**Monitoring for Environment and Security in Africa (MESA) EUROPEAID/132517/D/SER/Multi**

**TERMS OF REFERENCE**

***DRAFT***

**Technical Support to the Forest Monitoring Service: Capacity Building in basic GIS and Remote Sensing applications in forest monitoring for the National Focal Points**

**1 BACKGROUND**

**1.1 Beneficiary countries**

5 IGAD Member States (South Sudan, Sudan, Eritrea, Djibouti and Somalia) plus Burundi.

**1.2 Contracting Authority**

The Commission of the African Union

**1.3 Relevant background**

The Monitoring for Environment and Security in Africa (MESA) programme intends to contribute to poverty eradication and sustainable development by addressing the need for reliable, timely and accurate land, marine and climate data and information for Africa, fully exploiting Earth Observation (EO) data and technologies.

The programme is implemented in 48 countries and 5 Regional Economic Communities (RECs) with 6

Regional Implementation Centres (RICs) and 1 Continental Implementation Centre (CIC). The programme aims at five result areas and has some clear objectives in the areas policy formulation of environmental management using environmental monitoring by Earth Observation devices (see annex n.1, the Logical Framework). There is a requirement to establish a forest monitoring system within MESA based on a suitable and innovative methodology.

Result Area 5 on capacity building describes the capacity development and training of African stakeholders in Forest Monitoring through better understanding and competent use of EO’s services and products. The capacity to implement MESA services for informed decision making in Forest Monitoring at national and regional level shall be sufficient. Expanding technical capacity and intensive trainings will be essential to ensure sustainability and successful delivery of quality and reliability of MESA services with emphasis on training of trainers for cost effectiveness and long term sustainability.

Following the regional forest methodology review workshop that was attended by 10 national forest monitoring focal points from IGAD member state on 24-25 September 2014 and needs assessment survey on capacity building levels, it’s very clear that national focal points are at different levels in terms of GIS and remote sensing skills. During the discussions in the parallel sessions, the national focal points pointed out there will be no benefits of MESA to the IGAD member states if the capacity is not built to produce the same products and services that are being developed at RCMRD.

From the analysis of the needs assessment survey on capacity building, the following IGAD countries need training on basic GIS and remote sensing applications in forest monitoring; Burundi, Sudan, South Sudan, Eritrea, Somalia and Djibouti. Therefore, these Terms of Reference Keys seek an expert to prepare training materials for introduction to GIS and Remote sensing applications in forest monitoring and carryout basic GIS and remote sensing training of national forest focal points.

**2 OBJECTIVE, PURPOSE AND EXPECTED RESULTS**

**2.1 Overall Objective**

The overall objective of this consultancy work is to deliver training in GIS and Remote Sensing (RS) to maximum of 5 staff in each of the 6 countries.

The main specific objectives are:

1. Preparation of training materials to deliver a course aimed at introducing staff to GIS and remote sensing and their application to forest monitoring
2. Carry out training of national forest focal points in 6 countries for 10 man-days in each country

The above mentioned objectives will be achieved through adequately addressing the points under 2.2.

**2.2 Purpose**

The purpose is as follows:

1. To give a sufficient level of understanding so that the staff have an overall appreciation of the role of and limitations of GIS and RS in forest monitoring
2. To train critical project staff in the basics of GIS and RS sufficient for them to be able to carry out basic tasks in GIS and RS-based forest monitoring.
3. To provide staff with the basic tools to be able to take advantage of further training in GIS and RS to be given under the MESA project

**2.3 Results to be achieved by the Consultant**

1. Between 40 and 50 staff trained in 6 countries.

**3 SCOPE OF WORK**

**3.1 Project description**

The consultancy work aims at providing a core of staff able to fully engage with the project and implement in their home countries the Forest Monitoring Service being developed by MESA-ICPAC.

The Consultant will also liaise with EUMETSAT and JRC. The Consultant will consult the EU web site to become acquainted with the EU templates for report writing and timesheet.

