EUROPEAN COMMISSION
Joint Research Centre
Directorate E – Space, Security and Migration
Disaster Risk Management Unit (E1)

ANNEX I TO CONTRACT …

" Transfer of web-mapping technology for disaster risk & automation of data processing and reporting in Africa"

Technical Specifications

TABLE OF CONTENTS

INTRODUCTION

- The JRC operates a Web Map server and integrated Content Management System to analyse and map geographic data in order to monitor and forecast drought in the World. This work resulted in the development of a web application that manages monitoring, forecasting, and historic drought-related data. In this project, the transfer of the Web Map server version based on Open Source technologies will be implemented by ACMAD (African Centre for Meteorological Applications Development). ACMAD will install the system at their premises in Niamey, Niger. A similar project is currently run in collaboration with ICPAC in Nairobi, Kenya, therefore synergies between the two project teams will be looked after.

- In this document, we describe the work to be done on the technical platform at ACMAD as well as the organisational aspects necessary to make the system work as an independent web application. An important aspect is the transfer knowledge on the setup and the use of Spatial Database technology and of Web mapping technologies and Content Management Systems (CMS).

The system to be ported is here described. The website address where the system can be downloaded and initially installed is available in a private repository on GitHub: https://github.com/ec-jrc/MUKAU-GEOCMS. Access can be given upon request. The system is called MUKAU after a plant growing in drylands in East Africa.

1. SERVICE REQUIREMENTS

- The Joint Research Centre of the European Commission (JRC) currently operates two Drought Observatories (DO): the European Drought Observatory (EDO) and the Global Drought Observatory (GDO). JRC also developed a South and Central America Drought Observatory together with CIIFEN (Centro Internacional para la Investigación del Fenómeno de El Niño, Ecuador) that is fully based on Open Source technologies; it has a similar architecture as the two drought observatories and is based on a shared technical platform. The system is based on a spatial database containing geometric vector data describing square cells, containing reference grids of various spatial resolutions. Earth observation and meteorological data are fed into this system and converted, sometimes degraded or smoothed, to a structured database containing daily, 10-daily to monthly values. The database containing these time series is organized per reference cell and year.

- The spatial database is fed once a month (meteo data) or every day or 10 days (Earth observation or Model output data) with new products describing rainfall, temperature, vegetation conditions, and soil moisture contents. Feeding new data takes place by using a range of specific Open-Source software packages. In order to analyse and visualise the drought products, specific programs are made in PHP, Python, R and OSGeo MapServer PHP Map Script.

- The main challenge for drought monitoring is to explore a large variety of data with long time series. This implies the need to manage large databases and structured file systems with readily made maps. The database allows for structured storage of a large number of weather parameters, whilst the file system contains maps allowing users to quickly access the data in a cartographic format through the web system. Additionally, fast computing of a large number of variables is required; this is done through optimised data formats for array processing, mainly NetCDF.

1.1. DESCRIPTION OF THE WORK AND SPECIFICATIONS

1.1.1. Functionalities to be ported

In the following sections, we discuss the various functionalities to be ported from the JRC platform to a platform functioning at ACMAD, in Niamey, Niger. The main work is to install the system in a database configuration that feeds an internal system for development and testing, as well as a web-enabled system (in the so-called DMZ, Demilitarized Zone) that provides public information using a partial and controlled copy of the database. Furthermore, the system uses a stylesheet based upon standards of the European Commission and is therefore to be updated for CSS standards being available or developed at ACMAD.

The work in Niamey shall be monitored by a project manager based in Ispra and another one from ACMAD in Niamey; meetings using Internet connections will be put in place to monitor, discuss and follow up the project on a regular basis.

ADMAD will provide an expert to carry out the work described in this document and together with the JRC they will agree on the acceptance of the deliverables produced.

1.1.2. Database and data model

The Oracle Spatial database of the JRC in Italy contains data to be ported to the ACMAD PostgreSQL PostGIS database. The main tables to be converted describe pixel locations as vector data in decimal degrees. These tables come in six resolutions, 1 decimal degree, 0.5 decimal degree, 0.25 decimal degrees, 0.1 decimal degree, 0.08333 ($^{1}/_{12}$) and 0.04667 ($^{1}/_{24}$) decimal degrees. These six tables contain grid cell location, an identifier, a centroid of the grid cell and an additional geometry column describing the land part of the square cell. The tables will be provided by the JRC to ACMAD in a binary export format and subsequently the tables will be recreated in the ACMAD database. All additional monitoring and forecast information can be linked to these six reference tables. In addition also static georeferenced data will be provided but from the latter also ACMAD will select specific datasets to be integrated in the system and thus to be converted to PostGIS format.

1.1.3. Data ingestion tools

Rainfall, Soil Moisture and NDVI (Normalised DifferenceVegetation Index) vegetation data are ingested respectively monthly and every 10 days into the system. Long-term anomalies are subsequently computed for all variables.

The monthly rainfall is copied from a NetCDF file on an ftp server of the Global Precipitation Climatology Centre (GPCC), operated by DWD (Germany's National Meteorological Service) into the database and a NetCDF file. The database insertion takes place using an automated tool build in R, which in conjunction also updates a NetCDF mirror of the system. Once two datasets of different content quality are downloaded, the system automatically processes SPI data based on a long-term reference dataset with data from 1981 to 2010. The SPI data are converted to the database allowing subsequently an automated update of the web system and various map interfaces consulting this rainfall indicator.

The NDVI data originates from post-processed satellite imagery (MODIS data). They are converted to values in a georeferenced database using a script built in Python and using PostGIS Spatial SQL logic. Eventually fAPAR and soil moisture data will be made available by the JRC in real time with a dedicated transfer procedure and a specific Python module will ingest the data into the database set up at ACMAD.

1.1.4. Map Viewer

The Map Viewer is based on a so-called Mapfile containing the legend layout definitions and the access to the Spatial Database for the layers to be displayed using OSGEO MapServer technology. This Mapfile has to access the PostgreSQL/PostGIS database. The definitions regarding classifications and colour schemes can be re-used from the JRC implementation or ACMAD classification can be developed and shared back with the JRC.

The current Mapfile contains 38 layer entries. Whether all layers will be re-used at ACMAD will be subject to further definition. Up to 20 layers are to be foreseen in the initial set-up of this project. The various layers without time series are to be converted to the PostgreSQL/PostGIS format as well. Usually these datasets can be delivered as shape files.

The Map Viewer also contains the following user interface functions:

Function
Redraw
Zoom in, Zoom out, Pan
Zoom by rectangle
Zoom to country
Zoom to Town
Identify
Time series display at point
Save Image

Display Lat /Lon Grid

The functions listed above are based on a combination of technologies: JavaScript, PHP MapScript, MapServer and the PHP library to access PostgreSQL. To adapt these functions, skills in these three languages are required. Especially the time series function is specific for the MUKAU project and essential for drought research and analysis.

1.1.5. Content Management System (CMS)

MUKAU uses a custom-made content management system. The content management system is built upon five Relational Database Tables containing webpage content, header and footer definitions, and user access statistics. The content management system is built using PHP and the PostgreSQL library and can be run standalone from the other applications. JQuery JavaScript library is also used to manage the web interface.

