



## Working session I

**Dar es Salaam and Morogoro, Tanzania, 8-24 April 2013**

Held to inform the project:

*Support Tanzania in the development of multiple benefits maps to inform REDD+ safeguards policies*

## Report from working session

**Objectives of the project *Support Tanzania in the development of multiple benefits maps to inform REDD+ safeguards policies*, executed by UNEP-WCMC in collaboration with TFS, FAO and UNDP:**

1. Contribute to, and support the development of enhanced national scale spatial datasets, statistics and maps on biodiversity and ecosystem services for Tanzania for the purpose of informing REDD+ policies and measures, notably land use planning and prioritization of REDD+ intervention zones. The themes referred to in the Cancun environmental safeguards, including natural forest and priority areas for multiple benefits (carbon, biodiversity, other ecosystem services) will be mapped, building on and using the NAFORMA plot data alongside other relevant national scale spatial datasets.
2. Build capacity within Tanzania on spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+ and on approaches to developing information systems for safeguards.

**Objectives of the working session:**

1. Provide introductory training in QGIS, GRASS and SAGA.
2. Prepare a first set of maps defined as priority for the project in a workshop held in Morogoro, Tanzania, February 2013.

### Introduction

Eight people participated in the working session, nominated for participation by Tanzania Forest Service. The workshop lasted twelve working days, 8-23 April 2013. Seven days were spent working at TFS offices in Dar es Salaam, and five days were spent in Morogoro, at Sokoine University of Agriculture (SUA).

### Mode of working

The working session was conducted with the following main elements:

- **Introductory presentations** to the operative system and software used; the data registry compiled for the purpose of multiple benefits mapping in Tanzania; various types of datasets and the IP rights that they come with;

- **Group discussions** on how to address particular questions, and what the best way of creating and presenting certain maps might be;
- **Individual or paired work on a particular task**, starting with an introductory presentation, followed by individual work using a tutorial, with facilitators helping individuals as questions arose. The sessions were concluded with an overview of the steps of the process.

In line with contract terms, the working session was conducted using open source GIS software. In accordance with a decision taken at the project inception meeting in Rome, December 2012, QGIS was used, together with SAGA and GRASS toolboxes, as well as other free standing software. Most of the participants had little or no experience with the software used. The working session therefore had to include training elements to familiarize the participants with the working environment.

To facilitate the training and avoid having to configure many different systems, a live USB with the Xubuntu (Linux) operative system, and installations of QGIS, SAGA and GRASS with all necessary extensions, was provided to each participant (the FAO-FIN programme was of great assistance in providing technical advice and support for preparing these USBs). All GIS work was subsequently conducted in this environment. This setup ensured that each participant worked in identical OS, and valuable time did not have to be spent on configuring different computers. Most participants worked on their own laptops, and the machines were generally strong enough to process the data as required. A couple of the analyses on larger datasets took longer, and while the technical processes were thoroughly worked through with the participants on smaller datasets, the full dataset were then instead processed overnight by UNEP-WCMC, and results provided in the morning the next day.

In preparation for the working session, UNEP-WCMC had put substantial effort into compiling a data registry of relevant spatial datasets for Tanzania, with assistance from several people, including FAO HQ, WWF, FAO TZ, and SUA<sup>1</sup>. This data registry was provided to all participants on the live USB stick, along with a selection of the datasets relevant for the first working session.

This first working session required basic capacity building in the GIS software, and familiarize the team with the software and work environment, which determined the scope and pace of the working session.

## **Results – activities, map products and decisions made**

The below listed activities were covered. The last days of the working session were dedicated to preparing and giving a presentation on the outcomes of the working session, to representatives from TFS, UNDP, FAO and WWF/UNEP-WCMC. Feedback was given and incorporated in subsequent work (Annex IV).

- **Introduction to multiple benefits mapping; Xubuntu and QGIS; data management and IP rights**
- **Introduction to available biodiversity datasets and to working with vector data in QGIS**

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<sup>1</sup> Great help was received from Neil Burgess, Boniface Mbilinyi, Almas Kashindy, Soren Dalsgaard, Mikko Leppanen, Lauri Tamminen and Anssi Pekkarinen.

