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FINAL PROJECT REPORT

WWF REDD+ PILOT PROJECT

WWF TANZANIA COUNTRY OFFICE

2015

Final Project Report of WWF REDD+ Pilot Project entitled "Enhancing Tanzanian Capacity to Deliver Short and Long Term Data on Forest Carbon Stock across the Country,
Prepared and Produced by WWF Tanzania in partnership with SUA and University of York, UK

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Last but not least, we would like also to express our sincere obligation to Project Advisory Committee for advice and guidance that facilitated smooth project implementation.

ACRONYMS AND ABBREVIATIONS

AA	Authorized Association
AGLC	Above Ground Live Carbon
ASDP	Agricultural Sector Development Programme
BAU	Business As Usual
BRN	Big Results Now
CBC	Community Based Conservation
CBFM	Community-Based Forest Management
CBO	Community Based Organization
DoE	Division of Environment
FCPF	Forest Carbon Partnership Facility
FORCONSULT	Forest Consulting Unit at the Faculty of Forestry and Nature Conservation at SUA
GE	Green Economy
GHG	Greenhouse Gas
GIS	Geospatial information systems
ITCZ	Inter- Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
IUCN	International Union for Conservation of Nature
LAI	Leaf Area Index
LUP	Land use plan
MCDI	Mpingo Conservation Development Initiative
MRV	Monitoring, Reporting and verification
NAFORMA	National Forestry Resources Monitoring and Assessment
name	description
NBS	National Bureau of Statistics
NCMC	National Carbon Monitoring Centre
NFI	National Forest Inventory
NGO	Non-Governmental Organizations
NLUP	National Land Use Policy
NLUPC	National Land Use Planning Commission
PFM	Participatory Forest Management
POM	Point of Measurement
PSP	Permanent Sample Plot
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
RNE	Royal Norwegian Embassy
SOC	Soil Organic carbon
SUA	Sokoine University of Agriculture
TFCG	Tanzania Forest Conservation Group
TFS	Tanzania Forest Service
UN REDD	United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries

UNEP- WCMC	United Nations Environment Programme World Conservation Monitoring Centre
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania
VPO	Vice President Office
WMA	Wildlife Management Area
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

WWF Tanzania and project Partners implemented REDD+ Pilot Project financed by Norwegian Government for three years started 2011 to 2014. The main project objective was to contribute core data to the Tanzanian national Monitoring, Reporting and Verification (MRV) system through building Tanzanian capacity to deliver short and long term data on forest carbon stocks across the country. The project covered 10 vegetation types which had had inadequate carbon data to determine accurately carbon emission.

The project was implemented through three points: data collection and analysis, stakeholder insight and capacity building. One hectare plot method was used to collect information including woody biomass, soil, litters, grasses and deadwood. Similarly data on hemispherical photography, Suscan and degradation were collected from these established plots. Lidar data was acquired through flight in Udzungwa Mountains and verified through ground truthing in 11 plots. A total of 128 Permanent sample plots were established in 10 vegetation types across the country. Data collection was supplemented with engagement with Stakeholders. Stakeholders' workshops across regional zones and consultations captured information to determine possible land use/cover changes for 2025 and addressed existed gaps on environmental and social spatial data to support REDD+ Safeguards development. Capacity building for technical experts was achieved through organised training workshop and learning by doing in the field.

Results from this project revealed that average Above Ground Live Carbon (AGLC) in 10 vegetation types ranged from 18 tC/ha to 98.99 tC/ha except for upland grassland, floodplain grassland and *Acacia commiphora* which have less than 10 tC/ha. Montane forest has higher average AGLC (98.99) than other vegetation types due to favourable climate conditions and most of them are protected. However, results from carbon monitoring in Udzungwa indicated that there is slightly change of carbon enhancement annually since most trees have reached maturity. This means that REDD+ incentives in montane forest could be realised through management and conservation of existing carbon stock and other co-benefits related to biodiversity rather than carbon enhancement.

Average AGLC in Miombo woodland is low (25.55 tC/ha) compared to Lowland forest (66.06) because most are found in dry areas with some of them lacking proper management.

Deforestation and forest degradation is high with the forest being used to meet growing demand of biomass energy (charcoal and firewood) and unplanned expansion of agricultural and settlement area due to increasing population and weak governance. Therefore REDD+ incentives could be achieved through addressing drivers of land use change into sectoral policies and establish effective governance mechanism for its implementation at local level.

Developed land use/cover changes map for 2025 show that under Business as Usual (BAU), most unreserved forest are vulnerable to deforestation due to easily accessible, high demand of agricultural and forest product. On the other hand protected forests are vulnerable to forest degradation due to weak forest governance and inadequate resources to enforce the laws. Findings from this project suggest that land use/cover changes observed across the country could be addressed through adopting Green Economy (GE) where conservation issues will be integrated into development policies to achieve sustainable development as well as reduce carbon emission, which could be credited under performance based payment.

Results from Lidar data acquisition shows that the capacity of Tanzanian to capture and analyse laser data is limited as collected data are still analysed in University of York and will be completed in May 2015. Lidar technology is aimed at reducing workload for ground forest inventory however its application is still challenging for developing countries due to high cost involved in mobilising equipment from abroad and weather conditions (dense cloud cover) which obstruct laser data collection. Therefore it is recommended a multisource inventory including ground and remote sensing should be properly designed to provide relevant information at low cost for developing MRV.

Results from REDD+ safeguards shows that Montane forest not only has high carbon stock but are also rich in biodiversity including threatened species like reptiles. Therefore monitoring of REDD+ safeguards have the added importance of protecting threatened, endemic and rare species to ensure multiple benefits are gained from ecosystem.

Findings from capacity building exercises revealed that working in partnership with different institution/organisation found within and out the country is critical for effective technological/knowledge transfer. The total 60 villagers and 25 district staff trained are now competent in taking forest measurement in project area and could reduce monitoring cost in project area. Furthermore, 77 technical staff in Tanzania has gained knowledge and skill on data analysis and mapping using R statistical package, developing land use scenarios and mapping using open source GIS software. The acquired competence and skill resulted to effective REDD+ project implementation and could reduce dependence on international expert to lead most REDD+ activities particularly on data analysis, results interpretation and modelling in the country.

The project findings concluded that Tanzania has made strong steps to the completion of REDD+ readiness phase as enough data has been collected through NAFORMA and Pilot Projects to develop National Monitoring, Reporting and Verification system in the country. Moreover, the recently established National Carbon Monitoring Centre (NCMC) at Sokoine University of Agriculture is the point institution to collate data from different stakeholders to design MRV. However, it should be noted that accessing incentives under REDD+ performance based payment will not be possible unless main drivers of land use/cover changes (expansion of agriculture, demand of biomass energy and increased unplanned settlement) addressed in National polices for economic development.

WWF Tanzania with its partners is interested to address those challenges at both a national and subnational scale including MRV development. These combined approaches could enable communities/institutions to learn and understand through doing at large scale, and inform the government using evidence based to adopt Green Economy policies to attain emission reduction that could be credited through performance based payment.

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CHAPTER ONE

1.0: INTRODUCTION

1.1: Background information

It is estimated that 42% of Tanzania mainland area (48.1 million hectares) is forested[1], comprising of different vegetation types. Sound management of these forests can generate a number of environmental services such as water catchment, scenic beauty, biodiversity, and carbon sequestration, which in principle could be valued and paid for by various consumers. There is also a growing market for forest carbon due to the increasing recognition of the importance of forest management in Reducing Emissions from Deforestation and Forest Degradation (REDD+).

A key aspect of determining the carbon benefit of any forest carbon project is to accurately quantify the levels of carbon changes to known levels of precision. Determination of carbon changes requires baselines i.e. historical trends against which additional carbon benefits as a result of carbon project can be determined. Under REDD, the reference scenario is the baseline against which achievements made by a country can be measured and credited. Possible options for crediting forest carbon management include reduction in emissions from deforestation; reduction in emissions from degradation; enhancement; forest conservation; and conservation of the existing carbon stock. The last two options relate to forests with long protection status which would be credited based on the maintenance of carbon stock which would be compensated.

According to COP 15 decision 4/CP 15, non-Annex 1 countries interested in the REDD+ mechanism should establish a robust and transparent national forest monitoring system. A Monitoring Reporting and Verification (MRV) system is a combination of components that are interrelated and coordinated to obtain an inventory of Greenhouse Gas (GHG) emission associated with human practices that affect forest sector. A National MRV system is a key guarantee that parties will effectively meet their respective mitigation commitments under the United National Framework Convention for Climate Change (UNFCCC) while building trust among parties. Therefore forest monitoring system should provide forest emissions that are transparent and consistent as well as accurate.

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[1] "Forestland" means an area of land covered with trees, grass and other vegetation but dominated by trees.

Tanzania is interested in accessing incentives through potential REDD+ mechanisms that could support forest management in the country. Therefore National Forest Inventory (NFI) was conducted countrywide through the NAFORMA[2] project housed in Tanzania Forest Services (TFS). The main purpose of NFI was to generate carbon data for developing Monitoring, Reporting and Verification (MRV).

1.2: Project context and Objective

The main objective of the project was:

> to contribute core data to Tanzanian national Monitoring, Reporting and Verification (MRV) system that forms a part of the comprehensive forest carbon monitoring system for the country.

It further aimed at enhancing the capacity of Tanzanians to deliver short and long term data on forest carbon stocks across the country. According to the project agreement, the project had six outputs:

i. 120 Baseline carbon plots established in 10 different vegetation types structured across environmental and degradation gradients.
ii. Hemispherical Photographic survey of carbon plots established
iii. Utility of Lidar technology further tested in Tanzanian forest habitats
iv. Soil carbon surveyed across Tanzanian vegetation types
v. A range of future scenarios for changes in carbon stock produced
vi. Capacity building, dissemination and communication of project outputs undertaken.

All of these outputs focused on increasing carbon data available in Tanzania and contributing to getting Tanzania ready for the implementation of forest carbon projects under REDD+ or related mechanisms

In addition to these 6 outputs, savings from the project were used to address both biodiversity and social safeguards for REDD+ at the national scale in Tanzania. Although not part of the project document, this work also addresses a core need of the MRV system in Tanzania, and was agreed to be undertaken through discussion with the Norwegian Embassy.

[2] NARFOMA ked by Tanzania |Forest Service under Ministry of Natural Resources and Tourism undertook nationwide forest resource inventory in 2008.

The overall rationale of the project was to build capacity and fill gaps that were not being addressed by other funding sources for MRV aspects of REDD+ readiness. Capitalizing on stakeholder knowledge, three work streams were identified at the project inception meeting with other REDD+_ projects. These were:

a) Assessing the accuracy of carbon assessments within the country and the relationship between data collected through smaller and larger plots, by linking photographic methods to field plot measurements, and through linking LiDar technology to field plots.
b) Land cover change scenarios where the REDD+ mechanism has been implemented and where it has not been. This work would also aim to show how future land use changes would impact on carbon, biodiversity and social issues across the country.
c) Spatial safeguards information on biodiversity and ecosystem services and social values. This aimed to build upon the work funded by UN-REDD and provide further information to a potential Safeguards Information System (SIS) for the country.

Capacity building was to be provided at all levels of the project work. This included enhancing capacity at the village, local government, NGO, central government and academic levels.

1.3: Project Implementation

The WWF REDD+ Pilot Project was implemented for three years - 2011 to 2014 – and was financed by the Norwegian Government. There was a gap in operation in 2012 however the project resumed in April 2013 when Royal Norwegian Embassy (RNE) approved project work plan and budget for 2013 and 2014. The project team spent three months to mobilize assessment teams and resources from April to June 2013 followed with actual field work in June, 2013.

WWF Tanzania was the lead partner and implemented the project with SUA and University of York. have been executing project activities that ended December, 2014. Concerted efforts among the project partners and WWF Tanzania have contributed to the delivery of good progress towards attaining all project outputs.

CHAPTER TWO

2.0: PROJECT AREA AND METHODOLOGY

2.1: Project area

WWF REDD+ Pilot Project covered different land cover types of Tanzania mainland. The country is constituted by Tanzania Mainland and Zanzibar with a total area of 945,087 km^2 of which 886,037 km^2 is surface land (URT, 2009). Tanzania lies just south of the equator, at 10˚- 12˚S and 30˚E - 40˚E and has a tropical climate with regional variations due to topographical difference (McSweeney et al., 2010; URT, 2009). In large part, it is in a central plateau of around 900-1800m with the intersection of mountain ranges (McSweeney et al., 2010). The weather is varies in different zones with the coastal areas being warm and humid, with temperatures 25 to 17˚C through most of the year while the highland regions are more temperate, with temperatures around 20-23˚C throughout the year (McSweeney et al., 2010). Rainfall occurs seasonally driven mainly by the migration of the Inter-Tropical Convergence Zone (ITCZ) (McSweeney et al., 2010). The country consists of variety of soils with Cambisols covering 35.6% of the country. Other types of soils include: Histosols which is formed from organic matter, Andosols developing from volcanic materials and Fluvisols which is associated with important river plains such as Kilombero and Rufiji plains (MARI, 2006).

It is estimated that 42% of Tanzania mainland area (48.1 million hectares) is forested[3], varying from open savanna grassland mosaics to closed dense evergreen forest. Most evergreen forests are found within regions of global importance for biodiversity (Marshall et al., 2012; Platts et al., 2011; Platts et al, 2013). The country hosts six out of the 34 globally known biodiversity hotspots and is among 15 countries globally with the highest number of endemic as well as threatened species (URT, 2014).

2.1.1: Selection of Project area

The NAFORMA Project conducted a National Forest Inventory across the Country until 2013. Building on this work, this WWF REDD+ project focused its efforts on less well-covered vegetation types, also covered miombo woodland and coastal forest to integrate social factors, on the degradation gradient, and other aspects of the work required for REDD+

[3] "Forestland" means an area of land covered with trees, grass and other vegetation but dominated by trees.

(see Figure 1 and Table 1). The aim was to fill gaps in identified vegetation types to increase accuracy of carbon estimation for these key vegetation types.

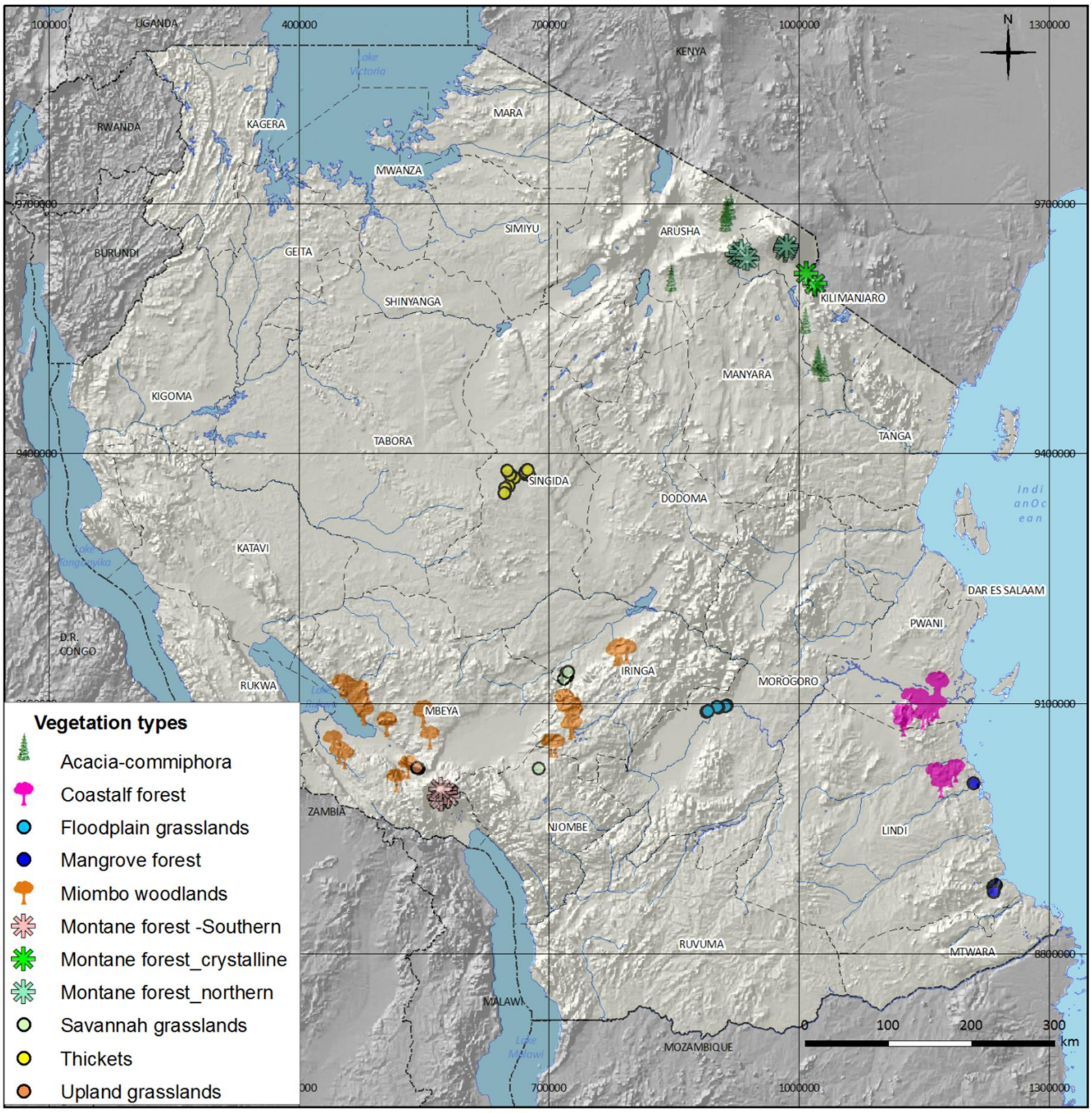


Figure 1: Location of the one hectare study plots within different vegetation types in Tanzania

Table 1: Selected vegetation types for carbon assessment

Selected vegetation types	**Reasons for selection**
Miombo Woodlands	Most extensive and diverse cover type, less studied with respect to carbon, higher potential for degradation through utilization. Possible sites in Iringa/Mbeya to include old growth and regenerating miombo stands. Particularly responsive to carbon sequestration under climate change scenarios.
Acacia/Commiphora Woodlands	An important cover type and quite widespread. No data on this type, high potential for degradation through utilization. Possible sites include the Somali-Masai regional center of endemism in Arusha, Dodoma and Mwanga. Particularly responsive to carbon sequestration under climate change scenarios.
Coastal Forests	Widespread and diverse, less studied with respect to carbon, includes woodlands in parts. Possible sites include Matumbi/Kichi Hills and selected parts in Kilwa and Coast regions
Grasslands	Extensive, different types – upland, savannah, and flood plains. Poorly studied/poor knowledge on their carbon content but big potential especially in the soils in floodplains. High potential for degradation through overgrazing, cultivation and conversion to plantations/woodlots. Possible sites include the Kilombero Valley Flood plains, High Altitude grasslands in the Eastern Arc and the southern highlands region – Mufindi, and savannah grasslands in Iringa/Mbeya
Bushlands and Thickets	Not very extensive, poorly studied with respect to carbon – poor knowledge on its carbon storage potential. Potential areas include selected parts of the Somali-Masai regional Centre of Endemism, and Itigi thickets
Mangroves	A specific cover type, no information on their potential for carbon storage, high potential for degradation through utilization. Potential sites in Rufiji and Kilwa with the former being particularly extensive. Very important area in the context of predicted sea-level change
Forests	Some knowledge on carbon storage potential though inadequate, forests on volcanic mountains poorly studies, more plots on the volcanic mountains of Rungwe, Hanang and the Eastern Arc Mountains where information is lacking (Uluguru, East/West Usambara, South/North Pare)

2.2: Number of permanent sample plots (PSP)

Determination of permanent sample plots was based on variation and similarity within the selected vegetation types as illustrated in Table 2.

Table 2 Number of PSP in each vegetation types

No	Vegetation type	Localities	Number of PSP
1	Miombo woodland	Iringa and Mbeya	40
2	Coastal Forest	Kilwa -Matumbi/Kichi Hill	25
3	Mangroves	Rufiji/ Kilwa	5
4	Acacia/Commiphora woodlands	Arusha/Mwanga	10
5	Bushland/Thickets	Singida (Itigi)and Dodoma	10
6	Floodplain Grassland	Kilombero	3
7	Upland Grassland	Mbeya/Iringa	2
8	Savannah Grasslands	Mbeya/Iringa	5
9	Forest on volcanic mountains	Mbeya and Kilimanjaro	14
10	Forest on crystalline Mountains	E/W Usambara / South	6
	Total		**120**

2.3: Plot shape and size

One hectare plot was used for carbon data collection in the field as illustrated in Figure 2. One hectare plots have been used elsewhere in Tanzania and other countries and are a part of the global Tropical Ecology Assessment and Monitoring (TEAM) protocol (Kuebler 2003). The method is a Standard Vegetation Monitoring Protocol applied across the world and useful for making comparisons with other studies in other countries.

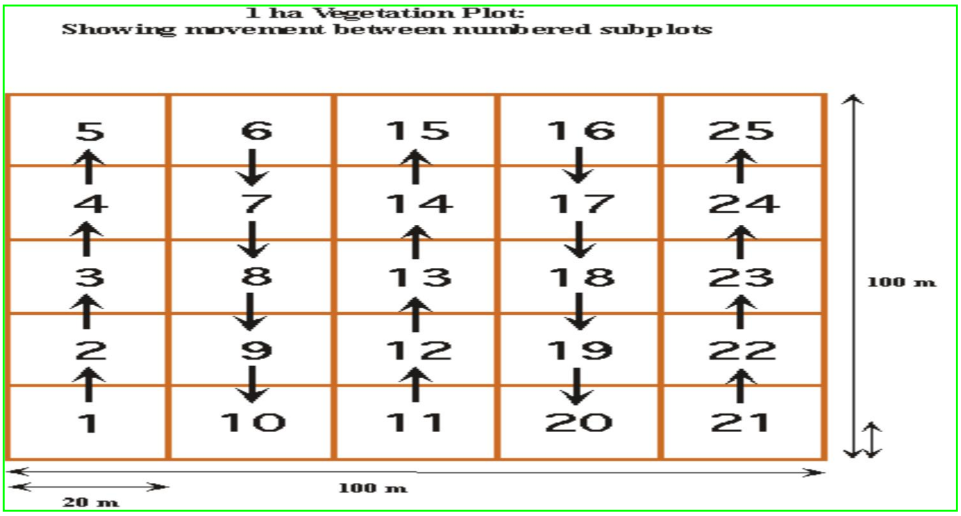


Figure 2: One hectare plot

2.4: Plot layout

Initially, predetermined plot coordinates for this project were overlaid to NAFORMA plots map to avoid overlaps. Unfortunately, we did not have access to the NAFORMA GPS plot data locations, so only a visual comparison was conducted. Then, one hectare plot was laid on the ground using ropes and wooden pegs, and recorded using GPS. Each plot corner of one hectare was marked with wooden peg and geo-referenced using GPS. Then the plot of one hectare (100 m x100 m) was divided into 25 subplots of 20mx20m, using ropes, to facilitate movement direction during data collection in the field as indicated in Figure 2.

Layout of one hectare plots in the field.

2.5: Measurements taken from Permanent Sample Plot (PSP)

The following parameters were taken from the PSP

2.5.1 Tree variables

All stems with Dbh ≥ 10 cm were measured at breast height within 20 sub-plots (20 by 20 m). Smaller stems with Dbh ≥5 and <10 were sampled in subplots 1, 5, 13, 21 and 25. Stem heights were measured from the tree base to the highest point from the ground (parallel to the main trunk) for all trees in the plots, using a leica distance meter (leica disto). Following the difficulties encountered to measure tree heights in woodlands using leica distance meter, a measured pole was used. All measured tree were tagged with unique numbers and painted at the point of measurement (POM). Species identification was done by a well experienced botanist in the field and where the species were not known, voucher specimens were collected for verification at the Tanzania National Herbarium.

Measuring tree variables in the field

2.5.2. Herbaceous layer

Herbaceous layer were collected from subplots 1, 5, 13, 21 and 25 of the 20 by 20 m. A quadrant of 1 by 1 m were established in each of the mentioned subplots where herbaceous materials were cut at the stem base, collected and fresh mass determined.

2.5.3: Litter

Litters were also sampled within the same subplots as above. The samples were mixed and weighed, then sub sample taken for laboratory analysis.

2.5.4: Deadwood

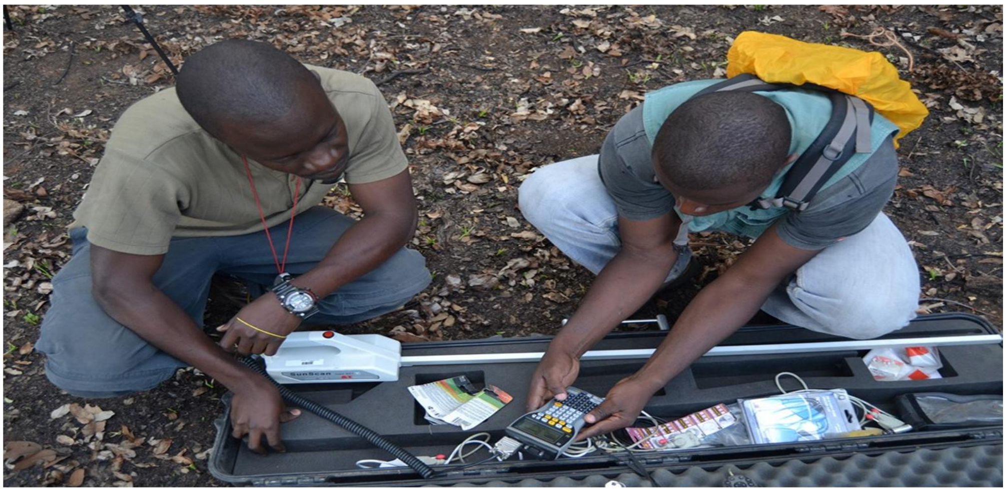
Samples collected from a quadrat measuring 1m x 1m in selected sub plots 1, 5, 13, 21 and 21 of the 20x20 m. Thereafter, samples weighed and sub sample taken for laboratory analysis.

2.5.5: Soil

Soil samples were collected from 15m away from the plot. Soil organic carbon varies with depth thus soil samples were excavated from a profile at different depths: 0 -15cm, 15 - 30cm 30 – 60cm and 60 – 100 cm. In sites with hardpan soil, the maximum depth conveniently for soil sampling was recorded.

2.5.6: Canopy cover

Hemispherical photographs were used to collect information on canopy cover. The data was taken in 13 points within each five subplots (1, 5, 13, 21 and 25) using a fisheye lens.



Field team adjusting Sunscan ready to take measurement in the field

2.5.7: Degradation

Degradation was assessed by observations on removals in each plot. Removals were determined by identification and measurements of all cut stumps in the plot. The drivers of degradation assessed by establishing the uses of the cut trees – either wood fuel (firewood, charcoal) or construction timber (poles, sawn wood).

To enable computation of the carbon loss through degradation, the basal diameter of each cut tree stump was measured and recorded.

2.6. Remote sensing

A Lidar flight was flown over Udzungwa Mountain using strips/transects to collect laser data to estimate carbon stock. Existing plots were targeted to make a comparison between ground-based and Lidar-based carbon data. The Lidar flight was flown successfully over Udzungwa Mountain in August, 2014, after being suspended twice previously due to presence of dense cloud cover. Dense cloud cover reduces light reflectance and also pilot visibility and thus prevents the use of Lidar in those conditions. Due to these challenges, the coverage of Lidar flight was only 60% of the targeted area since it was difficult to fly beneath the cloud to achieve high point density due to extreme topography variation (mountain) that could affect flight safety.

The Lidar data were acquired along flight lines sub-divided into 3x3km blocks. Each block is a separate dataset consisting of a 3-d point cloud (X/Y location and height of point (z)). The map indicating data acquisition area is shown in Figure 3.

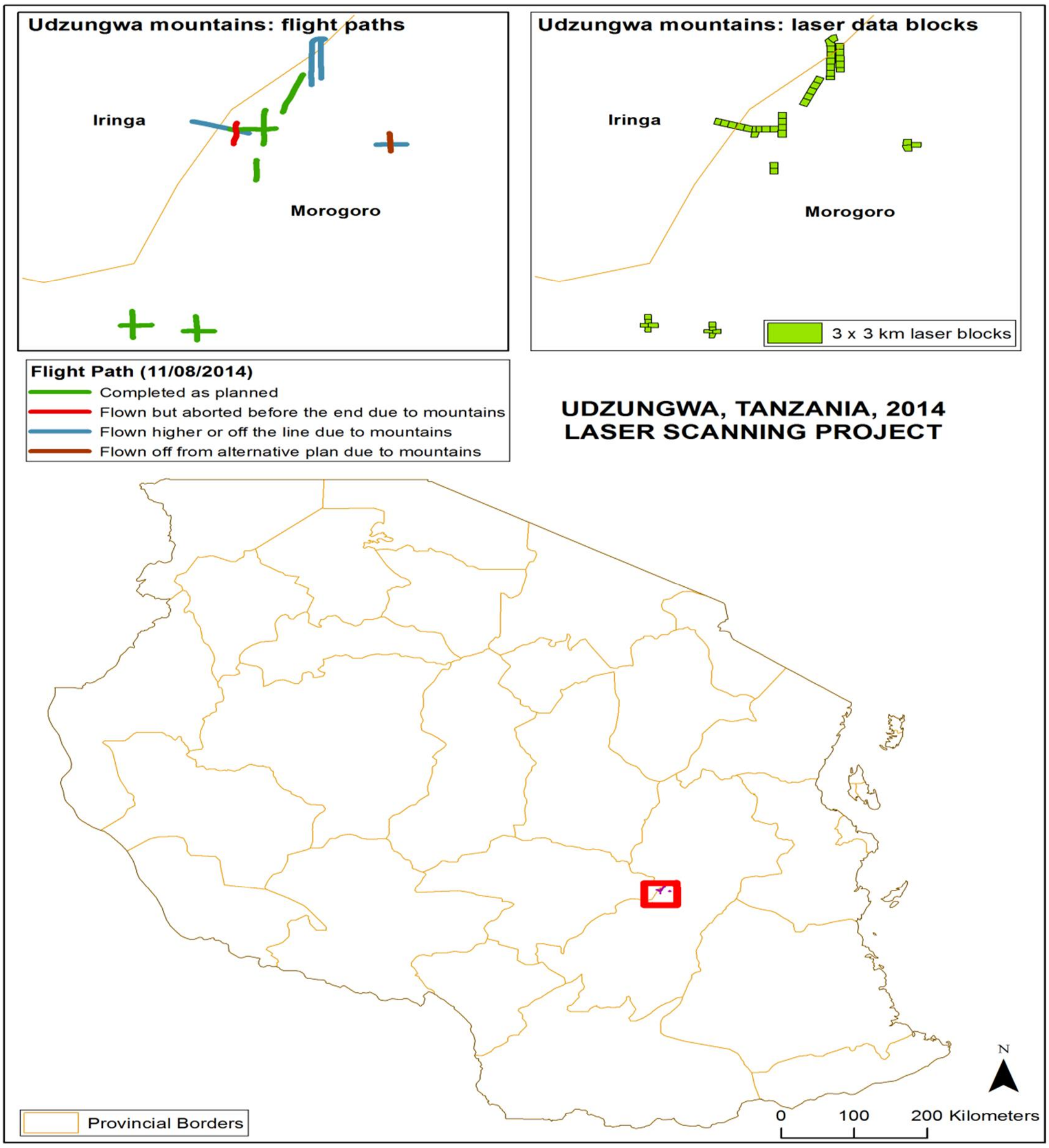


Figure 3: An overview map of Tanzania showing the location of the LiDAR flights

An inserted map shows flight lines and the 3x3km LiDAR blocks. Data have been acquired for all blocks but some have been flown off the scheduled flight line for reasons given in the legend

2.7: Re-measurement of established plots in Udzungwa Mountain

Lidar data acquisition was followed with re assessment of existing 11 PSP in Udzungwa Mountain. The plots were established in 2007 under Valuing the Arc Project. It was necessary to re-assess the established plots using the same methodology as Lidar flight flown over Udzungwa Mountain so as to establish relationship between plot and Lidar data for estimating carbon stock for the entire area.

