Republic of Mozambique
Ministry of Land, Environment and Rural Development

Mozambique's Forest Reference Emission Level for Reducing Emissions from Deforestation in Natural Forests

Government of Mozambique

03 October 2018

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EXECUTIVE SUMMARY

Main features of the FREL		Remarks
Proposed FREL (in tCO_2e/year)	38 956 426	
Type and duration of FREL	Historical average – 11 years (2003-2013)	
Adjustment of national circumstances	None	
National/Subnational	National	National, but reporting estimates at Provincial level and for groups of Districts as Mozambique wishes to pilot REDD+ at a sub-national level.
Activities included	Deforestation	Only deforestation of natural forest. Conversion of plantations is not included.
Pools included	AGB, BGB	Aboveground and Belowground. The dead wood and litter, and SOC will be included in the future modified submission.
Gases included	CO_2	
Forest definition	1 ha, 30% canopy cover, 3 meters tree height	
Relationship with latest GHG inventory	None	Past national communications are not consistent. Mozambique will work through 2018 to ensure consistency.
Description of relevant policies and plans	Yes	This shows that GHG emissions in the historical period are a good proxy of future GHG emissions.
Description of assumptions on future changes in policies	Not applicable	
Description on changes to previous FREL	Not applicable	
Future improvements identified	Include SOC and DOM pools. Include Forest degradation activity.	

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ACRONYMS

AGB	Aboveground Biomass
BGB	Belowground Biomass
CEAGRE	Centre for Agricultural Studies and Natural Resource Management
CENACARTA	National Center for Cartography and Remote Sensing
D&D	Deforestation and Forest Degradation
DINAB	National Directorate of Environment
DINAF	National Directorate of Forests
DINAT	National Directorate of Land
DOM	Dead Organic Matter
FAO	Food and Agriculture Organization of the United Nations
FNDS	National Fund for Sustainable Development
FRA	Global Forest Resource Assessment
FREL	Forest Reference Emissions Level
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
LULC	Land Use and Land Cover
LULUCF	Land Use, Land Use Change and Forestry
MASA	Ministry of Agriculture and Food Security
MIREME	Ministry of Mineral Resources and Energy
MITADER	Ministry of Land, Environment and Rural Development
NFI	National Forest Inventory
NGO	Non-governmental Organizations
REDD+	Reducing emissions emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks
SOC	Soil Organic Carbon
UEM	Eduardo Mondlane University
UNFCCC	United Nations Framework Convention on Climate Change

1 INTRODUCTION

Mozambique is a country located in southeast Africa, bordered by the Indian Ocean in the East, with boundaries in the North with Tanzania, Zambia in the Northwest, Malawi, Zimbabwe and Swaziland in the west and South Africa in the South. The total extension is 823,588.75 Km^2 in which 41% is covered by natural Forests and the total population estimated in 28 million inhabitants.

Forests play an important role in the economy of the country, especially in the rural areas and provide direct benefits to a large majority of the population as source of energy through the extraction of firewood and charcoal, construction materials, logging for timber, non-timber forest products (medicinal plants, fruits, etc.), source of nutrients for small scale agriculture, social and cultural values.

The third National Forest inventory estimated that forests in Mozambique suffered high rates of deforestation, estimated at 0.58% in 2007, corresponding to 220,000 ha/year. Acknowledging this situation, and understanding its impact to the economy and to the livelihood of rural population, the Government of Mozambique became part of the 47 Countries that benefited from funds from the Forest Carbon Partnership Facility (FCPF) to develop the National REDD+ strategy with the aim of reducing emissions from deforestation and forest degradation and enhancement of carbon stocks (REDD+). The process began in 2008 with the elaboration of the REDD+ readiness plan (R-PP), which was approved by the Committee of Participants of the FCPF in March 2012. In 2016, the country received additional funds from the FCPF to establish a National Forest Monitoring System (NFMS) and the Forest Reference Emission Level (FREL) of greenhouse gas emissions (GHG) for REDD+.

With the aim of consolidating the process of REDD+, Mozambique embraces the opportunity to submit a proposal of FREL to the United Nations Framework Convention on Climate Change (UNFCCC), responding to decision 1/CP.16, referring to the requests of developing countries with intention to perform activities related to REDD+.