**3.2 Target Groups**

Specifically, a maximum of 5 staff in each of the following institutions, although the beneficiary institution may invite staff to be trained from other institutions within the country up to the maximum to be trained:

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| --- | --- |
| **Country** | **Institution** |
| Burundi | Ministry of Environment  Forestry Department  Bujumbura, Burundi |
| Sudan | Sudan Forest National Corporation  Khartoum, Sudan |
| South Sudan | Ministry of Agriculture, Forestry  Directorate of Forestry  Juba, South Sudan |
| Eritrea | Ministry of Agriculture  Forestry Department  Asmara, Eritrea |
| Somalia | Ministry of livestock, Forestry and Rangeland  Director of Forestry and Rangeland  Mogadishu, Somalia |
| Djibouti | Ministère de l'Habitat, de l'Urbanisme et de l'Environnement (MHUE)  Djibouti |

**3.3 Specific Activities**

The work will be undertaken at the institutions in the countries given above. There will be a three day briefing given to the consultant at RCMRD in Nairobi. The bulk of the work will be to deliver a training programme that covers the following components:

This training in forest monitoring using QGIS software will cover the following areas:

**Day 1 & 2: Setting the Stage**

Lesson 1: Properties, characteristics and sources of satellite imagery to be used for the compilation of activity data. This will include the discussion of spatial, temporal, spectral and radiometric resolution. The relevant processing levels for the respective sensors, artefacts and possible defects common to imagery from both RapidEye and Landsat.

Practical 2: Exploring catalogues and ordering interfaces for satellite imagery to be used for the study site. Ordering Landsat images through the Earth Explorer, GLOVIS and EOLI interfaces. Familiarisation of the Eye Find interface to browse and order RapidEye data.

Practical 3: Introduction to QGIS. Software overview, design and functions.

This will include, looking at the QGIS user interface in detail, adding data to the map view, changing the display properties, panning, zooming and manipulating data layers. All icons and drop down menus in the user interface will be explained briefly. Users will be introduced to the display, manipulation and query of point, line and polygon vector data as well as geo-databases and OGC services. At the end of this practical, learners will be able to navigate, load and display data in QGIS with ease.

**Day 3 & 4: Geometric Corrections (Image Pre-processing)**

Lesson 3: Exterior and Interior orientation of satellite imagery. Models for the correction of image coordinates to ground co-ordinates.

Learners will be taught the difference and relationship between image geometry and ground range geometry.

Practical 3: Importing, mosaicking, stacking and clipping satellite imagery in QGIS.

In this practical learners will import and prepare common satellite imagery from Landsat and RapidEye in QGIS, preparing the data for geometric corrections. They will be exposed to the stacking, mosaicking and clipping tools in QGIS.

Practical 4: GCP collection, co-registration, geo-referencing and orthorectifying imagery in QGIS.

The leaner will use the Georeferencer plugin in QGIS, to collect ground control points (GCP’s) and subsequently geo-reference or align provided imagery. The orthorectification module which is part of the OTB plugin will be used to orthoretify a satellite image.

Lesson 4: Projections and resampling algorithms.

In this lesson the learner will be introduced to different map projections and resampling algorithms used to process raster data.

Practical 5: Re-projecting imagery and vector data in QGIS. Defining projections in QGIS.

In this practical the learner will be set reference projections to be used in the QGIS project, set projections on the fly and re-project raster and vector data.

**Day 5 & 6: Radiometric Corrections (Image Pre-processing)**

Lesson 5: The Information Path; from source to data product.

In this theory lesson the learner will be taught how light radiated by the sun dissipates over distance, interacts with the earth surface and is reflected back into space where radiation is measured by satellite sensors and binned to digital numbers. The learner will be introduced to the method of converting digital numbers back to radiance values which can subsequently be normalised to Top of Atmosphere reflectance.

Practical 6: Converting Digital Numbers to Top of Atmosphere Reflectance values.

In this practical the learner will use the raster calculator in QGIS to convert digital numbers from the supplied Landsat and RapidEye data to top of atmosphere reflectance values.

Lesson 6: Radiation interacting with Atmosphere and Surface. Atmospheric correction techniques.

