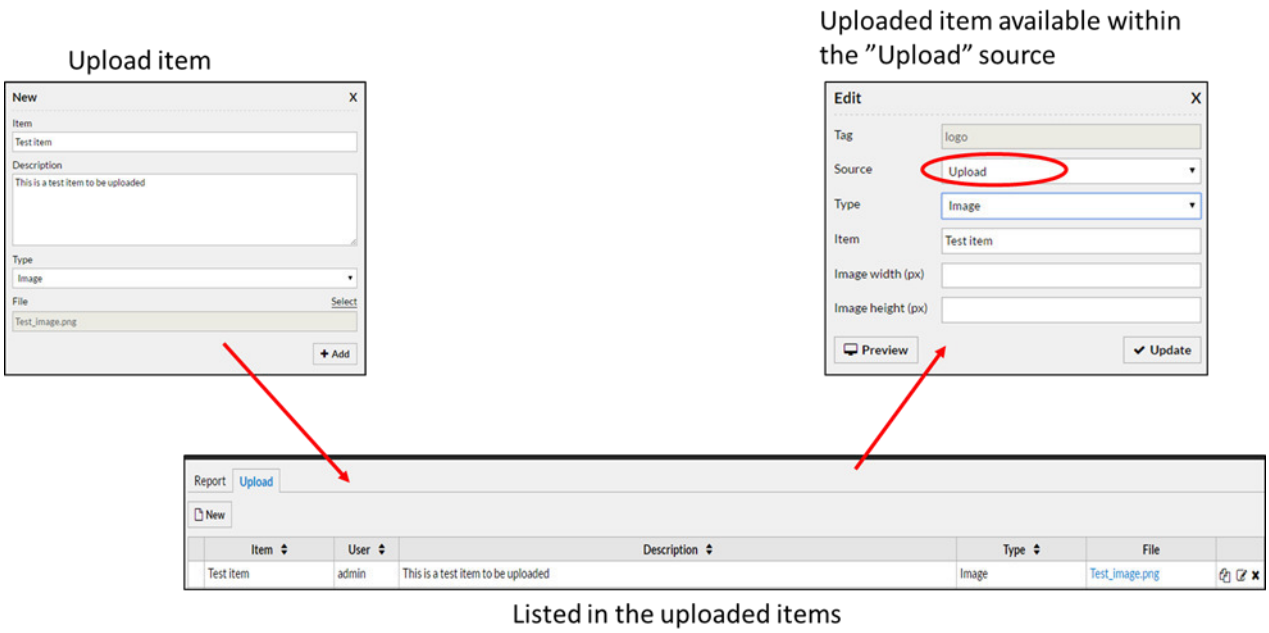


Figure 3-7 Process for uploading an item and making it available for a reporting tag

3.11 Automated reporting

Based on the frequency, the update of reports can be automated. The reporting application will automatically generate a new report, when the last generated report is older than the user-defined frequency. Several email recipients can be specified in the Alert email field to be informed when a new report has been produced.

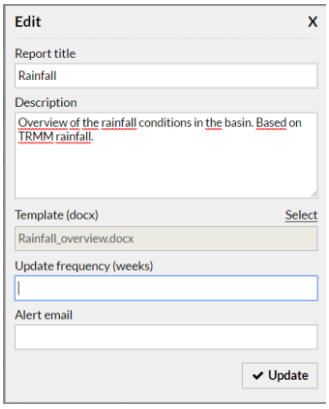


Figure 3-8 Edit dialog of the report where frequency and email can to be specified.

A notification is sent by email when a new report has been generated. The email contains a link to download the report as PDF without having to login to the Flood and Drought portal. Indication about the next report is also added to the email to the recipients have an idea when will the next update.

Figure 3-9 Example of email notification sent when a new report has been generated

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

Robust decision making tool

The Robust Decision Making application complements the Guidelines and is used to analyse model outputs generated at the end of the Basin Planning application workflow. The Robust Decision Making tool helps with understanding how uncertain external factors may affect the performance of a plan. The tool is available through the web portal.

Based on available information during the session, this guide decribes how to:

- Loading model outputs to the tool.
- Comparing the performance of two plans.
- Assessing the vulnerability of each plan to failure.

Open the RDM tool

Open the web portal**:**

http://www.flooddroughtmonitor.com

Please log in with your username and password.

Click on the RDM tool icon to be re-directed to the tool.

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1 Introduction to the Robust Decision Making tool

The Robust Decision Making tool is embedded in the web portal deployed within this technical assistance. The tool supports decision making under uncertainty and can be used with outputs from any model. In this exercise, we will use outputs from the planning application on the web portal.