- **Activity:** map extent of occurrence of threatened mammal species from the IUCN Red List database
- **Activity:** map NAFORMA tree species richness and tree density by cluster
- **Exploring map layouts and templates in QGIS**
- **Understanding map projections and how they work in QGIS**
  - **Activity:** which map projection should we use for analysis at the Tanzania national scale?
- **Understanding topology in QGIS**
  - **Activity:** Activating topology and editing polygon data, using LULC map
- **Introduction to raster data in QGIS, GRASS and SAGA, overview of Saatchi and Baccini**
  - **Activity:** practice adding raster datasets to QGIS and symbolise them, using Saatchi, Baccini and MSNFI map
  - **Activity:** Generating statistics from raster data
- **Defining and mapping natural forest: discussion**
  - **Activity:** mapping natural forest using the LULC map, based on different definitions
- **Mapping ecosystem services: discussion**
  - **Activity:** Initial stages of the process for mapping the importance of forests for limiting soil erosion using a simple approach

#### GIS analyses and skills covered in the working session

The analyses described above were completed with the entire group. Further technical detail is provided in the methodological brief, which is part of the project deliverables.

#### Map products

- Threatened mammal species richness, based on IUCN extent of occurrence data
- Tree species richness per cluster, based the NAFORMA inventory point data
- Stem density per cluster, based the NAFORMA inventory point data
- Raster maps of Saatchi, Baccini and NAFORMA (Rufiju district) above-ground biomass data, and complementary statistics
- Maps of natural forest according to different definitions, using the NAFORMA LULC map

#### Decisions made

- Which projection to use for maps and analyses in Tanzania
- Natural forest – which definitions to map and overlays to make
- Relevant ecosystem services to investigate for the next working session
- Comparison of carbon maps – basis for understanding of accuracy
- REDD+ actions for which potential zones for implementation could be investigated

## Annex I – Analyses covered in the working session

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The following analyses were conducted in the first working session:

- **Extract and process Red List vector data for extent of occurrence of species, producing a species richness map of threatened mammals, using a hexagon grid.**
  - o Extract IUCN individual species range polygons for Tanzania
  - o Select only threat categories for vulnerable, endangered and critically endangered species
  - o Overlay the individual ranges to create a richness map
  - o Produce the draft map layout in QGIS
- **Display tree species data from the NAFORMA inventory point data as tree species richness per cluster**
  - o Create mean coordinates for the clusters based on the plot locations
  - o Create a summary of the number of different species in each cluster
  - o Create a summary of the number of plots in each cluster
  - o Calculate the mean number of species in each plot by cluster
  - o Produce the draft map layout in QGIS
- **Stem density per cluster, based the NAFORMA inventory point data**
  - o Create a summary of the number of trees in each cluster
  - o Calculate the mean number of trees in each plot by cluster
  - o Produce the draft map layout in QGIS
- **Map natural forest based on three different possible definitions used in the country**
  - o Discuss the different definitions and their implications, and how natural forest should be mapped based on them.
  - o Use the NAFORMA LULC map, displaying the vegetation categories relevant for the different definitions
- **Comparison of above ground biomass maps<sup>2</sup>: Saatchi, Baccini and a preliminary NAFORMA multisource above ground biomass sample map for Rufiji**
  - o Undertake an overlay analyses with each carbon map and the NAFORMA LULC map to generate average biomass values per vegetation class and compared the differences
  - o Project Saatchi, Baccini and NAFORMA multisource above ground biomass map to same projection
  - o Clip Saatchi and Baccini to same extent as Rufiji sample
  - o Calculate difference between Saatchi and NAFORMA sample by subtracting one from the other
  - o Calculate difference between Baccini and NAFORMA sample by subtracting one from the other
  - o Produce a draft map layouts containing the 3 maps and their differences