The functionalities of the MUKAU content management system are:

- Interface for update and creation of textual content for end users
- Definition of standard Headers and Footers
- Control of user access at IP address level
- Search and Index pages generated from content definitions
- Definition of page content and its accessibility in side of bar menus

The current MUKAU content management system will be made available as an empty shell. Main task for the project is to decide upon menu structure and implement the structure. In addition, the CMS allows thematic users to adapt or create content on-line and thus allow the system to be updated with new content quickly during a disaster. The project will therefore simulate such situations in order to implement the system into the ACMAD organisation. ACMAD operates a web portal displaying various items with regard to the projects the institution is working on. Maps or other graphical products that MUKAU automatically generates and updates after new meteo- or satellite data are being processed will be included in this portal. Thus giving users and instant access to the most eminent results of the system. A link to access the system, for further investigation of the situation will be included as well.

1.1.6. Automation Data Processing and the Bulletin production

At ACMAD a series of Data Processing Chains are carried out, that lead to monitoring, forecasting and alerts of natural disasters such as droughts, floods or meningitis outbreaks. Ultimately, the monitoring and forecasting work results in a monthly or ten day bulletin in which the scientists of ACMAD explain the current meteorological situation, linked to food security and safety, to a wide audience. The objective of the project is to improve the automation of these data processing chains in such a way that both the speed and the quality are improved. The MUKAU mapping interface will display by default the actual database content and therefore provide users with updated maps displaying the actual and forecasted status with regard to a specific disaster type. From the MUKAU database and its integrated system mapping components, the ten day and monthly bulletin can be generated thus enhancing the creation of the bulletin and allowing users to consult details of the data on-line, using the web mapping-interface.

The main input for these processes is the drought report presented by ACMAD and the Training Manual for Drought Monitoring service at ACMAD, created by Bob Alex Ogwang. Data elements such as Cumulative Rainfall are input for well-known drought indices such as the Standard Precipitation Index (SPI). Various steps in the creation of the SPI values and subsequent maps can be automated further. In this project, the focus is on the integration of these data into the MUKAU database by using the system to generate automatically a monthly bulletin once the data for a specific period are processed. Currently such processing takes place in QGIS which can be fully automated using Python with specific GIS libraries. Other parameters used in the ACMAD drought monitoring are the Soil moisture Anomaly (NetCDF v4 format), the NDVI (from MODIS 250 meter data), continental lake level and a composite index based on SPI and Soil moisture anomalies. The system therefore follows largely the philosophy of the Global Drought Observatory.

Additional insight in the generation of these five base processes leading to the Bulletin of ACMAD is presented in Annex 2 and an example is given in Annex 3. Ultimately, MUKAU will be able to generate bulletins with maps selected by an operator, including textual hints per legend class.

1.2. MUKAU HARDWARE – SOFTWARE SPECIFICATIONS

Compilation Date: Monday 20 January 2020

Web deployment Software: Apache, version 2.4.6

Operating System: Red Hat Enterprise Linux Server Centos 7.0 until 2024

Back end Databases:

PostgreSQL version 9.6, 64 bit on Linux Redhat

Database Content Size indication:

- Rainfall: 2 GB, Aggregated by Month, 1 decimal degree, 45 years, World Wide, derived anomalies (SPI).

- Vegetation Absorption fAPAR, 10 GB (whole world 60 GB) with a monthly moving time-window updated every 10 days, 0.083 decimal degree, 18 years, anomalies based on 2002 - 2019 (As an example for NDVI)

- Soil Moisture Anomalies based on 2001-2019, 8 GB, Aggregated by 10 days, 0.1 decimal degrees

- Reference data: Rivers, Lakes, Countries, Provinces (FAO GAUL), 3 GB

Total 25 GB. (replicated external)

File System Requirements:

Drought Research requires high-resolution imagery. High-resolution imagery is stored outside the database on the shared file system. For example, the fAPAR imagery in high resolution (0.002 decimal degrees) consumes 100 GB for only 1 parameter for 15 years aggregated by 10 days. Therefore, future requirement is estimated at 400 GB.

Content Management System: Home made using five PostgreSQL Tables and a set of PHP programs. It allows users to update content on their browser, stores page view statistics and blocks DDOS attacks.

Operational Dependencies: The CMS operates partly inside DMZ only, not to be exploited on the external Internet.

Software packages and related Programming Languages applied:

On Web server:

- PHP version 7.3.8
- PostgreSQL 9.6, PostGIS 2.4
- MapServer 7.4.1 + PHP MapScript
- JavaScript
- jQuery 1.6.4 + flot 0.8.3
- OpenLayers 2.13.1
- Centos 7.x (including Apache)

On PC client:

- PL/pgSQL (launching algorithms, conversion)
- PostgreSQL Import/Export (synchronisation external database)
- ODBC driver (integrating avoiding conversion)

- Oracle Virtual Machine (optional)
- R (SPI computation)
- Python version 3.x
- GIS Client for example QGIS
- GDAL-OGR (raster/vector format conversion)
- FTP (downloading data)

User access: The system is open, not using passwords for Internet users. The system performs access checks at IP address level and identified users can be excluded from access. The system displays more functionality on the inside version and can also provide pages only accessible for specific IP addresses for the version in the local network.

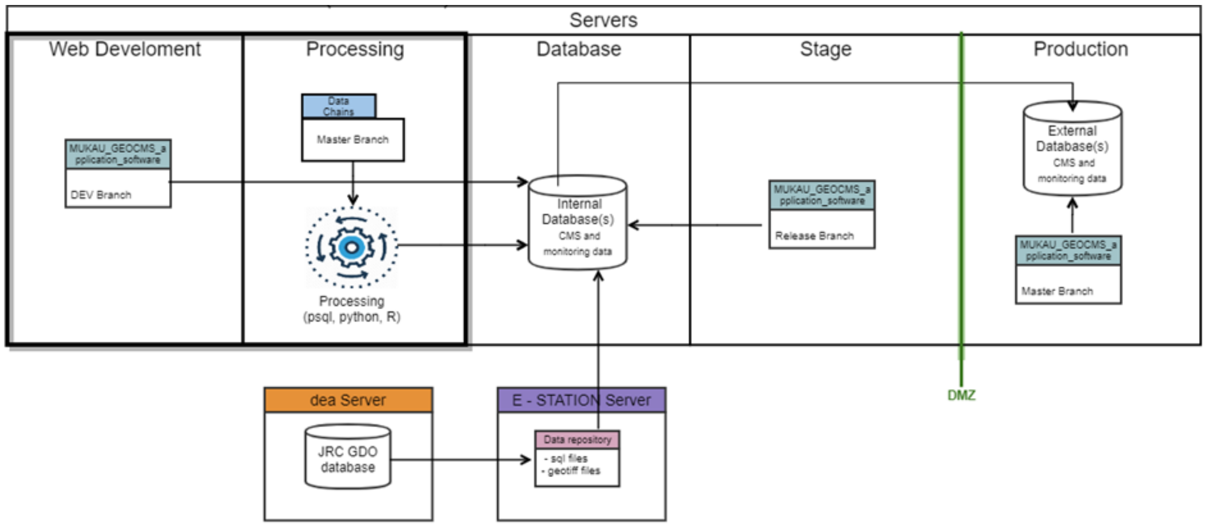
At database level, the system can be distributed across a large number of PostgreSQL users with tuned access rules. Thus spreading the risk of unauthorized access and the impact of mistakes. The synchronized database in the DMZ is read-only.