Robust decision making focuses on evaluating investments under different combinations of external factors in order to identify combinations of external factors that are likely to result in failure. The purpose of the methodology is to help decision makers and stakeholders identify ways in which investments are vulnerable to factors outside of their control. Decision makers and stakeholders can then identify investments that are likely to perform well regardless of future conditions or, in other words, "robust" investments.

As implemented in the tool, the methodology proceeds through the following steps:

- **Ensemble import:** Import of ensemble simulation results including plan identifiers, external factor identifiers, and output indicators.
- **Identification of failure thresholds:** Identification of failure thresholds for all output indicators.
- **Plan comparison:** Comparison of plans according to different metrics, along with comparison of ensemble results to failure thresholds.
- **Vulnerability analysis:** Identification of external factor values likely to cause plans to fail.

2 Ensemble import

In this step, we import a .csv table containing ensemble simulation results.

2.1 Prepare .csv table for import

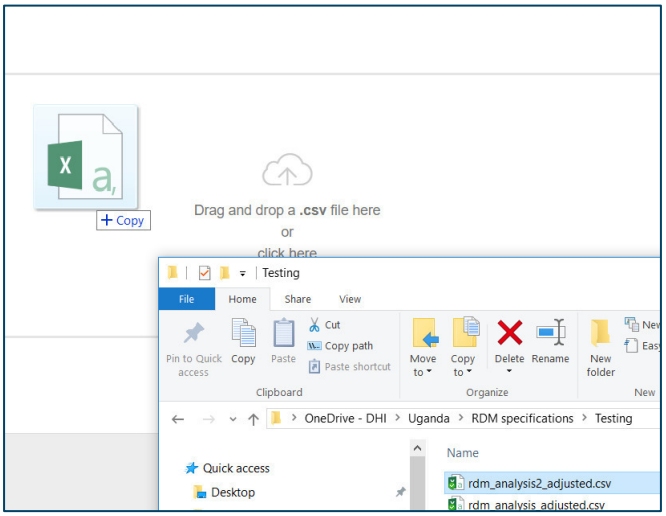
Ensemble simulation results are imported into the tool as .csv tables. Ensemble results can be imported from any model or other analysis tool as long as the table formatting conforms to a few simple formatting rules. The basin planning tool in the web portal prepares a .csv table automatically using the correct formatting. However, if importing results from another tool, the following rules should be followed:

- Each row of the table, apart from the head row, should present results from a single ensemble member.
- The first column should be an index with unique value for each ensemble member.
- The other columns should provide one of the following three types of information:
  - Plan identifier
  - Uncertain factor identifier
  - Output indicator
- Each column should be given a label in the header row.
- There are no constraints on the number of columns in the table. In other words, there are no constraints on the numbers of plan identifiers, uncertain factor identifiers, or output indicators.

	A	B	C	D	E	F	G	H	I	J	K
1	Ensemble index	PlanName	Climate Change	Irrigation annual return USD (Upland irrigation)	Irrigation demand m^3/s (Upland irrigation)	HydropowerDam annual return USD (HP3_Bujagali)	NPV HydropowerDam USD (Summary)	NPV Irrigation USD (Summary)	Annual Reliability of Supply Irrigation m^3/s (Summary)	Annual Reliability of Supply Environmental Flow m^3/s (Summary)	
2	1	High flow OutKyoga and Irr bounds CC	member_1	550000000	152456	1410000000	2010000000	193000000	12.48	1636.07	
3	2	High flow OutKyoga and Irr bounds CC	member_1	550000000	152456	282000000	626000000	193000000	12.48	1636.07	
4	3	High flow OutKyoga and Irr bounds CC	member_1	550000000	152456	3384000000	2560000000	193000000	12.48	1636.07	
5	4	High flow OutKyoga and Irr bounds CC	member_1	550000000	19057	1410000000	2010000000	193000000	15.6	1635.89	
6	5	High flow OutKyoga and Irr bounds CC	member_1	550000000	19057	282000000	626000000	193000000	15.6	1635.89	
7	6	High flow OutKyoga and Irr bounds CC	member_1	550000000	19057	3384000000	2560000000	193000000	15.6	1635.89	
8	7	High flow OutKyoga and Irr bounds CC	member_1	550000000	285855	1410000000	2010000000	193000000	23.41	1635.46	
9	8	High flow OutKyoga and Irr bounds CC	member_1	550000000	285855	282000000	626000000	193000000	23.41	1635.46	
10	9	High flow OutKyoga and Irr bounds CC	member_1	550000000	285855	3384000000	2560000000	193000000	23.41	1635.46	
11	10	High flow OutKyoga and Irr bounds CC	member_1	110000000	152456	1410000000	2010000000	-347000000	12.48	1636.07	
12	11	High flow OutKyoga and Irr bounds CC	member_1	110000000	152456	282000000	626000000	-347000000	12.48	1636.07	
13	12	High flow OutKyoga and Irr bounds CC	member_1	110000000	152456	3384000000	2560000000	-347000000	12.48	1636.07	