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<sup>2</sup> **Saatchi:** Saatchi S, Harris NL, Brown S, Lefsky M, Mitchard ET, Salas W, Zutta BR, Buermann W, Lewis SL, Hagen S, Petrova S, White L, Silman M, Morel A. (2011). Benchmark map of forest carbon stocks in tropical regions across three continents. *Proc Natl Acad Sci U S A.* 2011 Jun 14;108(24):9899-904. More information can be found at: <http://carbon.jpl.nasa.gov/> **Baccini:** A. Baccini, S J. Goetz, W.S. Walker, N. T. Laporte, M. Sun, D. Sulla-Menashe, J. Hackler, P.S.A. Beck, R. Dubayah, M.A. Friedl, S. Samanta and R. A. Houghton. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. 2012 *Nature Climate Change*, <http://dx.doi.org/10.1038/NCLIMATE1354>

## Annex II – notes from discussion on REDD+ actions and how potential zones for implementing them could be mapped

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### Restoration

- Restoration of degraded areas
  - LULC map: open land (if in protected area), bushland (where has been land-use change), carbon?
  - cultivated woodland (combine with livelihood creation, natural regeneration)

### Improved agricultural practices

- Agroforestry (tree, arable crops, livestock, bees)
  - Elevation (over 1000m? – get the range from Kilimanjaro)
  - Need compelled by the climate (precipitation, temp) and soil
    - E.g. shade needed for drip irrigation
  - High density population, limited supply of land
  - Slope
  - Potential for beekeeping (NAFORMA plots – species suitable for bees)
  - LULC overlay – which of the species are in woodland?
- Improved tillage farming on slopes
  - Slope dataset (>20-25 degrees – look up in literature), overlay with land-use: agriculture + cultivated bushland + **cultivated woodland**
  - Small plots – huge impact on soil erosion and runoff
- Balanced grazing practices (reduce number of ruminants?)
  - LULC: grassland, bushland
  - (link to degradation)
- Woodlots
  - More common in highland areas where the exotic species perform well. Many indigenous species grow too slowly. Dryland areas lower potential)
  - Elevation (over 900-2000 m)
  - Rainfall
  - Land availability (0.25-0.5 acre per household). Arusha – 10-20 trees, Iringa – 10 acres of trees, functions as a business
  - A nursery at the village level – a variable but not the key issue
  - Tenure is an issue
  - Northern part of Tanzania more dependent on fuel wood (resource crisis), more likely to use the wood for fuel. In southern Tz harvested woodlots will be used for timber, poles.
  - Ngitiri – acacia species (natives), fast growing dryland species. Could be regenerated or planted. Used as woodlots (can make charcoal or use for fire wood. Also as fodder).
  - Possible in woodland areas. Compare with land uses in the NAFORMA dataset – where would woodlot establishment be possible?

### Improved forest management

- Promote the development of village land use plans (with maps). There is a legal requirement that all villages have this, but due to lack of allocated funding, this is still in process
- PFM promotion

- All forest land minus protected land, (minus already under CBFM), TO BE CONTINUED
- Improved protection of government reserves (NR + catchment forest protection)
- Tenure security
- Certification of CBFM forest reserves

#### **Education**

- Forest education and extension
  - Could map available extension services (and lack of extension services)
- Promotion of family planning
- Education to farmers in good farming practices

#### **Policy measures**

- Promotion of alternative energy sources (solar, biogas, hydro-electricity, cow dung, burning of crop residues)
- Eco-friendly micro-enterprises (beekeeping, NTFPs, tree nurseries)
- Cost-benefit sharing
- Law enforcement of land-use
- primary and secondary school syllabus integration

### Annex III – Participant list

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	Name	Affiliation	Email
1	Giliba, Richard	FTI, Olmotonyi/GIS	<a href="mailto:richiea78@yahoo.com">richiea78@yahoo.com</a>
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## First week