Trees were re-measured at exactly the same point measured in 2007 to insure that biomass increment/loss estimates are reliable. However, there were adjustments on POM to few trees due to increasing deformity, buttress and bosses as they were affected with either Elephant or bending following fire and wind. Additional assessments such as hemispherical photographs were taken with the aim of comparing carbon content and LAI.

2.8: Steps and procedure for developing Land use and land use change scenario

2.8.1: Regional scenario workshop

Regional scenario workshops were conducted in the seven (7) zones established under Tanzania Forest Services (TFS) to ensure consistency and comparisons of information on land use/cover change. The areas covered were Southern, Southern Highland, Eastern, Western, Northern, Central and Lake Zone as indicated in Figure 4. Stakeholders represented different sectors (agriculture, forestry, water management, social development) from different institutions (regional and district departments and agencies, private sector, civil society). The main goal of the workshops was to capture information from stakeholders that could be used to determine possible future land use and cover changes to year 2025, based on business as usual (BAU) and green economy (GE) scenarios. The National Land use/cover change map developed by NAFORMA in 2010 was used as baseline.

Figure 4: Tanzania map showing different TFS management zones

The regional scenario workshops brought together about 187 participants where Participants were drawn from different institutions including Central and Local government, NGOs, CBO, Private sector, research institution and Agencies. The average attendance for each zone was 27 participants as indicated in Table 3 and Appendix 1. However it was noted that of the participants, 85% were male and 15% were female. The reason behind low attendance of women in those workshops is that most women in regional institutions occupy lower ranking positions and hence are not selected by their (male) bosses to represent the organization at meetings.

Table 3: Scenario Workshop Participants by Zone

No	Zone	Region	Participants	sex	
				male	**Female**
1	Southern	Mtwara, Lindi and Ruvuma	25	20	5
2	Southern Highland	Njombe, Mbeya, Iringa and Rukwa	30	25	5
3	Eastern	Morogoro and Coast	21	17	4
4	Central	Dodoma, Singida and Manyara	22	20	2
5	Northern	Tanga, Kilimanjaro and Arusha	23	20	3
6	Western	Katavi, Kigoma and Tabora	26	23	3
7	Lake	Kagera, Geita, Mwanza, Simiyu and Mara	40	34	6
	Total		**187**	**160**	**29**
	Average		**27**	**23**	**4**
	Percent (%)		**100**	**85**	**15**

2.8.2 Approach used for building scenarios.

Three steps were employed to develop scenarios for possible land cover changes as indicated in Figure 4.

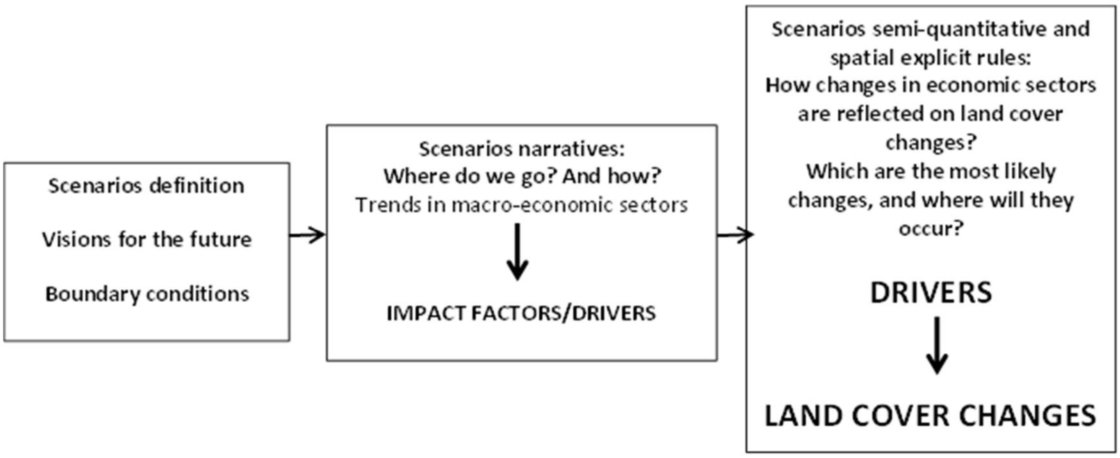


Figure 5: Steps for developing land use cover changes scenario

In the first step storylines conditions were defined through review of existing policies and expert opinions in Table 4.

Table 4: Storylines for two scenarios

BUSINESS AS USUAL: *The current rates of population growth, deforestation, and agricultural land expansion continue. Most people are employed in agriculture. Land demand by investors in commercial agriculture and mining sector is increasing. Biomass (fuelwood and charcoal) remains the prevalent source for energy, not only in rural areas but particularly in big cities. Interventions to reduce forests and woodlands loss and degradation (including REDD+) are not efficient or sufficiently implemented.*	***GREEN ECONOMY:*** *There is a shift to integrate the goals of socio-economic development and conservation of ecosystem services. Policy and programmes for reducing deforestation and forest degradation are implemented (including REDD+). Land demand for agriculture increases at a lower rate and dependence on biomass energy decreases. Forest degradation and deforestation rate is reduced.*

In the second step, the stakeholders were engaged in open discussions and group work to enrich the scenario narratives with sectorial analysis. In the third step the narratives were translated into possible land cover changes, Figure 6. For each specific conversion type, stakeholders discussed the likelihood of change on a 0-to-4 scale; they ranked the main drivers, and then provided spatial information on where the changes are likely to occur.

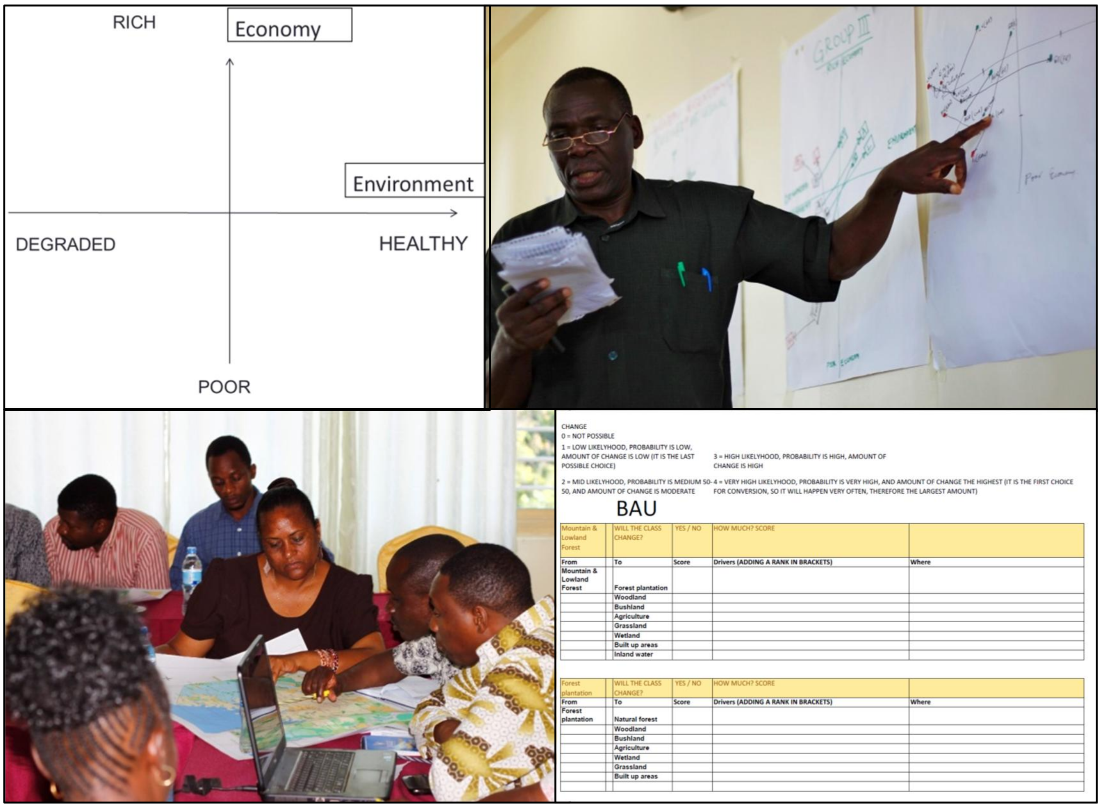


Figure 6: Group work discussion during Regional scenario workshop

Stakeholders produced scenarios narratives specific to their zone for the main sectors inducing land cover changes. These can be analysed to derive threats and opportunities behind foreseen land use and cover changes, either qualitatively or quantitatively (Figure 7a &b respectively).

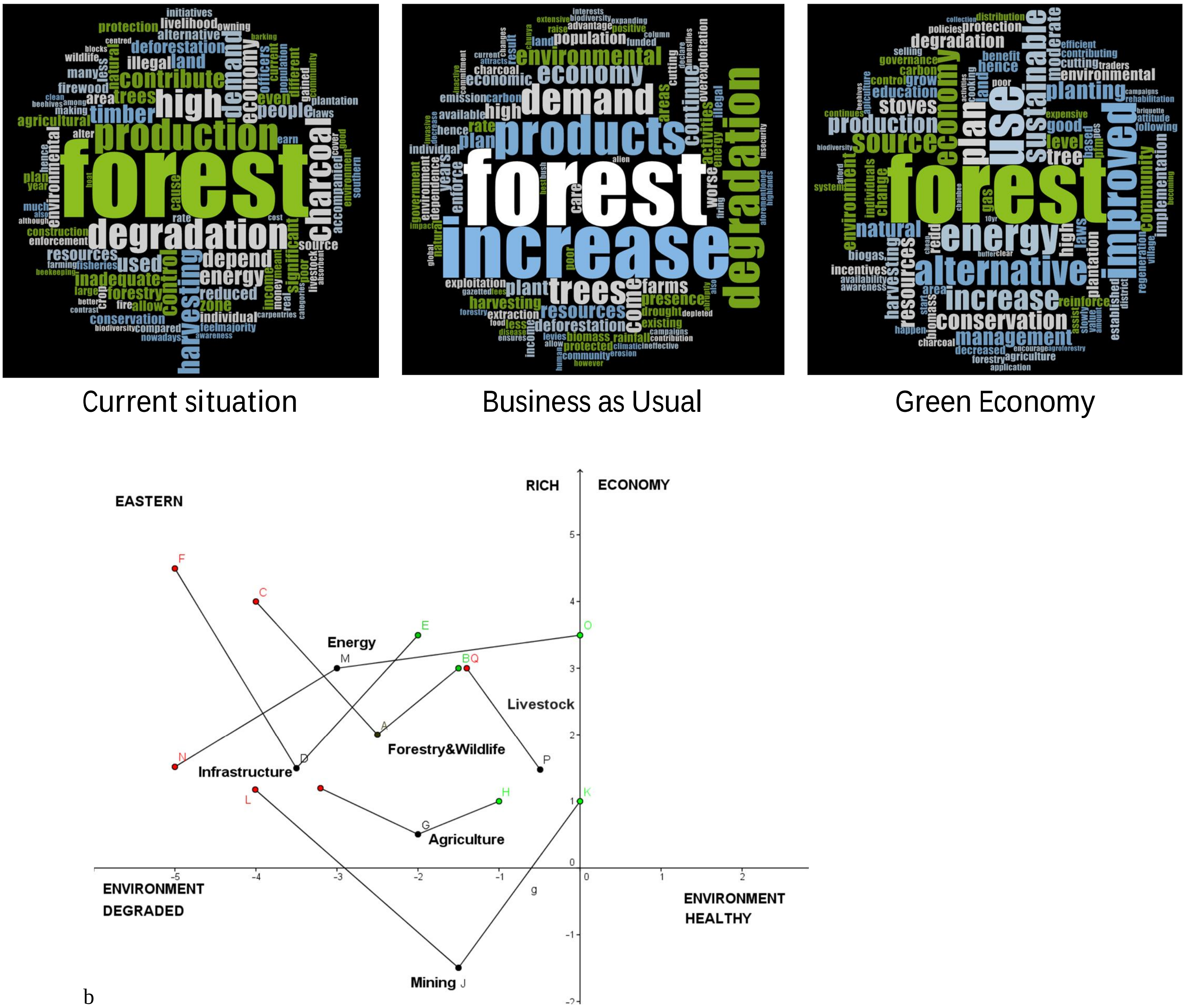


Figure 7a & b: Existing and anticipated situation for two alternative scenarios

2.8.3 National stakeholders' workshop

The project conducted National workshop on land use changes scenario and spatial information on Tanzania REDD+ Safeguards in October; 2014.The national workshop brought together 76 participants from different institutions including Government Non-Government Organization (NGO), Academic and research institution, Agencies and Private sector as shown in participants list appendix 2 . The main objective of the workshop was to share and validate results and the techniques used to forecast land use/cover changes and spatial information on REDD+ safeguards. Land use/cover changes are the main criteria to be used to monitor report and verify carbon emissions. During the workshop, stakeholders discussed and provided important inputs for potential future land use changes for 2025 across Tanzania and assessed proposed drivers of changes under Business As Usual (BAU) and Green Economy (GE). Stakeholders also established consensus on main drivers of land use /cover changes across the country.

Information from the national workshop was then used to refine or integrated into the land use change model to generate national map of potential land use/cover change for BAU and GE scenarios.

2.9: Spatial information on biodiversity and social data for REDD+ Safeguards.

Spatial Information to fill the existing gaps on biodiversity and social data for REDD+ safeguards were collected through stakeholder's workshops and desk work where different material gathered and reviewed.

2.10: Capacity building, dissemination and communication of project results.

Several methods were employed to improve the knowledge and skills of Tanzania to implement REDD+ effectively and achieve project goal. Therefore training workshop and learning by doing in the field were used to impart knowledge and skill on forest inventory technique, data analysis and GIS mapping to Tanzanian experts and villagers to ensure that project are properly implemented. Stakeholder's workshop and publications were also a means to communicate and disseminate project results to other stakeholders in and outside the country. Media was further used to broadcast project events/activities to the entire country.

CHAPTER THREE

3: DATA ANALYSIS

3.1: Data entry and cleansing

Initial data analysis started at SUA where collected data from the field was compiled, cleaned and entered into the established database. Thereafter, a Tanzanian master's student from SUA and one of the field assessment team members joined the project partner University of York in the UK to analyse data under close supervision of project partners in that institution. Data was analysed using R statistical package by a the same student who was a beneficiary of R-statistics training course organised in Morogoro by University of York.

3.2. Above Ground Tree Carbon (AGTC)

AGTC was estimated for each stem with a new improved biomass allometric equation, and assuming 50% of biomass is carbon (Chave et al., 2014). Biomass was calculated in metric tons including heights of trees to avoid an overestimation when using DBH only (Marshall et al., 2012). Wood specific gravity (WSG) was estimated as the mean value for each species from a database of 2961 records from 844 species (Zanne et al., 2009). Where WSG data were not available for a species, the mean value for all records of the nearest taxonomic unit (genus, family) were taken, or where these were not available, the mean of all remaining taxa in the same plot. The use of WSG is found to be more efficient in calculating above ground tree biomass especially when including much broader range of vegetation types (Chave et al., 2014). The following equation was used in calculating above ground tree biomass.

$$AGB\ (kg) = 0.112 \times [WSG\ (g.cm\text{-}3) \times DBH2\ (cm2) \times Height\ (m)]^{0.916}$$

3.3. Soil carbon

Soil samples were air dried then ground and passed through a 2mm sieve to remove stones and gravel. Fine and coarse roots were also removed. Soil organic carbon was determined based on the Walkley - Black chromic acid wet oxidation method, whereby the oxidizable matter in the soil is oxidized by 1N $K_2Cr_2O_7$ solution (Walkley and Black, 1934). The soil carbon was expressed as the % organic carbon with the following formula:

$$SOC\ (\%) = \frac{(meq.\ K_2Cr_2O_7 - meq.FeSO_4) \times 0.003 \times 100 \times f}{Mass\ (g)\ air\ dry\ soil\ sample} \times MCF$$

Where;

MCF = Moisture correction factor

f = Correction factor of the organic carbon not oxidized by the treatment (normally approx. 1.3) Computation of soil carbon density was based on soil mass per unit area obtained as the product of soil volume and soil bulk density determined from the bulk density samples in (g/cm^3) Soil samples are expected to be re-analyzed by the use of CHN analyzer for doing comparative analysis.

3.4. Herbaceous layer, Liter carbon and Course wood debris (Dead woods)

The wet combustion method was used to estimate percentage organic carbon from the dry mass of the herbaceous vegetation, litters and course wood debris (Nelson & Sommers, 1982). A portion (50%) of the herbaceous materials, litters and course wood debris was oven-dried to constant weight at 70_C to determine the dry mass (Andason & Ingram, 1993) and grounded to fine powder for total organic carbon determination. The total organic carbon was determined using the wet combustion procedure as described in Nelson & Sommers (1982). The amount of carbon in each sample was calculated as the product of percentage organic carbon and dry mass (Andason & Ingram, 1993).

3.5: Degradation

To enable computation of the carbon loss through degradation, the basal diameter of each cut tree stump was used to establish the diameter at breast height using a developed model for the miombo woodlands (Sawe et al 2014[4]).

3.6: Hemispherical photographs

The field team was trained by Dr. Simon Willcock andDr Marion Pfeifer in measuring Leaf Area Index (LAI) and further vegetation structure traits according to a standardized protocol (Pfeifer and Gonsamo, 2011) using two indirect approaches: hemispherical photography and Sunscan instrument (Delta-T devices, Cambridge). Twenty plots have been sampled between 09/08/2011 and 30/08/2011. Data files (*.csv) containing SunScan readings have been converted to excel and pre-processed to specify sampling points and subplots for each of the 20 plots, to check data and to eliminate erroneous data. R statistical software package was

[4] Sawe T, Munishi PKT Maliondo SM (2014).Woodland Degradation in the Southern Highlands Miombo of Tanzania: Implications on Conservation and carbon Stock. International Journal of Biodiversity and Conservation Volume 6(3) 230-237.

used to derive mean (± se) values of LAI for each subplot and plot. Hemispherical images (*.JPG) collected in each of the plots have been pre-processed by extracting blue band information from each image and applying a thresholding algorithm to each image. The resulting images were processed with CanEye Analysis software to obtain estimates of biophysical vegetation structure, including LAI and fraction of vegetation cover (Fcover) estimates. Following from the initial analysis a further 65 plots have been sampled for LAI using Hemispherical imagery – these will be processed over the coming year in conjunction with a focused analysis of the LiDAR.

LAI estimates from the existing plots have been low, partly caused by measurements having taken place in deciduous woody biomes in the dry season (i.e. many trees had shed their leaves). Problems occurred with the SunScan instrument, which were discussed with the field team to improve reliability and accuracy of measurements in the field. Uncertainties remain regarding the coordinate reference system used for GPS readings, details on plots (i.e. tree height, tree density, disturbance history, plot pictures) and whether additional GPS readings of large buildings/trees/road markers have been taken (required for adjusting geo location of the satellite images using ground control points method).

3.6.1: **Plot sampling and data analyses**

20 plots have been sampled in woodlands near Iringa in August 2011 (Figure 8). Many trees had shed their leaves (dry season).

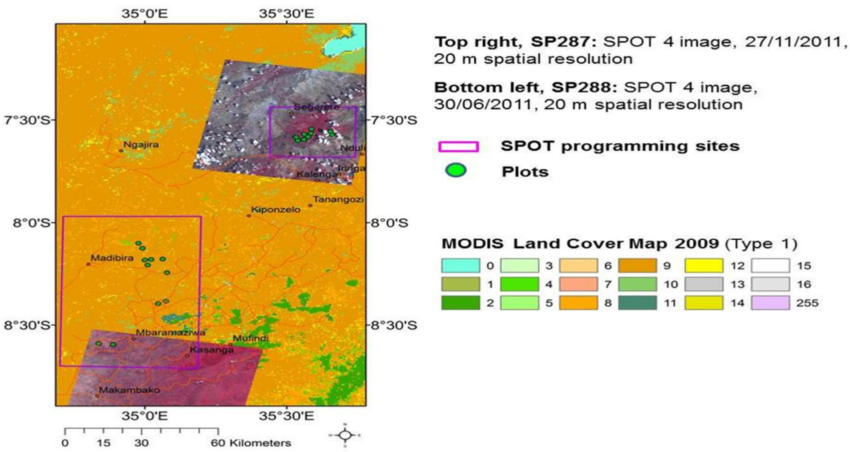


Figure 8: Location of plots sampled in August 2011 and overview on WWF Tanzania REDD+ focal

The sites for which SPOT and Formosat programming requests have been made.. 2 – Evergreen forest, 4 – Woodland, 8 – Woody savannah, 9 – savannah, 10 – grassland, 12 – cropland, 14 –

Sampling in the field followed the VALERI sampling design with one additional measurement in the Centre of each subplot, resulting in 13 sampling points per subplot and 5 subplots per plot (Figure.9)

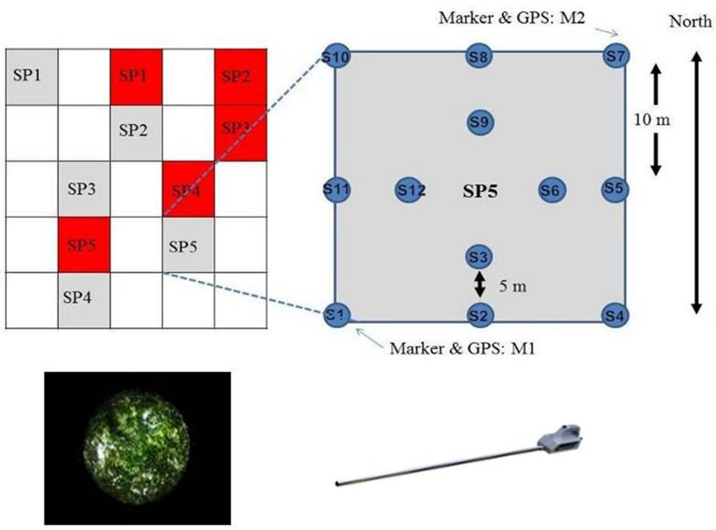


Fig 9: VALERI sampling design in the plots. See also field protocol by Pfeifer & Gonsamo, 2011.

Figure 9: VALERI sampling design in the plots.

Datafiles (*.csv) containing SunScan readings have been converted to Excel files (*.xls) and pre-processed to specify sampling points and subplots for each of the 20 plots, to check data and to eliminate erroneous measurements. A major issue was the BFRAC measurement, which when done incorrectly resulted in zero readings for LAI in that plot. Following plots need re-measuring completely: PSP20, PSP 16, PSP7, PSP17, and PSP5. For some of the other plot, only part of the subplots could be used. Following plots have complete SunScan readings for subsequent analyses: PSP1, PSP2, PSP 3, PSP4, PSP6, PSP 9, PSP 10, PSP 13 and PSP 15.

Hemispherical images were collected at the same sampling points in the same subplots as used for SunScan readings. Images were acquired with a NIKON D3100 digital camera equipped with a SIGMA 4.5 mm f2.8 fisheye lens adaptor (Fig. 10).

Figure 10: Examples of hemispherical images taken at 6 of the plots

Images were pre-processed carrying out the following steps: extraction of blue band information (to maximize contrast between vegetation and sky) and Ridler & Calvard threshold (to identify optimal brightness thresholds for distinguishing vegetation from sky). The images were then analyzed with CanEye canopy analysis software (CanEye v6.3) to derive estimates of fAPAR, LAI (which is actually PAI because tree trunks are included in the estimates of vegetation area) and fraction of vegetation cover (Fcover). LAI estimates derived via SunScan and hemispherical images were compared using R statistical software package.

3.7: Developing Land use land use change

Scenarios of land use/ cover changes were developed using a mixed approach, integrating participatory methods and spatial modeling. The modelers' team translated the sectorial analyses carried on by the stakeholders and the assessments on specific land use/cover changes into quantitative and spatial rules. The quantitative rules were interpreted to calibrate the estimate of forest and agricultural products demand andcalculated using secondary data. Supply demand was converted into surface which could be subjected either to degradation (decrease in tree cover and biomass) or deforested (replacement of tree cover by farmland), or both in sequence. The spatial rules were combined into spatial indicators of likelihood of change, which guided the allocation of land demand.

Spatial analysis was performed to produce land use /cover change map for two alternatives (BAU and GE) for 2025 using a baseline of 2010 NAFORMA land use/cover change map. Scenario maps were scaled up from zonal to national level by harmonizing the spatial indicators across the zone borders and adopting national scale demand estimates.

3.8: Analyzing biodiversity and climate change vulnerability data

Assessment of vulnerability species was done through stakeholders' workshop in Bagamoyo Tanzania. The 383 species assessed, represent all species of terrestrial snakes and lizards found in Tanzania and the adjacent countries Kenya, Uganda, Burundi and Rwanda (with the exception of chameleons, which were assessed by a separate process)Tanzania, 280 reptile species were assessed for Tanzania.

The workshop was attended by 12 experts in the reptile fauna of East Africa, five of whom are based in Tanzania and represents the leading specialists on reptiles. The workshop process was led by three facilitators from IUCN, who introduced participants to the Red Listing process. Subsequently the participants organized themselves into three groups, and each group focused on species found mainly in one set of geographical regions within East Africa (roughly delineated as: northern and eastern Tanzania and Kenya; the Albertine Rift, southern Tanzania and Uganda; and Tanzanian endemics and widespread species).

3.9: Lidar data processing

Terratec analysed the collected raw data in the form of laser scanning and orthophotos and the outputs were delivered to WWF Tanzania. However, the deliverables were transferred to University of York for further analysis since Tanzanian expert are lacking capacity on Lidar data analysis. The required outputs will be ready by May, 2015 to inform the Embassy in June, 2015. It should be noted that the knowledge and skill for Lidar data analysis will be transferred to Tanzania institutions particularly SUA and NCMC and the results will be included in database established in NCMC

CHAPTER FOUR

4.0: RESULTS AND DISCUSSION

Output 1: 120 permanent sample plots established in 10 vegetation types across the country

4.1.1: Number of plots established in different vegetation types

Achievement under this output is above the target of 120 PSP as extra of 8 plots were established in flood grassland (3) and forest on volcanic mountain (5). Therefore a total of 128 plots (Table 5) were established in 10 vegetation types across the country.

Moreover, the established plots covered a wide range of management regimes including National Forest reserve, Village land forest reserves, Local Authority Forest Reserve, National Parks and unreserved forest.

Table 5: Plots distribution in different vegetation types

No.	Vegetation type	Localities	Target (PSP)	Established (PSP)	Achievement %
1	Miombo woodland	Iringa and Mbeya	40	40	100
2	Coastal Forest	Kilwa -Matumbi/Kichi Hill	25	25	100
3	Mangroves	Rufiji/ Kilwa	5	5	100
4	Acacia/Commiphora woodlands	Arusha/Mwanga	10	10	100
5	Bushland/Thickets	Singida (Itigi)and Dodoma	10	10	100
6	Floodplain Grassland	Kilombero	3	6	200
7	Upland Grassland	Mbeya/Iringa	2	2	100
8	Savannah Grasslands	Mbeya/Iringa	5	5	100
9	Forest on volcanic mountains	Mbeya and Kilimanjaro	14	19	126
10	Forest on crystalline Mountains	E/W Usambara / South	6	6	100
	Total		**120**	**128**	**106**

The established PSP is important for future carbon monitoring to provide information on changes of carbon over time and contribute on establishment of Reference emission level for different vegetation types.

4.1.2: Carbon stock in different vegetation types

Result show that Montane forest contains has higher above ground live carbon (AGLC) followed with lowland forest in Table 6 (also see Figure 11and 12). Similarly, there is a higher total carbon stock in Montane forest (284.53 tC/ha) followed with upland grassland (260.36 tC/ha). This could be attributed by accumulation of organic matter in the soil for upland grassland that increased soil organic carbon. Additionally, good weather condition including temperature, soil and rainfall could be factors favouring annual tree growth and eventually accumulate higher carbon stock in montane forest.

The lowest mean value of AGLC is observed in *Acacia Commiphora* (6.21 ± 8.21)) followed with thickets (18.21 ± 8.45)a). The main reason behind low carbon stock is that *Acacia Commiphora* and thickets are mostly found in dry area where weather condition hampers tree annual growth. It is expected that relationship between carbon stock and various pools including plot data and environmental drivers will be produced later on and shared with important stakeholders.

Note that Herbs and tree carbon was summed up to get the above ground live carbon (AGLC). Also Mean total carbon presented in Table 6 was derived from summation of all measured carbon pools excluding the below ground carbon for trees.

Table 6: Mean carbon stock found in different vegetation types.