Specific Notions: The system makes use of a large number of PostGIS functions. Both in data preparation and conversion functions as well as on the data display function in the web part version.

The modules will need to run at least on a 64 bit hardware, 4 core PC, minimal 2.2 GHz per core, with MS Windows 10.x or Linux 7, 10 GB RAM, 10 GB of free hard disk space, at least 1388 x 768 video resolution but 1920 x 1080 is recommended.

The system consists at least of a Development and Test server, a Database server and an external Webserver with a partial copy of the database integrated as it is shown on figure 1.

Figure 1. System Architecture.



1.3. TASKS AND DELIVERABLES

Task 1

Installing the system servers (physical or virtual) at the premises of ACMAD, using the local network with a database server (at least 1) and various servers for development and processing (at least 1) and a production server in the DMZ with the database and webserver integrated.

Deliverables of Task 1:

D.1.1 Document with a description of computers, network structure and operating system software installed at ACMAD to be used in the project.
D.1.2 Detailed work plan for Task 2.

Task 2

Creation of the base software system at the premises of ACMAD, using PostgreSQL/PostGIS, MapServer, PHP and Python as working platform. Software installation at ACMAD using the hardware shall be made available by ACMAD in task 1. The installation takes place using the guidelines available on GitHub and recent experiences by ICPAC using container technology. The appropriate packages are installed on a development server in the internal network, a database server in the internal network and a combined application and database server in the DMZ. The internal server can copy data to the external server.

Deliverables of task 2:
D.2.1 Report on the installation of the base software system at ACMAD.

D 2.2 Performance test of the Database and its connections with the external platform and the internal platform.
D.2.3 Detailed work plan for Task 3.

Task 3

Adoption of the stylesheet of the Content Management System to work with ACMAD standards. Creation of the initial menu, and filling of the pages with 'semi-static 'content.

Deliverables of task 3:
D.3.1 Upgraded stylesheet scripts necessary for the adaptation of the look and feel of the system.
D 3.2 Proposed design of the menu and report on feedback of user community
D 3.3 Agreed design of the menu and implementation in MUKAU, filling of static page content
D.3.4 Detailed work plan for Task 4.

Task 4

Conversion of base spatial data to the two databases in PostgreSQL and PostGIS.

Deliverables of task 4:
D.4.1 Upgraded software scripts in PL/pgSQL to fill the databases with data provided by the JRC in PostgreSQL export format.
D 4.2 Filled databases and report on performance metrics
D.4.3 Detailed work plan for Task 5

Task 5

Integration of SPI computation module and module to synchronise soil moisture data with the JRC.

Deliverable of task 5:
D.5.1 Document describing the successful installation of the two modules on both the internal as well as the external system.
D 5.2 Integration of Web Map Service (WMS) layers displaying actual disaster risk in ACMAD's main web portal.

Task 6

Publication of the system on the Internet

Deliverable of task 6:
D.6.1: Report system implementation (as described in section 2) and working system.
D 6.2: Detailed work plan for Task 7.

Task 7

Automation of components of data processing chain at ACMAD and integration of MUKAU in order to generate a 10 day bulletin focussed on Drought with standard maps and legends

Deliverables of task 7:
D.7.1 Program to automate the processing of MODIS NDVI data, including the computation of anomalies. The data can be processed every 8 days and degraded to 0.0416 decimal degrees or lower for continental representation. From the data an anomaly will be computed and the results stored in the MUKAU database.
D.7.2 Development of software to store the following parameters of the bulletin in MUKAU PostgreSQL database: total rainfall, rainfall anomaly, maximum temperature, Standard Precipitation Index for 1, 3 and 6 cumulative months. Data can be in monitoring status and forecast status.
D 7.3 Realisation/adaptation of conversion software to upload files covering the level of mayor African Lakes and to integrate the result in the MUKAU database.
D 7.4 Creation of Legend classifications for MapServer transformation of the parameters in 7.1, 7.2 and 7.3 according to the existing specifications of the Bulletin in Annex 3.
D 7.5 Incorporation of the five new themes in the MUKAU WebMap service, addition of specific identify functions.
D 7.6 Creation of program to generate a PDF from the Mapviewer for user selected parameters of the African territory in Bulletin format..
D 7.7 Full implementation of the new functionalities on the internal MUKAU system and after testing export of functionalities in 7.4, 7.5 and 7.6 to the External MUKAU system.
D 7.8 Documentation of the new functionalities and advice on functionalities to be worked on in 2022.

1.4. INPUTS FROM JRC-ISPRA AND ACMAD

The JRC will provide access to the existing system and its database, export files with data, and access to the software (published on GitHub) to work with the system.
All the existing programs of MUKAU will be handed over as digital files via GitHub or via the eStation platform. The content of the database can be accessed and reformatted for subsequent conversion to the new system. ACMAD will provide access to hardware on which the new system will function and a workplace with Internet access.

2. REPORTING

- Intermediate reports D.1.1 to D.5.1 mentioned in section 1.3.
- Final report System Implementation (D.6)
- Final report Workflow automation and Bulletin creation (D.7)

The final report (D.6) shall document the execution of the project, with the exception of Task 7, from the beginning until the end, providing the chronological course of the project's activities and achievements ("project diary") organised by Tasks. It shall further include an adjusted project workflow chart of the completed tasks and deliverables of the project as well as all the previous deliverables as Annexes (D1.1 to D.5.1). It should also include a copy of the adapted software scripts developed during the project. Task 7 will be reported separately since it contains dependencies from other organisations such as national meteorological agencies.

The Table of Contents of the Final Report System Implementation:

1. Introduction (shall include purpose and scope of the project, description of the project and of its deliverables, as well as potential users and applications; shall include a graphic of the Project workflow).

2. Task 1 (chronological course of the Task 1 activities and achievements including technical, administrative, and organisational issues)

3. Task 2 (chronological course of the Task 2 activities and achievements including technical, administrative, and organisational issues)

4. Task 3 (chronological course of the Task 3 activities and achievements including technical, administrative, and organisational issues)

5. Task 4 (chronological course of the Task 4 activities and achievements including technical, administrative, and organisational issues)

6. Task 5 (chronological course of the Task 5 activities and achievements including technical, administrative, and organisational issues)

7. Task 6 (chronological course of the Task 6 activities and achievements including technical, administrative, and organisational issues)

8. Conclusions (shall include the main results and limitations of the project as well as recommendations for possible future improvements)

The Table of Contents of the Final Report Workflow automation and Bulletin generation:

1. Introduction (shall include purpose and scope of the task, description of the task and of its deliverables).

2. Overview current data exchange formats for rainfall, soil moisture and MODIS data

3. Description of conversion program for at least 4 formats

4. Description of MUKAU data-model for five (rainfall, soil moisture, NDVI, lake level and temperature) new parameters of ACMAD data to be included in MUKAU and relevant for the Bulletin generation

5. Description of conversion programs to port ACMAD Bulletin data to the proposed data-model.

6. Description of Bulletin generation program and related symbology files.

7. Recommendations for functionalities to be created in 2022

The two final reports are - together with all previous completed deliverables - the basis for the final payment of the project.