*Location: Dar es Salaam, TFS offices*

*Time: Start 9 am sharp, finish around 4 pm.*

<b>Mon 8</b>	<b>Welcome</b> <b>Introductions</b> <b>Logistics</b> <ul style="list-style-type: none"> <li>➤ Workshop schedule</li> <li>➤ Expectations for working sessions</li> </ul>	TFS ALL Almas
	<b>Brief introduction to UNEP-WCMC, REDD+ safeguards and multiple benefits, the project plan, and proposed outputs from</b>	LR
	<b>Outline of technical plan of work for the 2.5 weeks, and objectives of the training</b>	CR
	LUNCH break and email catch-up 13:00 - 14:30	
<b>Tue 9</b>	<b>Computer set up</b> <ul style="list-style-type: none"> <li>➤ Introductions to USB Linux install</li> <li>➤ Boot machines using USB sticks</li> <li>➤ Explore the Linux environment</li> </ul>	CR
	End of day email catch-up	
	<b>Introduction to method of working</b>	CR
	<b>Introduction to QGIS</b> <ul style="list-style-type: none"> <li>➤ Introduction to the data folder</li> <li>➤ Exploring the QGIS interface</li> </ul>	CR/LR
<b>Wed 10</b>	<b>Introduction to vector data</b> <ul style="list-style-type: none"> <li>➤ Querying vector data</li> <li>➤ Symbolising vector data</li> </ul>	CR
	LUNCH break and email catch-up 13:00 - 14:30	
	<ul style="list-style-type: none"> <li>➤ Exploring the data table and data we have collated for Tanzania</li> <li>➤ Presentation on data storage, IP rights and data terms of use</li> </ul>	LR LR
	End of day email catch-up	
<b>Wed 10</b>	<b>Introduction to the IUCN Red List: Exploring the Red List database portal</b>	LR
	<b>Activity: Using QGIS to extract and process Red List vector data, producing a mammal species richness map with a hexagon grid</b>	CR
LUNCH break and email catch-up 13:00-14:30		



	<b>Introduction to other biodiversity data sources</b> <ul style="list-style-type: none"> <li>➤ Red List spatial data</li> <li>➤ BirdLife data</li> <li>➤ Tropicos database</li> <li>➤ TanBIF</li> <li>➤ GBIF</li> </ul>	LR
	<b>Continue with Red List mapping exercise</b>	CR/LR
	End of day email catch-up	
<b>Thur 11</b>	<i>Morning free</i>	
	LUNCH 12:00-13:00	
	<b>Using the NAFORMA data for multiple benefits mapping</b>	LR
	<b>Activity: Importing and exploring NAFORMA biophysical data and analysis in QGIS. Product: NAFORMA tree species richness and density map by cluster</b>	CR
	End of day email catch-up	
<b>Fri 12</b>	<b>Continue NAFORMA plot tree species richness and density map</b>	CR/LR
	LUNCH break and email catch-up 13:00 - 14:00	
	<b>Fun Friday: Introduction to Map layouts and Templates</b> <ul style="list-style-type: none"> <li>• What makes a good map: discussion</li> <li>• Introduction to layouts in QGIS</li> </ul>	LR ALL CR
	<b>Activity: Getting familiarized with the QGIS layout tool and start to create a layout template, using the mammal species richness map (Red List) produced on Wednesday</b>	ALL
<b>W/E 13/14</b>		

## Second week

Location: Morogoro, SUA offices

Time: Start 8 am, finish around 5 pm.

	Agenda	
<b>Monday 15th</b>	<b>Summary of last week's activities and outputs</b>	LR
	<b>Map projections –presentation</b> <b>Activity: Understanding Map projection</b> <ul style="list-style-type: none"> <li>• Map projections of data</li> <li>• Data with no Map projection stored</li> <li>• Map projection of the project</li> <li>• Redefining Projection</li> <li>• Projecting data from one projection to Another</li> <li>• On the fly projections</li> </ul>	CR

