Position: Geo-Web Application Developer

Organization: ICPAC

Project: Intra-ACP Climate Services & Related Applications

Duration: Within one year

1. Background

IGAD is one of the Regional Economic Communities (RECs) of the African Union. IGAD was initially created in 1986 as the Intergovernmental Authority on Drought and Development (IGADD) to coordinate the efforts of the Member States in combating desertification and promoting efforts to mitigate the effects of drought. Whereas IGAD Climate Prediction and Applications Centre (ICPAC) is a Specialised Institution of IGAD with the mission fostering climate services and knowledge to enhance community resilience for prosperity in the Greater Horn of Africa.

IGAD Climate Prediction and Applications Centre (ICPAC) intends to award a service contract for individual consultancy of a full stack developer for the contract - transfer of web-mapping technology for disaster risk & automation of data processing and reporting. ICPAC in collaboration with Joint Research Centre (JRC) intend to transfer the open-source web mapping technology for disaster risk monitoring developed by JRC to ICPAC and to optimize the system for drought monitoring for the IGAD region. In addition to drought monitoring, components of specific data processing chain within ICPAC process will be automated to facilitate effective production and dissemination of Climate Services.

Scope of Work

The scope of this consultancy is to:

1) Develop a web application to manage, monitor and forecast drought-related information based on JRC's open-source Web Map server and Integrated Content Management System similar to the one used for the Global Drought Observatory;

2) automate selected workflows of data processing chains and reporting

Detailed specification of the tasks and functionalities of the two tasks can be found in the **Annex 1:** Technical Specifications.

Deliverables and Remuneration

The remuneration for this contract is based on deliverables over a staggered duration not exceeding one year.

Task	Description	Deliverables
Task 1	Install system servers at ICPAC	D.1.1, D.1.2
Task 2	Software installation	D.2.1, D.2.2, D.2.3
1st payment instalment (30%)		
Task 3	Adoption of CMS to work ICPAC standards	D.3.1, D.3.2, D.3.3, D.3.4
Task 4	Conversion of base spatial data to the PostgreSQL and PostGIS databases	D.4.1, D.4.2, D.4.3
Task 5	Integration of SPI computation module, synchronize fAPAR, Soil moisture with JRC data and ICPAC water data	D.5.1, D.5.2
2nd payment instalment (40%)		
Task 6	Publication of the system on the internet	D.6.1, D.6.2
Task 7	Automation of components of data processing chain at ICPAC and integration of MUKAU in order to generate a 10 day bulletin with standard maps and legends	D.7.1, D.7.2, D.7.3, D.7.4, D.7.5, D.7.6, D.7.7, D.7.8
3rd payment instalment (30%)		

Work Station

The consultant will be based at ICPAC within Nairobi Metropolitan Area, Kenya.

Minimum Qualifications and Experience

Education:

- University degree in Computer Science, Geo-Informatics, Computer Engineering, IT or other relevant field,
- Minimum of two (2) years of relevant experience in geo-applications design and development.

- Candidates should demonstrate their qualifications and proficiency in web application development and geo-application development (provide links to at least 2 samples of previous work in your application)

Technical Skills and Expertise:

The consultant performing the tasks shall have a minimum cumulative demonstrated experience of:

- at least 1 year in working with PostgreSQL and
- at least 1 year in working with PostGIS and
- at least 1 year in working with PHP and
- at least 1 year in working with PHP in combination with PostgreSQL/ PostGIS (PHP pgsql) and
- at least 1 year in working with OSGeo MapServer or a similar system and
- at least 1 year in working with python and
- GitHub and experience in web interface development (css/html, JavaScript).

How to Apply

Interested candidates are encouraged to apply via email (Hard copies will not be accepted) with subject line ''Application for Geo-Web Application Developer''. Applications should be received by close of business on 11th December 2020. Include an expression of interest, curriculum vitae, stating relevant achievements and illustrating capacity to undertake the work to the following Address: recruitments@icpac.net

Annex 1 to Contract

"Transfer of web-mapping technology for disaster risk"

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 our sister institution, ICPAC, that will install the system at their premises in Nairobi, Kenya.

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

The system to be ported is described in this document; we also give reference to the functionalities to be transferred to the technical platform of ICPAC. The website address where the system can be downloaded and initially installed is available in a private library at GitHub: https://github.com/ec-jrc/MUKAU-GEOCMS access to this library can be given upon request. The system is called MUKAU after a plant growing in dry lands in East Africa. There is also daily water level and river discharge data that is available at a local data base that will be added to the system to inform the hydrological content.

1. Service Requirements

- The Joint Research Centre of the European Commission (JRC) currently operates two Drought Observatories (DO): European Drought Observatory (EDO) and the Global Drought Observatory (GDO). JRC developed a South and Central America Drought Observatory together with CIIFEN (Equador) that is fully based on Open Source technologies; it has a similar architecture to 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 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 10 days (earth observation data) with new products describing the rainfall, temperature, vegetation conditions, and soil moisture contents. Feeding new data takes place by using a range of specific software packages, also

Open Source based. In order to analyse and visualize the drought products, specific programs are made in PHP, Python, R and OsGeo MapServer PHP Map Script.

– Additionally, a GEOSFM model output of daily water level and discharge timeseries is available at ICPA with threshold statistics of 5, 10 and 15 years return period. This will need to associated with the associated with stream shapefiles

– The main challenge for drought monitoring is to explore a large variety of data with long time series. This creates the need to manage huge 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 optimized data formats for array processing, mainly NetCDF.

1.1. REQUIREMENTS FOR TRANSFER

1.1.1. **Functionalities to be ported**

In the chapter below, we will discuss the various functionalities to be ported from the Platform functioning at the JRC in Ispra, Italy, to a platform functioning at ICPAC, in Nairobi, Kenya. The main work is to install the system in ICPAC 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 ICPAC.