The objective of the country, in submitting this proposal, is on the perspective of building capacity for the implementation at all levels, the National REDD+ Strategy recently approved by the Government in December 2016 aiming to promote sustainable development, resilience to climate change, integrated rural development focused in forest, agriculture and energy.

The reduction of emissions caused by deforestation and forest degradation (REDD+), an initiative of the Signatory States to the UNFCCC, has its primary objective the promotion of actions which result in the reduction of deforestation and forest degradation, as well as an increase forest cover through forest plantations, restoration of degraded forests, conservation of forest ecosystems and improvement of sustainable forest management practices.

This proposal was constructed using the best available information in the country, following the IPCC guidance and guidelines, adopting the "stepwise" approach accepted by Decision 12/CP.17, paragraph 10.

As part of the actions related to REDD+, the Government of Mozambique is implementing the Forest Investment Program of Mozambique (MozFIP) and the Zambézia Integrated Landscape Management Program (ZILMP). MozFip was created in the framework of the Climate Investment Funds (CIF), to support the efforts of REDD+ in Developing Countries. The ZILMP was created with the aim of promoting sustainable development through the conservation and management of forests with insertion on the efforts of REDD+ in nine (9) districts of Zambézia Province, namely, Gilé, Ile, Pebane, Alto Molocué, Maganja da Costa, Mocubela, Mulevala, Mocuba and Gurué. The Government of Mozambique is planning to use the ZILMP as a pilot to test REDD+ and performance based payments. It is expected that it will enter into an Emission Reduction Payment Agreement (ERPA) with the FCPF Carbon Fund in 2018. Moreover, the Government of Mozambique is also planning a second sub-national pilot REDD+ program around and within the Quirimbas National Park, in seven (7) districts of Cabo Delgado Province, namely Macomia, Quissanga, Meluco, Montepuez, Metuge, Ancuabe and Ibo, covering an area of 30,405 km^2, with an annual deforestation estimated in 5,522 hectares/year. There is a structure of implementation in place created by MITADER, with initiatives to reduce the pressure on forests. These include working in improved cook stoves and charcoal kilns, as well as introducing and disseminating sustainable agriculture good practices, to improve the productivity and the value chain. The main challenge is the involvement of the private sector in sustainable forest management and expansion of these initiatives in all districts, to encompass a larger number of beneficiaries, to reduce the current pressure in the Program Area, especially the Quirimbas National Park.

The Government is planning to submit this sub-national REDD+ program to the request for proposals for Result Based Payments of the GCF.

2 NATIONAL CIRCUMSTANCES

This chapter on national circumstances provides information on the legal framework and institutional arrangements, which comprises the description of the laws, regulations, Decrees, Diplomas existent in the country that support the efforts for reducing emissions from deforestation and forest degradation and identify the gaps and the actions in place towards a solid legal framework. This includes a description of institutional arrangements for MRV system and the potential gaps for its effective implementation. Furthermore, a description on drivers of deforestation is provided, which includes information of the current deforestation, identifies the main drivers of deforestation and forest degradation and its contribution to total deforestation. To end with, this chapter provides information on plans and policies in terms of what is intended to do in view of the current institutional and legal framework and the drivers of deforestation. Plans are more operational and they will be applied in the coming 5 to 11 years from now and include the roadmap for the implementation and operationalization of the countries Measurement, Reporting and Verification system[1] (MRV).

2.1 Legal framework

In 1992, Mozambique adhered to the Rio convention to contribute to the sustainable use of natural resources. As a result, an Environment law (Decree Nº. 20/97) was drawn up, which defines the legal basis for the improved use and management of the environment and its components, to achieve sustainable development. This law prohibits the pollution of air, water and soil and practices that accelerate erosion, desertification and deforestation. Deforestation is the main topic that deserves attention in the forest sector as it is the main threat to the sustainability of forest natural resources. To enforce the legal framework, the Forest and Wildlife Law (Decree Nº. 10/99) was approved in 1999 to ensure the protection, conservation, development and rational use of forest and wildlife resources for economic, social and ecological benefit of current and future generations of Mozambicans. The implementation of the forest Law was then reinforced by its regulation (Decree 12/2002) which is focused on the