The final reports have to be properly structured, concise and in correct English language. The Consultant is requested to discuss the structure and outline of the report prior to development to ensure agreement.

The reports shall include the following mandatory information: Contractor name, contract number, document title and signature.

The Contractor shall produce the final reports in electronic format (e.g. MS Word).

The contractor shall use for all deliverables the visual identity methodology provided by the Contracting Authority, if requested.

The final reports (D.6 & D7) shall contain the following disclaimer:

"The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein."

3. FORMAL MEETINGS

Interactions with the Commission via video/telephone conferences and e-mail exchanges during the contract performance will take place on monthly basis; the work will take place at premises of ACMAD in Niamey, Niger.

The kick-off meeting (M-1) will be held as soon as possible, within **the first 2 weeks** after the entry into force of the contract. The Commission will make a proposal for the date of this meeting.

During this meeting (**M-1) the consultant will present the project proposal to the JRC staff to be discussed in order to clarify any potentially remaining discrepancies between the parties and potentially fine-tune it.**

During meeting (M-2) the contractor shall:

- present the execution of Task 2 (D.2.1, D.2.2 and D 2.3). All deliverables shall be sent to JRC at least 2 working days before the meeting.
- discuss and agree any issues or revisions regarding the development of Task 3.

Any follow up of the meeting M-2 regarding the review of deliverables D.2.1 and D.2.2 will be done through **exchange of emails** between the parties.

<u>During meeting (M-3) the contractor shall:</u>

- present the execution of Task 3 (D.3.1, D.3.2, D 3.3, D 3.4,).
The deliverables should be sent to JRC at least 2 working days before the meeting.
- discuss and agree any issues or revisions regarding the development of Task 3.

Any follow up of the meeting M-3 regarding the review of deliverables D.3.1 to D 3.4 shall be done through **exchange of emails** or comments in **GitHub** between the parties.

<u>During meeting (M-4) the contractor shall:</u>

- present the execution of Task 4 (D.4.1, D 4.2, D.4.3) and Task 5 (D.5.1, D.5.2).
The deliverables should be sent to JRC at least 2 working days before the meeting.
- discuss and agree any issues or revisions regarding the development of Task 4 and Task 5.

Any follow up of the meeting M-4 regarding the review of deliverables D.4.1, D.4.2, D 4.3, D.5.1, D.5.2 shall be done through **exchange of emails** and **GitHub** between the parties

<u>During meeting (M-5) the contractor shall:</u>

- present the execution of Task 6 (D.6.1, D.6.2). This deliverable should be sent to JRC at least 2 working days before the meeting.

Any follow up of the meeting M-5 regarding the review of deliverable D.6.1 and D.6.2 be done through **exchange of emails** between the parties.

<u>During meeting (M-6) the contractor shall:</u>

- present the report produced in Task 6 and the planning for Task 7, present the MUKAU online system.

<u>During meeting (M-7) the contractor shall:</u>

- present the database model to store the various drought parameter data in the MUKAU database. Display a prototype to load the data to the MUKAU database. Present the planning for the remaining tasks under Task 7.

<u>During meeting (M-8) the contractor shall:</u>

- present the working system to upload drought parameter data to the MUKAU database, present a prototype to upload five parameters mainly delivered in NetCDF files to the MUKAU database, present the integration of the five parameters in the Table of Content and Legend file component of the MUKAU web mapping system. Present the prototype interface for the generator of the 10 daily Bulletin.

<u>During meeting (M-9) the contractor shall:</u>

- present the final report of the work carried out in Task 7, present the online system with the Bulletin generator and optionally exploit the Bulletin generator also on the MUKAU system in the internet as created in Task 6.

<u>All the meetings</u> will take place via video or telephone conference **on the date mutually agreed**. For these meetings the contractor must prepare the **agenda** at least one week prior to the meeting in agreement with the JRC and produce the meeting minutes within **3 days** after the meeting for review and commenting by the JRC. Meetings are expected to be held every month during the project duration. The working language of the meetings and the accompanying documents will be English. Progress on the system development will be presented at a workshop with the National Meteorological Agencies in order to enlarge the user base and describe user requirements for a possible follow up of the project in 2022.

4. CHRONOLOGICAL SUMMARY TABLE OF OUTPUT AND MEETINGS

Timing	**Reference**	**Title**	**Type of deliverable**
N	M-1	Kick-off meeting	Power-Point presentation of the Project Proposal
N+15 days	T1	Task 1	D.1.1, D 1.2, D.1.3
N+*[x days]***	T2	Task 2	D.2.1, D.2.2, D 2.3
N+*[x days]***	M-2	Video conference on the completion of Task 2	Present the execution of task 2
N+*[x days]***	T3	Task 3	D.3.1, D3.2, D 3.3, D 3.4

Timing	Reference	Title	Type of deliverable
N	M-1	Kick-off meeting	Power-Point presentation of the Project Proposal
N+15 days	T1	Task 1	D.1.1, D 1.2, D.1.3
N+*[x days]***	T2	Task 2	D.2.1, D.2.2, D 2.3
N+*[x days]***	M-2	Video conference on the completion of Task 2	Present the execution of task 2
N+*[x days]***	M-3	Videoconference on the completion of Task 3	Present the execution of task 3
N+ *[x days]***	T4	Task 4 and 5	D.4.1, D.4.2, D 4.3, D.5.1, D.5.2
N+ *[x days]***	M-4	Videoconference on the completion of Task 4 and 5	Present the execution of task 4 and remainder of task 5
N+ *[x days]***	T5	Task 6	D.6.1, D.6.2
N+ *[x days]***	M-5	Videoconference on the completion of Task 6	Present the execution of task 6
N+ *[x days]***	T6	Final report System Implementation, work plan Task 7	D.6.1
N+ *[x days]* **	M-6	First activities Task 7	D 7.1, D 7.2
N+ *[x days]* **	M-7	MODIS reader	D 7.3, D 7.4
N+ *[x days]* **	M-8	NetCDF reader, classifications	D 7.5, D 7.6
N+ *[x days]* **	M-9	Final report Bulletin Automation	D 7.7, D 7.8

***N= date of the contract entering into force**

** **As defined in the contractor's offer.**

This above chronological summary table completed with the proposed timing (x) for the delivery of the services must be included by the consultant at the kick-of meeting of the project.