SN	Vegetation Type	Mean AGLC [t/ha]	Mean Soil Carbon [t/ha]	Total Carbon [t/ha]
1	Miombo-Southern	25.55 ± 17.61	77.65 ± 42.09	104.16 ± 41.30
2	Miombo-Coastal	36.30 ± 12.31	75.70 ± 39.03	112.30 ± 38.04
3	Montane Forest	98.99 ± 37.03	183.80 ± 75.72	284.53 ± 82.79
4	Thickets	18.21 ± 8.45	43.26 ± 4.51	64.98 ± 8.74
5	Upland Grassland	2.58 ± 1.54	257.77 ± 29.31	260.36 ± 27.77
6	Savannah	1.70 ± 0.83	116.87 ± 42.75	118.58 ± 42.80
7	Mangrove forest	18.26 ± 11.84	188.41 ± 75.56	206.71 ± 70.11
8	Lowland Forest	66.06 ± 46.19	47.72 ± 23.31	114.57 ± 47.16
9	Flood Plain Grassland	8.32 ± 2.08	72.82 ± 20.65	81.15 ± 21.39
10	Acacia-Comiphora	6.21 ± 8.21	57.611 ± 37.13	64.16 ± 36.90

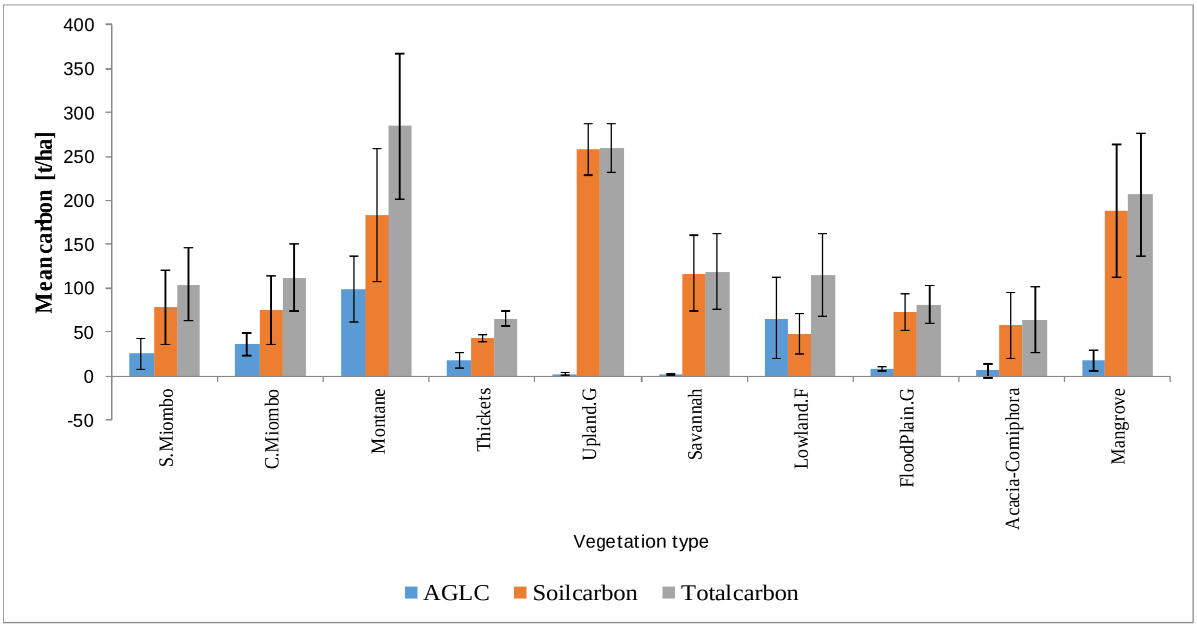


Figure 11: Variation of carbon pool across different vegetation types

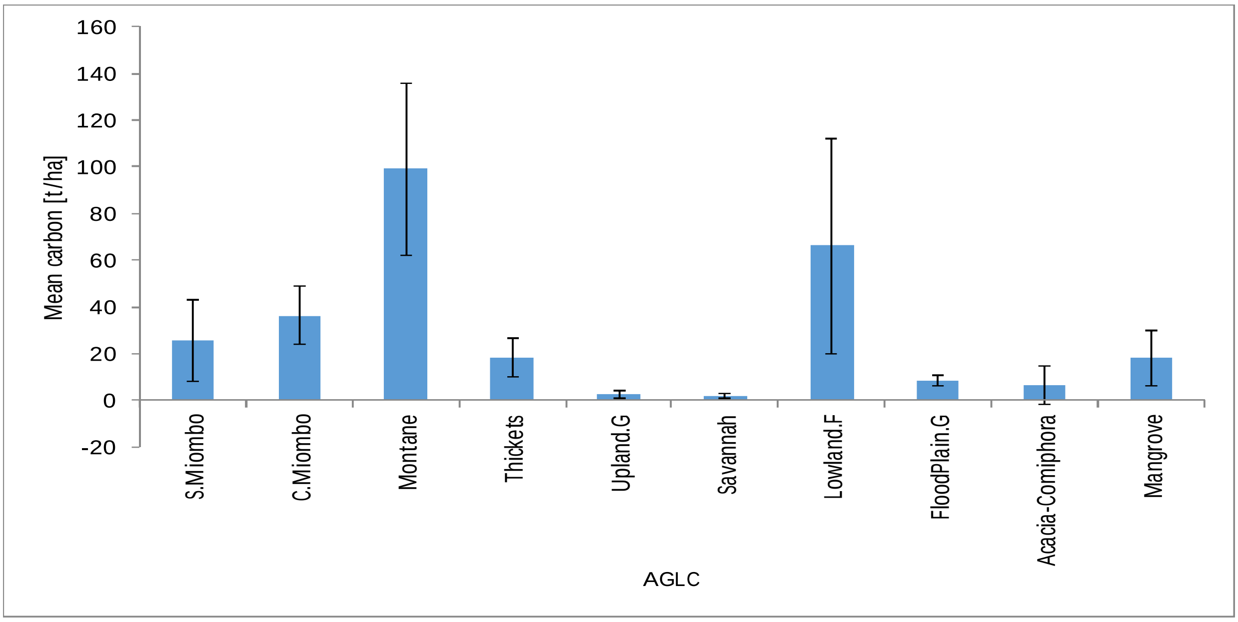


Figure 12: variation of AGLC across different vegetation types

4.1.3: Environmental and Anthropogenic factors influencing carbon storage in miombo woodland

Findings particular from miombo woodland, indicates that carbon storage is the product of a trade-off between environmental variables that set the limits of growth, therefore influencing biomass accumulation, and anthropogenic variables that influence the rate of biomass removal (Table 7). Analysis shows that anthropogenic variables are equally as important as environmental variables in explaining the spatial heterogeneity of carbon, and therefore represent an important consideration during forest inventory data collection. It is suggested that wet and dry Miombo carbon storage is subject to different climatic and anthropogenic controls, which should be recognised during the development of conservation interventions. Main factors affecting carbon storage in dry miombo are poverty (more carbon), population pressure (less carbon) and species richness has shown positive response on carbon stock in wet miombo.

Table 7: Multi-model averages for environmental and anthropogenic variables influencing carbon storage

A. dry Miombo (total annual precipitation < 1000mm; *n* = 39) and B wet miombo habitat (total annual precipitation > 1000mm; *n* = 37).

Variable	Estimate	S.E.	Adj. S.E.	*z* value	*P* value	Relative Importance
A. Dry miombo[a]						
(Intercept)	-0.458	2.144	2.212	0.207	0.836	
Poverty	7.797	2.315	2.388	3.266	0.001***	1.00
Population pressure[3] **(σ = 5)**	-0.003	0.001	0.001	2.566	0.010**	1.00
Simpson's Diversity (quadratic term)	-3.667	1.437	1.492	2.459	0.014*	1.00
Slope	-0.365	0.150	0.156	2.345	0.019*	1.00
Species Richness	0.068	0.023	0.024	2.864	0.004**	0.80
Precipitation of the driest quarter	0.050	0.037	0.039	1.277	0.202	0.29
Richness (quadratic term)	0.001	0.000	0.000	2.495	0.013*	0.20
B. Wet miombo[b]						
(Intercept)	-39.374	32.808	33.537	1.174	0.2404	
$^3\sqrt{}$**Richness**	30.615	6.074	6.263	4.888	<0.001***	1.00
Simpsons (quadratic term)	-71.149	56.614	57.592	1.235	0.2167	0.79
Mean maximum monthly temperature	-31.204	15.263	15.797	1.975	0.0482*	0.77
Cumulative fire frequency	-5.986	3.569	3.700	1.618	0.1057	0.52
Simpson's Diversity	58.580	36.156	37.571	1.559	0.119	0.29
Precipitation of the driest quarter	2.143	1.535	1.595	1.343	0.1792	0.22
Distance to market towns	0.390	0.277	0.288	1.352	0.1762	0.09
Poverty (quadratic term)	30.235	27.292	28.364	1.066	0.2864	0.05
Poverty	65.807	59.529	61.867	1.064	0.2875	0.05

* *P* < 0.05; ***P* < 0.01; ****P* < 0.001

[a] Model-averaged coefficients based on two top-models within two ΔAICc (100.77 - 101.07).

[b] Model-averaged coefficients based on twelve top-models within two ΔAICc (283.66 – 285.59).

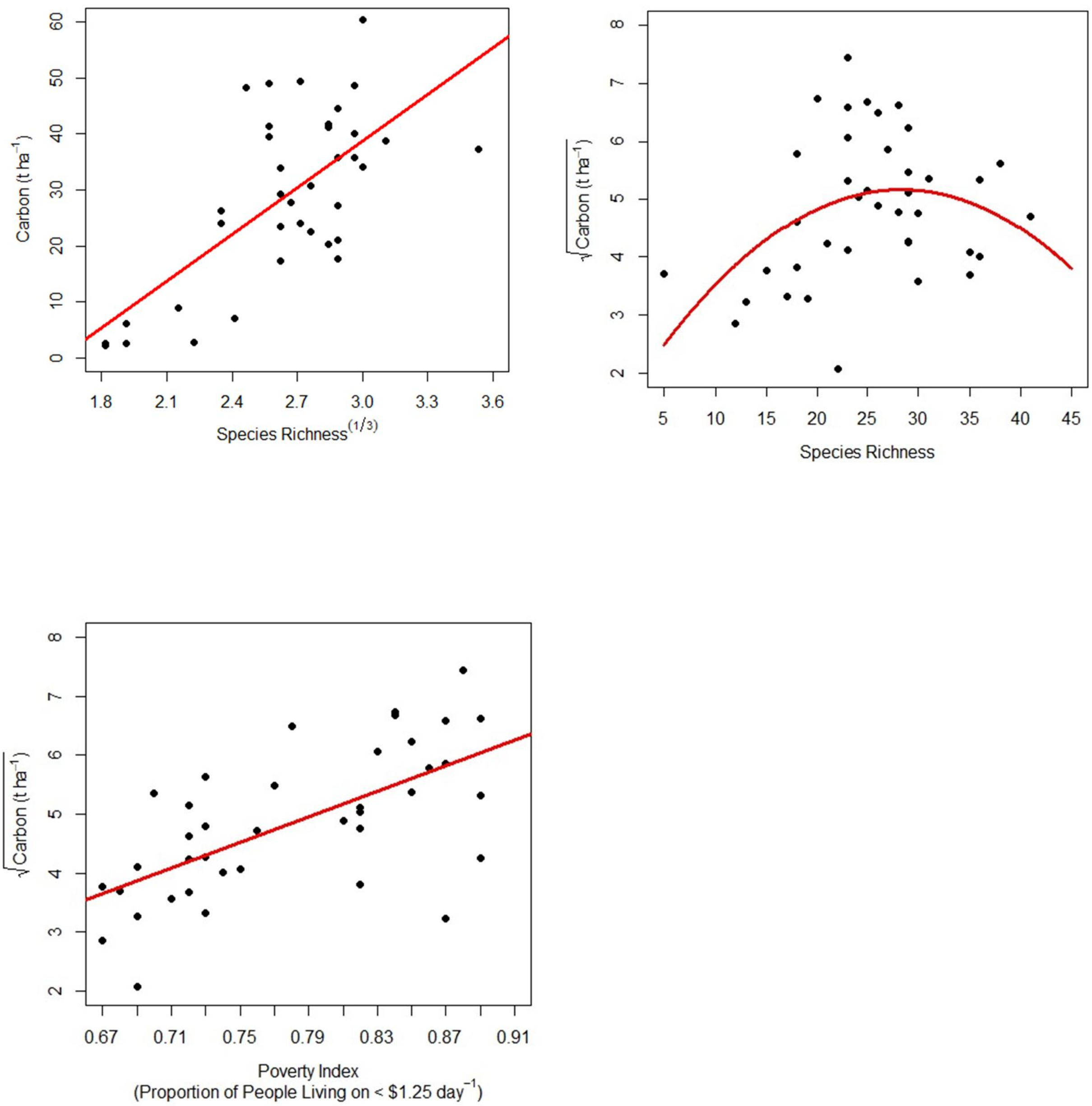


Figure 13: Influential predictors of carbon stored in dry miombo habitat (*t* ha^{-1})

derived from an information theoretic statistical approach. Variables include (a) population pressure (σ = 5; power six transformation); (b) species richness; (c) Simpson’s Diversity Index (power 6 transformation); (d) slope (degrees); (e) poverty index (demonstrating the proportion of the population living on less than $1.25 day^{-1}). Regression lines are derived from univariate generalized linear models (*n* = 4) and polynomial regression (*n* = 1).

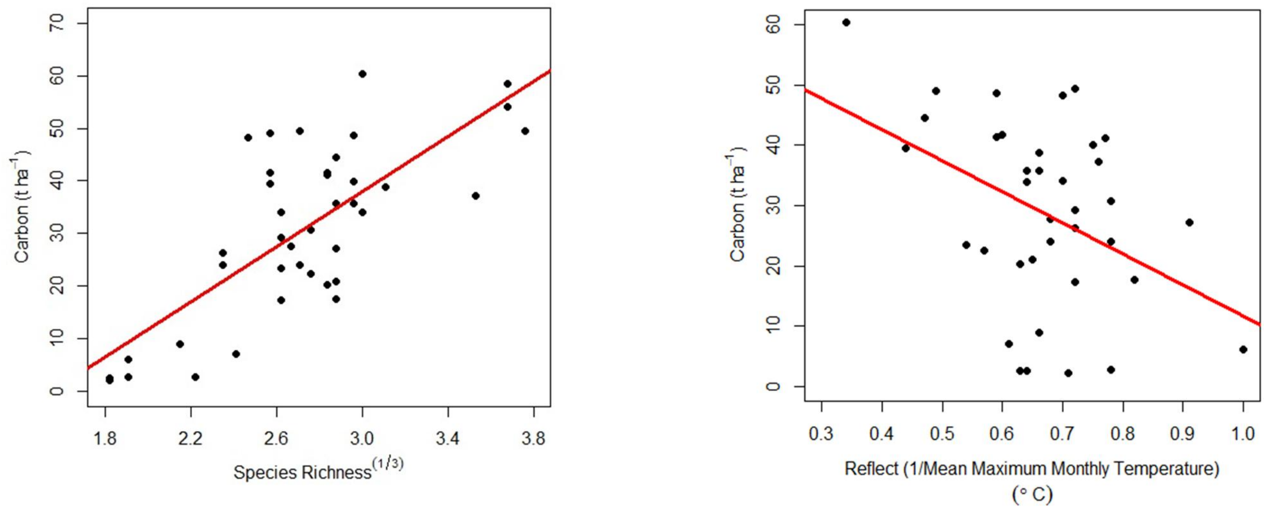


Figure 14: Influential predictors of carbon stored in wet miombo habitat (*t* ha^{-1})

Derived from an information theoretic statistical approach. Variables include (a) species richness (cube root transformation; (b) mean maximum monthly temperature (°C; variable reflected and transformed as reciprocal). Regression lines are derived from univariate generalized linear models (*n* = 2).

It was found that there is higher carbon stock in wet Miombo (29.86 t C ha^{-1} 24.93 – 34.80) than dry Miombo (24.97 t C ha^{-1} 21.25 – 28.74) although the overlapping of the confidence intervals shows there is no significant differences in these values. Inspection of the descriptive statistics suggests that this is likely the result of greater climatic stability (Temperature range: wet, 11.8°C 11.7-12.0, versus, dry, 17.1°C 17.0–17.2; precipitation in driest quarter: wet, 29.5mm 27.8-31.3, versus, dry 1.5mm 0.9-2.4), population density (wet: 9.7 people km^{-2} 5.6-14.8, versus, dry: 2.8 people km^{-2} 1.7-4.3), and therefore pressure, and increased isolation from large population centres and the remote demands they place on forest resources (wet: 63.7km 56.3-71.3, versus, dry: 56.3km 47.5-65.4).

Community composition variables were the strongest predictors of carbon storage in both wet and dry Miombo, highlighting the potential for REDD+ to align forest conservation objectives, carbon credit payment schemes and environmental co-benefits. The consistent positive influence of a species rich floral community likely reflects the importance of a functionally diverse floral assemblage. It was found that carbon is positively influenced by a species rich floral community, however, when niche differentiation is maximised, competition begins to demonstrate a deleterious effect on carbon storage.

Precipitation and water stress are considered governing factors in the geographical distribution of forest ecosystems and have proved the most consistent predictors of biomass. Total annual precipitation and dry season length have demonstrated positive and negative relationships with biomass respectively, suggesting the importance of climatic stability and water availability. In accordance with these findings, there is a negative relationship between carbon and dry season length in dry Miombo. This could be explained by seasonal water stress which has been shown to impact and even cease growth rates and reduce biomass accumulation.

Conversely, carbon storage in wet Miombo was found to be temperature-driven and negatively related to the mean maximum monthly temperature. This suggests that when a precipitation threshold is reached a climatic shift occurs, during which heat stress displaces water stress as the limiting factor regulating biomass accumulation. Back transformation of the mean maximum monthly temperature variable revealed that air temperatures beyond 30°C are associated with declines in carbon. The relationship between plant growth and air temperature is complex: low temperatures influence the efficiency of photosynthesis, thus limiting biomass accumulation, conversely, high air temperatures are associated with higher respiration costs, which, if not offset by higher photosynthetic activity, results in lower biomass.

The present study documented a negative influence of slope on carbon storage, which is in accordance with the evidence in the scientific literature that shallow slopes are related to high biomass due to the combined influence of soil nutrients, exposure to disturbance and erosion. Miombo biomass has been shown to be climatically-driven, demonstrating a positive relationship with precipitation up to a threshold of 650mm, beyond which biomass becomes disturbance-driven. Biomass is generally higher in regions where fires are infrequent (>10.5 years) and less intense. We found a negative relationship between fire intensity and carbon, but only in our wet Miombo sites, which were characterized by an average total annual precipitation of 1105mm. These findings support the hypothesis that Miombo is disturbance-driven beyond the 650mm precipitation threshold.

We found physical properties of soil structure to have a greater influence on carbon than chemical properties, the positive influence of soil clay content suggests that well-structured soils have the capacity to support larger trees and thus promote biomass (Lewis *et al.* 2013).

Despite this relatively minor contribution, the true extent to which edaphic factors influence carbon storage in Miombo remains uncertain. Resolution is unlikely to occur on the strength of ancilliary GIS data alone, thus necessitating the incorporation of soil sampling procedures alongside forest inventory methods.

Overall, anthropogenic variables demonstrate a consistently negative influence on carbon, highlighting the sensitivity of Miombo to anthropogenic pressure. Dry Miombo carbon storage was negatively influenced by local scale population pressure, while wet miombo carbon demonstrated a negative influence with distance to market towns. Collectively, these results suggest that carbon storage is influenced by pressure from regional population centres and allude to an urban influence on rural ecosystems driven by demand for forest products. The lack of consistency between anthropogenic correlates influencing carbon in wet and dry miombo highlights the regionally specific nature of the influential explanatory variables.

Poverty, however, represents the exception to the rule, and is the only social variable that does not demonstrate a strictly negative influence on carbon. In dry Miombo, the proportion of people classified as poor demonstrated a positive relationship with carbon, which appears counter-intuitive, as one would expect a greater level of dependence on forest resources with decreasing household income, thus facilitating biomass removal and the loss of carbon. It is much more conceivable that the positive influence of poverty reflects the geographical juxtopositioning of the rural poor and forest resources, with over 75% of local communities living in adjacency to Miombo categorized as poor (Bond *et al.* 2010). Alternatively, rural is synonymous with poverty in project region, in this context, the finding could suggest that carbon is influenced by accessibility; remote regions are likely to contain the poorest people but the greatest carbon due to a relaxation of demand for forest resources as a product of inaccessibility. The influence of poverty on carbon in wet Miombo is less clear, demonstrating an inverse, curve linear relationship. The ambiguity and inconsistency both within and between Miombo types could arise from assessing the influence of poverty on carbon on a limited temporal scale, degradation as a result of local anthropogenic pressure is well documented, therefore, time-scale analysis could, potentially, reveal the true nature of the relationship between poverty and carbon.

Miombo woodlands are important carbon sinks across the African landscape, yet inadequate protection and unsustainable utilisation is causing widespread degradation of these ecosystems and the services they provide. A better understanding of the correlates of forest degradation is essential to develop effective conservation interventions and ecological restoration strategies. Charcoal production, non-timber forest product extraction and agricultural expansion are often implicated as the main correlates of forest loss and degradation; however, these represent proximate rather than ultimate causes. Our social investigation has found that population density, distance to urban demand centres and the combined population pressure are the true correlates of Miombo loss, and effective policy should acknowledge the increasing threat of population growth and the resulting escalation of demand for forest products. Rural poor are the custodians of carbon, poverty alleviation should be addressed more effectively in REDD+, which requires a comprehensive, context-specific understanding of poverty. However, this is complicated by the very nature of the term "poverty", which is inherently ambiguous. Poverty is defined as an inability to satisfy predefined minimum standard of living, suggesting that poverty is a multidimensional entity, incorporating measures of health, education, empowerment and access to infrastructure alongside wealth. The efficacy of compensatory schemes such as REDD+ is dependent upon understanding which aspects of poverty drive biomass removal, facilitating the development of incentives that reconcile the contrasting goals of poverty reduction and forest conservation. A first step to achieving this involves decoupling the financial dimension of poverty from the broader societal components.

4.1.4: Degradation and Emissions

The degradation was highest in the miombo woodlands followed by the coastal forests. The other vegetation types remain relatively intact. A total of 1,432 cut stems were recorded in 40 plots of the miombo woodlands which is an average of 358 stems per hectare. In the coastal forests a total of 337 cut stems were recorded in 25 plots which is an average of 14 stems per hectare. This implies that the utilization pressure and hence degradation in the miombo is higher compared to other vegetation types. The major drivers of degradation are collection of wood fuel (firewood and charcoal) and to a lesser extent construction material (poles and sawn timber). The emissions resulting from degradation in the miombo woodlands amount to 121.8 t C ha^{-1} which translates to 461.8 t CO_2e ha^{-1}.

All major miombo woodland species (*Brachystegia spiciformis*, *Brachtsyetgia boehmii* and *Julbernadia globiflora*) seem to contribute a major proportion of the degradation in the miombo woodland associated to their uses for fire wood and charcoal production. Other species also contribute to degradation to a laser extent including *Pericopsis angolensis, Albizia antunesiana*, *Combretum molle* and *Pterocarpus angolensis*. These species are used mainly as a source of construction material such as building poles (*Pericopsis angolensis* and *Combretum molle*) and sawn timber (*Pterocarpus angolensis*)

In the coastal forests degradation emits 48.9 ton C ha-1 that translates to 87.4 t CO_2e ha^{-1}. The miombo species in the coastal forests contribute the bigger proportion of degradation as in the miombo woodlands. Other species in the coastal forests that contribute to emissions from degradation include *Baphia kirkii, Diallium holtzii, Diospyros verucosa, Hymenocardia ulmoides, Diplorhyncus condilocarpon, Pterocarpus angolensis* and *Piliostigma thoningii*.

Output 2: Hemispherical photographic survey of carbon plots established

4.2.1 Number of plots surveyed

Hemispherical photographs taken from 115 established permanent sample plots in 7 vegetation types.

4.2.2: Preliminary results on LAI.

Observed LAI (and PAI) were low in all plots ranging from 0.164 to 0.774 when averaged across subplots using hemispherical images (PAI True) and from 0.12 to 1.87 when averaged across all subplots using SunScan readings (Fig. 15).

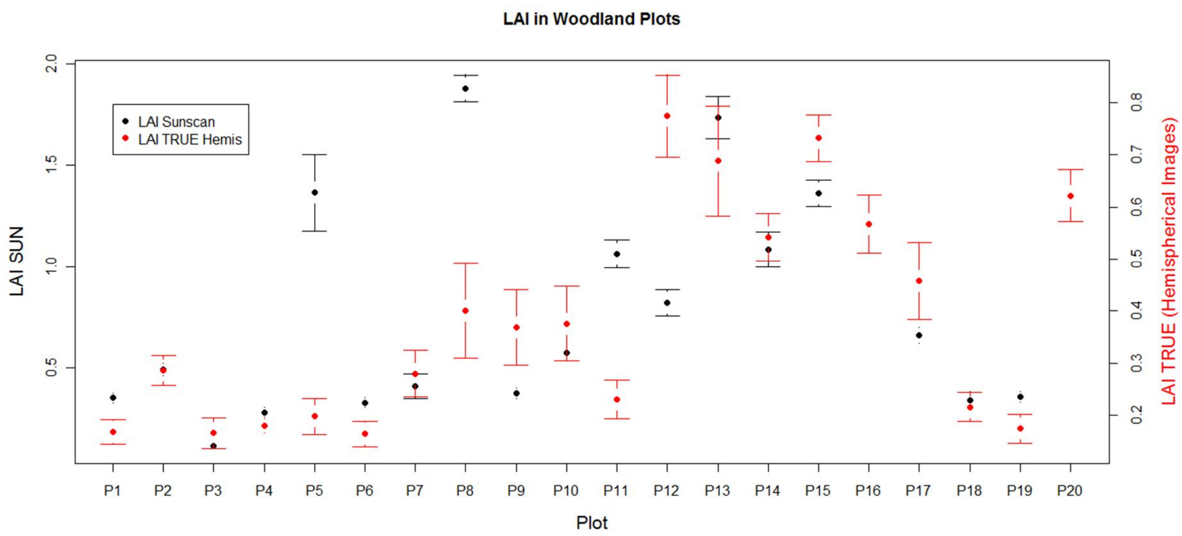
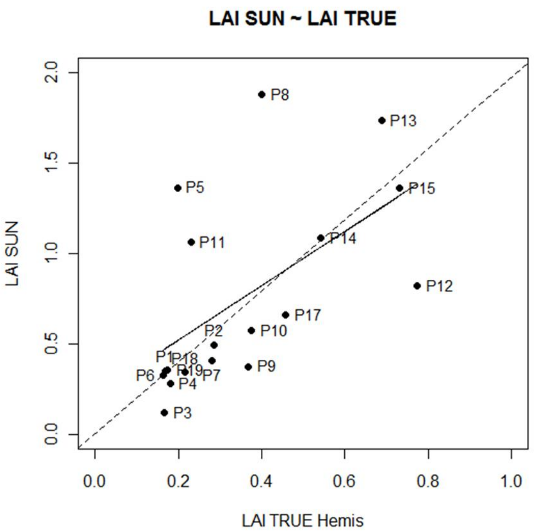


Figure 15: Mean estimates of LAI derived using hemispherical images (True PAI; red) and LAI derived using SunScan

Note: Mean estimates of LAI derived using hemispherical images (True PAI; red) and LAI derived using SunScan readings for plots 1 to 20.

We would have expected a good agreement between LAI derived using SunScan measurements and PAI derived using hemispherical images. However, some plots deviated quite considerably from that expectation (Fig.16). It is not clear yet, whether this disagreement is due to field conditions and limitations using the different methods in different environments (e.g. hemispherical images tend to underestimate LAI in vegetation dense environments and overestimate LAI in low-density vegetation) or due to measurement error when using the SunScan instrument.



Correlation between LAI measurements derived using SunScan instrument and derived using hemispherical images. Linear model: $R^2_{adj} = 0.29$ ($p < 0.05$), black line

Figure 16: Correlation between LAI measurements derived using SunScan instrument and derived using hemispherical images.

Output 3: Utility of LiDar Technology further tested in Tanzanian forest habitats

4.3.1: Coverage of Lidar flight in Udzungwa Mountain

Laser data collected successfully from 13 transect/ strip out of 24 indicated on operational flight plan as shown in Table 8. Lidar Flight covered 60% of the required area (177 square km) due to constraints of topography and weather condition as dense cloud interfere sensors (laser and camera) to capture information.

Table 8: Transect/strip covered by Lidar flight

Line/strip no.	Status
1	Completed
2	Completed
3	Completed
4	Completed
5	Flown higher or off from the line due to mountains.
6	*)

Line/strip no.	Status
7	*)
8	Flown off from the planned alternative due to mountains.
9	Flown higher or off from the line due to mountains.
10	Flown higher or off from the line due to mountains.
11	Completed
12	Completed
13	*)
14	*)
15	*)
16	*)
17	*)
18	*)
19	*)
20	*)
21	Completed
22	Flown, but aborted before the end due to mountains
23	Flown higher or off from the line due to mountains.
24	*)
25	Completed

*) Not flown since the mission was aborted before completion due to difficult weather conditions.

Terratec Company delivered the required deliverables in form of laser scanning and orthophotos to WWF Tanzania in November, 2014. A separate detailed report on this output will be submitted to the RNE in May, 2015 after completing analysis in April, 2015. The revised submission is due to the assignment being delayed due to weather condition as aforementioned.

Preliminary results shows that application of LiDar technology to assess vegetation and carbon stock in Tanzania is more expensive than expected as it involves hiring services from outside the country. Moreover, it is limited by bad weather conditions, particularly dense cloud cover and topography, which both limit its capacity to capture laser data.

4.3.2 Changes of carbon stock in Udzungwa Mountains

Result shows that, generally there is no significant difference in carbon stock between 2007 and 2014. However, there is observed gain and loss of carbon stock in some of the plots within the studied period as illustrated in Table 9. The reason behind loss of carbon is that some trees were removed from the system through natural mortality and illegal timber harvesting. The amounts of carbon content were tested by bootstrap and the results revealed that there is no significance difference of carbon content between the two periods in the Udzungwa Mountains as shown in Figure 17. However, this shouldn't contradict the fact that the forest continues to sequester carbon over time even with a minimal increment. It is observed that there is an average increase of 12.6 tC/ha for two years interval (Table 9)

Table 9: Variation in Carbon stock across elevation gradient in Udzungwa Mountains for 2007 and 2014

PSP	Elevation [m]	Carbon [t/ha]		Status	Monitored by TEAM
		2007	2014		
1	271	266.5 ± 15.2	279.3 ± 15.2	Carbon gain	NO
2	587	194.8 ± 10.9	229.9 ± 13.8	Carbon gain	NO
3	670	266.1 ± 25.9	321.7 ± 33.2	Carbon gain	YES
4	595	240 ± 14.5	193.5 ± 11.9	Carbon lost	NO
5	809	169.2 ± 19.5	141.3 ± 17.2	Carbon lost	NO
6	1450	314 ± 18.8	326.9 ± 19.2	Carbon gain	NO
7	1456	371.5 ± 16.6	411.3 ± 19.5	Carbon gain	YES
8	1175	261.4 ± 13.7	258.5 ± 13.8	Carbon lost	NO
9	1124	469.2 ± 30	384.7 ± 25	Carbon lost	YES
10	1772	300.9 ± 14	434 ± 21	Carbon gain	YES

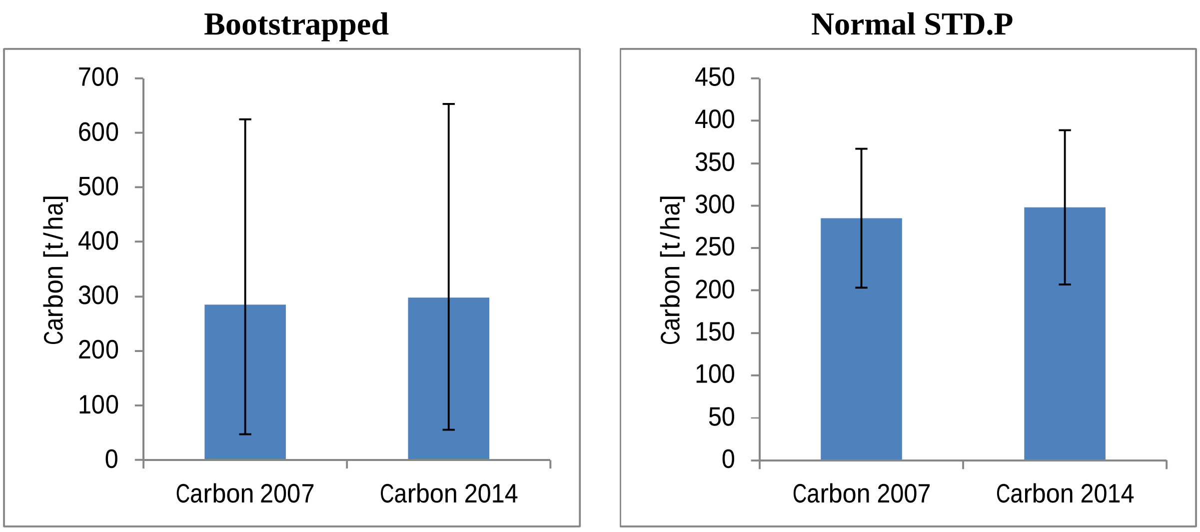


Figure 17: Variation in Carbon stock between 2007 and 2014

Output 4: Soil carbon surveyed across Tanzanian vegetation types

Results from soil analysis are crucial inputs for mapping Soil Organic Carbon (SOC) and finally producing the National Soil Carbon Map. It was found that upland grassland, mangroves, montane forest and savannah contain higher amount of soil organic carbon than other vegetation types as illustrated in Table 6. Moreover it was observed that least soil organic carbon is found in thickets followed with lowland forest and *Acacia commiphora*. This variation could be attributed to variability in local environment factors such as soil nutrient dynamics and rainfall pattern as well as severity of disturbances. Also temperatures in upland ecosystems on mountains are low, resulting in low decomposition rate of organic matter, hence accumulation of soil organic carbon in high mountain ecosystem provide more soil carbon compared to adjacent ecosystems on lower altitudes.