1 http://www.redd.org.mz/uploads/SaibaMais /ConsultasPublicas/MRV%20Road.pdf

management of forest activities, community engagement and law enforcement. After the Bali Conference (COP 13), which recognized the contribution of REDD+ to climate change, Mozambique started to find other ways to improve the management of its forests. In 2008, Mozambique prepared the first Emissions Reduction Project Idea Note (ER-PIN) that created conditions for preparing the legal and institutional grounds for REDD+. During this period, the country produced the REDD+ Decree (Decree 12/2013) which establishes the institutional arrangements in terms of MRV, establishes that the Government of Mozambique has the right to validate, verify and issue Emission Reductions titles and provides procedures for licensing REDD+ projects that wish to generate titles of Emission Reductions. As part of the REDD+ Readiness phase, the country produced the National REDD+ strategy in 2016. This strategy significantly impacted the forest related laws, policies and National Programs. Currently the forest sector is making reforms on the law, regulation, policy and strategy and the national forest program.

In 2017, Mozambique ratified the Paris Agreement and agreed to the global target of keeping global average temperatures well below 2°C. To achieve this, the country is in a process of designing the National MRV system which comprises four Components: AFOLU, Transport, Energy and Solid Residues. The MRV for REDD+ is part of the AFOLU, and is intended to conduct the following activities:

- Monitor GHG from deforestation and forest degradation which includes the monitoring of changes in land use and land cover, forest inventory, monitoring with a network of permanent sampling plots and estimation of GHG emissions and removals.
- Development of the National Platform for Sustainable Management of Natural Resources, which comprises the REDD+ programs and projects, Safeguard Information System (SIS), Grievance Redress Mechanism, benefit sharing and transactions.
- GHG reporting at national and international level.
- Periodical evaluations of REDD+ programs and projects.

To achieve the intended activities, ongoing efforts are taken ahead by different institutions within the Ministry of Land, Environment and Rural Development (MITADER), Ministry of Agriculture and Food Security (MASA), Eduardo Mondlane University (UEM) and Ministry of Natural Resources and Energy. Within MITADER, the institutions involved are the

National Directorate of Forests (DINAF), National Directorate of Land (DINAT), National Directorate of Environment (DINAB), National Center for Cartography and Remote Sensing (CENACARTA) and The National Fund for Sustainable Development (FNDS).

As part of the recent experience working on the production of the emission factors during the fourth National Forest inventory the Roles of the institutions involved were:

- DINAF (MITADER) – Leader of the National Forest Inventory, Quality control and Quality assurance
- FNDS (MITADER) – Coordinate the operations and logistics of the National Forest inventory
- IIAM (MASA) – Supply technical staff for identification of species and field work
- FAEF (UEM) – Soil analysis, supporting on the production of the Report of the National Forest Inventory, supplied allometric equations to estimate the carbon pools
- FCB (UEM) – Supplied technical staff for identification of species
- To produce the activity data, the following institutions were involved:
- DINAF (MITADER) – Provided conditions to train MRV unit team to learn the use of Collect earth used to produce the activity data; provided the National 4x4 km grid and did the Quality assurance of the activity data;
- FNDS (MITADER) – Produced the activity data
- CENACARTA (MITADER) – Did the assessment of process of production of data

With regards to the production of activity data and emission factors, the arrangements have been agreed to, but not formalized. One of the challenges is the formalization of institutional coordination, which requires policies on data sharing to be well defined and the institutions strategic plans harmonized.

2.2 Causes of deforestation and degradation

A study conducted by CEAGRE and Winrock International (2016) analyzed seven drivers of Deforestation and Degradation (D&D): commercial agriculture, shifting agriculture, extraction of timber products, production of firewood and charcoal, urban expansion, mining and livestock. This analysis considered that the seven drivers are interrelated in a multitude of ways and together are responsible for most of the D&D that occurs in Mozambique.

The study found that shifting agriculture is the major cause of deforestation in Mozambique, being responsible for 65% between 2000 and 2012. The other major causes identified were urban expansion (12%), extraction of timber products (8%) and production of firewood and charcoal (7%).