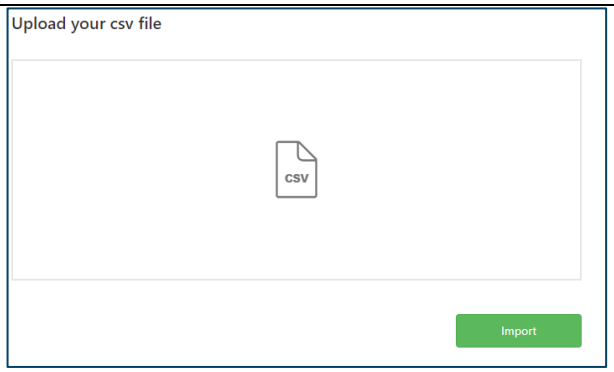
2.2 Select table for import

A table can be selected for import either by browsing or by using drag-and-drop functionality.



2.3 Import

You can import the table by clicking on the “Import” button.



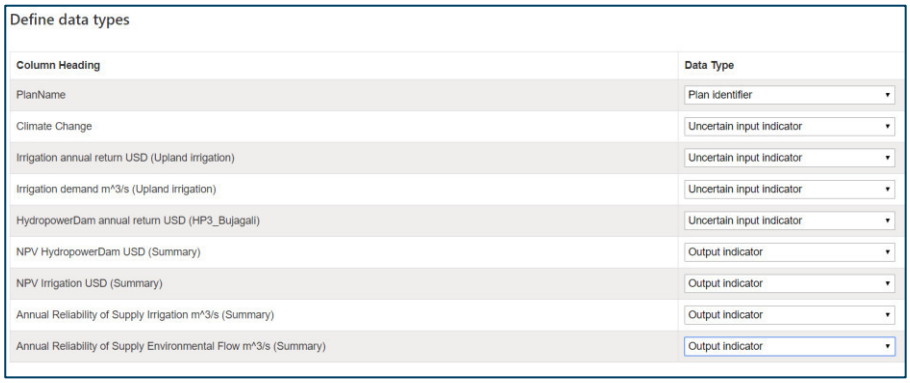
3 Define data types

In this step, we categorize each column in the .csv table imported in the previous step.

3.1 After import, each column heading (except the first column) is displayed on the “Define data types” tab. Each heading must then be categorized as one of three types using drop-down list functionality.

- Plan identifier
- Uncertain factor identifier
- Output indicator

Click the Next button after all column headings have been categorized.



4 Select failure thresholds

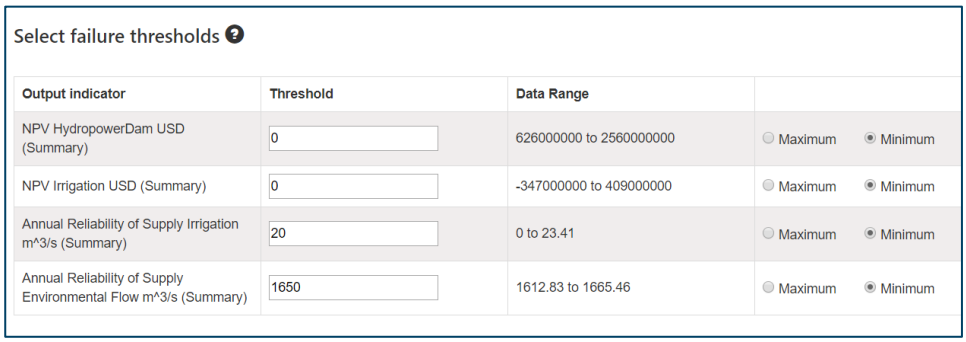
In this step, we define a failure threshold for each of the output indicators.

4.1 Define thresholds

The column headings identified as output indicators in the previous step are displayed on the “Select thresholds” tab. A failure threshold must be defined for each threshold using text entry. Each threshold should be defined as either a maximum or a minimum value.

The data range for each indicator is displayed in the “Data range” column. It’s not necessary that the failure threshold be within this range. In other words, it’s possible that all indicator values are acceptable, or not acceptable.

Press Next after all failure thresholds have been defined.