	<p><b>Activity: Which map projection should we use for analysis at the Tanzania scale maps and analysis.</b></p> <p><b>Activity: Prepare layout map for IUCN mammal species richness</b></p>	
	LUNCH break and email catch-up	
	<b>Understanding topology in QGIS</b>	CR
	<b>Activity: Activating topology and editing polygon data.</b>	
	End of day email catch-up	
<b>Tuesday 16th</b>	<p><b>Introduction to raster data</b> Types of raster data Adding raster data to QGIS Symbolising raster data</p> <p><b>Activity: practice adding different types of raster datasets to QGIS and symbolise them.</b></p> <p><b>Baccini and Saatchi biomass data presentation</b></p> <p><b>Activity: Generating statistics from Raster data</b></p> <ul style="list-style-type: none"> <li>➤ From raster data</li> <li>➤ from combined vector and raster data</li> </ul>	CR CR LR
	LUNCH break and email catch-up 13:00-14:00	
	<b>Continue with exercise</b>	CR
	<b>Activity: compare Baccini, Saatchi and NAFORMA biomass map for Rufiji district. Overlay with LULC map and generate statistics: average biomass value per LULC class.</b>	
	End of day email catch-up	
<b>Wednesday 17th</b>	<b>Defining and mapping natural forest: discussion</b>	LR/ALL
	Production of natural forest maps according to selected definitions, using the LULC map. Overlays with admin boundaries and protected areas.	CR
	LUNCH break and email catch-up	
	<b>Discussion on ecosystem services mapping</b>	LR
	Completion of SAGA calculation of average biomass values per LULC class	CR
	End of day email catch-up	
<b>Thursday 18th</b>	<b>Presentation on hydrological services (including water world)</b>	CR/LR
	Introduction to Raster Analysis Tools (QGIS, GRASS, SAGA)	CR
	<b>Activity: Prepare map of importance of forests for limiting</b>	

	<b>soil erosion</b>  (includes exercise on editing point data for dams)	
	LUNCH break and email catch-up	
	<b>Continue with Activity: Prepare map of importance of forests for limiting soil erosion</b>	CR
	Continue with carbon mapping exercise	
	End of day email catch-up	
<b>Friday 19th</b>	<b>Activity: Finalize NAFORMA point mapping exercise</b>	CR/LR
	LUNCH 13:00-14:00	
	<b>Activity: Finalize carbon mapping exercise – producing statistics</b>	CR/LR
	End of day email catch-up	
<b>W/E 20/21</b>		

## Third week

*Location: Dar es Salaam, TFS offices*

*Time: Start 9 am sharp, finish around 4 pm.*

<b>Mon 22</b>	<b>Discussion on mapping potentially suitable areas for implementation of different REDD+ activities.</b>	LR
	LUNCH break and email catch-up 13:00 - 14:00	
	<b>Cont. discussion from morning</b>	LR
	<b>Discussion of output list and data mining</b>	LR
	End of day email catch-up	
<b>Tue 23</b>	<b>Preparation of presentations and poster for Tuesday</b>	ALL
	Ensuring each delegate has a working copy of QGIS on their Windows laptops and antivirus installed, and a final copy of all the info we have prepared during the working session.	ALL
	LUNCH break and email catch-up 13:00 - 14:00	
	<b>Presentation to wider group in TFS and UN-REDD</b>	ALL
	End of day email catch-up	
<b>Wed 24</b>	<i>Meetings AM</i>	
	<i>Airport PM</i>	

## Annex V: Feedback from participants in working session

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### 1. Among the topics covered during working session 1, what did you learn that was the most useful?

- Analysis of Vector and Raster data (Combining, Merging, Dissolving and Buffering)
- Understanding the projections and its implications on area distortion
- Being able to work on Layouts in Qgis
- Generating statistics from Raster data
- To be exposed to different sources of data i.e. IUCN
- I learnt application of QGIS in species and carbon mapping
- QGIS in general (Vector data, Topology, Adding files to QGIS and joining table, Raster data, DEM data), SAGA and GRASS
- Joining tables, vector and raster analysis, working with DEM data and water in QGIS and SAGA and finally map layout in QGIS
- Introduction to vector data and topology, Analysis of vector data, generating statistics from raster data and working with DEM data and water in QGIS
- All topics were relevant in the development of multiple-benefits maps to inform REDD+ planning and safeguards policies.