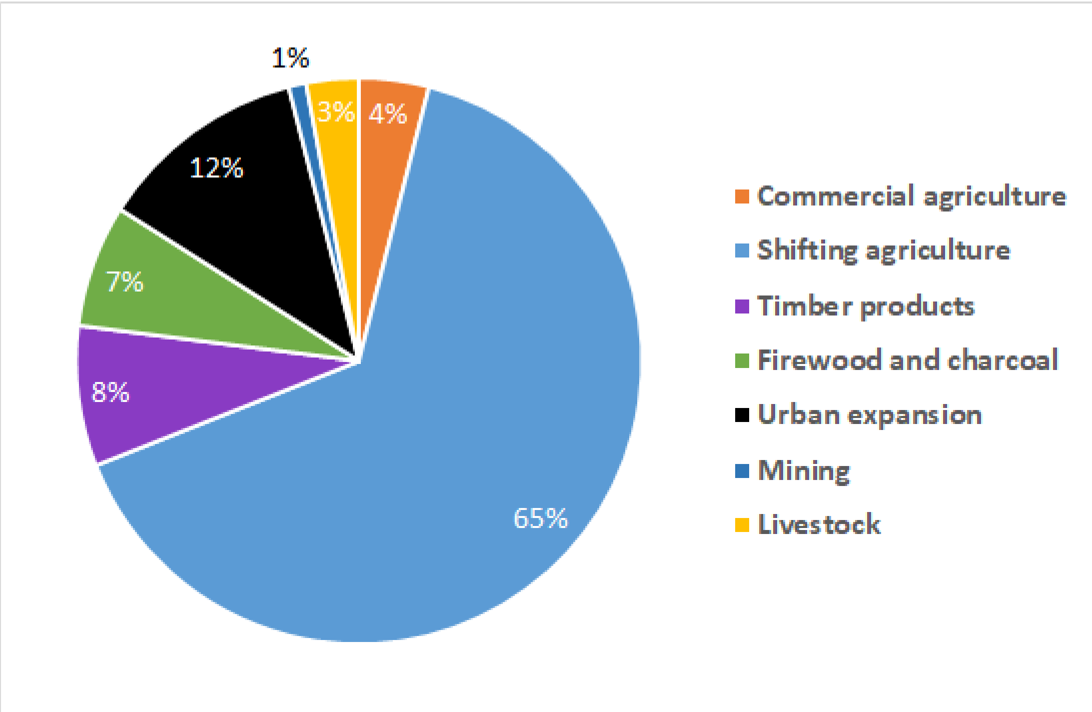

Figure 1. Proportion of deforestation for each driver (data from Ceagre and Winrock International, 2016)

On the other hand, the activity data analysis presented in this report showed that 86% of all deforestation events were due to conversion to agriculture, 13.5% to conversions to grassland, with the remaining conversions being responsible for less than 0.5%. Although the two analyses have very different methodologies, they both agree that agriculture is the main driver of deforestation. Additionally, if we interpret a conversion to grassland as resulting from timber product extraction, production of firewood, charcoal and livestock, then the two studies also show agreement, since these three drivers are responsible for 18% of deforestation in the study by CEAGRE and Winrock International (2016). The largest difference between these two analyses is in the role of urban expansion as a driver of deforestation. This could be explained because in the activity data only direct conversions were measured, whereas urban expansion can have multiple indirect effects of deforestation rates.

In the study by CEAGRE and Winrock International (2016), the main drivers vary per Province, according to each Province's economic, social and natural characteristics. In the south of Mozambique (Maputo, Gaza and Inhambane Provinces), urban expansion has a much greater impact on deforestation (23%) than in other regions of the country (7% in the north and 11% in the centre). In the Northern Provinces (Cabo Delgado, Nampula and Niassa), shifting agriculture has a greater impact on emissions (72%) than the centre (60%) or south (59%) of the country. The type of forest can also have an impact on deforestation rate. For example, mopane forests are more affected by charcoal production, timber exploration and grazing, whereas miombo forests are more heavily impacted by agriculture.