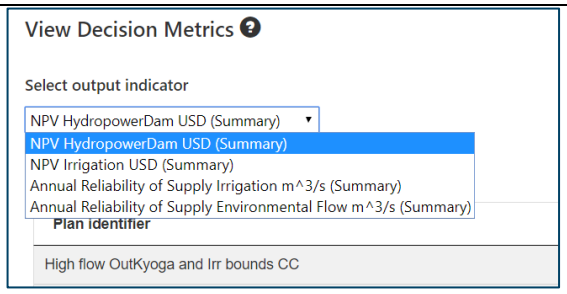


5 View decision metrics

In this step, the user is presented with two metrics that can be used to compare plans.

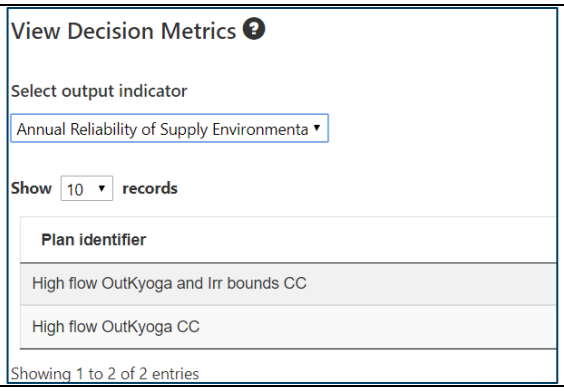
5.1 Select output indicator

In the first step, the user selects an output indicator for which metrics will be computed. The output indicator is selected from the drop-down list in the top left-hand corner of the tab.



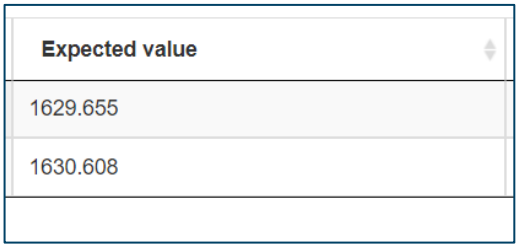
5.2 View plans

Plans are displayed in the first column of the table. If two or more columns were defined as plan identifiers, then every possible combination of plan identifiers is displayed.



5.3 View expected values

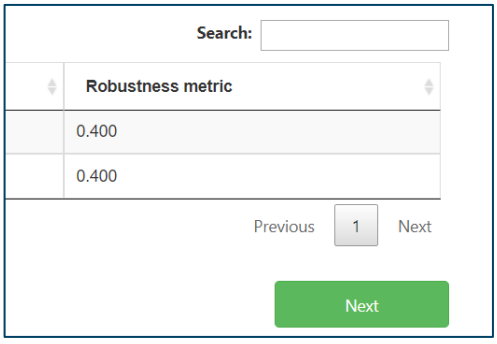
Expected values are displayed in the second column of the table. The expected value is an average of indicator values for the plan given in the first column.



5.4 View values of robustness metric

Values of the robustness metric are displayed for each plan in the third column. The robustness metric is equal to the fraction of ensemble members with output indicator values that are not defined as failing.

Click Next when ready to move on to the next step.

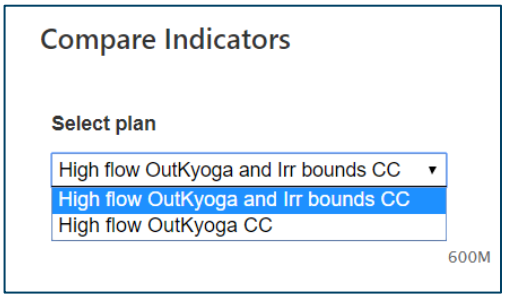


6 Compare indicators

In this step. plotting tools are used to compare output indicator values to failure thresholds

6.1 Select plan

Output indicators can be compared to failure thresholds for one plan at a time. A plan is selected using the drop-down list located in the top left-hand corner of the tab.



6.2 Select output indicators

Two output indicators may be compared at a time. Select output indicators to be plotted on each axis using the output indicator drop-down lists. Output indicators are plotted together with threshold values for each indicator.

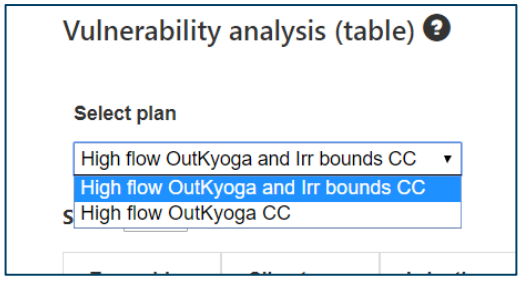
Press next when ready to move on to the next step.

7 Vulnerability analysis (table)

In the first vulnerability analysis step, we view external factor values that may cause plans to fail.