Output 5: A range of future scenarios for changes in carbon stock produced

4.5.1: Scenario results

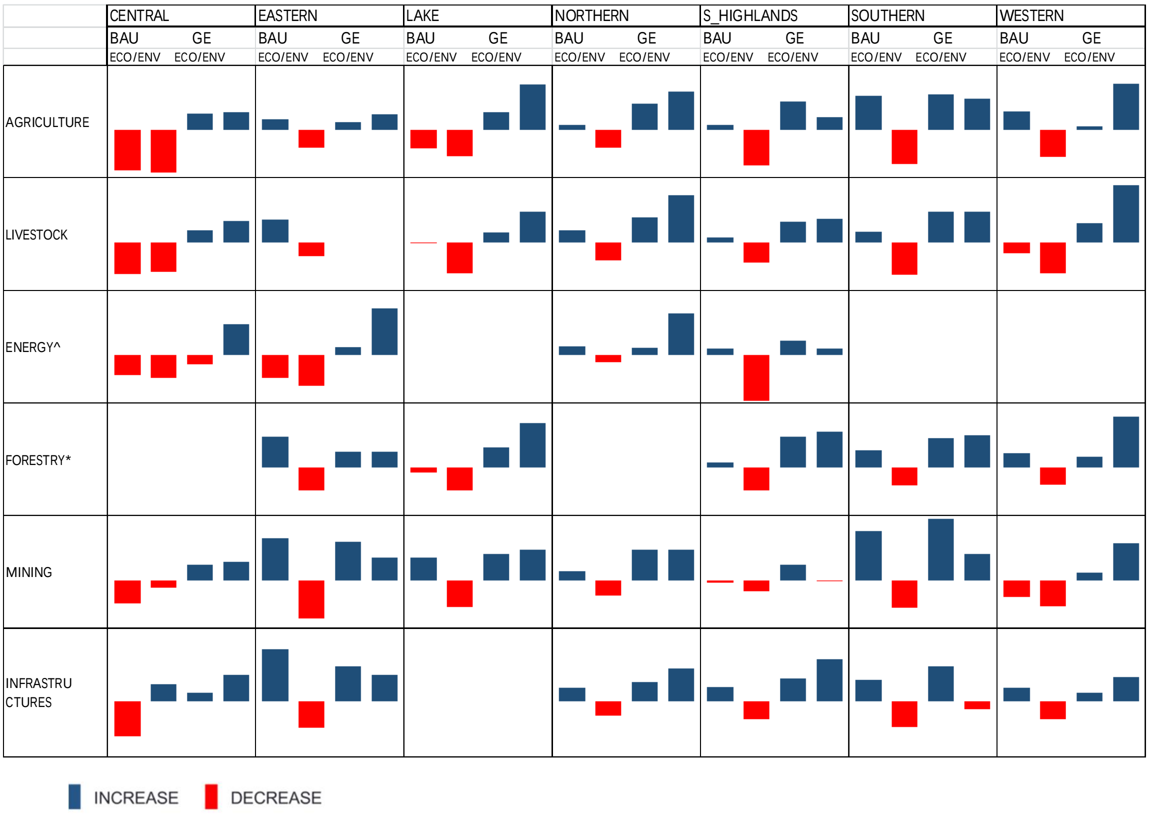
Agriculture, livestock, forestry, energy, mining and infrastructure sectors were identified as the main sectors affecting land use and cover in every zone. Wildlife and fisheries were also important in some zones (e.g.: Northern for wildlife and Lake Zone for fisheries). Agriculture, livestock and biomass energy (reported either under Energy or Forestry sector) were generally the sectors with strongest effects although it is noted that the sectors' impacts varied across regions.

It was found that most sectoral policies under Business As Usual (BAU) are favouring economic growth at the expense of environmental degradation and consequently increase carbon emission. However, in Central and Lake Zones, even economic performance of agriculture and livestock was reported to be undermined by current practices. In fact, stakeholders envisaged decrease of soil fertility and productivity in these areas which currently provide a large part of agriculture production. This could trigger an even larger expansion of farmland.

Under Green economy (GE), stakeholders perceive that there will be improvement of environment management with less emission from land use conversion because the environmental agenda will be integrated into development policies to ensure sustainable development. However, stakeholders envisaged that it would generally not be possible to have a total reversion of the emission trends and the subsequent increase in carbon storage,.

Conservation areas could play an important role in this process. It is interesting to note that in Eastern zone, no Green Economy scenario was foreseen for livestock sector, reflecting the idea that a change in livestock practice would require a cultural change which is not likely to happen by 2025 (Table 9). This challenge was also mentioned in other zones (Southern, Southern Highlands and Western).

Table 10: Trend of economy and environment under alternative scenarios



4.5.2: Drivers of deforestation and degradation: focus on miombo ecosystem

The main drivers of land use changes in Miombo woodland under two different scenarios are shown in Table 11. It was noted that population growth, farmland expansion, infrastructure developments and livestock keeping are main drivers of land use/cover change under BAU particularly in miombo woodland.

Table 11: Drivers of Miombo woodland "deforestation"

Note: replacement of tree cover, including changes to farmland, grassland, human settlements and infrastructures. Total index is calculated by the likelihood scores of specific conversions and the ranks of the drivers, summed over possible changes.

DEFORESTATION	BUSINESS AS USUAL	GREEN ECONOMY	Total index
DRIVERS			
Population growth			**63.3**
Population growth	43.0	4.0	47.0
Population growth with immigration	6.5	2.0	8.5
Settlement expansion	6.0		6.0
Settlements expansion	1.8		1.8
Farmland expansion			**29.2**
Demand for agricultural land	8.0	1.0	9.0
Shifting cultivation	7.7		7.7
Demand for fertile soil	3.3	2.3	5.5
Commercial agriculture	4.0		4.0
Commercial farming	2.0		2.0
Global market	1.0		1.0
Infrastructure development			**14.5**
Infrastructure building	7.0	1.5	8.5
Irrigation (dams)		3.0	3.0
Investments	2.0		2.0
Settlement expansion	1.0		1.0
Livestock keeping	**13.8**		**13.8**
Investments farming	**5.3**	**7.5**	**12.8**
land demand	**6.0**	**6.0**	**12.0**
Charcoal production	4.0		**4.0**
Crop price/market	**3.5**		**3.5**
Industries	**2.5**	**0.7**	**3.2**
Land Management (change)		**3.0**	**3.0**
Agriculture policies		3.0	**3.0**
Investments mining	**3.0**		**3.0**
political will	**1.0**	**1.5**	**2.5**
Irrigation	**0.8**	**1.5**	**2.3**
Fire	**2.0**		**2.0**
Mining activities	**0.7**	**1.0**	**1.7**
Land Management	**1.5**		**1.5**
Poverty	**1.5**		**1.5**
Poor practices, low inputs	**1.0**		**1.0**
Land Management (lack of)	**0.7**		**0.7**
Illegal logging	**0.4**		**0.4**

Table 12 shows that biomass energy, livestock keeping farmland expansion and demand for forest products contribute to forest degradation in miombo woodland. Therefore identified drivers could most likely change miombo woodland into open woodland and bush land with increased carbon emission.

Table 12: Drivers of "degradation

Note: decrease in tree cover and biomass), including changes from miombo to open woodland and bushland. Total index is calculated by the likelihood scores of specific conversions and the ranks of the drivers, summed over possible changes.

DEGRADATION DRIVERS	**BUSINESS AS USUAL**
Biomass energy	**33**
Charcoal production	32.0
Fuel wood	1.0
Livestock keeping	**23.5**
Fire	**17.9**
Farmland expansion	**16**
Shifting cultivation	12.5
Demand for agricultural land	3.5
Forest products demand	**11**
Population growth	8.0
Illegal logging	**5.9**
land demand	**5.5**
Mining activities	**5.1**
Livestock practices	**2.5**
Ranches	1.5
eradication of tse-tse fly	1.0
Logging	**2.2**
Poor practices, low inputs	1.5
Crop price/market	**1.0**
Beekeeping	**0.8**
Roads	**0.7**

4.5.3: Potential change of miombo woodland to forest plantation

Table 13 shows that miombo woodland could change to forest plantation under BAU due to high demand of forest product induced by population growth. This situation could attract more people/investors to replace miombo woodland with forest plantation to meet the growing demand and earn substantial income.

Table 13: Changes to forest plantations

Deforestation/Afforestation	BUSINESS AS USUAL	GREEN ECONOMY	Grand Total
DRIVERS			
Forest products demand	**16.5**	**6**	**22.5**
Timber and poles	6.0		6.0
Wood price/market	2.0	3.0	5.0
Investments plantations	3.0	2.0	5.0
Demand for wood products	3.0		3.0
Wood demand for tobacco curing		1.0	1.0
Furnitures	1.0		1.0
Forest products demand	1.0		1.0
Pulp and paper	0.5		0.5
Investments forestry	**2.0**	**5.0**	**7.0**
Charcoal production	4.3		4.3
Afforestation	**0.7**	**1.5**	**2.2**
Political will	**1.5**		**1.5**
Change of policy		**1.5**	**1.5**
Community awareness		**1.0**	**1.0**
Tobacco curing		**0.7**	**0.7**
Accessibility	**0.7**		**0.7**

Even though the drivers of conversion to forest plantation seem stronger in BAU than in GE scenario, in terms of likelihood of the conversion it was less significant. In fact increase in forest plantations is one of the possible interventions to fulfill demand for forest products.

Therefore forestry investments would be encouraged in areas with good climate to support forest plantation as shown in figure 18. However, note that this could generate a further competition for land uses (marginal woodland to be converted, or grassland) which should be taken into account when planning afforestation interventions.

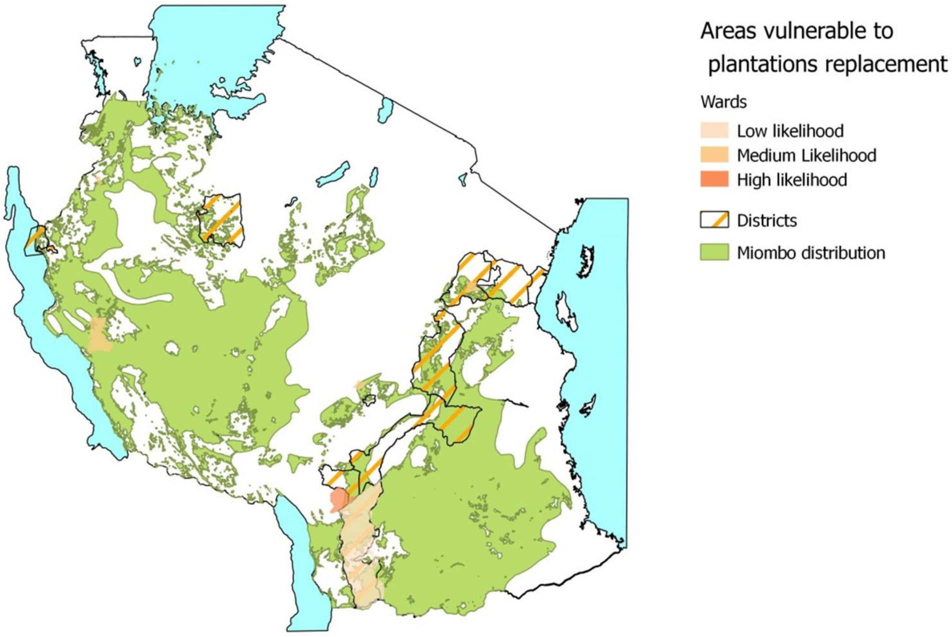


Figure 18: Specific areas identified by stakeholders for potential replacement of Miombo woodland with forest plantations**.**

4.5.4: Land use/cover changes maps developed based on Business as usual and Green economy

Information collected during stakeholders consultations were used to create composite spatial indicators of land use and cover change likelihood, for different land cover classes under BAU and GE scenarios (Figures 19 and 20 respectively).

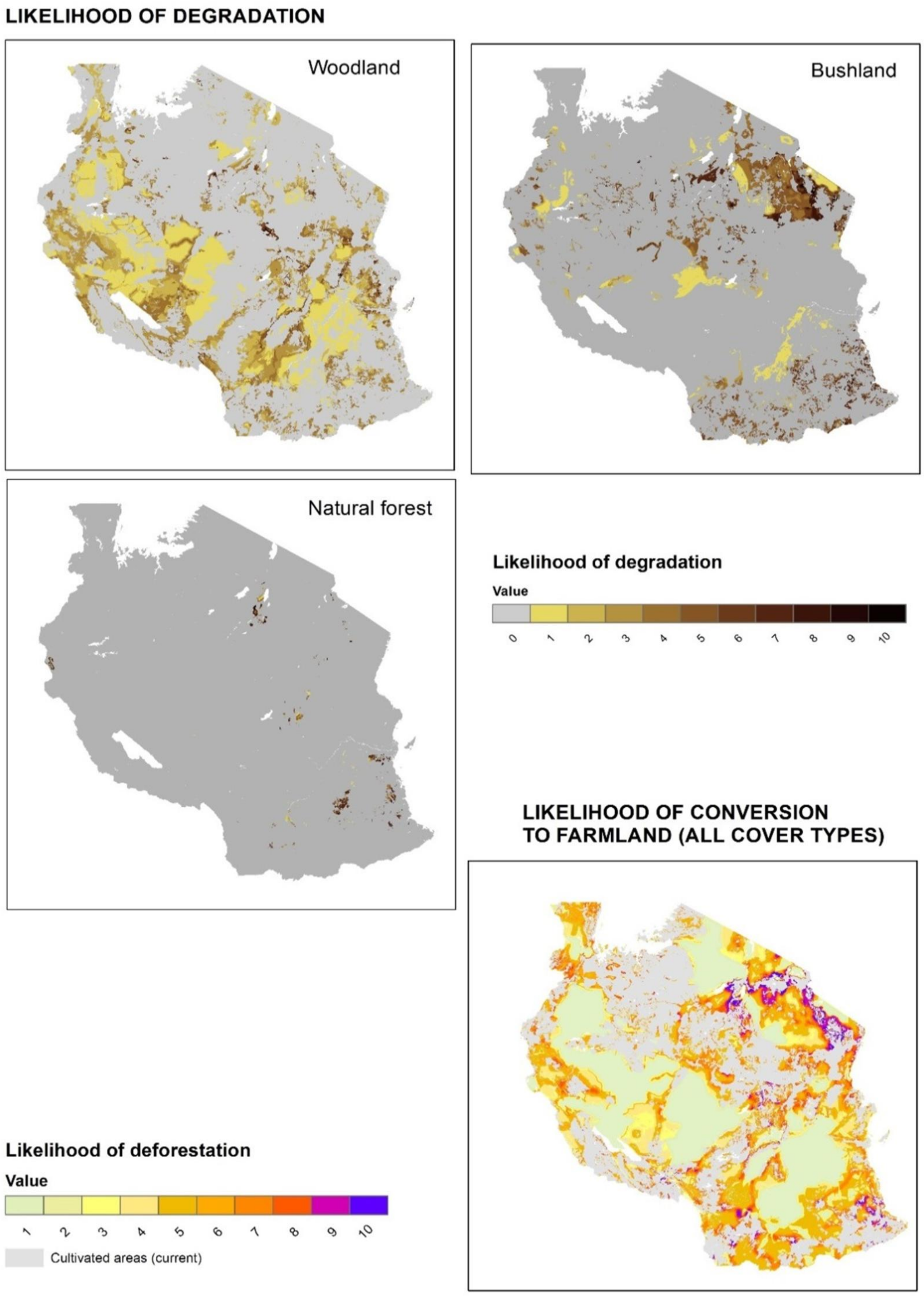


Figure 19: Likelihood of degradation and deforestation of different land cover types under BAU scenario

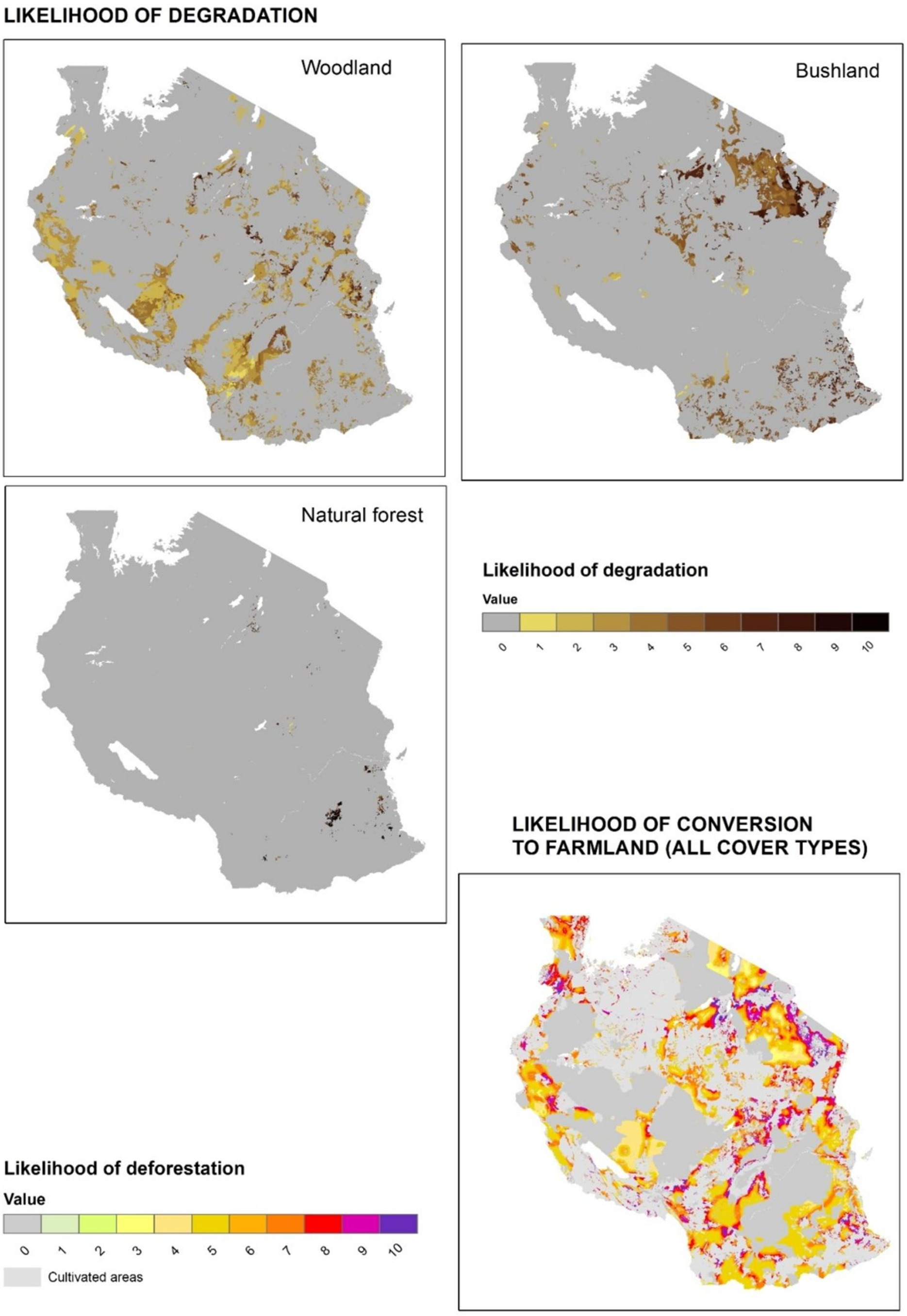


Figure 20: Likelihood of degradation and deforestation of different land cover types under GE scenario.

The spatial indicators of likelihood of change drive the allocation of demand for forest product (degradation) and for new farmland (deforestation). Degradation and deforestation in the model are partially additive and partially cumulative, which means that changes may overlap in some areas (e.g. changes from closed woodland to grassland follows changes from closed woodland to bushland). In particular, the conversion to farmland is considered the final state. Here we do not consider urbanisation, since human settlements are actually included in the cultivated cover classes in the NAFORMA land cover map, besides the major urban areas.

In the GE scenario, we assumed that legal protection is enforced and forests are sustainably managed (REDD+ implementation), therefore permanent changes are not allowed in gazetted areas (in dark grey in the map). This is influencing the scores of the likelihood indicators outside protected areas, which are usually higher than in the BAU scenarios (evident in particular for farmland expansion). Since “available” land to be converted is squeezed between already cultivated areas (light grey) and protected sites, the conversion likelihood results higher. This suggests the important role of protected sites in reducing the risk of land use changes.

In our model, areas with highest scores for the indicators will be converted first, and then followed by those with lower scores. To what extent the conversion may take place is determined by demand estimated according to the scenarios narratives. In the GE scenario, the actual demand for either raw forest product or new farmland would decrease (thanks to increased efficiency in production). Therefore, despite higher values in the likelihood indicators, the actual land cover changes result less than in the BAU scenario, as can be seen in the final scenario maps (Figure 21 and 22).

Figure 15 and 16 shows developed map for possible future land use/cover changes under the two alternatives scenarios (BAU and GE) for 2025. Results show that land cover changes could be reduced due to some important intervention including adopting green economy policies and effective implementation of PFM and REDD+ and law enforcements.

Under the assumptions of the BAU scenario- increasing demand for fuel wood and charcoal and for new farmland driven by population growth; failure of REDD+ and other policies, implementation would continue to remove tree cover and biomass and vegetation. Moreover, total surface of forest, woodland, bush land, grassland and wetland would decrease at an annual average rate of 1.4% (Table 14). Applying specific carbon stock estimates for Tanzania (Wilcock et al. 2012), this would correspond to a loss of 1.25 Pg (Pg = 10^9 tonnes) in carbon stock.

Under the assumptions of GE scenario- effective REDD+ implementation and sustainable forest management achieved by 2025; crop productivity increased by 20%- the annual rate of land cover change would be reduced to 0.9%. This would correspond to 0.76 Pg of carbon stock reduction by 2025. Therefore, the difference in carbon emissions between GE and BAU scenario would be about 0.5 Pg (Pg = 10^9 tonnes).

The reported quantifications of carbon emissions under the two scenarios are based on the land demand we applied, and therefore represent two possible "quantitative" interpretations of the envisaged trends. However, given that assumptions are consistent under the two scenarios, the relative difference between them is independent by the absolute quantities. Therefore, it is correct to conclude that under a green economy scenario, the combined implementation of REDD+ program and the existing (but so far not neglected) agricultural policies would lead to a reduction of emission of about 40%.

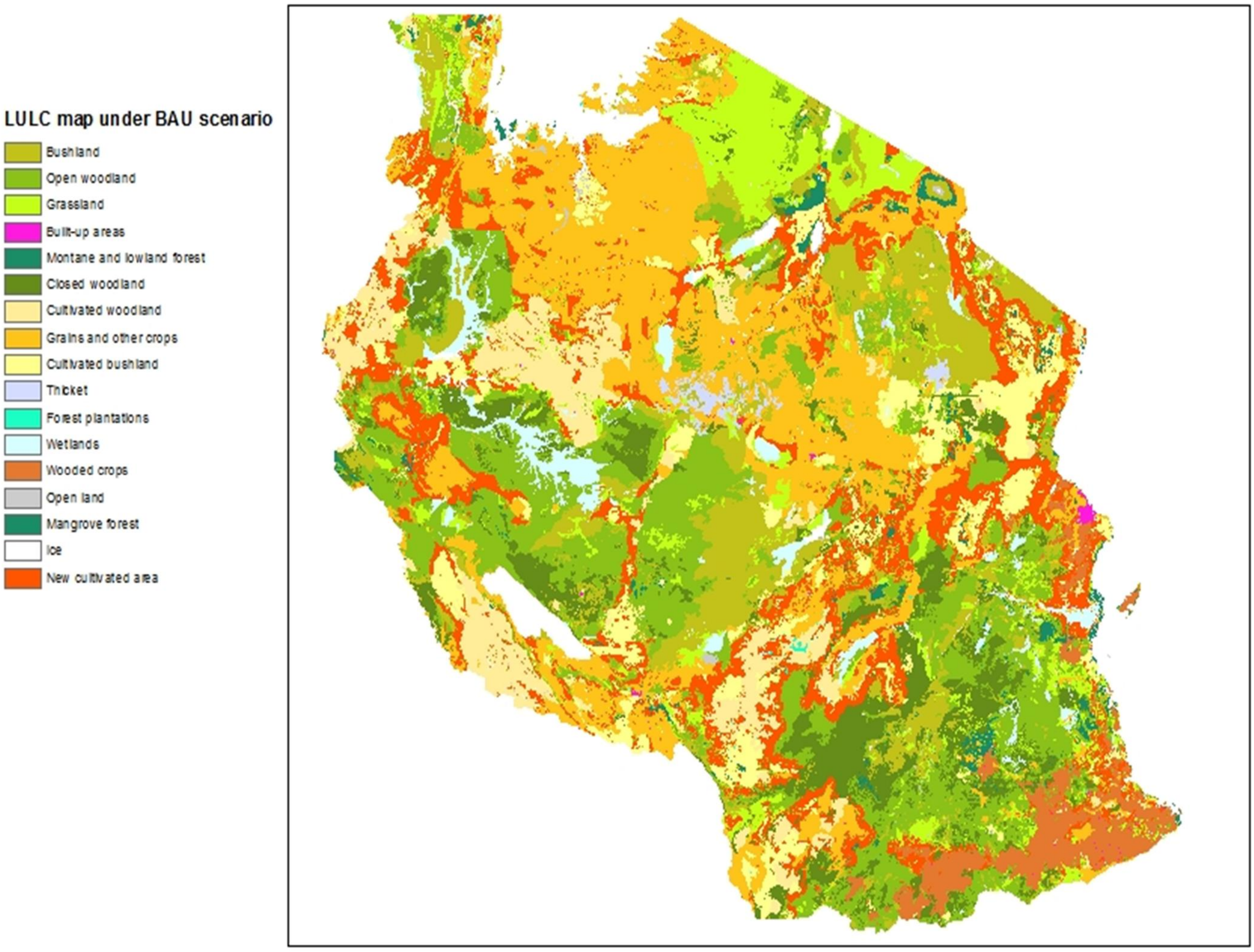


Figure 21: Land use/cover map under BAU scenario.

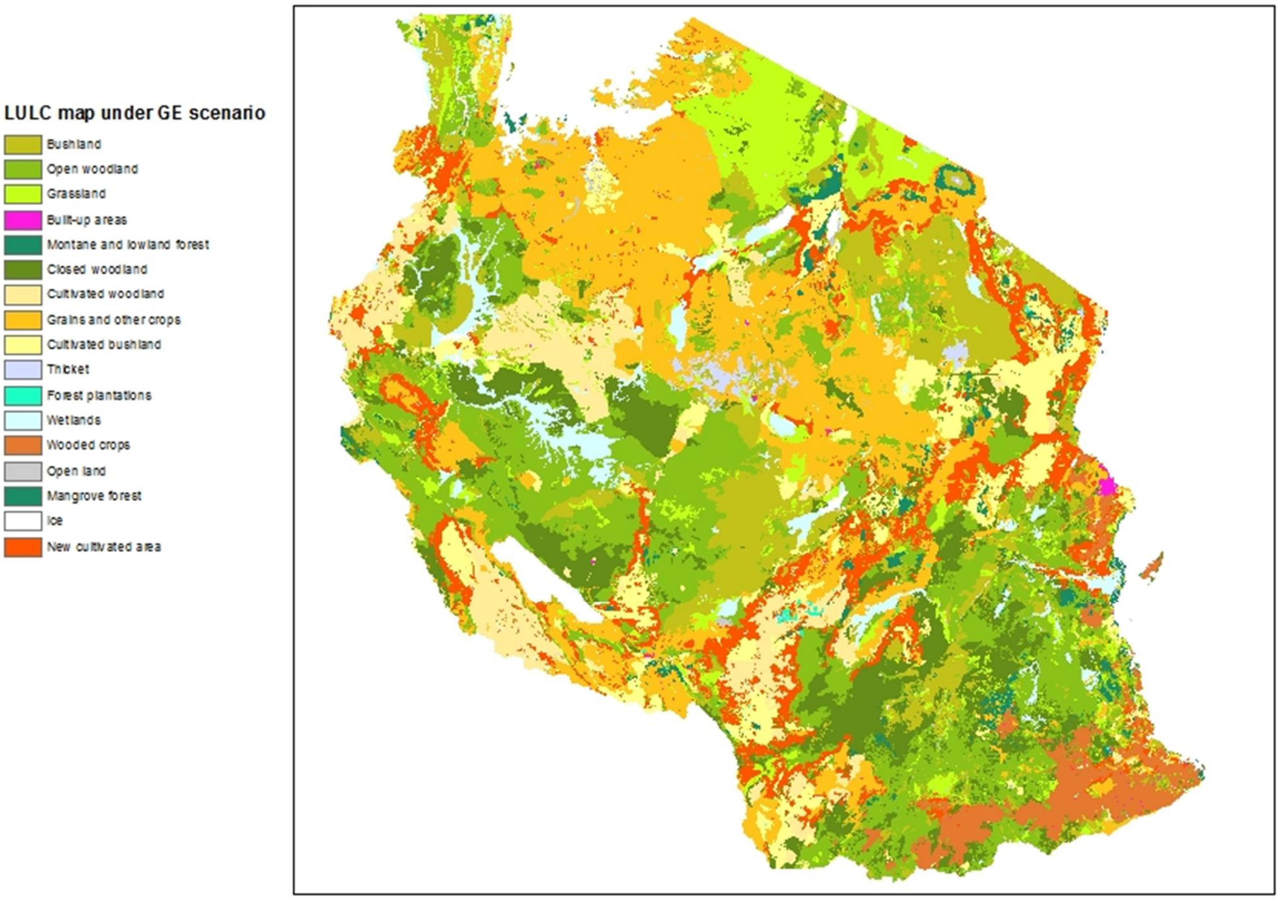


Figure 22: Land use/cover under GE scenario.

Table 14 – Percentage changes in land cover surfaces by 2025 under BAU and GE scenarios.

Mean carbon stock for each class and lower (LCI) and upper (UCI) 95% confidence intervals values are reported according to Willcock et al 2012*.

Land cover	BAU 2025-2010	GE 2025-2011	Mean Carbon stock (Mg/ha)	LCI-UCI	Carbon balance (Pg)
Bushland	-21.6	-16.2	212.1	149.1_301.8	-0.144
Open woodland	-23.6	-15.1	196.1	174_219.9	-0.350
Grassland	-7.8	-2.2	153.4	104.7_162.7	-0.053
Montane and lowland forest	-26.2	-11.2	429.7	346.9_527.4	-0.099
Closed woodland	-17.6	-14.2	301.4	231_351.1	-0.108
Thickets	-0.9	0.0	212.1	149.1_301.8	-0.001
Wetland	-20.7	-9.1	719.8	755.6_791.9	-0.263
Mangrove forest	-13.4	-10.0	212.1	149.1_301.8	-0.001

*Towards Regional, Error-Bounded Landscape Carbon Storage Estimates for Data-Deficient Areas of the World. Willcock S, Phillips OL, Platts PJ, Balmford A, Burgess ND, et al. (2012) PLoS ONE 7(9): e44795. doi: 10.1371/journal.pone.0044795

4.5.5: Environmental and social spatial data to support REDD+ planning and safeguards development

WWF Tanzania through its partner organizations, Sokoine University of Agriculture, IUCN and UNEP-WCMC, completed a compilation of spatial information on biodiversity, ecosystem service and social data to fill information gaps on spatial environmental and social parameters for National REDD+ safeguards, building on work by UN-REDD/NAFORMA in 2013 (Appendix 3). The objective was to identify and meet environmental and social spatial data needs to support REDD+ planning and safeguards development in Tanzania. Various maps and statistics were developed to address the existing gap. The final results are presented in the report Augustino et al. (2014)[5].

The report introduces REDD+ in Tanzania and summarizes progress in developing a national approach to safeguards (section 2), and explains how spatial data is useful for integrating safeguards and multiple benefits considerations into REDD+ planning and for developing a Safeguards Information System (SIS) (section 3). It then provides a gap analysis of the spatial information useful for addressing elements of Tanzania's REDD+ Safeguards Standards, outlining how this project can fill some gaps in the spatial data (section 4). In sections 5 and 6, the report presents a set of new maps made available through this project. These cover social aspects of 'The Tanzania REDD+ Social and Environmental Safeguard Standards', as well as a range of biodiversity, climate change vulnerability and ecosystem services information. The report then discusses how these maps can inform climate policy and land-use planning, particularly for REDD+, and for forest restoration. It concludes with policy recommendations for the development of Tanzania's future Safeguards Information System.