5. OTHER GENERAL MODALITIES AND RESPONSIBILITIES

5.1. Communication

The communication between the contractor and the Contracting Authority shall be done by phone, videoconference, electronic mail, normal and registered mail.

English language shall be used throughout the project duration for communication, reports, software and other documentation. English shall also be used in particular for software documentation.

During the initial phase (kick-off meeting (M-1) and training) the communications will take place in English. Please note that the existing project documentation is available in English.

5.2. Acceptance of deliverables

The procedure for accepting the deliverables is the following:

1. The Contracting Authority receives the deliverables according to the contract deadlines;

2. If required, the consultant presents the deliverables for discussion with the JRC;

3. Further actions which, in the opinion of the JRC, would be necessary for the acceptance of the deliverables will be undertaken by the contractor without delay. A new deliverable which takes into account comments or suggestions made by the Contracting Authority shall be re-submitted (**two) weeks** unless specified otherwise.

5.3. Place of Work

The place of work will be in Niamey, Niger, in the offices provided by ACMAD.

6. ANNEX 2, DETAILS ON AUTOMATION OF DATA PROCESSING CHAIN AT ACMAD

6.1. Introduction

Module 2: Generation of drought monitoring products

This module provides the steps taken to generate each drought product to be used in the generation of the composite drought monitoring product

3.1 Precipitation in percent of average

It is important to note that precipitation anomaly product may be used as well, and it is computed for monthly and seasonal precipitation **(PR)** based on precipitation estimates from CAMS_OPI dataset (Estimated PR minus PR climatology). The reference period used for computing the climatology is 1981-2010. The blue color on the map **(Figure 2a)** indicates areas where the precipitation are above the long-term average, while red depicts areas with precipitation below average for the month/season**.**

Total **precipitation in percentage of average** is computed using the expression;

$$PR(\%) = \left(\frac{CurPR}{LTAPR}\right) x100\,\%$$

CurPR: Total current precipitation

LTAPR: long term average precipitation (1981-2010) [Monthly or Seasonal].

It is also worth noting that this product depict areas of evolving PR deficits as potential drought areas.

Currently, the monthly and seasonal precipitation datasets are downloaded using scripts and the processing of percentage (%) of average is done using excel. Surfer/QGIS is used for the generation of maps (e.g. Figure 2). The detailed procedure for generating this product at ACMAD is available in ACMAD's PC10/MESA**/BAO/PRCP).

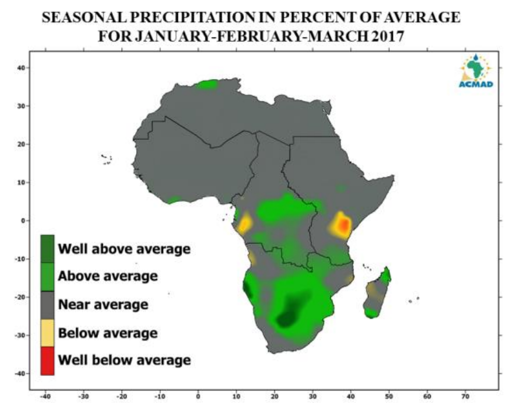


Figure 2: Precipitation in percent of average for JFM 2017 season

NB: The following are essential considerations in producing precipitation in percent of average map.

[1] Percent of average precipitation is divided into five categories: **well above average, above average, near average, below average and well below average**.

[2] If ***LTAPR*** is below 30 mm (monthly) or below 100 mm (seasonal) the formula is not applicable.

For monthly average precipitation

If the value<=30, the percentage is 100 (near average or climatology indicated by grey color)

For seasonal average precipitation

If the value<=100, the percentage is 100 (near average or climatology indicated by grey color)

3.2 Standardized Precipitation Index (SPI)

SPI is a powerful and a flexible index that is easy to calculate. Precipitation is the only required input parameter. In addition, it is just as effective in analysing wet periods/cycles as it is in analysing dry periods/cycles. Ideally, it needs at least 20-30 years of monthly values, with 50-60 years (or more) being optimal and preferred (Guttman, 1994,1998,1999).

The classifications of SPI values are provided in table 1. 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 "magnitude".

Table 1: SPI values

2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

It is worth noting that since 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.

The SPI was designed to quantify the precipitation deficit for multiple timescales. These timescales reflect the impact of drought on the availability of the different water resources

Soil moisture conditions respond to precipitation anomalies on a relatively short timescale. Groundwater, stream-flow and reservoir storage reflect the longer-term precipitation anomalies. So, for example, one may want to look at a **1 or 2-month SPI for meteorological drought**, anywhere from **1-month to 6-**

month SPI for agricultural drought, and **6-month up to 24-month SPI or more for hydrological drought** analyses and applications. The next section provides the procedure for downloading the required data to generate SPI.

The data used in the generation of the monthly and seasonal Standardized Precipitation Index *(McKee et al, 1993, 1995)* is downloaded using scripts. R package under Linux/windows is then used to compute the respective SPIs. At ACMAD, the SPI map is currently being generated using QGIS. The detailed procedure for generating this product is provided in the procedure/manual for generating SPI at ACMAD (Available in ACMAD'S PC10/BAO/SPI).

The figure below provides an example of a generated SPI for the month of March 2017.

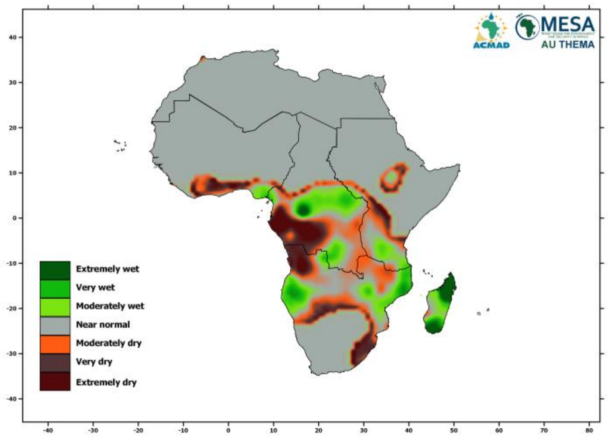
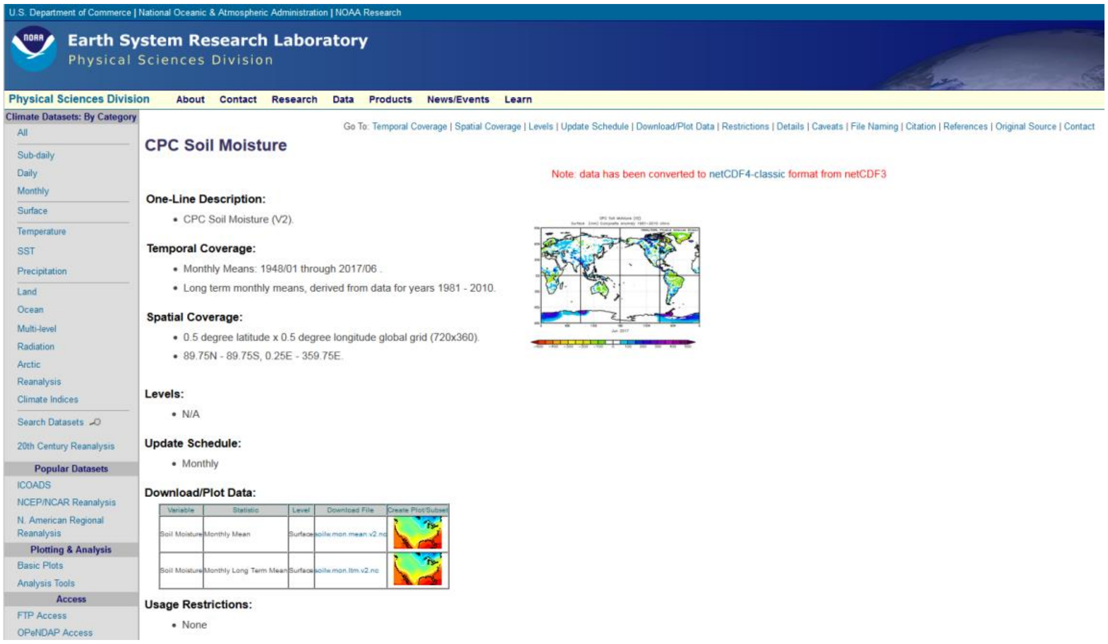