### 2. Which topics did we cover too fast and which topics too slow?

#### Too fast:

- Using QGIS to extract and process IUCN Red List species data
- None of the topics covered slowly but GRASS, SAGA and map visualization such as to insert grids were covered so fast
- GRASS and SAGA
- working with vector data in QGIS

#### Too slow:

- Working with Raster data (Baccini and Saatchi carbon datasets) and how they were produced.
- Working with DEM data and water in QGIS and SAGA
- Raster Analysis (QGIS, GRASS, SAGA)
- None
- Mapping NAFORMA tree species richness and tree density by cluster
- Generating statistics from raster data using GRASS and SAGA

#### Other:

- All other topics covered at normal speed
- It was ok to me
- All topics were fairly covered on a relatively equal time, only that we had a lot time lost during lunch time (moving to and from Peacock hotel)

### 3. The next working session we will have to be very focused, keep a slightly higher pace, and make sure we finalize the products we need. But we will also do our best to make sure that you learn the necessary things for you to use QGIS, SAGA and GRASS in your work. Is there anything in particular that you would like to learn in the next working session which we haven't covered yet?

- Adding below-ground biomass to the model and finally generate statistics
- Making a map in QGIS from GPS coordinates (coordinates as example will be provided)

- Clarifications on topology
- Georeferencing images as we can be able to use scanned images
- Yes, I wish to learn things like image classification, change detection and how to prepare a database to feed QGIS. I understand time is not on our side but just give us some hints to go about.
- Also will be happy if I can get some plugins for accuracy assessment and change detection. Corinna you remember we tried but things could not work
- YES: boundary map drawing in general and adding topographic map on it in order to digitize different features
- Yes, how to download GPS data captured from the field to QGIS and Georeferencing scanned image
- More emphasis on spatial analysis of various scenarios in natural resources management
- Developing map layouts and templates in QGIS e.g. Matrix legend, layout template with pre-fixed layers, and saving layout.
- Vector to raster conversion like point features into raster data mode
- Raster overlay analysis
- Customization of chain processes in QGIS (similar to Model Builder tool in ArcView or ArcGIS)

#### **4. What parts of the structure of working session 1 did you think worked well?**

- Mapping the natural forests of Tanzania by using the three different definitions
- Working with Vector data in QGIS (Topology and Analysis)
- Discussions
- QGIS and its components especially generating statistics and analysis from raster data, developing map layouts etc
- The whole of session that was done in Morogoro and the session on introduction to vector analysis
- Structure of using training guide associated with trainers' involvement I think worked well.

#### **5. What should be changed for the next working session, in terms of the structure of the work?**

- The structure work pretty well for me, as it has an element of ownership, i.e. each participant were working on their machine though sometime we were getting stuck, we were able to learn through our mistake quickly.
- May be to ensure the participants finish the exercise with right products
- If possible hard copy technical material guidance for the training of each day should be provided one day before starting the real working day.
- I think tutorial should be prepared in advance and given to participants at right time when learning
- Nothing to change
- Nothing to change
- The structure is ok, only the starting time should be 9:00 morning and end time should be specific e.i 16:00hrs in DSM and 17:00hrs in Morogoro
- Discussion to be done in the afternoon

#### **6. Any other comments/feedback?**

- I really appreciate for the knowledge you are transferring to us
- I suggest that the next working session to be conducted far away from the TFS premises as we need much concentration
- Do not have, I enjoyed the session
- If time allows, repeat: Map finalization (adding legend), generating statistics and analysis from raster data.
- Many thanks to you, you were always there for us, you were very tolerant, thanks again

- To have clear time table especially in Morogoro
- To follow the working session plan
- I would to have a recap on attribute table manipulation and preparation of dataset (vector or raster) for various analyses. I consider this as a key process in GIS and mapping, for example how do you prepare point data from XY to shapefile, how do you create an attribute table, what should be in the attribute table and what should not be in. How do you go on adding other textfile table on the attribute table?
- It will also be useful if you will demonstrate how to generate predetermined XY point on map either random or systematically like that of NAFORMA cluster distribution.
- IF time allow, you may also demonstrate on how to partition our machines so that it use the two platform (Ubuntu on one hand and MS windows on other hand).
- We had good meal in Dar.