The maps developed by the project address national priorities for biodiversity and ecosystem aspects; socio-economic and livelihoods data; forest cover change and how it relates to priority aspects of biodiversity and ecosystem services; and potential areas for REDD+ activities that would enhance biodiversity and ecosystem services while generating alternative livelihoods.

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[5] Augustino, S., Bowles, P., Carr, J., Cox, N., Hicks, C., Mant, R., Mbilinyi, B., Meng, H., Ravilious, C., Runsten, L., Salvaterra, T., Silayo, D., Tognelli, M., Zahabu, E.2014. Environmental and social spatial data to support REDD+ safeguards and planning in Tanzania. SUA, Morogoro, United Republic of Tanzania; UNEP-WCMC, Cambridge, UK; IUCN Global Species Programme, Cambridge UK and Washington DC, USA.

The maps and corresponding GIS datasets are intended to be used by decision makers during the preparation of Phase II of REDD+ Readiness in Tanzania. The maps are intended to be included in a safeguards GIS system at the National Carbon Monitoring Centre (NCMC). In addition, the maps may provide a baseline and decision support when developing the SIS for determining what information to collect and how. Further consideration of environmental and social issues are however likely to be needed for effective planning of REDD+ actions and the development of the SIS, particularly at a subnational level.

4.5.6: Threatened species and its dependence on forest

It was found that 31 species of 280 reptile species found in Tanzania are considered are considered to be globally threatened with extinction (Table 15),

Table 15: Red List assessments of reptile species in Tanzania

Red List Category	Total Number of species assessed	Percentage of total assessed
Critically Endangered	2	<1
Endangered	8	3
Vulnerable	21	7.5
Near Threatened	3	1
Least Concern	206	73.5
Data Deficient	38	14
Not Evaluated*	2	<1
TOTAL	**280**	**100**

It was also found that in East Africa, the major threats are from habitat modification mainly for plantation agriculture (and to a lesser extent from timber extraction and pastoral activity), particularly to restricted-range montane reptiles. This is mainly a threat to forest species, including the Critically Endangered Ornate Shovel-snout (*Prosymna ornatissima*) of the Kitundu Hills and Matilda's Horned Viper (*Atheris matildae*) of the Southern Highlands.

Tanzania's high grasslands also contain threatened endemics such as the Udzungwa Long-tailed Seps (*Tetradactylus udzungwensis*) (Endangered), a lizard of high swampy grassland already believed to be of conservation concern as a result of the establishment of pine plantations in this area of the Udzungwas. Similar pressures are likely to threaten a Southern Highlands grassland lizard, Braun's Mabuya (*Trachylepis brauni*) (Vulnerable) in future.

One species, a skink with no common name (*Typhlacontias kataviensis*) (Endangered), is known only from Katavi National Park where it is restricted to sandy ridges along flood plains, and may be at risk from dam construction in the surrounding landscape.

The international pet trade is a particular threat to some restricted-range species, including two Tanzanian endemics. The precise distribution of Matilda's Horned Viper has been withheld as this species is likely to be attractive to collectors, and as a restricted-range species already under pressure from deforestation is unlikely to be able to sustain harvest for the pet trade. The Turquoise Dwarf Gecko (Lygodactylus williamsi) (Critically Endangered), which was assessed prior to the workshop, is currently collected at unsustainable levels, and like other threatened Uluguru endemics is also at risk from deforestation.

Appendix 4 shows the concentrations and proportions of threatened reptile species throughout Tanzania. When considering total numbers of threatened species, one finds the greatest concentrations (up to 16 species per grid cell) in the regions of Tanga and Morogoro. Elsewhere, in regions such as Kilimanjaro, Iringa and northern Morogoro, numbers of threatened reptile species can reach up to eight per grid cell (though more typically three to five). At other scattered locations throughout the country, one or two threatened species are present.

In terms of proportions of threatened reptile species, Appendix 4 suggests that the highest percentages are also found in Tanga and Morogoro, where up to 25% of species are considered threatened. Locations where 10-20% of reptile species are considered threatened can be found in Kilimanjaro and Iringa regions, as well as northern Morogoro, while at other scattered locations throughout the country low proportions (1-5%) of the reptile species present are considered globally threatened.

Appendix 5 shows the concentrations and proportions of climate change vulnerable reptile species throughout Tanzania by 2055. When considering total numbers of vulnerable species, one finds the greatest concentrations (up to 18 species per grid cell) in northern Tanga. In areas surrounding this, including in much of Kilimanjaro, other parts of Tanga and locations within Pwani and Dar es Salaam between 10 and 13 climate change vulnerable reptiles per grid cell can be found. Between four and nine species of climate change vulnerable reptiles per grid cell can be found along much of northeastern (bordering Kenya) and eastern (coastal and inland) Tanzania, as well as in the regions of Kagera, Rukwa, Dodoma, Morogoro and the islands of Zanzibar and Pemba. Elsewhere, large areas in western, northern and eastern Tanzania support one to three species of climate change vulnerable reptile species, while in much of central and southern Tanzania these numbers can only be found at scattered locations.

In terms of proportions of climate change vulnerable reptile species, our assessments suggest that by 2055 the greatest impacts could occur in northern Kagera and the island of Pemba, where, at some locations, up to 36% of species are assessed as climate change vulnerable. Elsewhere, along much of northeastern and eastern Tanzania, and particularly in the regions of Arusha, Kilimanjaro, Tanga, Pwani and Dar es Salaam, between 15 and 25% of reptiles in a given grid cell are considered vulnerable to climate change. At most other locations in Tanzania, where climate change vulnerable reptiles species occur, these represent 1-5% (though in some places reaching 15%) of species present.

Appendix 5 shows that the number of reptile species considered to be both globally threatened with extinction and vulnerable to climate change ranges from 13, by 2055, using RCP4.5 and an optimistic assumption of missing data values, to 30 species, under all pessimistic data treatments, with the exception of 2055 using RCP4.5 (22 species).

Table 16: Numbers (and percentages) of Tanzanian reptile species considered globally threatened and climate change vulnerable.

	RCP4.5		RCP8.5	
	Optimistic	**Pessimistic**	**Optimistic**	**Pessimistic**
2055	13 (5%)	22 (8%)	16 (6%)	30 (11%)
2085	16 (6%)	30 (11%)	16 (6%)	30 (11%)

4.5.7. Distribution of forest-dependent amphibian, bird, mammal and reptile species

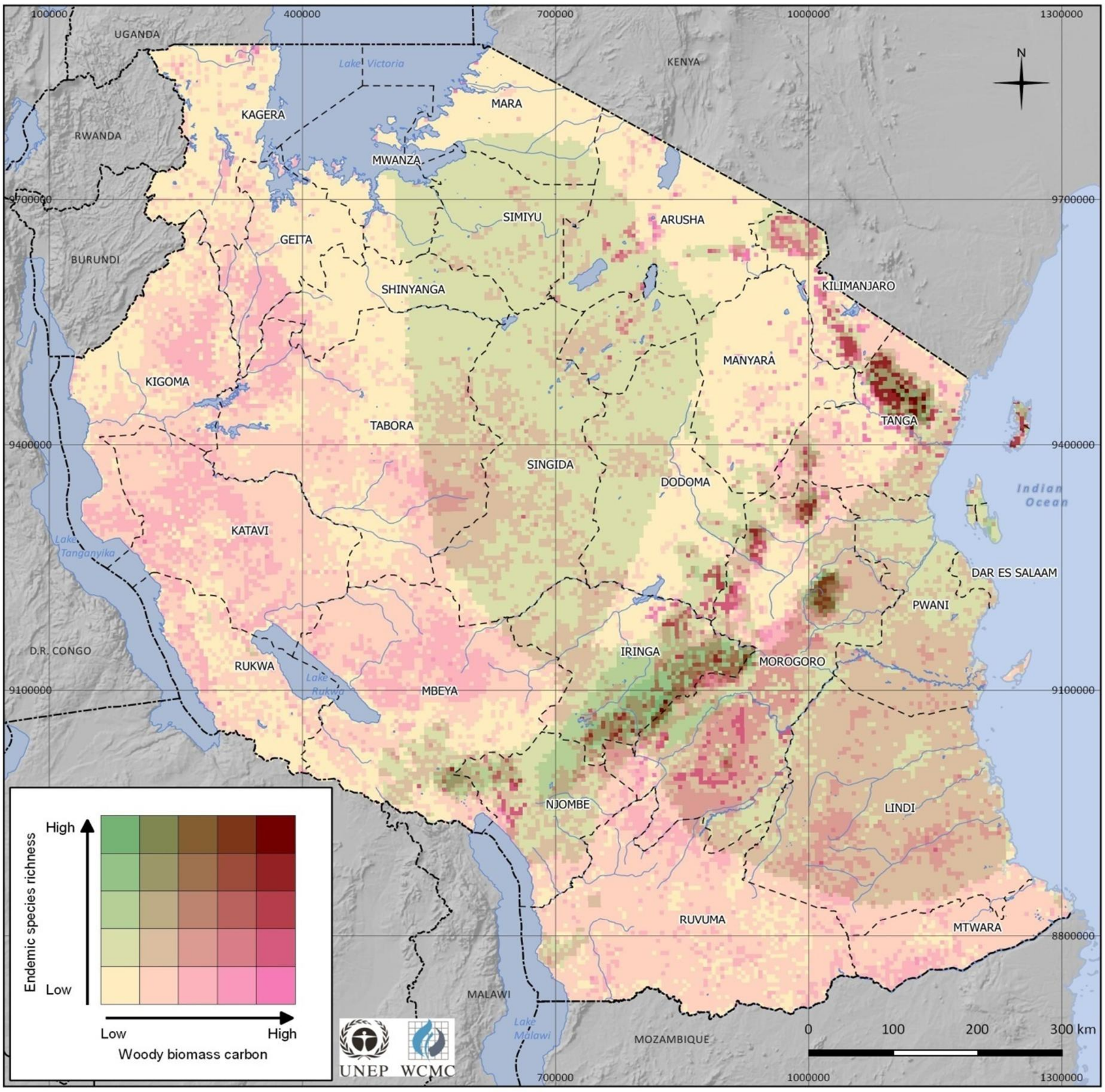
Analyses of IUCN Red List habitat data showed that 59 of the 274 reptile species considered (21.5%) are forest-dependent, and that 25 of these (9% of the total species) are considered globally threatened with extinction.

The distributions of forest-dependent reptiles in Tanzania are shown in figure 23 and Appendix 6, which suggests that northern Tanga and a small area in the middle of northern Morogoro support the highest numbers (up to 24 species per grid cell). Other locations with high densities of forest-dependent reptiles include the region along the border of Iringa and Morogoro, and south-eastern Lindi, where between 12 and 18 species of forest-dependent reptile can be found in some grid cells. From seven to eleven species of forest-dependent reptiles per grid cell can be found in much of Lindi and southern Morogoro as well as some small patches in north-western Njombe, eastern Iringa (bordering Morogoro) and northern Mtwara. Elsewhere, large areas in western, northern and eastern Tanzania support only one to three species of forest-dependent reptile species, while in much of central and southern Tanzania these numbers can only be found at scattered locations (e.g. Ruvuma and the islands of Zanzibar and Pemba).

In terms of proportions of reptile species present that are forest-dependent, the greatest percentages (27-34%) are found in central Tanga, central Morogoro, along the border of Iringa and Morogoro, and on Lake Victoria. The high value shown on Lake Victoria, however, is likely the result of the low (relative to other parts of the country) number of reptile species found there: Only three reptile species were found in this area: Naja nigricollis, Trachylepis maculilabris and Varanus niloticus; and only Trachylepis maculilabris is forest-dependent among the three. Throughout much of the country 8-15% of reptile species are considered forest-dependent, although in the southeast, areas with higher proportions (15-28%) are quite common, while in the north, areas with lower proportions (3-8%) are more common.

Endemic species richness in relation to woody biomass carbon stocks

This map shows the relationship between endemic species richness and woody biomass carbon. Areas with high carbon and high endemic species richness are shown in dark red, while areas with low carbon and high endemic species richness are shaded green, and high carbon and low endemic species richness are shaded pink. Different REDD+ actions may have different benefits and risks in different areas. The biomass carbon within a location affects the potential emissions from converting that area from forest to another land use, with highest emissions in areas of high carbon and high levels of conversion. Additionally, efforts to preserve carbon stocks in areas which are also high in endemic species richness may support biodiversity conservation.



Data sources:
Endemic species: IUCN. 2014. The IUCN Red List of Threatened Species. Version 2014.2. http://www.iucnredlist.org. Downloaded on 1st August 2014.
Woody biomass carbon: NAFORMA 2013: NAFORMA woody biomass. 5km preliminary dataset based on field data.

Map projection: WGS84 / UTM Zone 36S
Map prepared by: UNEP-WCMC
Date: August 2014

Figure 23: Endemic species richness and above ground biomass carbon

Figure 23 above show relationship between endemic species and woody biomass carbon stock. It is clear that different REDD+ actions may have different benefits and risks in different areas. REDD+ aims to decrease GHG emissions from the forest sector through the reduction of deforestation and forest degradation and the protection and enhancement of carbon stocks. The biomass carbon within a particular area affects the potential emissions from converting that area from forests to another land use. It is observed that the highest emissions occur where there are highest carbon stock and high level of conversion. By considering locations where there is congruence between forest carbon stocks and biodiversity, such analysis can assist in the identification of locations where the emission reduction objectives of REDD+, as well as multiple benefits for biodiversity conservation, can be achieved. Areas where both carbon stocks and biodiversity are under threat are potentially areas where REDD+ implementation can bring the greatest benefits for both these priorities.

4.5.8. Spatial information relevant to social safeguards to support REDD+ planning

Despite the fact that significant information and spatial data is already available in different formats such as reports and GIS layers, analysis to establish what spatial information is relevant to social safeguards to support REDD+ planning in Tanzania is still missing.

Therefore, it was important to do a gap analysis to establish the needful spatial dataset. From the analysis a number of possible maps to support REDD+ planning in Tanzania were identified. However, in consideration of time and data availability, only maps listed in Tables 17 were selected for further mapping.

Table 17: Maps to facilitate national level REDD+ social safeguards planning in Tanzania

Themes identified within the Tanzania REDD+ safeguards policy	Issues or Questions which the maps should/ could address	Ideas for new maps	Data layers needed
Good governance and sustainable natural resources management Community participation in the management of forestry through PFM and wildlife resources through WMAs provides the institutional framework for strengthening natural resource management and governance at local level	• Where are community managed land resources (WMA and PFM)	Map 1: Updated WMAs and PFMs	Map 1: Location of WMAs and PFMs
Presence of Village Land use plans '2.1.4 Land use plans including forest management plans in areas included in the REDD+ implemented activities recognise and respect customary and statutory rights of forest dependent communities specifically women and other marginalized/vulnerable social groups that contribute to sustainable forest management	• Where are the villages with LUPs to date?	Map 2: Status of land use planning in Tanzania, i.e. percentage of villages with LUP in each District	Map 2: Percentage of village LUPs per district in Tanzania (based on information from Land Use Planning Commission and villages as per the 20002 census dataset)
Food security for rural community '3.4.1Programs to improve food security are introduced, promoted, sustainably implemented, monitored and evaluated	• What is the status of food security in the country? • Where are the programmes to improve food security?	Map3: Probability of occurrence of food insecurity Map 4: Districts identified for BRN and ASDP projects	Map3: Vulnerability to food insecurity (based on food situation recalls from the last six seasons) Map 4: Districts identified for BRN and ASDP projects

4.5.9: Good governance and sustainable natural resources management

Community participation is one of the key factors for ensuring good governance and sustainable management of natural resources. Local communities have been involved in the management of natural resources through Participatory Forest Management (PFM) and Community Based Conservation (CBC).

Although significant information and spatial data for the PFMs and WMAs is already available from previous studies, the information is scattered and not easily accessible, making it difficult for a planner to have complete information. For the information to be relevant for REDD+ planning, it was therefore necessary for this project to compile and update the information from different sources. The map (Figure 24) shows the locations of WMAs (both with AA and other status) and locations of PFMs (both CBFM and JFM).

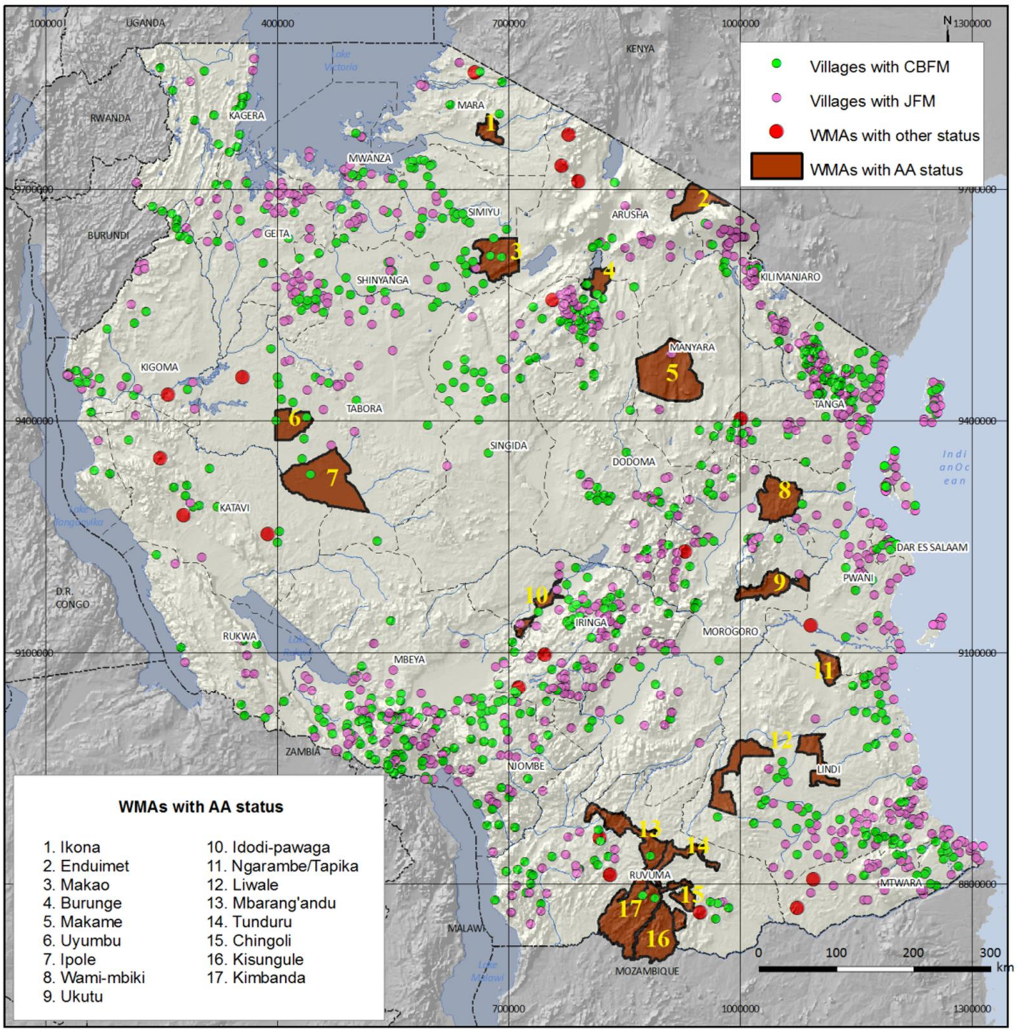


Figure 24: Locations of WMAs and PFMs

4.5.10: Presence of Village Land use plans

Land use planning is key to effective natural resource management. It helps to balance ecological, economic and social objectives, thereby facilitating implementation of REDD+ as well as preventing land use conflicts.

Tanzania suffers from high rates of deforestation and forest degradation due to heavy pressure for conversion of forests, particularly on general land, to other competing land uses. Among other factors, the situation is aggravated by the lack of/inadequate land tenure clarity and land use plans. The existing National Land Use Policy (NLUP) and National Land Use Planning Commission (NLUPC) provide safeguards to support REDD+ implementation in

Tanzania. While NLUP provides planning recommendations for different sectors such as forestry, NLUPC is responsible for preparation of physical land use plans. In order to explore the status of land use planning at District level, in Tanzania, this study mapped the percentage of villages with land use plans in each District (Figure 25). The study used data set provided by NLUPC showing number of villages with land use plans in each District and census data from 2002 obtained from the National Bureau of Statistics (NBS).

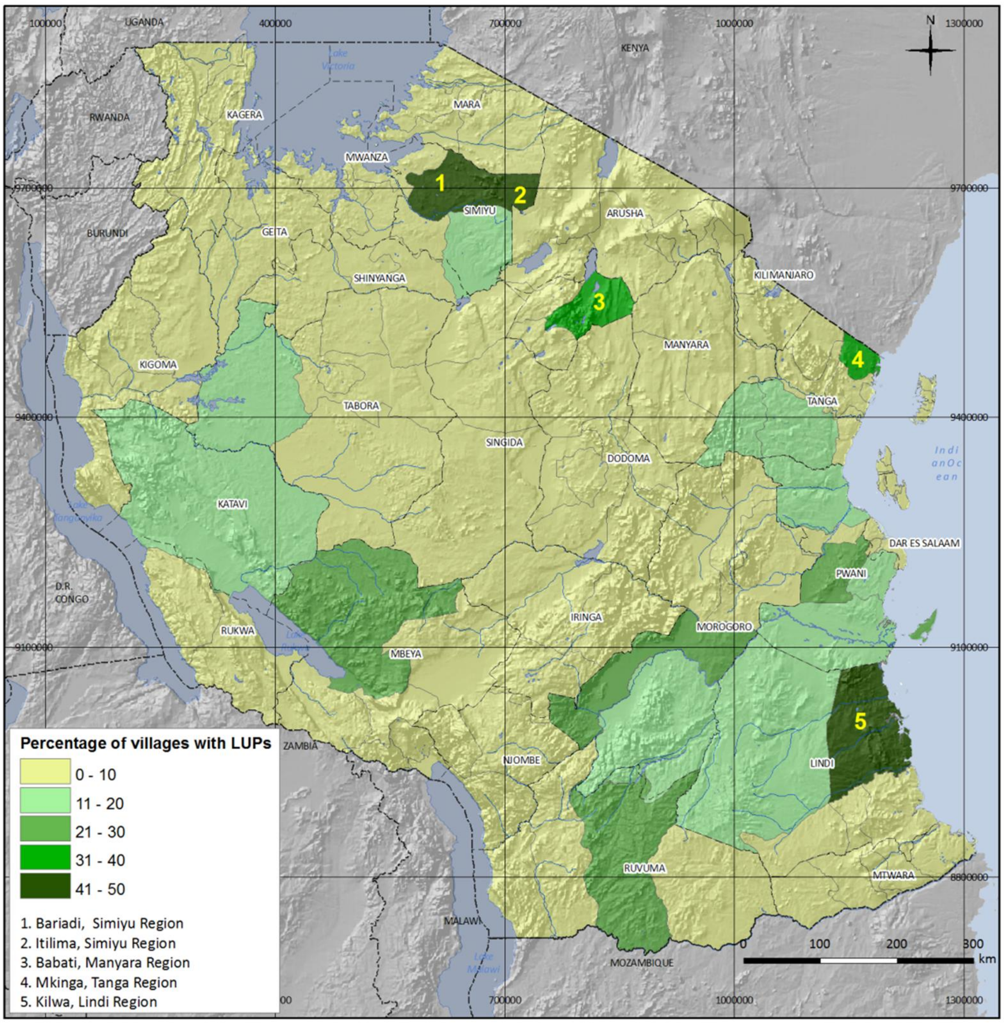


Figure 25: Percentage of villages with LUPs in each District. Source: NLUPC and NBS

The map shown in figure 25 reveals an uneven distribution of land use planning activities over the country. Most of the activities have been concentrated in villages in Bariadi and Itilima Districts in Simiyu Region, Babati District in Manyara Region, Mkinga District in Tanga Region, and Kilwa District in Lindi Region. This could be due to the fact that most of these activities rely on funding from donors such as WWF, MKUKUTA and other international agency.

4.5.11: Food security for rural community

Agriculture (including livestock) is the dominant sector in Tanzanian economy, providing livelihood, income, and employment to over 80% of the population and it accounts for 27% of GDP, 30% of export earnings, and 65% of raw material for domestic industries.

Agriculture sector is however one of the key drivers of deforestation in Tanzania. Forests are annexed for agriculture use because either the current area under agriculture is not enough to support population pressure, or area under agriculture use becomes unproductive due to poor agricultural practices as a result people has to find virgin land, which is temporally fertile, or the practice of shifting cultivation.

In order to ensure that proposed REDD+ initiatives contribute to the adaptation and mitigation to climate change while contributing to food security for improved livelihoods, the national REDD+ safeguard proposes that programs to improve food security are introduced and implemented. This study maps the Districts with some of the financed or planned national agricultural programmes contributing to the improvement of agricultural productivity in Tanzania. The programmes are Agricultural Sector Development Programme (ASDP[6]) and Big Results Now (BRN[7]) (Figure 26). In addition, the study has mapped the vulnerability to food security in different districts of Tanzania based on food situation recalls from the last six seasons, i.e. 2007/08, 2008/09, 2009/2010, 2010/11, 2011/12, and 2012/13 (Figure 26).

It is envisaged that the upcoming REDD+ initiatives will use this information as an input during planning for agricultural programmes.

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[6] ASDP – objective of the programme is to enable farmers to have better access to and use of agricultural knowledge, technologies, marketing systems and infrastructure, all of which contribute to high productivity

[7] BRN initiative aims to adapt new methods of working under specified timeframe for delivery of the step-change required. For the agriculture sector, by 2015, 25 commercial farming dealing with paddy and sugarcane, 78 collective rice irrigation and marketing schemes, and 275 collective warehouse-based marketing schemes

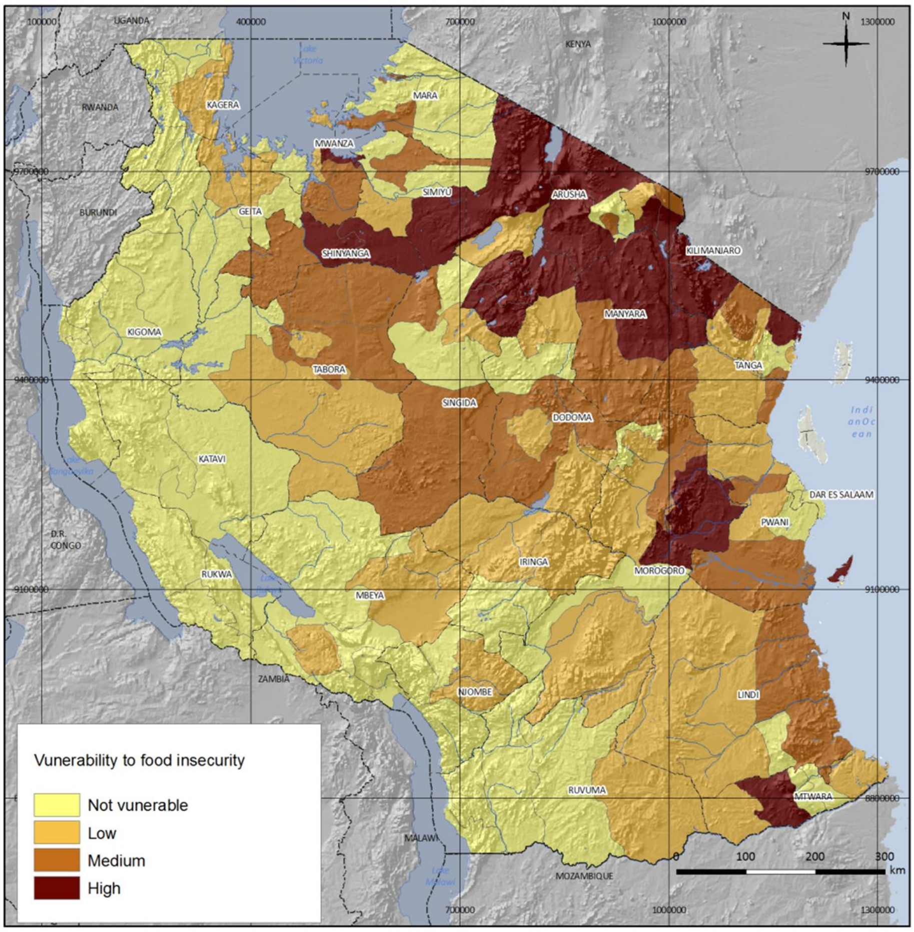


Figure 26: Vulnerability to food insecurity**.** Source: MAFSC (2012)

Note this map indicates districts where food shortages are likely/not likely to occur based of the average food crop production forecast in the last six seasons. (Source: Crop Monitoring and Early Warning National Food Security

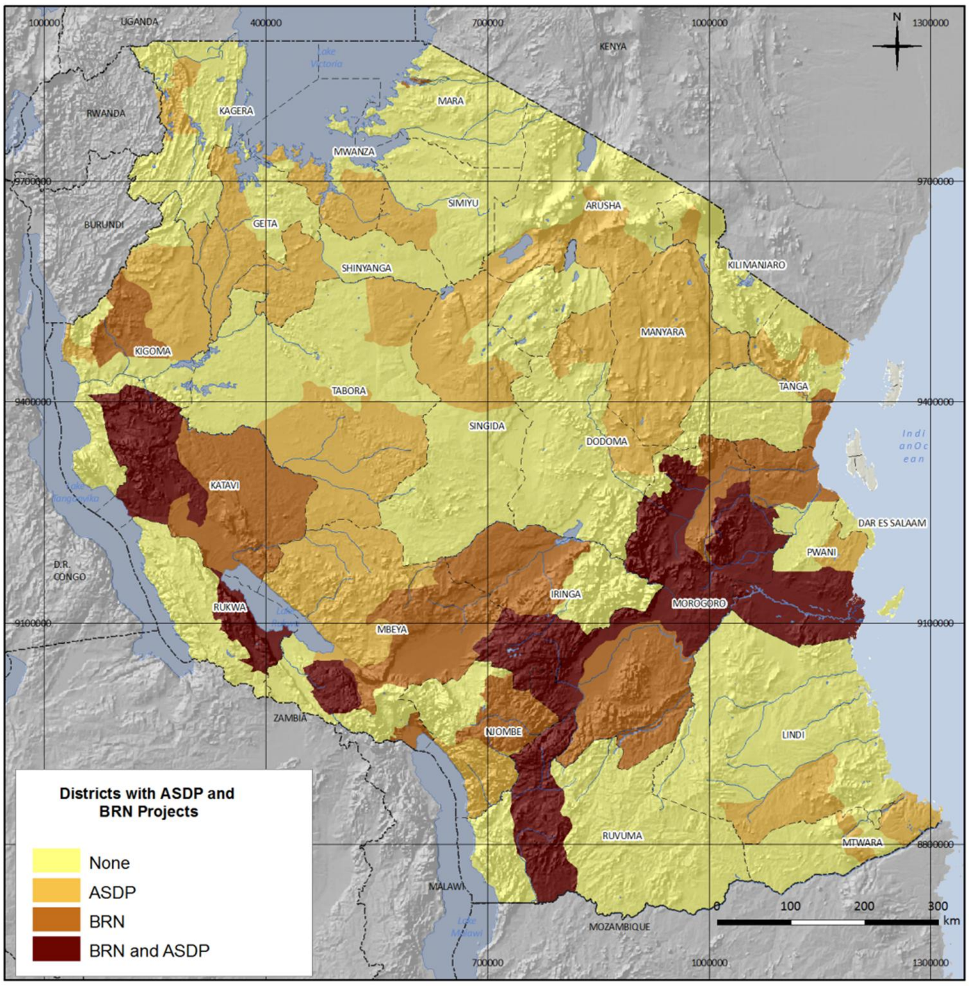


Figure 27: Distribution of ASDP and BRN projects: Source: MAFS C

Note that the map shows the districts with ASDP and BRN agricultural programmes, which aim to enhance food productivity and hence improve food security and allow communities to better, adapt to climate change.