Figure 3: Standardized Precipitation Index for the month of March 2017

3.3 Soil moisture anomaly (SMA)

The monthly soil moisture data is downloaded from the link https://www.esrl.noaa.gov/psd/data/gridded/data.cpcsoil.html



Both Long Term Mean (LTM) and Monthly Mean (MM) soil moisture data are downloaded and the required anomaly is computed as ***'SMA = Current month's soil moisture – long term (1981-2010) average soil moisture for the month'.***

The computation and display of the soil anomaly map are currently being done using Grid Analysis and Display System (GrADS). A typical example is provided below (Figure 4) for the month of March (The script for generating this product is provided in ANNEX I).

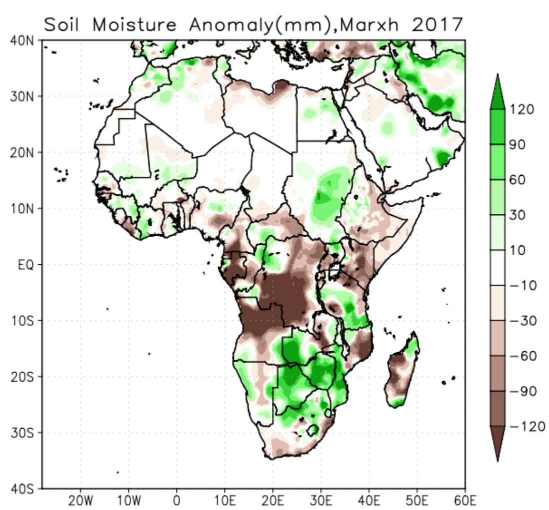
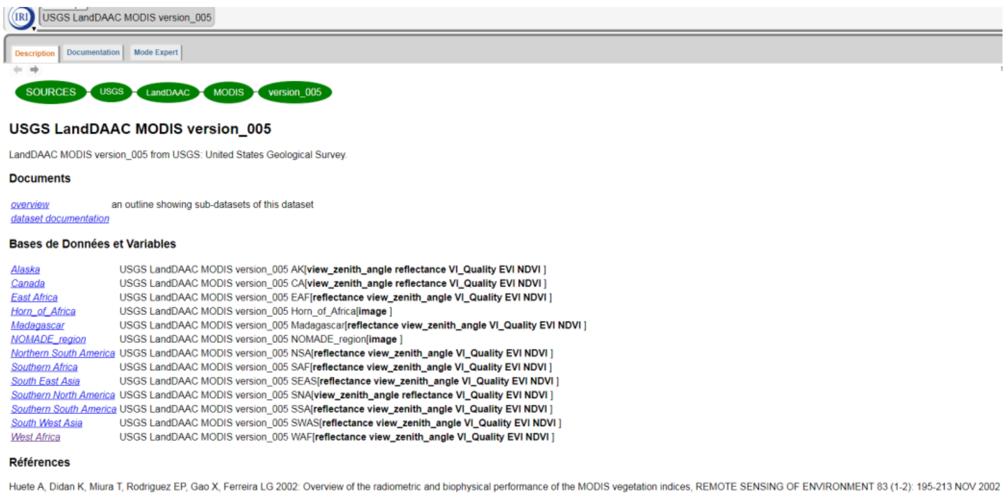


Figure 3: Soil moisture anomaly for the month of March 2017

3.4 Normalized Difference Vegetation Index (NDVI)

NDVI can be used to measure and monitor plant growth, vegetation cover, and biomass production. The data is accessible from IRI data library following the link: http://iridl.ldeo.columbia.edu/SOURCES/.USGS/.LandDAAC/.MODIS/.version_005/ (or from EUMETsat) and selecting the region of interest.


USGS LandDAAC MODIS version_005

Description | Documentation | Mode Expert

SOURCES USGS LandDAAC MODIS version_005

USGS LandDAAC MODIS version_005

LandDAAC MODIS version_005 from USGS: United States Geological Survey.

Documents

overview — an outline showing sub-datasets of this dataset
dataset documentation

Bases de Données et Variables

Alaska	USGS LandDAAC MODIS version_005 AK[**view_zenith_angle reflectance VI_Quality EVI NDVI**]
Canada	USGS LandDAAC MODIS version_005 CA[**view_zenith_angle reflectance VI_Quality EVI NDVI**]
East Africa	USGS LandDAAC MODIS version_005 EAF[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
Horn_of_Africa	USGS LandDAAC MODIS version_005 Horn_of_Africa[**image**]
Madagascar	USGS LandDAAC MODIS version_005 Madagascar[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
NOMADE_region	USGS LandDAAC MODIS version_005 NOMADE_region[**image**]
Northern South America	USGS LandDAAC MODIS version_005 NSA[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
Southern Africa	USGS LandDAAC MODIS version_005 SAF[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
South East Asia	USGS LandDAAC MODIS version_005 SEAS[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
Southern North America	USGS LandDAAC MODIS version_005 SNA[**view_zenith_angle reflectance VI_Quality EVI NDVI**]
Southern South America	USGS LandDAAC MODIS version_005 SSA[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
South West Asia	USGS LandDAAC MODIS version_005 SWAS[**reflectance view_zenith_angle VI_Quality EVI NDVI**]
West Africa	USGS LandDAAC MODIS version_005 WAF[**reflectance view_zenith_angle VI_Quality EVI NDVI**]

Références

Huete A, Didan K, Miura T, Rodriguez EP, Gao X, Ferreira LG 2002: Overview of the radiometric and biophysical performance of the MODIS vegetation indices, REMOTE SENSING OF ENVIRONMENT 83 (1-2): 195-213 NOV 2002

A typical example of the NDVI for the month of March is shown in figure 4 (A GrADS script which can be used to generate NDVI anomaly is provided in ANNEX II).