Here the learner is introduced to different factors affecting the radiation path of light through the earth’s atmosphere and how to correct for these effects using several empirical correction techniques as well as Radiative Transfer Models in particular the 6S model from Vermote.

Practical 7: Atmospheric corrections in QGIS.

The learner will use the raster calculator in QGIS to apply empirical atmospheric correction techniques to the satellite imagery and use the GRASS plugin in QGIS to run the 6S atmospheric correction model on both Landsat and RapidEye data.

**Day 7 & 8: Image Exploration Image Classification**

Lesson 7: Indexes, PCA’s, time series analysis

In this theory lesson the learner will be introduced to a range of vegetation and land cover dependent indices, their strength and weaknesses and fields of application for this study. The theory behind a principle component analysis (PCA) and methods to analyse imagery quantitatively in a time series analysis will be discussed.

Practical 8: Calculating a range of vegetation and other indexes in QGIS and performing a time series analysis.

Learners will calculate a range of indices for the study area and from the supplied data, using the Raster Calculator in QGIS, display these optimally and evaluating their information content for use in this project. Learners will use the “heartbeat” plugin to visualise the phenological behaviour over

time for the forests of interest. They will further develop and calculate temporal and change indices using the provided time series data and the QGIS raster calculator. 8/14

Practical 9: Undertaking a Principal Component Analysis in QGIS / GRASS plugin.

Learners will use the GRASS plugin to calculate a principal components for Landsat and RapidEye and apply a Tasselled Cap transformation to both datasets using the QGIS raster calculator, evaluating the usefulness for the classification of forests.

Lesson 8: Different measures of image texture, principles of image fusion.

In this lesson learners will be introduced to different methods of quantifying image texture of relevance for the characterisation of forests in high resolution imagery. They will also be introduced to a range of techniques fusing high spatial resolution panchromatic imagery with low spatial resolution multispectral imagery.

Practical 10: Calculating a range of texture measures in QGIS and fusing imagery / pan-sharpening data.

Learners will use the OTB plugin in QGIS to calculate a range of textural measures from the high resolution panchromatic Landsat 7/8 and RapidEye multispectral imagery. Furthermore learners will apply a range of pan sharpening techniques using once again OTB plugins to fuse the Landsat panchromatic with the multispectral data.

Lesson 9: Statistical, contextual and rule based classifiers.

In this session learners will be introduced to the theory behind supervised and unsupervised classifications, which might be purely pixel based statistical classifiers, use additional contextual information, or depend on rule-sets. The learner will be referred to examples in the use of each technique for the compilation of activity data from both Landsat and RapidEye.

Practical 11: Unsupervised Classification

In this exercise the learner will use the OTP plugin to perform a KMeans classification using previously calculated indexes and the ToA reflectance data from the separate sensors and bands and acquisition dates. A final classification product will be created by recoding the data, and working within predefined masks generated by the raster calculator.

Practical 12: Collecting training sites.

Learners will use the open layers plugin to visualise high resolution satellite imagery from GoogleEarth in QGIS and together with the Landsat and RapidEye imagery, digitize training areas for different classes to be extracted from the imagery during a supervised classification. Several of the vector editing tools available will be used in QGIS during this exercise.

Practical 13: Supervised statistical, contextual and rule based classifications in QGIS.

Training data collected in practical 12 will be used to run several supervised classifications using the Semi-Automatic classification plugin in QGIS and other functions from the OTB plugin.

Lesson 10: Post classification workflows.

Learners will be introduced to the theory of workflows to clean and merge classification products to more accurate and visually appealing datasets.

Practical 14: Combining and cleaning classification results in QGIS.

Material covered in theory lesson 10 will be applied in practice using a range of filters and models available through QGIS plugins and the raster calculator.

**Day 9 & 10: Fieldwork preparation & Fieldwork**

Lesson 11: Planning a field campaign.