4.5.12: Ecosystems and ecosystem services

Tanzania's REDD+ Safeguards direct that the REDD+ programme in the country "maintains, promotes and enhances sustainable conservation of the country's natural forests for their biodiversity and all ecosystem services (co-benefits) while meeting the needs of forest dependent communities" (VPO 2013a). It also specifies indicators related to ecosystems and ecosystem services, including: 7.2.3: 'REDD+ activities are designed to maintain and enhance biodiversity, ecosystem services and forest dependent community needs'. Importantly, the maintenance and enhancement of ecosystem services through REDD+ initiatives can also assist in the delivery of other benefits, such as increasing resilience to climate change, and in addressing other types of safeguards, such meeting the needs of forest dependent communities. Tanzania's mangrove forests provide a range of important ecosystem services. Figures 28 and 29 shows forest mangrove cover change in Tanzania 1990-2010. More maps and further discussion on this topic are presented in Augustino et al. (2014).

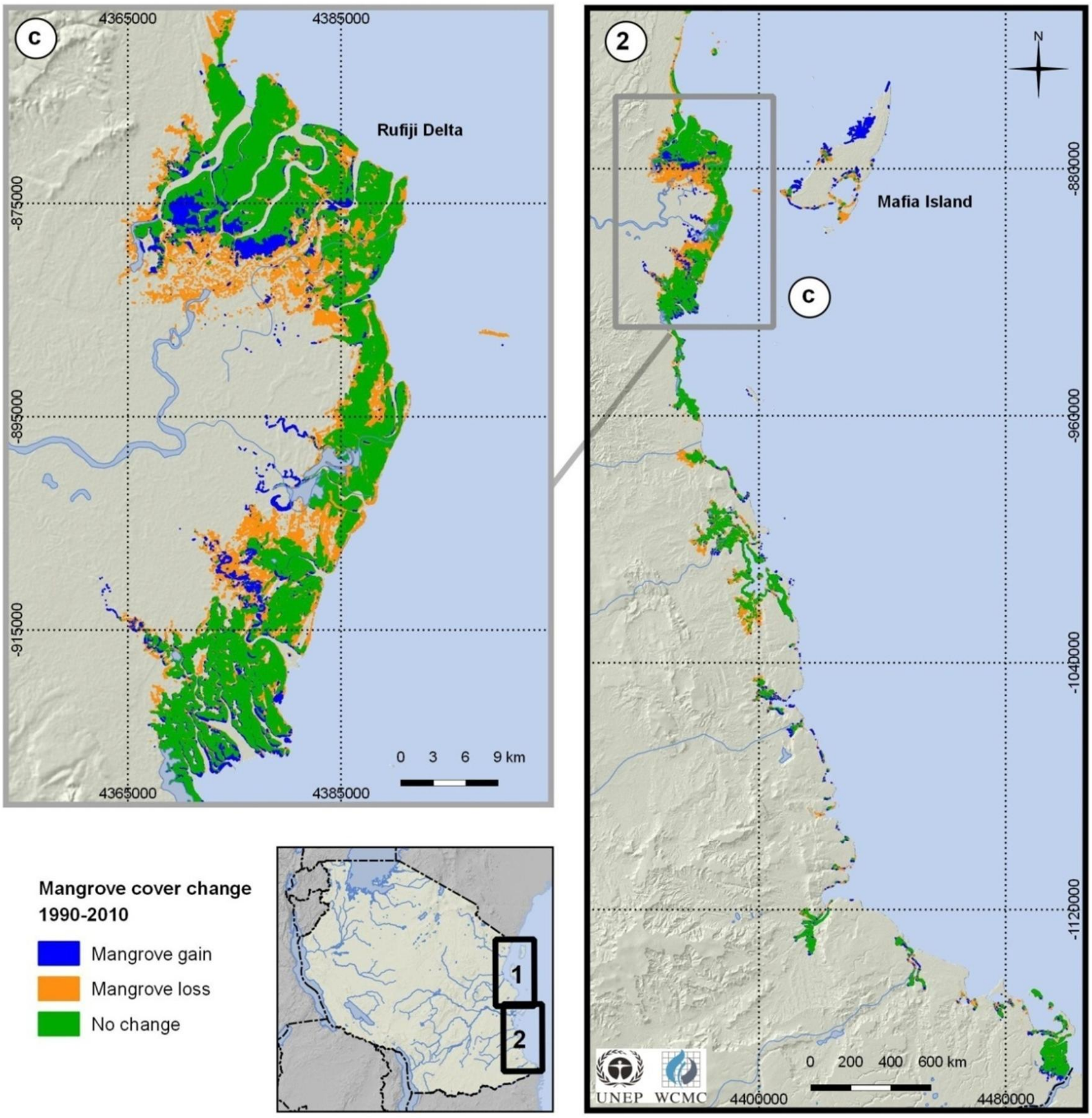
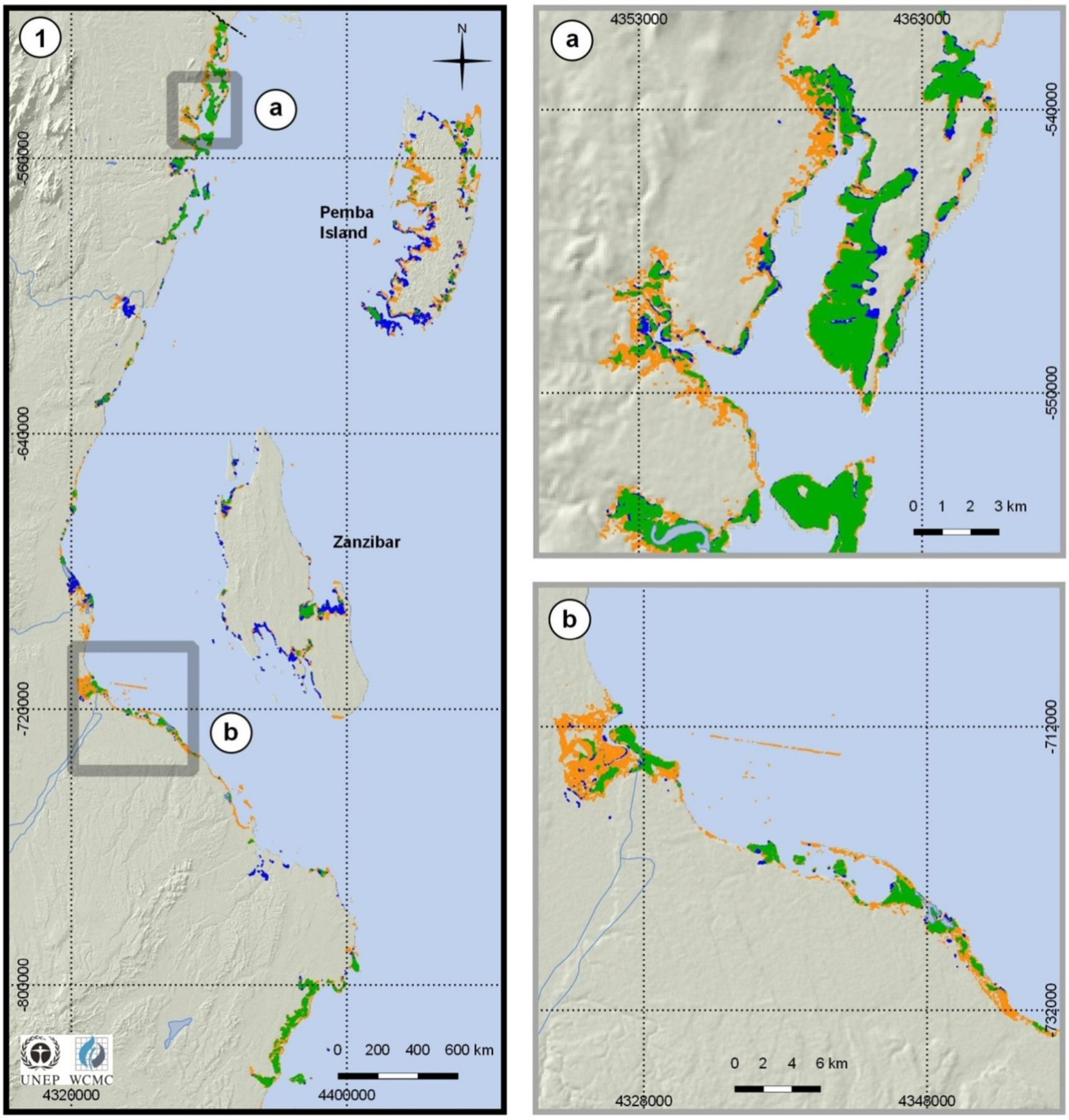


Figure 28: Mangrove forest cover change, 1990-2010,

Mangrove forest cover change, 1990-2010

Mangrove forests provide a number of important ecosystem services, including carbon storage, protection from coastal erosion and nurseries for coastal fisheries. As such, protection and/or enhancement of mangroves can contribute to both climate change mitigation and adaptation. Protecting, restoring or sustainably managing mangrove forests can thus give a number of benefits to local populations as well as the country as a whole. Mangrove ecosystems are pointed out in the Forest Act as sensitive areas requiring particular attention, and such areas have also been highlighted in Tanzania's REDD+ Safeguards Standards. The map below shows gains and losses in Tanzania mangrove forests from 1990 to 2010. Green indicates no change, while loss is shown in orange and gain in blue.



Data sources:
Giri, G., Ochieng, E., Tieszen, L.L., Zhu, Z., Singh, A., Loveland, T., Masek, J. And Duke, N. (2011). Status and distribution of mangrove forests of the world using Earth observation satellite data. Global Ecology and Biogeography, 20(1): 154-159.

Map projection: WGS84 / UTM Zone 36S. Map prepared by: UNEP-WCMC. Date: August 2014

Figure 29: Mangrove forest cover change, 1990-2010, with insets showing the northern coast

4.5.13: Potential zones for REDD+ actions to reduce deforestation

In the process of identifying where REDD+ actions to reduce deforestation and forest degradation can have the most impact, it is necessary to know (i) where the frontiers of deforestation are, (ii) the locations of the drivers are the most severe and how they interact with carbon stocks and (iii) elements that could potentially benefit from REDD+ actions.

In 2013, UN-REDD and NAFORMA mapped a number of indicators of drivers of deforestation and forest degradation: oil and gas concessions, population pressure, fires, road network and charcoal activities. However, a dataset recording areas of recent deforestation is crucial to summarize impact, and this was not available at the time. A global dataset recently made available by Hansen et al. (2013) shows areas of tree cover loss and tree cover gain at 30 × 30 meter resolution. Figure 29 uses this dataset to show areas of tree cover loss and gain between the years 2000 and 2012. The map shows that deforestation detectable at 30 m resolution occurs in many parts of the country, but that concentrated deforestation is limited to a smaller number of areas. It also shows that the boundaries of some reserved (government) land are well enforced, with little deforestation taking place inside the borders, while others, usually smaller reserved areas, have been heavily affected. See the inset maps in Figure 30 for examples of this in the Centre of the country.

It is important to note that tree loss does not have to be the loss of natural forest, but can also be felling of tree plantations or perennial crops. Foresters attending a working session of the project in Morogoro in April 2014 suggested that this could be the case for some of the areas of tree loss in Mtwara, the south-eastern corner of Tanzania. Similarly, tree gain could be natural regeneration of forest, or new timber plantations or perennial crops. Maps showing tree cover change can be useful for REDD+ planners to select areas to be studied more closely to understand what the local drivers of deforestation are and whether or not REDD+ can take action to reduce pressures on the forest. Areas of recent deforestation can sometimes indicate a frontier, with more deforestation likely to occur nearby. Further investigation is also needed to understand the underlying drivers of deforestation and degradation. If the cause of deforestation is the establishment of permanent agricultural areas, for example, different actions may be appropriates than if the cause is forest fire. Action can also be taken to reverse deforestation, such as by restoring recently deforested land. See section 7 of

Augustino et al. (2014) for further discussion on potential zones for REDD+ actions in Tanzania.

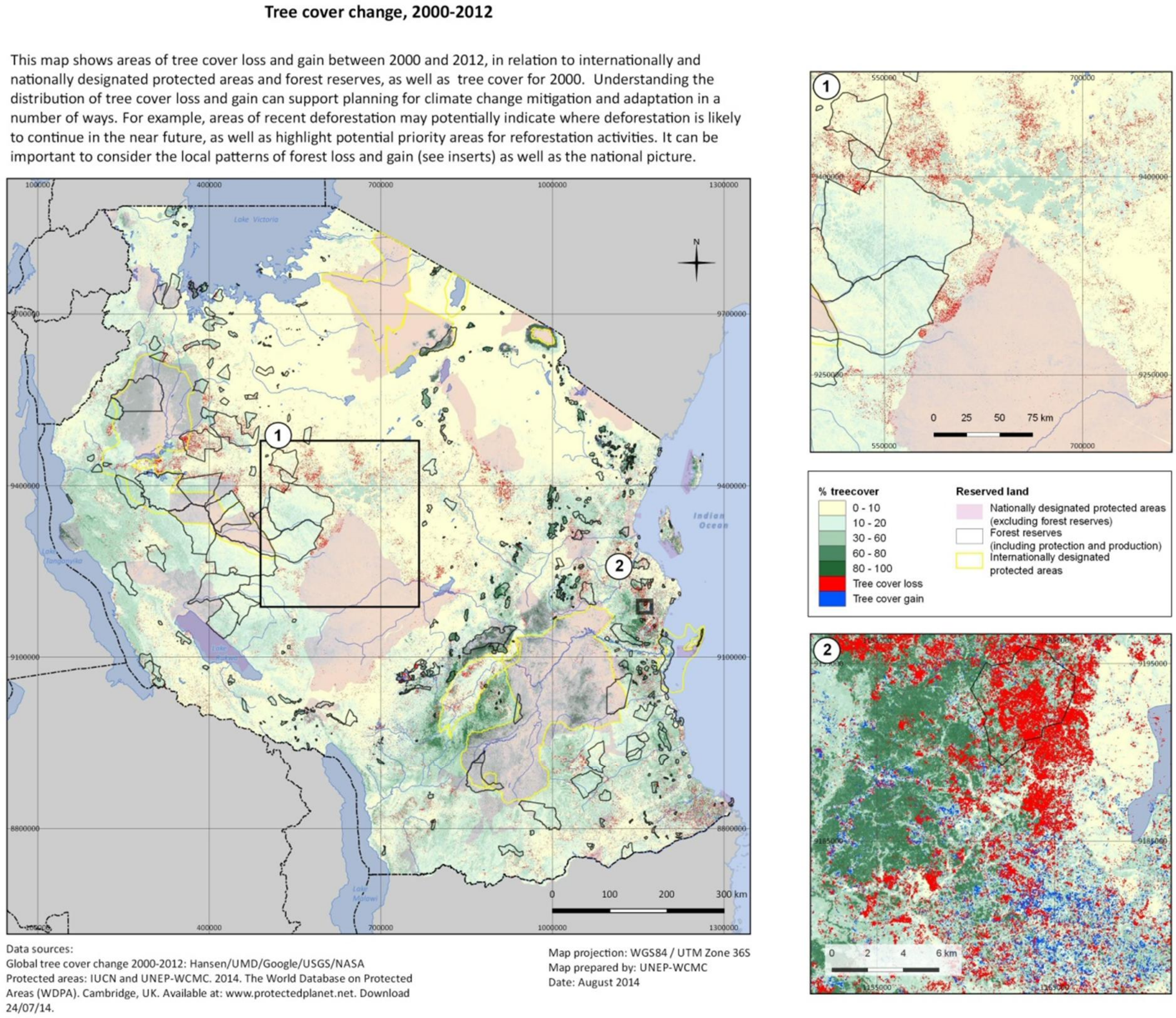


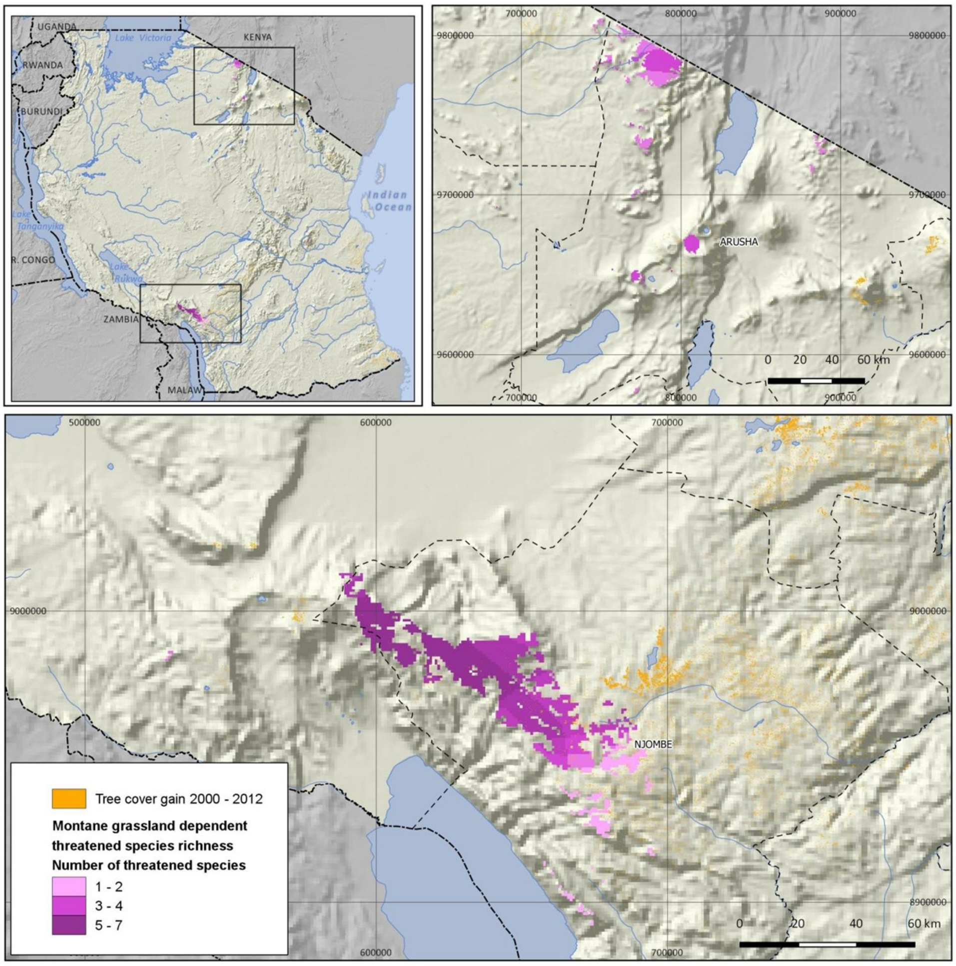
Figure 30: Tree cover change in Tanzania, 2000-2012

4.5.14: Using maps to help avoid risks from REDD+ - Montane grassland dependent species and tree cover gain

One potential risk from enhancement of forest carbon stocks activities is if new forest areas are planted on areas of natural important non-forest ecosystems. Figures 31 and 32 show the distribution of montane grassland dependent threatened and endemic species in Tanzania, in relation to gains in tree cover. The maps show that areas such as Arusha, Mara and Simiyu in the north of the country, and scattered patches in Morogoro, Njombe and other parts of the country host higher densities of threatened species that occur in montane grasslands. In terms of endemic montane grassland dependent species, these areas are even more restricted, concentrated in small patches in the Eastern Arc Mountains. Tanzania’s REDD+ Safeguards prioritize the protection of rare, endemic and threatened species and ecosystems; the country’s grasslands are home to biodiversity of national and international conservation importance and face a number of threats to their existence, including the expansion of industrial tree plantations, such as pine and eucalyptus. For example, the maps highlight the areas where forest gains overlap and/or border with areas important for montane grassland species. This is of particular significance to REDD+ implementation, as to align with the Cancun safeguards and Tanzania’s safeguards policies, REDD+ actions should not include or encourage the conversion of non-forest ecosystems, such as grasslands, to forest.

Montane grassland dependent threatened species richness and tree cover gain, 2000-2012

This map shows areas inhabited by montane grassland dependent species that are considered threatened by the IUCN Red List (Critically Endangered, Endangered, Vulnerable) in relation to recent gains in tree cover (2000-2012). A particular threat to these areas includes planting of new forests in natural grassland areas. Grassland areas that have been converted to forest may indicate a loss of this important habitat type and associated biodiversity. If such activities were to take place under REDD+, it could be considered a breach of Tanzania's REDD+ Safeguards Standards, which emphasize that threatened species should be protected. Areas with high richness in species that are both threatened and dependent on montane grassland habitat are shown in dark pink, while areas with low richness in these species is in pale pink. Areas that have experienced tree cover gains are highlighted in orange.



Data sources:
Grassland dependent species: IUCN 2014. The IUCN Red List of Threatened Species. Version 2014.2. http://www.iucnredlist.org. Downloaded on 1stAugust 2014.
Global tree cover change 2000-2012: Hansen/UMD/Google/USGS/NASA
Grassland areas: NAFORMA, 2013. NAFORMA land-use land-cover map 2010.

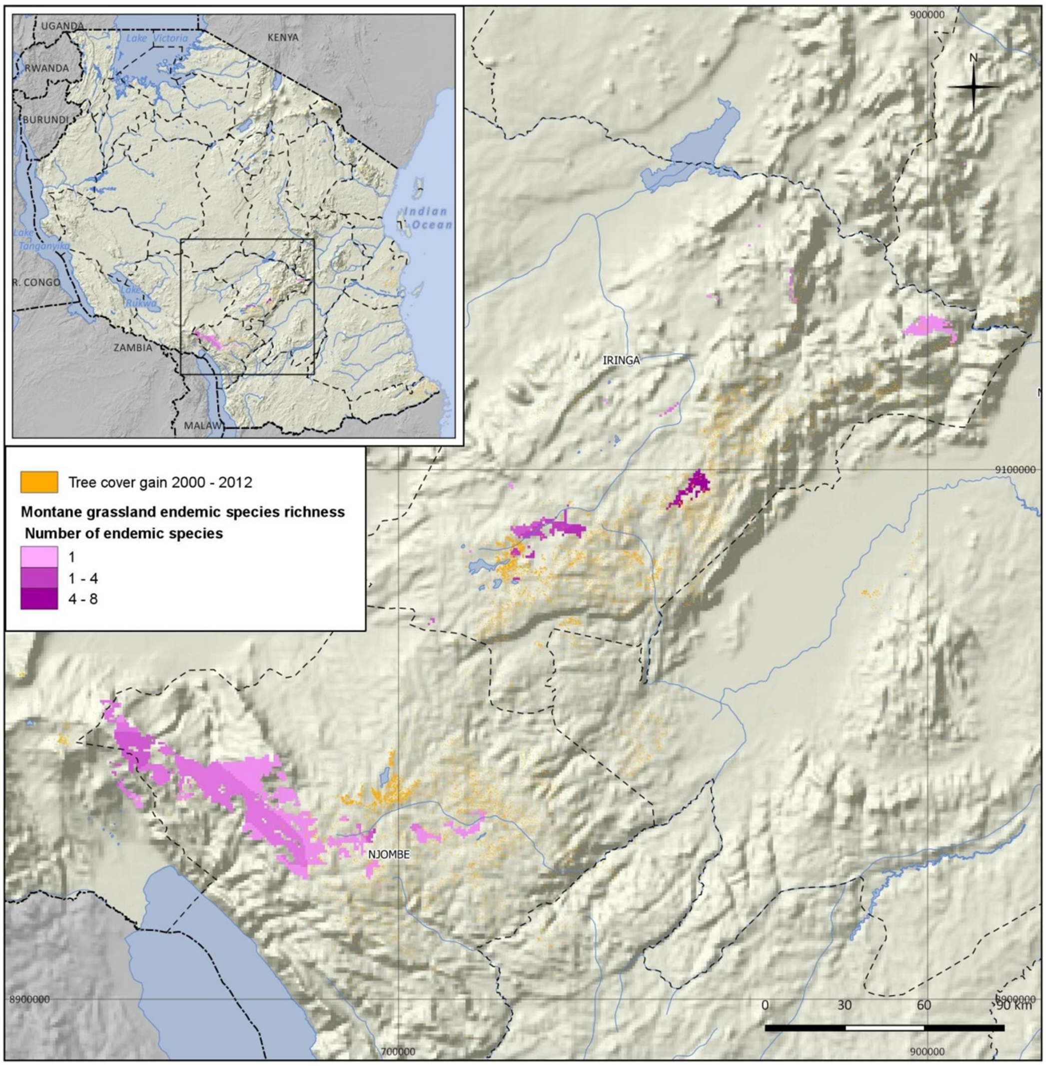
Map projection: WGS84 / UTM Zone 36S
Map prepared by: UNEP-WCMC
Date: August 2014

Note: Only grassland dependent species ranges within grassland areas in the NAFORMA land-use land-cover map in areas above 2000m are displayed.

Figure 31: High-altitude grassland dependent threatened species richness and tree cover gain, 2000-2012

Montane grassland endemic species richness and Tree cover gain, 2000-2012

This map shows species richness for montane grassland dependent species that are endemic to Tanzania, in relation to recent gains in tree cover (2000-2012). Similar to the previous map, the areas highlighted indicate the location of rare and endemic species, which need to be protected as per Tanzania's Safeguards Standards. A particular threat to these areas includes planting of new forests in natural grassland areas. Areas with high richness in species that are both endemic and dependent on montane grassland habitat are shown in dark pink, while areas with low richness in these species is in pale pink, with a concentration in the centre and south of the country. Areas that have experienced tree cover gains are in orange; grassland areas that have been converted to forest may indicate a loss of this important habitat type and associated biodiversity. Planners should consider the potential biodiversity impacts of future conversion of such areas through REDD+ or other afforestation/reforestation interventions.



Data sources:
Grassland dependent species: IUCN 2014. The IUCN Red List of Threatened Species. Version 2014.2. http://www.iucnredlist.org. Downloaded on 1st August 2014.
Global tree cover change 2000-2012: Hansen/UMD/Google/USGS/NASA
Grassland areas: NAFORMA, 2013. NAFORMA land-use land-cover map 2010.

Map projection: WGS84 / UTM Zone 36S
Map prepared by: UNEP-WCMC
Date: August 2014

Figure 32: Montane grassland endemic species richness and forest gain, 2000-2012

Output 6: Capacity building, dissemination and communication of project outputs undertaken

The project has been enhancing the capacity of Tanzanians from village to national level to understand methodologies for carbon assessment and data analysis. The project also collaborated with different government institutions including National Carbon Monitoring Center (NCMC) and TFS on data sharing. This was done to ensure that collected carbon data from different REDD+ Pilot project are embedded in the database of the NCMC for developing National MRV for sustainability and national ownership.

4.6.1: Local Community (villagers) and district staff empowered on carbon monitoring

During the project period, a total of 30 villagers and 25 district forest officers were exposed to various techniques on forest inventory techniques including the use of inventory equipment. The initial project team including an expert from SUA and University of York trained 12 members of Field assessment team on one hectare protocol for assessing carbon stock, taking measurements using hemispherical photograph and Sunscan. Thereafter, project team trained 25 district staff on forest carbon assessment using one hectare protocol particularly plot layout, use of inventory equipment and procedures for taking measurements. During field work, assessment teams were responsible to training local communities on basic inventory techniques. The villagers had an opportunity to learn by doing when they participated in field carbon assessment in project area.

Villagers were able to successfully take field measurements. Thus the project concludes they have gained knowledge and skill for carbon assessment and monitoring in different vegetation types. It was worth noting that 20% and 30% of trainees in district and village levels were female respectively.

4.6.2 Technical staff empowered on data analysis

Project team in collaboration with University of York conducted two separate session of training course on R statistical package in 2013 and 2014. Each training session involved theory and practical methods to increase participants understanding on R applications. The target group was mainly postgraduate level scholars and/or staff working on monitoring and modelling forest structure. The course brought together 27 participants including 22 men and 5 women from REDD+ Pilot project, Academic and research institutions particular SUA and other institutions represented were National Environmental Management Council (NEMC) and Udzungwa Project as illustrated in Appendix 7.

The course focused on the application of the R programme to describe and quantify data from carbon plots collected under the MRV process to assess carbon storage potential of a number of key ecosystem types in Tanzania. The course introduced the use of remotely sensed earth observation products (both freely available via the internet) and how these can be used within a GIS for carbon assessment at a range of scales (from the plot to global change research). It was observed that most participants increased their knowledge and skill on designing, executing and analyzing environmental survey, and have gained competence and skills to use R- statistical software.

4.6.3: Building capacity of technical staff on mapping and developing scenarios

15 participants from different institutions including Governments (MLHSD, secondary school), NGO (TFCG, PFP), Academic and research institution (SUA, FTI), and Agencies (TFS, KFS) were trained on scenario analysis to generate land use/cover change maps using GIS techniques.

The training lasted 3 days and consisted in learning-by-doing sessions on the process of scenarios building, starting from this project as case study. The trainee practiced how to develop new storylines and how to project quantitative and spatial indicators to future states. They also acquired information on available global or national datasets which can be used for land cover changes analyses. The training aimed at delivering some specific technical skills to trainees meanwhile encouraging the attitude for multi-disciplinary approaches in management of environmental challenges.

Moreover, Project team in collaboration with WCMC staff organized training workshop on mapping using Q GIS open source in Morogoro for five days. The training brought together 11participants (Appendix 9) from different institutions mostly from SUA and TFS as they had experience attained from previous training conducted through UN- REDD. The training mainly focused on creating an endemic species richness map, overlaying with a carbon stock density map using matrix style legend, calculating statistics, application of QGIS for creating maps, transformation of maps from one coordinate to another coordinates and image processing.

Most useful results from the training was the knowledge acquired in which the trainees could be able to produce maps to be used in national forest monitoring system and thereafter to be a very important input to REDD+.

4.6.4: Capacity on species vulnerability assessment

A total of 12 technical staff from different institutions gained knowledge and skill to conduct species vulnerability assessment. During the training, most participants were able to understand and to follow processes for conducting Red List and climate change vulnerability assessments. Therefore they can conduct similar assessments elsewhere, whether at the national, regional or global level, of species occurring in Tanzania. Similarly individuals were also able to build their professional networks to include experts associated with the IUCN Species Survival Commission, which is likely to greatly increase capacity to gather relevant species data in the future.

4.6.5: Installation of CHN machine and Training of technician

Expert from LECO Company worked together with Laboratory technicians to install CHN soil analyser at SUA particular in Biology Laboratory. The LECO CN628 Carbon Nitrogen analyser serial Number 3446 was installed at SUA which involved the following:

I. Fitted Helium, Oxygen and compressed air gas piping and regulators.
II. Fitted a voltage Regulator on the power lines of the instrument and PC package.
III. Repacked all reagent tubes.

Moreover, LECO experts trained both 8 laboratory technicians and 5 master’s students at SUA on the use of CHN instrument. The training was organized into two session mainly theory and practical to increase participants understanding. Therefore facilitators explained operation procedures for running CHN for soil analysis, maintenance, and safety. Facilitators explained also calibration/operation of carbon IR Cell and Nitrogen Thermo conductivity. Trainees had enough time to experience hand on operation of the instrument purposely to increase their competence on application procedure. Finally, the instrument was tested with certified standard namely EDTA. Results were well within the detection limit of the standards.

4.6.6: Data sharing with National Carbon Monitoring Centre

Project team consulted interim Staff at NCMC on sharing project data/results as inputs for developing MRV. However, since NCMC is not yet operational it was agreed that project data will be embedded into institutional database when operation starts.