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

ICPAC 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 ICPAC PostgreSQL POSTGIS database. The main tables to be converted are tables that describe pixel locations as vector data in Decimal Degrees. These tables come in five resolutions, 1 decimal degree, 0.5 decimal degree, 0.25 decimal degrees, 0.1 decimal degree and 0.08333 ($^1/_{12}$) decimal degrees. These five tables contain the 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 ICPAC in a binary

export format and subsequently the tables will be recreated in the ICPAC 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 ICPAC 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 fAPAR (fraction of Active Photosynthetic Absorbed Radiation) vegetation data are ingested respectively monthly and every 10 days into the system. Long-term anomalies are subsequentially computed for all variables.

The summarized monthly rainfall is copied from a NetCDF file on an ftp server from 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 fAPAR 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 Oracle Spatial SQL logic. The fAPAR and soil moisture data will be made available by the JRC in real time with a dedicated internet connection and a specific Python module will ingest the data into the database set up at ICPAC.

The Hydology data (Water level and discharge) is from a GeoSFM model running at ICPAC. The post-processed data is available in .txt format. Location of datapoints is also available as shapefile. The model runs operationally once a day and updates the outputs accordingly.

1.1.4. Map Viewer

The Map Viewer is based on a so-called Mapfile; it is a file 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 ICPAC classification can be developed and shared back with the JRC or other partners.

The current Mapfile contains 38 layer entries. Whether all layers will be re-used at ICPAC 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 contains beside this reference to a Mapfile 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, which are JavaScript, Mapscript based on a Mapfile and PostGIS PHP. For adaption of 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, head 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 or 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 ICPAC organisation.

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
- 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
- Daily River Water level and discharge in from a local database, 1Gb

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

o Centos 7.x (including Apache)

On PC client:

o PL/pgSQL (launching algorithms, conversion)
o PostgreSQL Import/Export (synchronisation external Database)
o ODBC driver (integrating avoiding conversion)
o Oracle Virtual Machine (optional)
o R (SPI computation)
o Python version 3.x
o GIS Client for example QGIS
o GDAL-OGR (raster/vector format conversion)
o 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.

1.3. TASKS AND DELIVERABLES

Task 1

Installing the system servers (physical or virtual) at the premises of ICPAC, using the local network with a database server (at least 1) and various clients for development (at least 1), testing (at least 1) and a 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 ICPAC to be used in the project.
D.1.2 Detailed work plan for Tasks 2.

Task 2

Creation of the base software system at the premises of ICPAC, using PostgreSQL/PostGIS, MapServer, PHP and Python as working platform. Software installation at ICPAC using the hardware shall be made available by ICPAC in task 1. The installation takes place using the guidelines available on GitHub and provided in the annex. 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 ICPAC.
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 Tasks 3.

Task 3

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

Deliverables of task 3:
D.3.1 Upgraded style sheet 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 Tasks 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 Tasks 5

Task 5

- Integration of SPI computation module and module to synchronize fAPAR and Soil moisture data with the JRC.
- Integration of the ICPAC hydrology (river discharge & water level) with daily updates of the database

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.

Task 6

Publication of the finalized system on the Internet

Deliverable of task 6:
D.6: Final report (as described in section 2) and working system.

1.4. INPUTS FROM JRC-ISPRA AND ICPAC

The JRC-ISPRA 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. ICPAC will provide access to hardware on which the new system will function, access to the server hosting the hydrology database and a workplace with internet access.

2. Reporting

Intermediate reports D.1.1 to D.5.1 mentioned in section 1.3.

Final report (D.6)

A final report (D.6) shall document the execution of the project 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 that were developed during the project.

The Table of Contents of the Final Report:

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

The final report is - together with all previous completed deliverables - the basis for the final payment of the project.

The final report has 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 report shall include the following mandatory information: consultant name, contract number, document title and signature.

The consultant shall produce the final report in electronic format (e.g. MS Word).

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

The final report (D.6) 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 ICPAC in Nairobi, Kenya.

The kick-off meeting (M-1) will be held as soon as possible, within **the first 2 months** 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 both 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.

During meeting (M-3) the contractor shall:

- present the execution of Task 3
- present the execution of Task 3 (D.3.1, D.3.2, D 3.3 and 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 4.

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.

During meeting (M-4) the contractor shall:

- present the execution of Task 4 (D.4.1, D 4.2 and D.4.3).
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 5.

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

During this meeting (M-5) the contractor shall:

- present the execution of Task 5 (D.5.1). 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.5.1 shall be done through **exchange of emails** between the parties.

All the meetings will take place via video or telephone conference **on the date mutually agreed**. For these meetings the consultant 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. The working language of the meetings and the accompanying documents will be English.

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
N+*[x days]***	M-3	Videoconference on the completion of Task 3	Present the execution of task 3
N+ *[x days]***	T4	Task 4	D.4.1, D.4.2, D 4.3
N+ *[x days]***	M-4	Videoconference on the completion of Task 4	Present the execution of task 4
N+ *[x days]***	T5	Task 5	D.5.1
N+ *[x days]***	M-5	Videoconference on the completion of Task 5	Present the execution of task 5
N+ *[x days]***	T6	Final report	D.6.1

*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. Duration of the contract

The duration of the contract shall not exceed **12 (twelve) months** after the kick-off meeting.

ICPAC

6. Other general modalities and responsibilities

6.1. 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.

6.2. 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-ISPRA;

3. Further actions which, in the opinion of the JRC-ISPRA, would be necessary for the acceptance of the deliverables will be undertaken by the consultant 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.