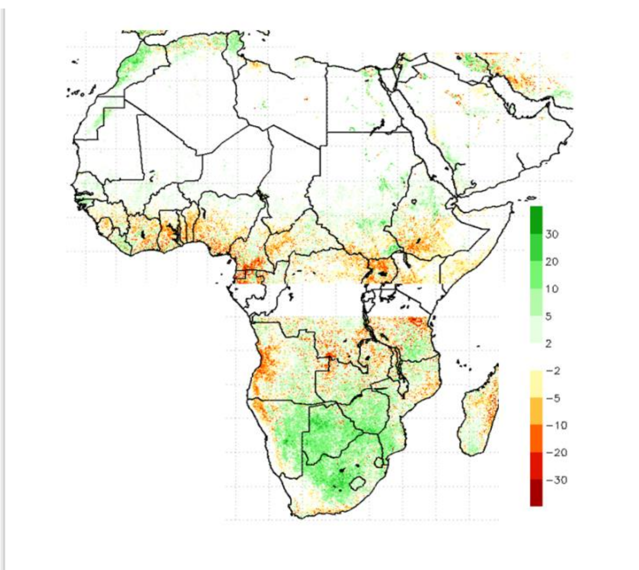


Figure 4: NDVI anomaly for the month of March 2017

3.5 Continental lake level

The continental lake level products are provided by Sentinel3. The locations of the lakes are marked red. The name of a given lake appears by placing the curser on the mark. On double clicking the mark, a graph showing the lake height variation over several years up to present is shown.

It is important to note that the final product is generated following the diagram below. The drought intensity is then provided over three categories (weak, moderate, severe) for each drought type. This is consolidated using QGIS. The impacts on society, economy and environment is collected and included in drought monitoring product.

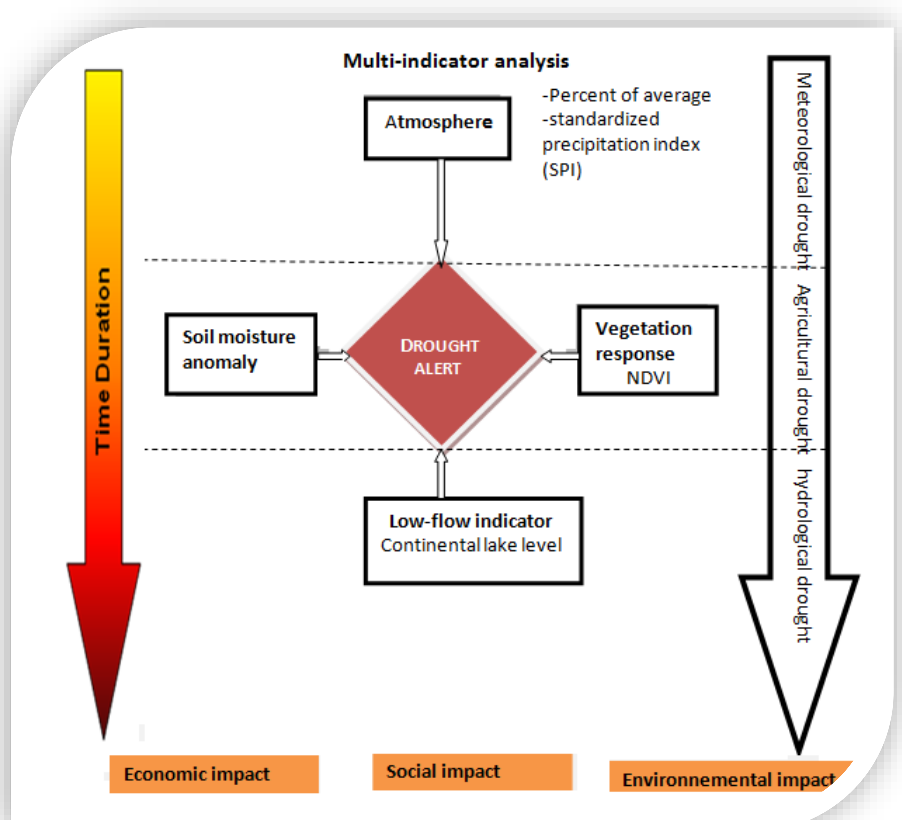


Figure 5: Procedure for drought monitoring based on composite approach *(ACMAD-MESA document)*

3.6 Drought monitoring product based on composite approach

The African Drought Monitor focuses on continental, broad-scale conditions by creating composites of the cumulative precipitation deficits during the past and the current month, standardized precipitation index deficits, monthly soil moisture deficits and monthly vegetation stress with four drought indicator categories provided below.

In the categories, RR, SPI, SM and NDVI denote rainfall percentage, standardized precipitation index, soil moisture anomaly, and Normalized difference vegetation index, respectively.

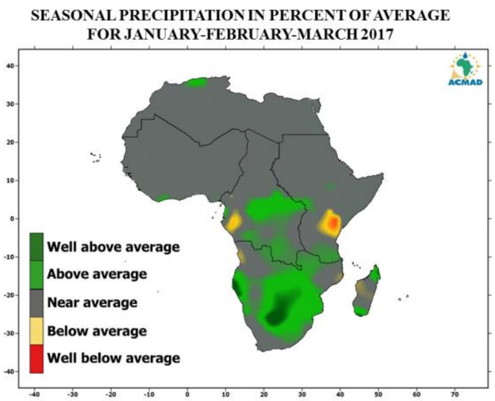
RR < [50]% or RR [50; 75]% ; SPI[-3;-2] or SPI<[-3]; SM<[-60] & NDVI<[-0.20]: **Severe drought**

RR [50; 75]%; SPI[-2;-1]; SM [-60; -10]mm & NDVI [-0.20; -0.1]: **Moderate intensity drought**

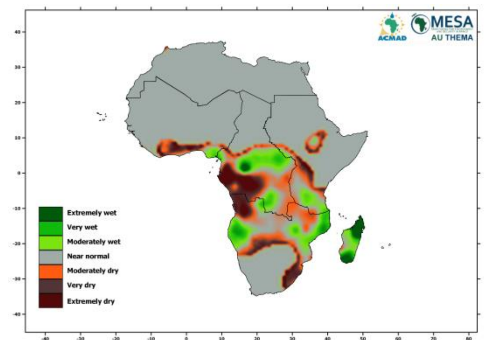
RR [75; 100]%; SPI[-1;-0.5]; SM [-30; -10]mm & NDVI [-0.1; 0.05]: **Low intensity drought**

No drought signal

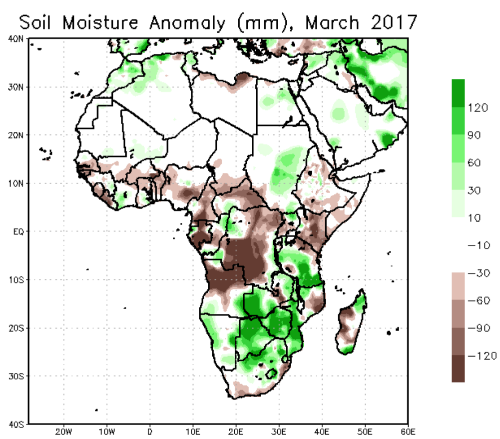
A typical African drought monitor, expressed as a composite of precipitation deficit, soil moisture deficit, SPI and vegetation stress is provided below for the month of March 2017