This lesson will cover the theory behind planning routes to be travelled during a field visit minimizing time and cost for the maximum of information gathered. Spatial statistics and sampling methods with related costs and accuracies will be covered in this lesson. The sampling and data gathering techniques will be mainly of relevance to land cover classification verification and accuracy assessment but will also prepare students for lesson 12.

Practical 15: Spatial analysis of road network, buffering and random sample selection.

In this practical, students will digitise or edit road networks using the open layers plugin providing google earth backdrop data and the available RapidEye and Landsat imagery. During this exercise learners will clip, subset and buffer vector data and then generate random sample points in a stratified fashion to be visited during field work.

Practical 16: Collecting Land Cover classification verification data.

Students will visit the field for the chosen study area and collect land cover validation data, taking photographs of the selected sample plots with digital cameras. The GPS will be connected to either a laptop or tablet providing visualisation of both the locality on satellite images and the GPS reception quality. Data will be captured effectively using the forms in practical 18, directly in QGIS.

Practical 17: Collecting forest inventory data using QGIS database forms.

Plots earmarked for forest inventory during practical 16 will be visited and all relevant trees measured. Information will be captured on database forms in QGIS.

**4 REQUIREMENTS**

**4.1 Non Key Expert: GIS and Remote Sensing expert (Forest Monitoring)**

*Qualifications and skills*

* Masters’ Degree or equivalent in Natural Resources management or Geo-information systems or forestry from a recognized university.
* Certificate/Diploma in GIS if candidate does not have a Master’s degree in geo-information.
* Possess over 2 years of experience in using QGIS related to NRM and Forest Monitoring.

*General professional experience*

* At least 2 year’s experience in training students in GIS/RS and Geoinformation related subjects
* Knowledge of Forest mapping and monitoring Knowledge of REDD+ mapping using GIS required
* GIS and remote sensing analytical skills using open source software (QGIS) for image processing and analysis.
* Fluent in either English or French with a proven working knowledge of the other language
* Good writing skills

*Specific professional experience*

* Technical skills on the subject of Forest monitoring, mapping, and REDD+ mapping using QGIS
* Good background in remote sensing and QGIS techniques and applications, mainly for multi resolution/sensor approach, spatial analysis.
* Good experience in forest mapping, imagery classification and spatial data modelling.

**4.2 Facilities provided by the RIC**

The expert shall be equipped with a personal laptop computer and training materials in softcopies. A training room, overhead projector and computers for the trainees will be provided by the respective focal point institutions. While at RCMRD, a fully furnished office with internet will be provided.

**4.3 Equipment**

No equipment is to be purchased

**5 LOGISTICS AND TIMING**

**5.1 Location**

The expert will report to ICPAC and proceed to RCMRD for inception report writing and agreeing to the schedule of the training. The expert will provide a softcopy of the training materials (lecture notes, exercises and data) on CD which will be printed or copied by the institutions receiving the training.

Due to the insecurity situation in Somalia, the Somalia focal points will be trained at RCMRD

Human Dynamics will arrange all flights related to this assignment.

**5.2 Commencement Date and Period of Implementation**

The expert will carry out training of national forest focal points (Maximum of 5 people) in 5 IGAD countries (Sudan, South Sudan, Eritrea, Somalia and Djibouti) and Burundi. The training will last for 10 days in each country. In addition the expert will have three days at RCMRD at the start of the assignment writing the inception report and 4 days writing the final report.

Total working days for the contracting period will be 75 days. The work will run without interruptions.

No work days from home are permitted.

**6 REPORTS**

At RCMRD, the consultant will report to the Forest Thematic Expert and at ICPAC to the MESA/RIC Manager. The Consultant will produce an inception report and work-plan two days after the start of the assignment of no more than 5 pages. In the inception report a time plan, with details on the traveling to RIC and RECs, will also be annexed. Production of training materials is a duty of the consultant.

Finally, the Consultant will be required to submit, together with the corresponding invoice, a final report of no more than 25 pages (without annexes) in which he/she will report on the activities carried out during the assignment. The report is to be submitted no later than 14 days after the training finishes. An Interim report is required at midway of his/her work to be agreed with ICPAC and RCMRD.