4.6.7: Stakeholders' workshop on MRV

Project team in collaboration with National Carbon Monitoring Centre organized a two days stakeholder's workshop on MRV in Morogoro, June, 2013. The workshop drew 18 representatives from REDD+ Pilot Project (5), TFS (1), NAFORMA project (2), Zanzibar Wood Biomass Survey (1) and REDD+ Task Force (1), CCIAM (1) SUA (2) NCMC (2), WWF US (1) and WWF REDD+ Project (2). The main purpose of the workshop was to share experience and lessons on forest carbon measurements methodology.

It was realized that some pilot project adopted NAFORMA methodology of using concentric plot while others modified some methodologies to suite its conditions like MCDI. It was also informed that WWF REDD+ Pilot was the only pilot project using one hectare plot for forest carbon assessment.

It was also observed that pilot project collected useful data to contribute toward developing MRV in the Country. However, some data could be lost since most of the project lack storage facilities to handle the data properly for long period. It was agreed that each pilot project should find a safe means to store the data for a long period and ensure they are available for use with other stakeholders. It was also agreed that NCMC should design a contract format for data sharing that could be used to collect data from different pilot project and other actors who have important information for MRV design. However, operationalization of the agreement was not realized during the period of the project because legal establishment of NCMC delayed.

4.6.8: Dissemination of project information

Information regarding this project was disseminated through workshop, publication and leaflets. Project team also invited some media staff to participate in various workshop organized across the country to broadcast project information. Therefore some media particular Tanzania Broadcasting Corporation (TBC), Independent Television (ITV) and Star TV disseminated project/workshop information through Radio and Televisions and consequently increased communities awareness on Project activities including land use/cover change matters in the country.

Information on project status and land use /cover changes issues was delivered to 189 stakeholders attending the regional workshops and to other 40 stakeholders at the national workshop on scenarios, by introductory slide presentations.

Moreover, three scientific papers have been produced as shown below and two of them published in an international Journal as one way of disseminating information among stakeholders in and outside the country.

Scientific Papers produced:

Burgess, N.D., S. Mwakalila, P. Munishi, M. Pfeifer, S. Willcock, D. Shirima, S. Hamidu, G.B. Bulenga, J. Rubens, H. Machano and R. Marchant (2013). REDD herrings or REDD menace: Response to Beymer-Farris and Bassett. Global Environmental Change http://dx.doi.org/10.1016/j.gloenvcha.2013.05.013

Burgess, N.D., P. Munishi, S. Mwakalila, M. Pfeifer, S. Willcock, D. Shirima, S. Hamidu, G.B. Bulenga and R. Marchant (2012). Enhancing Tanzanian capacity to deliver short and long term data on forest carbon stocks across the country, The Arc Journal 27: 22-26.

Deere, N, Burgess, N., Finch, F., Seki, H., Mukama K., Sharima, D., Munishi, P., Mbilinyi, B., Platts, P., Pfeifer, M., Willcox, S., Marchant, R. Short and long term perspectives on carbon change from Tanzania. Presentation at the World University Network Workshop on Maximizing community benefits from REDD. Hong Kong, Dec 11-13th

CHAPTER FIVE

5.0: Project Impacts

The key impact of the project is the increased availability of national carbon data for MRV. Hundred and twenty eight (128) permanent sample plots have been established in areas that are poorly covered in terms of carbon assessment in 10 different vegetation types. The established permanent plots will be used for future carbon monitoring in different vegetation types to determine the carbon dynamics and with respect to land use and/or socio-ecological changes in Tanzania. The data collected under this project has increased data availability that would be collated by National Carbon Monitoring Centre for developing MRV system in the country.

The project has complemented spatial information on social and biodiversity which will pool the knowledge and experiences in establishing national Safeguard Information System (SIS). The Safeguard Information System is very important tool to inform safeguards during REDD implementations.

The identified BAU and GE scenarios have provided important baseline information on how the country can address green economy frameworks. The results will inform decision makers on policy reviews and provide guidelines and regulations on best practices for the growing development sectors and the economy.

The overall impact of the project is the technical expertise and analysis that provides a measurement of carbon stocks and related biodiversity significance for researchers and decision makers.

6.0 Sustainability

The objective of tbe project was to generate short and long term carbon data to contribute to the National MRV. The data generated and analyzed is now a permanent part of the body of knowledge both nationally and globally on carbon sinks. The data is part of the long term strategy for conservation and sustainable use of carbon sinks..

There are three components that have been generated by the project that are sustainable:

i) **Data generated:** Information/data has been generated for National MRV system and will be utilized and expanded. The baseline carbon data has provided a measure to the national carbon changes in emissions/ removals from forest-related activities. Possible “compensation baseline” to provide financial payments for verified emissions reductions for ‘positive incentives”

ii) **Technical capacity developed:** Increased the long term capacity of local and national institutions to integrate natural capital conservation and socio-economic development as well as the local communities. This capacity can be harnessed by REDD+ projects and beyond.

iii) **Monitoring System developed:** The engagement of the local communities for data collection as well as the direct link with SUA and the new NCMC has provided sustainable linkages for current monitoring as well as future monitoring that can be scaled-up as required by the country.

WWF Tanzania and its partners are dedicated to sustaining the efforts of this project to the extent of their capacity. WWF Tanzania and its partners will continue to monitor the established permanent plots in different vegetation. Masters and PhD students at SUA and York will be encouraged to undertake studies/researches regarding carbon monitoring in project area. This will provide a basis for future REDD+ programs and projects to support MRV in Tanzania.

7.0: CONCLUSIONS AND RECOMMENDATIONS

The Project has contributed significantly to issues in the relevant cover/forest types in Tanzania with regards to:

- Information/data for National MRV system and the long term strategy for conservation and sustainable use of carbon sinks.
- Initial data/information that can feed into national Reference Emission Levels (REL) /Reference Levels
- Baseline to measure changes in emissions/ removals from forest-related activities
- Possible "compensation baseline" to provide financial payments for verified emissions reductions for 'positive incentives"
- Emission Factors i.e. carbon changes in the five IPCC pools - The project has provided data for all Carbon Pools
- Data for both Tier 2 and 3 in regards to Emission Factors which did not exist - best estimates
- Biodiversity and Social Safeguards in REDD+ implementation
- Increased the long term capacity of local and national institutions to integrate natural capital conservation and socio-economic development.

These achievements are important as Tanzania strive towards readiness for actual implementation of REDD+ initiative.

To improve the capacity of Tanzania to participate in performance based payments, the information generated in these projects would be further enhanced through monitoring the carbon changes over time in these plots to detect carbon stock changes and improve our emission factors for different vegetation/forest types.

Tanzania suffers from high rates of deforestation and forest degradation which are among the main carbon emission sources. REDD+ policy has been initiated through adoption of a national strategy and legal frameworks supporting participatory forest management (PFM) to promote emission reduction and poverty alleviation. PFM experiences and REDD+ pilot projects faces difficulties in accessing carbon markets and inadequate financial mechanisms for benefit sharing. This situation may decrease community participation and accelerate carbon emissions. Efforts for establishing Monitoring Reporting and Verification (MRV) system and Reference Emission Level (REL) exist but are not coordinated between the national and local actions, and REL are still missing due to insufficient data and analysis capacity.

In light of these national challenges, we provide the following recommendations to maintain the achievements of the REDD+ projects to date, and to capacitate the country on monitoring and managing the carbon stocks:

- Development of Emission Factors (EF) and Relative Emission Levels/Emission level (REL/EL) at subnational and National Level
- Monitoring of the plots to establish changes in carbon stocks for additionally and development of Tier 3 emission factors
- Further assessment of social and biodiversity safeguards at sub regional level and in specific biomes is necessary as these differ from one biome to another
- Further capacity enhancement in MRV and biodiversity safeguards assessment

Appendix 1: list of participants for regional stakeholders workshop on land use/cover changes scenarios

No.	NAME	INSTITUTION	ZONE	REGION	POSITION
1	ABBAKARY MURSHID	UKEREWE DISTRICT	LAKE ZONE	MWANZA	DISTRICT FOREST OFFICER
2	ABUSHIRI MBWANA	KILWA DISTRICT	SOUTHERN ZONE	LINDI	DISTRICT NATURAL RESOURCE OFFICER
3	AFRICUNUS CHALE	REGIONAL SECRETARIET	SOUTHERN ZONE	RUVUMA	REGIONAL FOREST OFFICER
4	ALEX BASUBIZAHE	BABATI DISTRICT	CENTRAL ZONE	MANYARA	DISTRICT FOREST OFFICER
5	ALLOYCE MAWERE	REGIONAL SECRETARIET	SOUTHERN HIGHLAND ZONE	IRINGA	REGIONAL FOREST OFFICER
6	ALLY LINJENJE	REGIONAL SECRETARIET	SOUTHERN ZONE	MTWARA	REGIONAL AGRICULTURE OFFICER
7	ALPHA NTAYOMBA	REGIONAL SECRETARIET	LAKE ZONE	SIMIYU	REGIONAL FOREST OFFICER
8	AMANI NGOMWA	MAKETE DISTRICT	SOUTHERN HIGHLAND ZONE	NJOMBE	DISTRICT AGRICULTURE OFFICER
9	AMICUS BUTUNGA	TBC	LAKE ZONE	MWANZA	JOURNALIST
10	ANDREW AKILI	MATI - UYOLE	SOUTHERN HIGHLAND ZONE	MBEYA	DRIVER
11	ANDREW MANYERERE	SERENGETI DISTRICT	LAKE ZONE	MARA	DISTRICT LIVESTOCK OFFICER
12	ATUGONZA KYARUZI	WORLD VISION	LAKE ZONE	KAGERA	COORDINATOR
13	AUGUSTINE MATHIAS	REGIONAL SECRETARIET	WESTERN ZONE	KATAVI	REGIONAL FOREST OFFICER
14	AUGUSTINO LAWI	MBARALI DISTRICT	SOUTHERN HIGHLAND ZONE	NJOMBE	DISTRICT AGRICULTURE OFFICER
15	Barnabos Mbwambo	Siha District Council	NORTHERN ZONE	KILIMANJARO	District Livestock Officer
16	BATRO NGWILANGWA	FREDKIN CONSERVATION FUND	LAKE ZONE	SIMIYU	COORDINATOR
17	BATURI NYANGASA	BAGAMOYO DISTRICT	EASTERN ZONE	COAST	AGRICULTURE OFFICER
18	BENSON KILANGI	KILOLO DISTRICT	SOUTHERN HIGHLAND ZONE	IRINGA	DISTRICT AGRICULTURE OFFICER
19	BERNADETHA CHILE	TANZANIA FOREST SERVICE	EASTERN ZONE	COAST	FOREST OFFICER
20	BETWEL MWAUDIKU	MPANDA DISTRICT	WESTERN ZONE	KATAVI	DRIVER
21	BILLIE EDMOTT	REGIONAL SECRETARIET	WESTERN ZONE	SHINYANGA	REGIONAL FOREST OFFICER
22	BILY MSHANA	Morogoro Environmental Conservation Group.	EASTERN ZONE	MOROGORO	CHAIRMAN
23	BISWALO MAKWASA	KALAMBO DISTRICT	SOUTHERN HIGHLAND ZONE	RUKWA	DISTRICT NATURAL RESOURCE OFFICER
24	BOAZ SANGA	TANZANIA FOREST SERVICE	SOUTHERN ZONE	MTWARA	PRINCIPLE FOREST OFFICER

25	BRIGHTON MLIVATWA	WANGING'OMBE DISTRICT	SOUTHERN HIGHLAND ZONE	NJOMBE	DISTRICT LIVESTOCK OFFICER
26	BRYSON BARIKIEL		CENTRAL ZONE	MANYARA	FIELD OFFICER
27	CHARAHANI MALIGANYA	STAR TV	LAKE ZONE	MWANZA	JOURNALIST
28	CHARLES KIDUA	REGIONAL SECRETARIET	CENTRAL ZONE	SINGIDA	REGIONAL FOREST OFFICER
29	CHARLES SYLVESTER	KAESO	SOUTHERN HIGHLAND ZONE	RUKWA	PROGRAMME MANAGER
30	CREATY MNYANGE	VI AGROFORESTRY	LAKE ZONE	MARA	AGRICULTURE OFFICER
31	DAMAS MUMWI	LIWALE DISTRICT	SOUTHERN ZONE	LINDI	DISTRICT NATURAL RESOURCE OFFICER
32	DANIEL ISSARA	REGIONAL SECRETARIET	EASTERN ZONE	COAST	REGIONAL FOREST OFFICER
33	DANIEL MAJALLA	NCU	LAKE ZONE	MWANZA	FAM
34	DASTAN KWAGILWA	KILOLO DISTRICT	SOUTHERN HIGHLAND ZONE	IRINGA	DRIVER
35	DAVID MAKABILA	REGIONAL SECRETARIET	LAKE ZONE	GEITA	AGRICULTURE OFFICER
36	David Shilatu	TPC - SUGAR PLANTATION	NORTHERN ZONE	KILIMANJARO	Manager
37	DEMITRUS KAMTONI	MPANDA DISTRICT	WESTERN ZONE	KATAVI	DISTRICT FOREST OFFICER
38	DOTTO NONGA	NKASI DISTRICT	SOUTHERN HIGHLAND ZONE	RUKWA	DISTRICT AGRICULTURE OFFICER
39	DR. ALPHONCE PASCAL	KISHAPU DISTRICT	WESTERN ZONE	SHINYANGA	DISTRICT LIVESTOCK OFFICER
40	DR. FERDINARD BAKILILEHI	BARIADI DISTRICT	LAKE ZONE	SIMIYU	DISTRICT LIVESTOCK OFFICER
41	DR. PETROL JACOB	MVOMERO DISTRICT	EASTERN ZONE	MOROGORO	DISTRICT LIVESTOCK OFFICER
42	DR. VALERIO KIPUTA	KARAGWE DISTRICT	LAKE ZONE	KAGERA	DISTRICT VETERINARY OFFICER
43	EDWIN KUNYEKWA	KASULU DISTRICT	WESTERN ZONE	KIGOMA	DISTRICT FOREST OFFICER
44	ELGIUS NDIMBO	MBINGA DISTRICT	SOUTHERN ZONE	RUVUMA	DRIVER
45	ELIAKIM OLE-WAVII	KWIMBA DISTRICT	LAKE ZONE	MWANZA	DISTRICT LIVESTOCK OFFICER
46	ELIYA MTUPILE	MBIDEA Mbinga Development and Environment Action	SOUTHERN ZONE	RUVUMA	SECRETARY
47	EMERSON NJUMBO	KARATU DISTRICT	NORTHERN ZONE	ARUSHA	DISTRICT AGRICULTURE OFFICER
48	EMMANUEL JACKSON	NZEGA DISTRICT	WESTERN ZONE	TABORA	DISTRICT LIVESTOCK OFFICER
49	EMMANUEL MTITI	JGI Jane Goodall Institute	WESTERN ZONE	KIGOMA	PROGRAMME DIRECTOR
50	ENG.ALLY MAGANGA	RESIDENT MINES OFFICE	LAKE ZONE	GEITA	REGIONAL MINE OFFICER
51	ESHA MTAWANYA	JUMUIKO	SOUTHERN ZONE	LINDI	CHAIRPERSON

52	FADHIL NJILIWA	UFP UDZUNGWA	EASTERN ZONE	MOROGORO	PROJECT COORDINATOR
53	FRANCIS MASHUDA	TCCIA	CENTRAL ZONE	SINGIDA	CHAIRMAN
54	FRANCIS RUSENGULA	WWF TANZANIA	EASTERN ZONE	MOROGORO	PROJECT COORDINATOR
55	FRANCISCO NDAZI	MAGU DISTRICT	LAKE ZONE	MWANZA	DISTRICT FOREST OFFICER
56	FRANK KISANGA	ILEJE DISTRICT	SOUTHERN HIGHLAND ZONE	MBEYA	ENVIRONMENTAL OFFICER
57	FRANK LUCHANGULA	TAHEA	LAKE ZONE	MWANZA	COORDINATOR
58	FREDREK MAZENGO	TANZANIA FOREST SERVICE	WESTERN ZONE	TABORA	FOREST OFFICER
59	FRIDA MOLLEL	SINGITA GRUMENT GAME RESERVE	LAKE ZONE	MARA	NATURAL RESOURCES OFFICER
60	FULGENCE MAKUNGU	REGIONAL SECRETARIET	LAKE ZONE	GEITA	DRIVER
61	FURAHA ELIAB	ITV	SOUTHERN HIGHLAND ZONE	MBEYA	JOURNALIST
62	G.H. MWAMKINGA	MATI - UYOLE	SOUTHERN HIGHLAND ZONE	MBEYA	PRINCIPLE RESEARCHER
63	Gabriel Moshi	Mlingano Agricultural Research Institute	NORTHERN ZONE	TANGA	Principal Agriculture Officer
64	GAUDENCE TARIMO	RUFIJI DISTRICT COUNCIL	EASTERN ZONE	COAST	DISTRICT FOREST OFFICER
65	GEORGE BULENGA	SUA	EASTERN ZONE	MOROGORO	PROJECT FIELD TEAM MEMBER
66	George Madundo	MIFIPRO	NORTHERN ZONE	KILIMANJARO	Coordinator
67	GERVAS MAGASHI	SIKONGE DISTRICT	WESTERN ZONE	TABORA	DISTRICT NATURAL RESOURCE OFFICER
68	GLORY MASSAO	MCDI	SOUTHERN ZONE	LINDI	PROJECT MANAGER
69	GOODLUCK MOSHI	TANZANIA FOREST SERVICE	SOUTHERN HIGHLAND ZONE	MBEYA	DRIVER
70	GOODLUCK SWAI	Rombo district	NORTHERN ZONE	KILIMANJARO	District agriculture Officer
71	GUMBO MVANDA	REGIONAL SECRETARIET	SOUTHERN HIGHLAND ZONE	NJOMBE	REGIONAL FOREST OFFICER
72	HALIFA MSANGI	REGIONAL SECRETARIET	CENTRAL ZONE	DODOMA	REGIONAL FOREST OFFICER
73	HALIMA KILUNGU	SUA	SOUTHERN HIGHLAND ZONE	MBEYA	LECTURER
74	HAMIDU SEKI	SUA	EASTERN ZONE	MOROGORO	PROJECT FIELD TEAM MEMBER
75	HAMIS OMARY	MANYONI	CENTRAL ZONE	SINGIDA	DISTRICT FOREST OFFICER
76	HAMZA NKUMULWE	LIMAS	SOUTHERN ZONE	LINDI	COORDINATOR
77	HENJEWELE JOACHIM	KAHAMA TOWN COUNCIL	WESTERN ZONE	SHINYANGA	LAND AND NATURAL RESOURCE OFFICER
78	HILDEBRANDUS LEO	KCU (19900) LTD	LAKE ZONE	KAGERA	SECRETARY GENERAL
79	IMELDA YOHANA	Njombe environmental conservation	SOUTHERN HIGHLAND ZONE	NJOMBE	SECRETARY

80	INNOCENT LUPEMBE	TANZANIA FOREST SERVICE	SOUTHERN HIGHLAND ZONE	MBEYA	FOREST OFFICER
81	Issa Msumari	Muheza District Council	NORTHERN ZONE	TANGA	District Forest Officer
82	J. MWAKASONDA	TOTAL LAND CARE	WESTERN ZONE	TABORA	OPERATION MANAGER
83	JACKSON SHIJA	KONGWA DISTRICT	CENTRAL ZONE	DODOMA	DISTRICT AGRICULTURE OFFICER
84	JAFARI OMARI	REGIONAL SECRETARIET	LAKE ZONE	KAGERA	REGIONAL FOREST OFFICER
85	JAMES NINDI	RECOSO	SOUTHERN HIGHLAND ZONE	RUKWA	PROJECT MANAGER
86	JEREMIAH WANDALI	SEMA	CENTRAL ZONE	SINGIDA	MONITORING OFFICER
87	JOACHIM MSHANA	IRINGA DISTRICT	SOUTHERN HIGHLAND ZONE	IRINGA	DISTRICT FOREST OFFICER
88	JOHA MRUA	NJOMBE DISTRICT	SOUTHERN HIGHLAND ZONE	NJOMBE	DISTRICT FOREST OFFICER
89	JOHN HELBERT	SUA	EASTERN ZONE	MOROGORO	PROJECT FIELD TEAM MEMBER
90	JOHN BUTTINDI	REGIONAL SECRETARIET	LAKE ZONE	MWANZA	CIVIL ENGINEERING
91	JONATHAN MWAKYUSA	UNDP	WESTERN ZONE	TABORA	DRIVER
92	JONATHAN MMBAGA	MUSOMA MUNIICIPAL	LAKE ZONE	MARA	DISTRICT FOREST OFFICER
93	JOSEPH BUTUYUYU	REGIONAL SECRETARIET	SOUTHERN HIGHLAND ZONE	MBEYA	REGIONAL FOREST OFFICER
94	JOSEPH MGANA	KILOMBERO DISTRICT	EASTERN ZONE	MOROGORO	DISTRICT FOREST OFFICER
95	JOSEPH MKUMBI	MPWAPWA DISTRICT	CENTRAL ZONE	DODOMA	DISTRICT AGRICULTURE OFFICER
96	JOSEPH PIUS	TANROAD	LAKE ZONE	MWANZA	CIVIL ENGINEERING
97	JOSHUA MWAKYUSA	BUKOMBE DISTRICT	LAKE ZONE	GEITA	LIVESTOCK OFFICER
98	JOSIAH MSHUDA	Dodoma Environmental Network	CENTRAL ZONE	DODOMA	DIRECTOR
99	Julius Nobert	Regional Secretariat	NORTHERN ZONE	ARUSHA	Regional Forest Officer
100	JUMA MUNYENGI	REGIONAL SECRETARIET	CENTRAL ZONE	SINGIDA	DRIVER
101	JUMBE KAWAMBWA	REGIONAL SECRETARIET	SOUTHERN ZONE	LINDI	REGIONAL FISHERIES OFFICER
102	JUNGWA MWANGA	REGIONAL SECRETARIET	SOUTHERN HIGHLAND ZONE	MBEYA	DRIVER
103	KEVIN KALEGEYA	REGIONAL SECRETARIET	LAKE ZONE	MARA	REGIONAL TRADE OFFICER
104	KITOGO LAWRENCE	EMEDO	LAKE ZONE	MWANZA	PROJECT OFFICER
105	KIZITO GALINOMA	TCCIA	SOUTHERN ZONE	MTWARA	VICE CHAIRMAN
106	KOMBA OTMARY	REGIONAL SECRETARIET	LAKE ZONE	GEITA	REGIONAL LAND OFFICER
107	LAMECK NOAH	REGIONAL SECRETARIET	EASTERN ZONE	MOROGORO	REGIONAL FOREST OFFICER
108	LEE JOSHUA	GEITA DISTRICT	LAKE ZONE	GEITA	DISTRICT FOREST OFFICER

109	LEONARD NZILAYILLUMBE	REGIONAL SECRETARIET	WESTERN ZONE	KIGOMA	REGIONAL FOREST OFFICER
110	LIGHTNESS MOSES	OXFAM	WESTERN ZONE	SHINYANGA	AGRICULTURE OFFICER
111	LUFUNYO LULANDALA	SUA	EASTERN ZONE	MOROGORO	PROJECT FIELD TEAM MEMBER
112	MAGRETH NDUDA	WWF TANZANIA	SOUTHERN ZONE	RUVUMA	M&E
113	Magreth Mkomwa	Uaminifu Women Group	NORTHERN ZONE	TANGA	Director
114	MAO EMANUEL	RIFT VALLEY	CENTRAL ZONE	MANYARA	MANAGER
115	MARCO MWAIRWA	USHETU DISTRICT	WESTERN ZONE	SHINYANGA	DISTRICT NATURAL RESOURCE OFFICER
116	Mariam Semlowe	Sari (Selian Agricultural Research Institute)	NORTHERN ZONE	ARUSHA	Principal Agriculture Officer
117	MATHAYO KASAGARA	ACT LAKE RUKWA	WESTERN ZONE	KATAVI	BISHOP
118	MENRAD BUTAWANYA	SONGEA DISTRICT	SOUTHERN ZONE	RUVUMA	DISTRICT NATURAL RESOURCE OFFICER
119	METSON MWAKANYAMALI	KDU	SOUTHERN ZONE	RUVUMA	GAME WARDEN
120	MIRAMBO GIBSON	KITETO DISTRICT	CENTRAL ZONE	MANYARA	DISTRICT AGRICULTURE OFFICER
121	MOGELA MBAGO	UNYANYEMBE HONEY COMPANY	SOUTHERN ZONE	LINDI	OPERATION MANAGER
122	MUHOIN KHALFANI	KAKONKO DISTRICT	WESTERN ZONE	KATAVI	AGRICULTURE OFFICER
123	NAUMANGA ISSA	TANDAHIMBA DISTRICT	SOUTHERN ZONE	MTWARA	DISTRICT AGRICULTURE OFFICER
124	NELBERT MBILINYI	LUTIKILO MIXED FARM	SOUTHERN ZONE	RUVUMA	ASSISTANT MANAGER
125	NGATARA KIMARO	TANZANIA FOREST SERVICE	LAKE ZONE	MWANZA	FOREST OFFICER
126	NG'ONDI MAPALALA	MEATU DISTRICT	LAKE ZONE	SIMIYU	DISTRICT AGRICULTURE OFFICER
127	NGUSSA KINAMHALA	BGG Bliss Green generation	WESTERN ZONE	KATAVI	DIRECTOR
128	NGWANDU MICHAEL	REGIONAL SECRETARIET	CENTRAL ZONE	MANYARA	REGIONAL FOREST OFFICER
129	NICHOLAUS MCHOME	REGIONAL SECRETARIET	SOUTHERN HIGHLAND ZONE	RUKWA	REGIONAL FOREST OFFICER
130	NIWAELI KIMAMBO	WCS	SOUTHERN HIGHLAND ZONE	MBEYA	GIS EXPERT
131	NSOKO EDWIN	UNDP	WESTERN ZONE	TABORA	COORDINATOR
132	NUHU KITALUKA	MUFINDI DISTRICT	SOUTHERN HIGHLAND ZONE	IRINGA	FOREST OFFICER
133	OSCAR YOHANA	KIGOMA UJIJI	WESTERN ZONE	KIGOMA	TOWN PLANNER
134	OTHMAR HAULE	KILOSA DISTRICT	EASTERN ZONE	MOROGORO	NATURAL RESOURCES OFFICER

135	PASKAZIA MWESIGA	GEITA GOLD MINE	LAKE ZONE	GEITA	ENVIRONMENTAL OFFICER
136	PATRICK AKITANDA	TANZANIA FOREST SERVICE	CENTRAL ZONE	DODOMA	ASSISTANT ZONAL MANAGER
137	PAULINA ALEX	NELICO	LAKE ZONE	GEITA	DIRECTOR
138	PAULO LYIMO	SUA	EASTERN ZONE	MOROGORO	RESEARCHER
139	PHILIP MKUMBATA	MBOMIPA -WMA	SOUTHERN HIGHLAND ZONE	IRINGA	CHAIRMAN
140	PHILIPINA SHAYO	WWF TANZANIA	SOUTHERN ZONE	LINDI	COORDINATOR
141	PHILIPO JACOB	MONITORING CENTRE	EASTERN ZONE	MOROGORO	PROJECT COORDINATOR
142	PHILIPO MBAGA	FARM AFRICA	CENTRAL ZONE	MANYARA	COORDINATOR
143	PIUS KAVANA	TAWIRI	WESTERN ZONE	KIGOMA	RESEARCHER
144	PRISCA NTABAYE	SUMBAWANGA DISTRICT	SOUTHERN HIGHLAND ZONE	RUKWA	DISTRICT BEEKEEPING OFFICER
145	PRISCA KASSILE	AGRICULTURE AND DEVELOPMENT	LAKE ZONE	SIMIYU	COORDINATOR
146	RAMADHANI HAMISI	KONDOA DISTRICT	CENTRAL ZONE	DODOMA	DISTRICT FOREST OFFICER
147	Raphael Mahinya	Regional Secretariet	NORTHERN ZONE	KILIMANJARO	Regional Forest Officer
148	RAZONA PASCHAL	SUA	EASTERN ZONE	MOROGORO	RESEARCHER
149	Richard Giliba	FTI	NORTHERN ZONE	ARUSHA	GIS expert
150	ROGERS WILLIAM	STAR TV	LAKE ZONE	MWANZA	JOURNALIST
151	S B Mawanya	Monduli District	NORTHERN ZONE	ARUSHA	District Agricultural officer
152	SAID SHEMAHONGE	KIBONDO DISTRICT	WESTERN ZONE	KIGOMA	DISTRICT AGRICULTURE OFFICER
153	SAIDI KABANDA	UWANDA GAME RESERVE	SOUTHERN HIGHLAND ZONE	RUKWA	PROJECT MANAGER
154	SALEHE KIHUYO	TANZANIA FOREST SERVICE	EASTERN ZONE	COAST	DRIVER
155	SALI MANG'OSA	FARMER GROUP	SOUTHERN ZONE	LINDI	PASTORALIST
156	SALUM BAKARI	URAMBO DISTRICT	WESTERN ZONE	KATAVI	DRIVER
157	SAUDA MUNGA	WOMEN GROUP	CENTRAL ZONE	DODOMA	MANAGER
158	Sebastian Gambares	KINAPA	NORTHERN ZONE	KILIMANJARO	Chief Conservator
159	SELEMAN MNYEKE	BIHARAMULO DISTRICT	LAKE ZONE	KAGERA	DISTRICT FOREST OFFICER
160	SETH AYO	WILDLIFE DIVISION	LAKE ZONE	SIMIYU	PROJECT MANAGER
161	SHERYL QUAIL	UNIVERSITY OF FROLIDA/SUA	EASTERN ZONE	MOROGORO	RESEARCHER
162	Silvia Ceppi	OIKOS EAST AFRICA	NORTHERN ZONE	ARUSHA	Scientific advisor

163	Simon Lugazo	TFCG- Korogwe	NORTHERN ZONE	TANGA	Project manager
164	SIMON LYIMO	MABUKI RaNCH	LAKE ZONE	MWANZA	ASSISTANT FARM MANAGER
165	SOMBI SOMBI	SINGONET	CENTRAL ZONE	SINGIDA	COORDINATOR
166	STANLEY BALUWESHI	TUNDURU DISTRICT	SOUTHERN ZONE	RUVUMA	FOREST OFFICER
167	STEPHEN SEMHANDA	HANANG DISTRICT	CENTRAL ZONE	MANYARA	DISTRICT PLANNING OFFICER
168	SYLVANUS GWIBOHA	TARIME DISTRICT	LAKE ZONE	MARA	DAICO
169	SYLVIA KALEMELA	TFCG	SOUTHERN ZONE	LINDI	GIS EXPERT
170	THEOPHIL ISHENGOMA	SINGIDA RURAL	CENTRAL ZONE	SINGIDA	DISTRICT LIVESTOCK OFFICER
171	THERESIA NGENDELLO	UKILIGURU AGRICULTURAL RESEARCH INSTITUTE	LAKE ZONE	MWANZA	RESEARCHER
172	THOMAS NYAMBA	NJORECU LTD	SOUTHERN HIGHLAND ZONE	NJOMBE	MANAGER
173	Timotheo Sosiya (??)	Regional Secretariat	NORTHERN ZONE	TANGA	Regional Forest Officer
174	VICENT MWAFUTE	MBINGA DISTRICT	SOUTHERN ZONE	RUVUMA	DISTRICT FOREST OFFICER
175	WILBERT MAHUNDI	TMMTF Tanzanian Mineral Mining Trust Fund	SOUTHERN ZONE	RUVUMA	DIRECTOR
176	Yibarila Chiza kamele	Handeni District Council	NORTHERN ZONE	TANGA	Production and marketing officer
177	YOBU KIUNGO	REGIONAL SECRETARIET	WESTERN ZONE	TABORA	REGIONAL FOREST OFFICER
178	YOHAN TESSUA	FIDE Friends in Development	CENTRAL ZONE	MANYARA	CHAIRMAN
179	YOHANA NCHIMBI	TCCIA	SOUTHERN ZONE	RUVUMA	REGIONAL CHAIRMAN
180	YUSTO MUCHURUZA	KADETFU	LAKE ZONE	KAGERA	DIRECTOR
181	ZAWADI JILALA	SUA	EASTERN ZONE	MOROGORO	PROJECT FIELD TEAM MEMBER
182	ZEDEKIAH OSANO	MSALALA DISTRICT	WESTERN ZONE	SHINYANGA	DISTRICT AGRICULTURE OFFICER
183	AYUBU OMARY		NORTHERN ZONE		
184	MPISHI ABSHIR		NORTHERN ZONE		
185	RICHARD MBUGITON		NORTHERN ZONE		