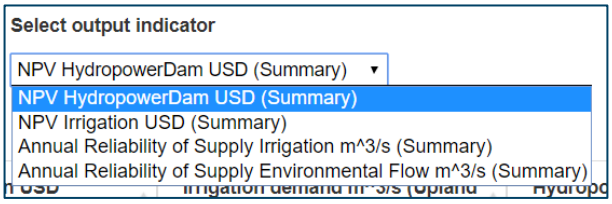
7.1 Select plan

The vulnerability analysis can be applied to one plan at a time. Select a plan using the drop-down functionality in the top left-hand corner of the tab.



7.2 Select output indicator

The vulnerability analysis can also only be applied to one output indicator at a time. Select an output indicator using the drop-down functionality at the top of the tab.



7.3 View vulnerability analysis

Results of the vulnerability analysis are displayed in a table. The table presents ensemble members with unacceptable values for the selected indicator. The ensemble index is displayed

in the first column along with values of uncertain input indicators in the next columns. Values of the selected output indicator are displayed in the final column and highlighted in blue.

Click next when ready to move to the final part of the methodology.

Show 10 records Search:

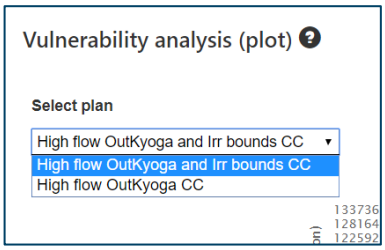
Ensemble Index	Climate Change	Irrigation annual return USD (Upland irrigation)	Irrigation demand m^3/s (Upland irrigation)	HydropowerDam annual return USD (HP3_Bujagali)	Annual Reliability of Supply Irrigation m^3/s (Summary)
1	member_1	550000000	152456	1410000000	12.48
2	member_1	550000000	152456	282000000	12.48
3	member_1	550000000	152456	3384000000	12.48
4	member_1	550000000	19057	1410000000	15.6
5	member_1	550000000	19057	282000000	15.6
6	member_1	550000000	19057	3384000000	15.6
10	member_1	110000000	152456	1410000000	12.48
11	member_1	110000000	152456	282000000	12.48
12	member_1	110000000	152456	3384000000	12.48
13	member_1	110000000	19057	1410000000	15.6

8 Vulnerability analysis (chart)

In the second vulnerability analysis step, we view results in chart form.

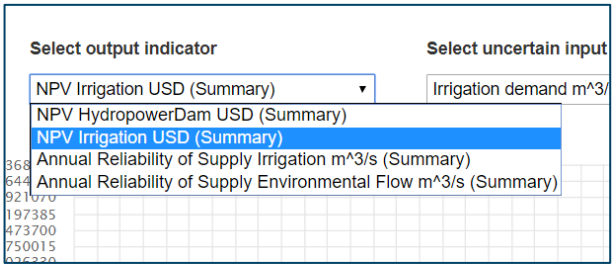
8.1 Select plan

The vulnerability analysis can be applied to one plan at a time. Select a plan using the drop-down functionality in the top left-hand corner of the tab.



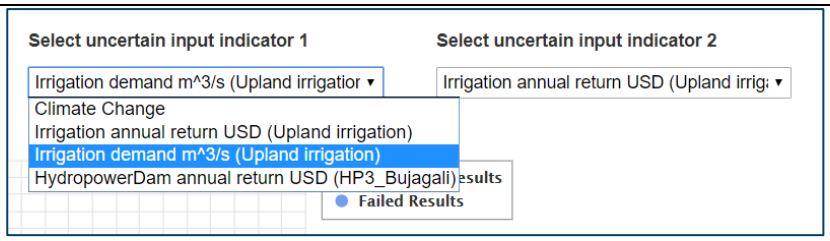
8.2 Select output indicator

The vulnerability analysis can also only be applied to one output indicator at a time. Select an output indicator using the drop-down functionality at the top of the tab.



8.3 Select uncertain input indicators

The vulnerability analysis chart displays values for the selected plan and output indicator as a function of two uncertain input indicators. Select uncertain input indicators to plot on each axis of the chart using the drop-down functionality at the top of the table. can also only be applied to one output indicator at a time. Select an output indicator using the drop-down functionality at the top of the tab.



8.4 View vulnerability analysis

The vulnerability analysis displays all ensemble members for a selected plan as a function of the two selected uncertain input indicators. Ensemble members with acceptable values for the selected indicator are displayed as open circles, while results with unacceptable values are displayed as blue circles.

The chart can be used to identify combinations of uncertain input factor values that are likely to cause failure.