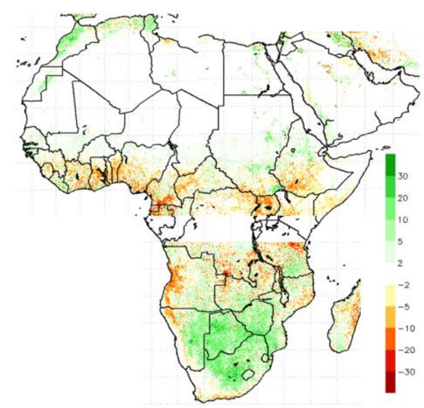
(a) Seasonal precipitation in percent of average from JFM 2017
(Data source: NOAA NCEP CPC CAMS_OPIv0208)



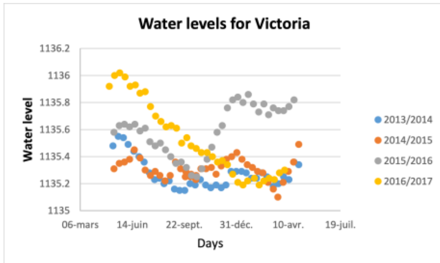
(b) Standardized precipitation index for March 2017 (Data source: NOAA NCEP CPC CAMS_OPIv0208)



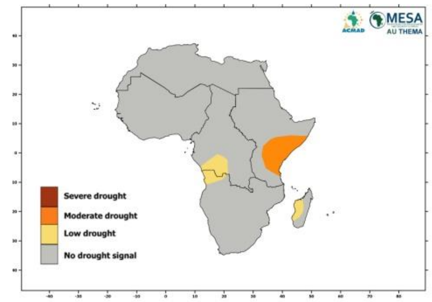
(c) Soil moisture anomaly for March 2017
Data source: http://www.esrl.noaa.gov/psd/data/gridded/data.cpcsoil.html



(d) NDVI anomaly for March 2017.
Source E-station



(e)Daily water level of Lake Victoria
Data Source:
http://hydroweb.theialand.fr/collections/hydroweb

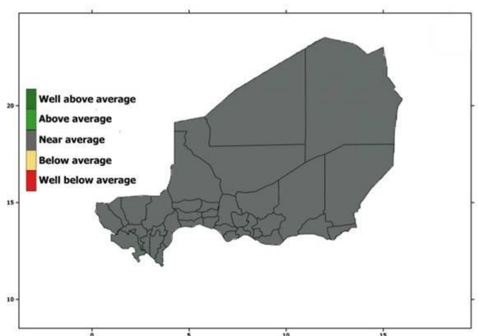


(f) African Drought Monitor, expressed as a composite of precipitation, SPI, soil moisture deficit, vegetation stress, and lake level valid for March 2017.

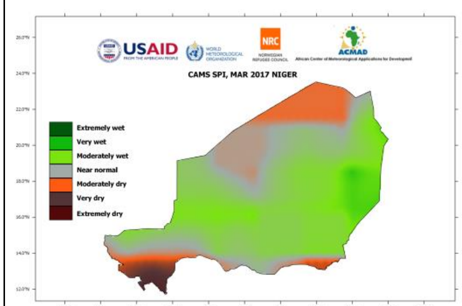
The African drought monitor (Figure 5) shows that low intensity drought was recorded over southwestern DRC, northern Angola and western Madagascar.

Moderate drought was observed over most parts of Kenya, southern South Sudan, southern Ethiopia, northern Tanzania and Somalia

The composite drought monitoring approach can be downscaled/used to monitor drought in a given country such as Niger *(Example below)*



(a) Precip percent of average for JFM 2017



(b) SPI for March 2017 over Niger

<table>
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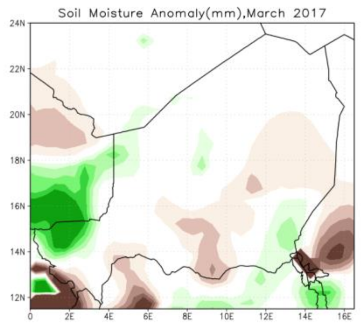
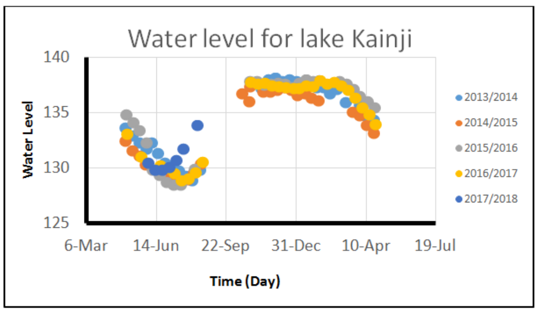
<td>


(c) Soil moisture anomaly for March 2017 over Niger
</td>
<td>(d)NDVI anomaly for March 2017 over Niger (Data needs to be acquired)</td>
</tr>
<tr>
<td>


(e)Daily water level for Lake Kainji
Data Source:
http://hydroweb.theialand.fr/collections/hydroweb
</td>
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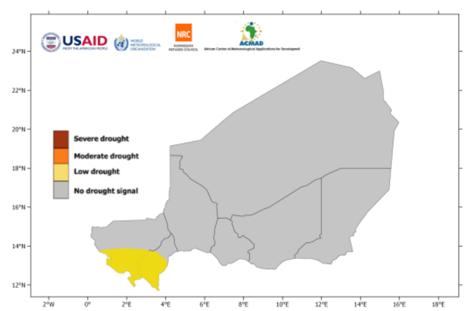

g) Composite drought map for June 2017 over Niger
</td>
</tr>
</table>

Figure 7: Generation of the drought monitor for Niger using precipitation in % of average, SPI, soil moisture anomaly, NDVI anomaly *(to be added)* and lake level. Figure 5(f) provides a sample drought monitor for Niger.

It is important to note that after generating the country's drought monitor, it is important to produce a drought bulletin consisting of the following sub-sections:

- Highlights (*Provide an overview of the performance of the past season)*
- Review of the drought indicators *(Consisting the drought indicators used to generate the drought monitor)*
- Drought monitor *(Provide the 'Drought Monitor intensity'& description of the observed drought cases based on the criteria in use)*
- Recorded impacts *(Capture the observed impacts over the different regions of the country)*

- Climate and hazards outlook *(Capture the observed and the expected SST anomaly evolution in the coming months & the expected precipitation and temperature in the coming seasons)*

- Potential impacts expected and response measures *(Provide the expected impacts and the associated measures to be taken in the country for the different sector; Agriculture and Food Security Sector, Health Sector, Disaster Management Sector, Water Resources Management and the Energy Sectors)*

NB: Refer to the ACMAD's 'Drought Service and Seasonal Climate Forecast bulletin' for details of this product (Available: ACMAD PC10/GFCS/Bob).