Appendix 2: List of Participants in National Stakeholders Workshop on land use/cover changes scenarios and REDD+ Safeguards

No.	NAME	ORGANIZATION	WORK PLACE	DESIGNATION
1	ABBAS KITOGO	UNDP	DSM	MRV SPECIALIST
2	ALAMD HUGUHA	WORLD DIVISION	DSM	HGW
3	ALMAS KASHINDYE	FTI	ARUSHA	PROJECT MANAGER
4	ANDRAW WARIKI	MCDI	KILWA	FOREST MANAGER
5	ASTERIA.S.RINGIA	MAFC	DSM	MESA
6	ATHUMAN.J.MSUYA	NBS	DSM	CARTOGRAPHER
7	BEATRICE JOSEPH	KCC	DSM	INTERN
8	BEDA MAPUNDA	RUVUMA BASIN	MTWARA	WATER ENG.
9	BONIFACE MBILINYI	SUA	MOROGORO	RESEARCHER
10	CASSIAN SIANGA	TNRF	ARUSHA	SFPO
11	CHARLES M.MSANJA	MNRT	DSM	PGO
12	CHARLES MKUDE	VPO	DSM	DRIVER
13	CLAUDIA CAPITAN	YORK	YORK	RESEARCH FELLOW
14	DAMAS MUMWI	LIWALE DC	LIWALE	DLNRO
15	DOSSANTOS SILAYO	SUA	MOROGORO	LECTURER
16	ELIAS MSUYA	MTANZANIA	DSM	SENOIR REPORTER
17	ERICK.H. MHANDO	MANET	MOROGORO	RESEARCHER
18	FARES.E.MAHUHA	MAFC	DSM	ASS.DIRECTOR
19	FRANCIS RUSENGULA	WWF	UDZUNGWA	P.COORDINATOR
20	FREDDY MANYIKA	SUA	DSM	FOREST OFFICER
21	FREDRICK LUKALO	MAFC	DSM	DRIVER
22	FREDY MWANJALA	CHANEL l 10	DSM	REPORTER
23	GEORGE BULENGA	SUA	MOROGORO	RESEARCHER
24	GEORGE KAFUMU	VPO	DSM	BPFO
25	GERALD KAMWENDA	WWF	DSM	CONSERVATION MANAGER
26	HADJI HATIBU	TFS LAKEZONE	MWANZA	ZONE MANAGER
27	HALIMA KILUNGO	OUT	DSM	LECTURER

28	HAMIDU SEKI	SUA	MOROGORO	RESEARCH ASS.
29	HAMISI ABDALLAH	SUA	MOROGORO	DRIVER
30	HAMZA NKUMULWA	LIMAS	LIWALE	FOREST OFFICER
31	HENRY FELIX	WWF	DSM	INTERN
32	HENRY URIO	BRN	DSM	PAO
33	ILDEFONCE NDEMELA	TIC	TIC-HQ	LAND SPECIALIST
34	ISAAC MALUGU	WWF-TZ	DSM	PROGRAMME COORDINATOR
35	J.M DAFFA	WWF- TZ	DSM	POLICY ADVISOR
36	JAFF FELTEN	CAMCO	DSM	DIRECTOR
37	JOHN HERBERT	SUA	MOROGORO	RESEARCHER
38	JOSEPH CHEWALE	TBC	COAST REGION	JOURNALIST
39	JOSEPH MANGOWI	WWF -TZ	DSM	DRIVER
40	JOSEPH.J.KIGULA	MNRT	DSM	PFM COORDINATOR
41	JULIUS NGALYMA	ITV	DSM	CAMERA MAN
42	KATE MASSARELLA	YORK	YORK UNIVERSITY	PhD STUDENT
43	KEKILIA KABALIM	TFS	TFS-HQ	SCART
44	KOMBA OTMARY	RS	GEITA	LAND OFFICER
45	KUSAGA MUKAMA	WWF-TZ	DSM	PC
46	LAUREAN MODEST	VPO	DSM	DRIVER
47	LAZARO MPEKA	SUA	MOROGORO	DRIVER
48	MARY SWAI	TATEDO	DSM	PROJECT MANAGER
49	MASOUD TABU	DAILY NEWS	DSM	JOURNALIST
50	MATHEW MPANDE	ICRAF	DSM	SCIENTIST
51	MATRIDA SIMFUKWE	WWF	DSM	M&E OFFICER
52	MAULIDI MKIMA	YARA(T)LTD	DSM	AGRONOMIST
53	MCHIHIYO.R.P	TMA	DSM	COORDINATOR
54	MSAKI SAMWEL	MINISTRY OF LANDS	DSM	MAPPING OFFICER
55	NATHANIEL.J.MSENGI	MAFC-MDU	DSM	LAND SURVEYOR
56	NEIL BURGESS	WCMC	UK	ADVISOR

57	NICKSON MSOKA	FTI OLMOTONYI	ARUSHA	DRIVER
58	NOVATE KESSY	WWF TZ	DSM	EXTRACTIVE OFFICER
59	OTHMAR HAULE	KILOSA DC	KILOSA	FOREST OFFICER
60	PILI MSATI	NLUPC	DSM	SOC
61	PKT MUNISHI	SUA	MOROGORO	LECTURER
62	RAYMOND KILLENGA	EAMCEF	MOROGORO	PROGRAMME OFFICER
63	RICHARD GILIBA	ECOPRC	ARUSHA	TRAINING COORDINATOR
64	RICHARD MUYUNGI	VPO - DE	DSM	ASST. DIRECTOR
65	ROBERT MERCHANT	YORK	YORK UNIVERSITY	LECTURER
66	RONALD.N.PANGAH	RS-MTWARA	MTWARA	FOREST OFFICER
67	SANJO .M. MGETA	TANROADS	DSM	ENVIRONMENTALIST
68	SHABAN TOLLE	ITV	DSM	JOURNALIST
69	SIMON MWANSASU	UDSM	UDSM	LECTURER
70	SUDI MALLE	WWF TZ	DSM	DRIVER
71	SUMA MINGA	WWF TZ	DSM	INTERN
72	SUZANA AUGUSTINO	SUA	SUA	RESEARCHER
73	SYLIVIA.M. KALEMELA	TFCG	DSM	GIS OFFICER
74	WILLIAM MDUMA	MALIASILI	DSM	DRIVER
75	YOBU.M. KIUNGO	RS-TABORA	TABORA	RFO
76	ZAHABU ELIAKIM	SUA	MOROGORO	CONSULTANT

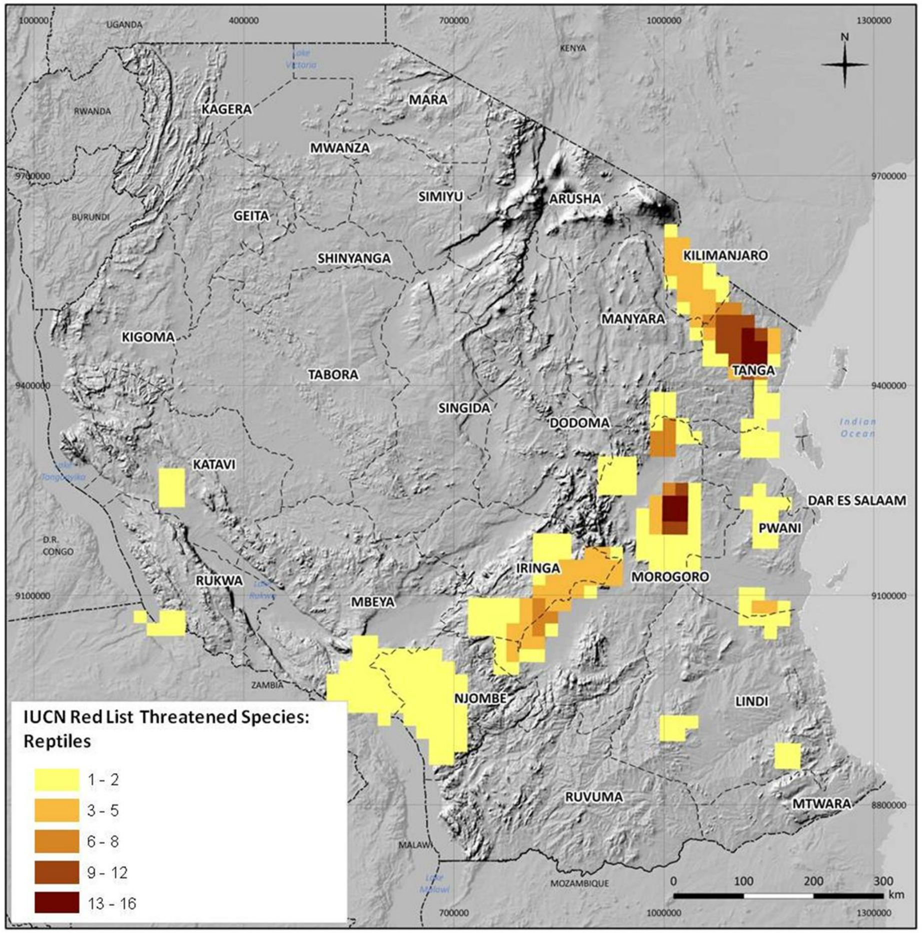
Appendix 3: Existed gap on Tanzania REDD+ Safeguards Standards.

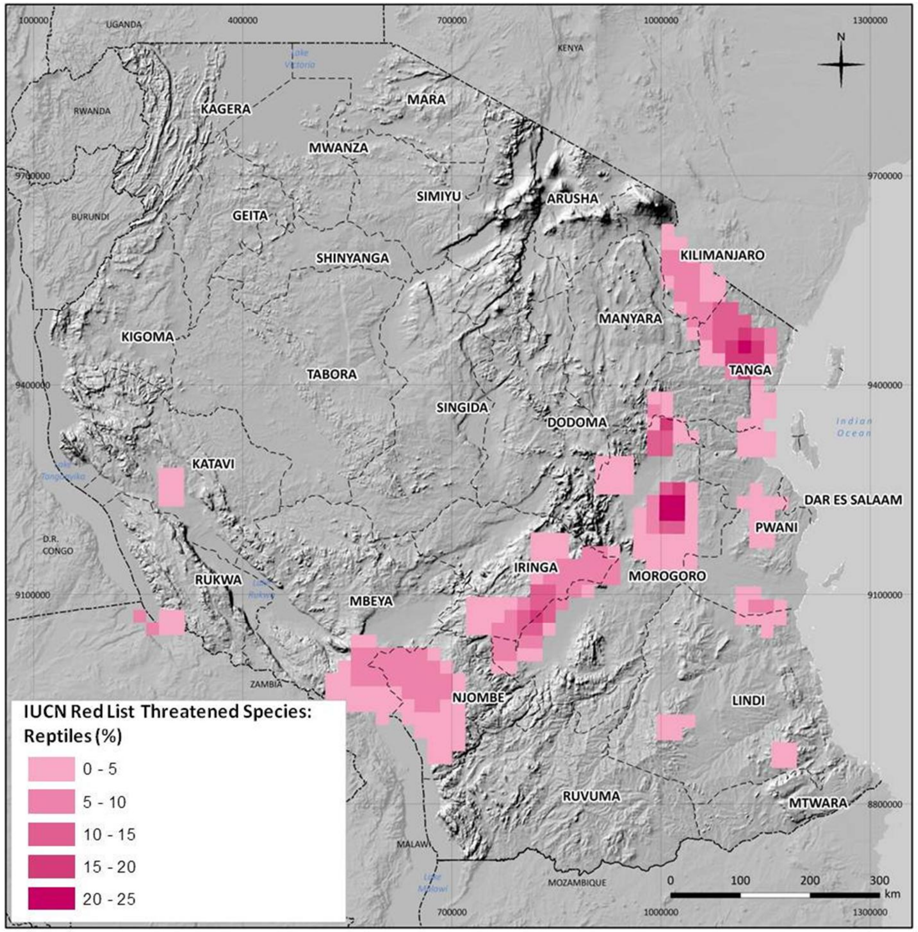
Themes identified within the Tanzania REDD+ Safeguards (VPO 2013a)	Issues or Questions which the maps should address	Maps created in current project	Maps created by UN-REDD/NAFORMA in 2013
<u>Good governance and sustainable natural resources management</u> Indicator 1.3.2: "All relevant stakeholders including forest dependent communities, including the marginalized and vulnerable groups, access to justice promoted and respected." Indicator 1.4.1: "REDD+ initiatives are well integrated in the forestry and other relevant sectors." Indicator 1.7.1: "The REDD+ initiatives contribute to socio-economic and sustainable diversification of the use of natural forest resources."	• Where are community managed land resources (WMA + PFM)? (Community participation in the management of forestry through PFM and wildlife resources through Wildlife Management Areas (WMAs) provides the institutional framework for strengthening natural resource management and governance at local level). Other relevant questions for future efforts: • What is the distribution of/proportion of marginalized/vulnerable groups in areas targeted for REDD+ actions?	Map 1: Updated WMAs and PFM	Land use designations: reserved land by the Tanzanian government (forest reserves and protected areas) and location of PFM activities Potential zones for REDD+ actions to extend areas of Community Based Forest Management (CBFM) to enhance sustainable management of forests NTFPs observed in the plots of the NAFORMA biophysical survey Potential zones for REDD+ action to enhance sustainable management of forest in production forest reserves
<u>Presence of Village Land use plans (LUPs)</u> Indicator 1.7.2: "The REDD+ initiatives support land use planning to enhance effective and sustainable management of natural forest resources." Indicator 2.1.4: "Land use plans including forest management plans in areas included in the REDD+ implemented activities recognize and respect customary and statutory rights of forest dependent communities specifically women and other marginalized/vulnerable social groups that contribute to sustainable forest management."	• Where villages with developed land are use plans to date? Other relevant questions for future efforts: • Where are current land uses providing sufficient land for the communities in villages (in relation to standard demands)? • Where are community managed land resources, e.g. WMA, in association with the developed village land use plans? • What is spatial distribution of Land Parcel ownership –those with customary title deeds or statutory title deeds in relation to forest resources targeted for REDD+?	Map 2: Status of land use planning in Tanzania, i.e. percentage of villages with LUP in each District	
<u>Food security for rural communities</u> Indicator 3.4.1: "Programs to improve food security are introduced, promoted, sustainably	• What is the status of food security in the country? • Where are the programmes to improve food	Map 3: Districts identified for Big Results Now (BRN) and Agricultural Sector Development Programme (ASDP) projects	Plots where the NAFORMA field inventory has observed impact on the land from charcoal production

implemented, monitored and evaluated." Indicator 3.4.2: "Programs to improve energy security are introduced, promoted, sustainably implemented, monitored and evaluated." Indicator 3.4.3: "Programs for land use and master plan are emphasized and implemented."	security? • Where are the suitable lands for improved food security? Other relevant questions for future efforts: • Where are communities who are energy secure/insecure? • Where are communities who are likely to become energy insecure due to REDD+ activities? Or are already energy insecure due to REDD+ activities? • What is land suitability for main crops, along with other factors related to improved food security (e.g. road access)?	Map 4: Vulnerability to food insecurity	
<u>Species</u> Indicator 7.2.2: "Species that are rare, endemic or threatened with extinction are identified, protected, restored and monitored."	• What is the distribution of endemic species in Tanzania? • What is the distribution of threatened amphibian, bird, mammal and reptile species species in Tanzania? • What is the distribution of climate change vulnerable amphibian, bird and reptile species in Tanzania? • What is the distribution of forest-dependent threatened amphibian, bird, mammal and reptile species in Tanzania?	Map 5: Distribution of globally threatened amphibian, bird, mammal, and reptile species Map 6: Distribution of globally threatened reptile species Map 7: Distribution of forest-dependent amphibian, bird, mammal and reptile species Map 8: Distribution of forest-dependent reptile species Map 9: Distribution of climate change vulnerable amphibian, bird and reptile species Map 10: Distribution of climate change vulnerable reptile species Map 11: Endemic species richness and above-ground biomass carbon	Average tree species richness in NAFORMA plots Observed threatened tree species in the NAFORMA inventory Animal species (mammals, birds, amphibians, threatened and total) richness in relation to above ground biomass carbon Important wildlife corridors in relation to protected areas, natural forest and woody biomass carbon stocks
<u>Ecosystems and ecosystem services</u> Principle 7: "The REDD+ initiative maintains, promotes and enhances sustainable conservation of the country's natural forests for their biodiversity and all ecosystem services (co-benefits) while	• What is the distribution of ecosystems which provide important ecosystem services such as mangroves?	Map 12: Forest cover change in Tanzania, 2000-2012 Map 13: Forest dependent threatened species richness and forest cover loss,	Estimations of extent of natural forest according to different relevant definitions, using the NAFORMA LULC map Woody biomass carbon stocks, natural

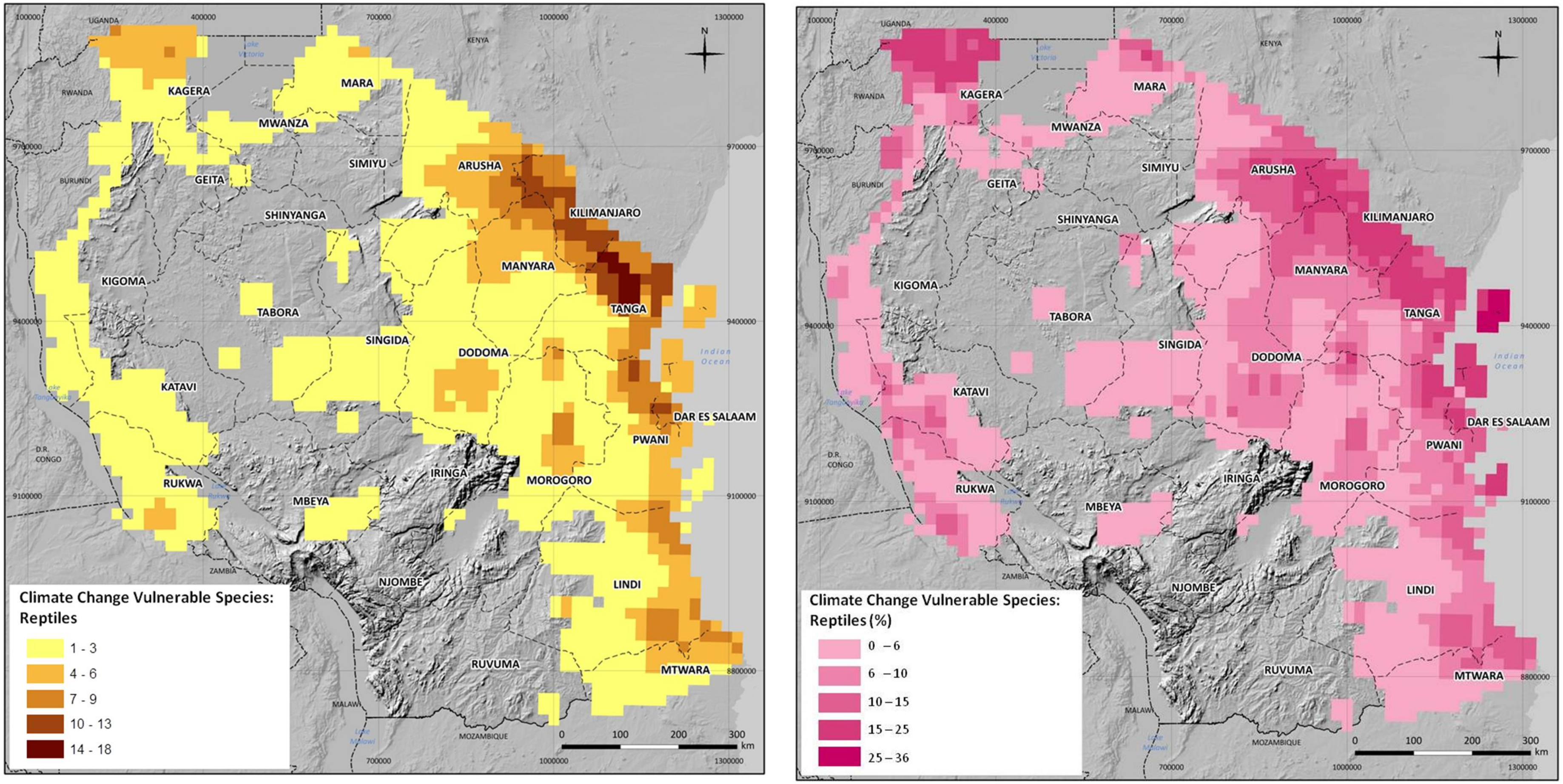
meeting the needs of forest dependent communities." Indicator 7.2.2: "Species that are rare, endemic or threatened with extinction are identified, protected, restored and monitored." Indicator 7.2.3: "REDD+ activities are designed in a participatory manner to maintain and enhance biodiversity and all ecosystem services while considering the sustainable use of forest resources by forest dependent communities." Criteria 7.3: "The REDD+ initiatives protect natural forests from degradation and conversion to other land uses including forest plantations." Indicator 7.3.3: "REDD+ activities are designed to maintain and enhance sustainable conservation and protection of natural forests." Criteria 7.4: "The REDD+ initiative ensure restoration of degraded areas using available indigenous or alternative compatible species." Land Policy Statement 4.2.10 - Mechanisms for protecting sensitive areas will be created. Sensitive area means: - Catchment area - Area with high biodiversity - Mangrove area	• What is the current distribution of mangrove forest and what mangrove areas have been recently deforested? • What are the biomass carbon stocks in mangroves? • Which areas include habitat for threatened and endemic forest species, and which of these areas have recently been deforested? • Which areas include habitat for threatened and endemic montane grassland species, and which of these areas have experienced forest gains? Other relevant questions for future efforts: • What is the distribution of the smallest/ most critical ecosystems in Tanzania? • What are the areas where nature or culture based tourism is occurring and coinciding with forest resources? What is the potential for extending tourism activities to other areas? • What forests in water catchment areas may be particularly important for regulating water supply and so in supporting multiple benefits from a REDD+ perspective?	2000-2012 Map 14: Forest dependent endemic species richness and forest cover loss, 2000-2012 Map 15: Mangrove forest cover change, 1990-2010 Map 16: Potential above-ground biomass carbon in mangroves and mangrove loss, 1990-2010 Map 17: Montane grassland dependent threatened species richness and forest gain, 2000-2012 Map 18: Montane grassland endemic species richness and forest gain, 2000-2012	forest and protected areas Non-timber forest products observed in the plots of the NAFORMA biophysical survey. Importance of forests for limiting soil erosion Potential zones for REDD+ action to rehabilitate forests

Appendix 4: Distribution of globally threatened reptile species in Tanzania



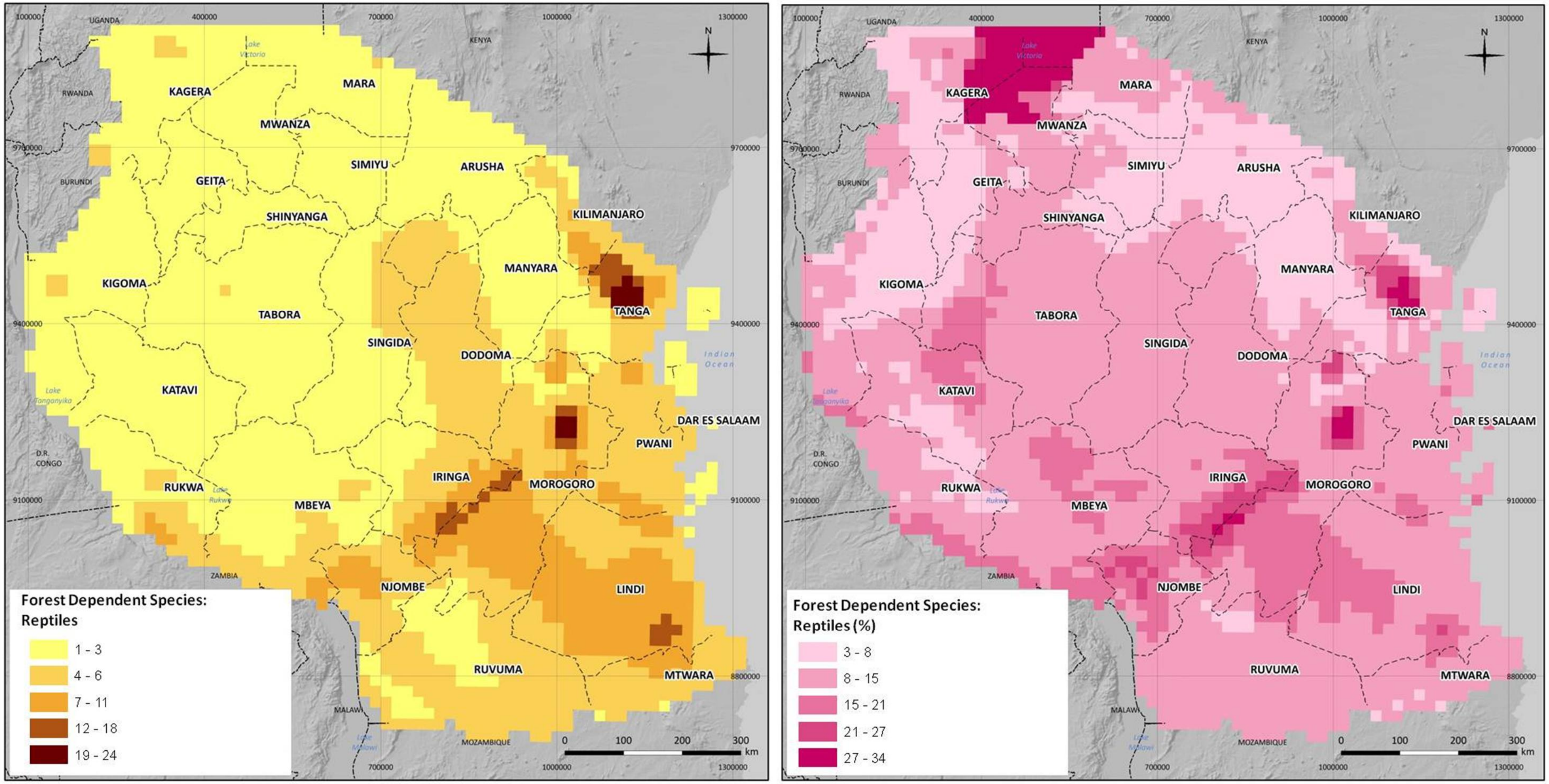


Appendix 5: Distribution of climate change vulnerable reptile species in Tanzania



Maps show total numbers of species (left-hand side) and total proportions of species (right-hand side) (per 10 minute grid cell) believed to be vulnerable to climate change impacts, using exposure measures based on climate projections in 2055, under emissions pathway RCP4.5 and an optimistic assumption for all unknown data values.

Appendix 6: Distribution of forest dependent reptile species in Tanzania



Appendix 7: List of participants on R programme training course

No.	Name	Institution	Current position
1	Albart Mangowi	Sokoine University of Agriculture	Masters student
2	Baraka Naftal	Sokoine University of Agriculture	Assistant researcher,
3	Crispus Mugambi	ICIPE/CHIESA	Research assistant,
4	Emanuel Martin	Sokoine University of Agriculture	TEAM site manager &PhD student
5	Ezekiel Edward	Sokoine University of Agriculture	Lecturer,
6	Fadhili M. Njilima	Udzungwa Forest Project	Project Co-coordinator
7	George Bulenga	Sokoine University of Agriculture	Masters student
8	Getrude Nyagawa	Sokoine University of Agriculture	Masters student
9	Gift Mathew Ngowo	NEMC	Environmental Management Officer
10	Godgift Swai	Sokoine University of Agriculture	Academic Staff,
11	Hamidu A Seki	Sokoine University of Agriculture	Masters student
12	James Odanga	International Centre of Insect Physiology and Ecology	PhD student
13	Kusaga Mukama	WWF Tanzania	Coordinator for REDD+ Pilot Project
14	Leah Mwakasege	Sokoine University of Agriculture	Masters student
15	Lucas Theodory	Sokoine University of Agriculture	Masters student
16	Lufunyo Lulandala	Sokoine University of Agriculture	Masters student
17	Mohamed Kambi	Pennsylvania State University	Pennsylvania State University
18	Mourice Mbunde	Wildlife Conservation Society of Tanzania	Executive Officer, Morogoro Branch
19	Mponie Mwaluseke	Sokoine University of Agriculture	Masters student
20	Pantaleo K. T. Munishi	Sokoine University of Agriculture	Professor
21	Paulo John Lyimo	Sokoine University of Agriculture	Research assistant,
22	Samwel Daudi Nyasani	National Environment Management Council (NEMC)	Environmental Management officer
23	Samwel Shaba	World Agroforestry Centre (ICRAF)	Field research supervisor
24	Simon Mwambola	The Nelson Mandela African Institute of Science and Technology	Masters student
25	Tumaini Samwel Kiure	WCST	Executive officer (Morogoro branch)
26	Yohane France	Sokoine University of Agriculture	Masters student

27	Zawadi Jilala	Sokoine University of Agriculture	Masters student

Appendix 8: List of Participants for training workshop on developing land use/cover scenarios

No	Name	Designation	Organisation
1	Adrew Ferdinands	GIS &IT Expert	Private Forest Programme
2	Almas Kashindye	Project Coordinator	ECOPRC
3	Dr. Claudia Capitani	Facilitator	University of York
4	Dr. Reuben Kadigi	Lecturer and Ass.Prof.	SUA
5	Elikana John	GIS Analyst	Tanzania Forest Service
6	Emmanuel Lyimo	M&E	TFCG
7	Endeshi Melakiti	Cartographer	Ministry of Land
8	Gloria Nderumaki	Teacher	Karatu Secondary
9	Halima Kilungu	Lecturer	Open University of Tanzania
10	Jacob Mlula	Driver	WWF Tanzania
11	Kekilia Kabalimu	SCARTO	TFS
12	Mukama Kusaga	Project Coordinator	WWF Tanzania
13	Nickson Msoka	Driver	ECOPRC
14	Prof. PKT Munishi	Prof. and Lecturer	SUA
15	Richard Giliba	Training Coordinator	Olmotonyi Forest training Institute
16	Rose Akombo	Ass. Director	Kenya Forest Services

Appendix 9: List of participants attended mapping workshop

No	Name	Work place	Organization
1	Elias Ntibansubile	DSM	Tanzania Forest Services
2	Gasper Dionice	DSM	Tanzania Forest Services
3	Juma R Mwangi	Dodoma	Tanzania Forest Services
4	Kekilia Kabalimu	DSM	Tanzania Forest Services
5	Lucas Theodory	Morogoro	Sokoine University of Agriculture
6	Masilika Pastory	DSM	Tanzania Forest Services
7	Renatus Paul	Tabora	Tanzania Forest Services
8	Richard Giliba	Arusha	Forest Training Institute
9	Simon Kitereja	Morogoro	Sokoine University of Agriculture
10	Yohane Mwampashi	DSM	Tanzania Forest Services
11	Yusufu H Matembo	Morogoro	Sokoine University of Agriculture