This study predicted that the deforestation rate of Mozambique is expected to increase in the next 10 years, due to population growth and urban growth. On the other hand, improvements in the forest management process may lead to a significant reduction in illegal timber exploration, which may result in reduced rates of D&D. The impact of the drivers of forest degradation was assumed to have been captured in the estimation of deforestation, since the analysis assumes that the drivers of deforestation and forest degradation are multiple and complex and act in unison.

A first order estimation of emissions resulting from the three most important causes of forest degradation (timber exploration, production of firewood and charcoal, and wildfires), predicted that forest degradation is responsible for almost 30% of total emissions.

2.3 Policies and plans

In order to implement the REDD+ strategy, the Government of Mozambique is reformulating the policies in the forest sector and testing the implementation of programs and projects on the ground. Two programs are being currently being implemented at sub-national level: the Zambézia Integrated Landscape Management Program (ZILMP) and the Integrated Landscape Management Program in Cabo Delgado Province (PROGIP-CD). The ZILMP was created with the aim of promoting sustainable development through the conservation and management of forests with insertion on the efforts of REDD+ in nine (9) districts of the Zambézia, Province, namely, Gilé, Ile, Pebane, Alto Molocué, Maganja da Costa, Mocubela, Mulevala, Mocuba and Gurué. The Government of Mozambique is planning to use the ZILMP as a pilot to test REDD+ and performance based payments. It is expected that it will enter into an Emission Reduction Payment Agreement (ERPA) with the FCPF Carbon Fund in 2018. The second sub-national pilot REDD+ (PROGIP-CD) program covers nine (9) districts of the Cabo Delgado Province, namely Macomia, Pemba-Metuge, Montepuez, Ibo, Ancuabe, Quissanga and Meluco. This area has the Quirimbas National Park which cover 9,130 Km^2, that is under pressure due to human activities. Agriculture, demand for fuelwood and charcoal, urban expansion, illegal logging and mining are the main drivers of deforestation and forest degradation. To reduce the pressure especially in the Quirimbas National Park, it needed to promote sustainable practices in agriculture, timber extraction and in charcoal production. The Government is planning to submit this sub-national REDD+ program to the request for proposals for Result Based Payments to GCF, and find possible collaborations with different parties for its implementation.

In terms of the MRV system for REDD+, there are also plans for future work on the production of emission factors and activity data. In 2018 and 2019, the establishment of the National network of Permanent Sample plots in the country will be conducted. This activity will be led by IIAM (MASA), with the direct involvement of FNDS (MITADER), DINAF (MITADER), FAEF (UEM) and FCB (UEM).

The National Platform for Management of Natural Resources that initially was being developed by DINAF is in a process of redesign due to the new requirements of the MRV system. In general, it is expected that data sharing policies, quality assurance and quality control, and institutional coordination are reflected in the reforms that are happening in the forest sector.

3 TRANSPARENT, COMPLETE, CONSISTENT AND ACCURATE INFORMATION

3.1 Transparency

Both the activity data and the NFI results will be published in individual reports and in this report. Once the National Platform for Management of Natural Resources is online, it will be possible to access the results. The reviewers of the technical assessment under the UNFCCC will have access to all relevant files.

To ensure transparency on the process, the guidelines are available on the web[23]. Transparency is also guaranteed with the consultation with different stakeholders on the process of defining the period, the selection of the allometric equations, dissemination of the documents and information to the public for comments, consultation and use.

3.2 Completeness

The methodology used to calculate the activity data, emission factors and the FREL itself is described in detail in this document (Section 8 and 9). The data used in the calculations is available and thus the FREL can be reconstructed independently.

3.3 Consistency

The future GHG inventories will adhere to the definitions used in this FREL, thus ensuring consistency between the two.

3.4 Accuracy

Regarding emission factors, data was collected by a well trained and certified team of forestry engineers that conducted the field work and supervised by the QA/QC team and an independent auditor. Data transfer was done in digital form and it was subject to QA by a team not involved in the data collection. Processing was done in an automated way by a researches with QA conducted by a team not involved in the processing.

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2 http://www.redd.org.mz/uploads/SaibaMais/ConsultasPublicas/AD%20Accuracy%20Assessment.pdf

3 http://www.redd.org.mz/uploads/SaibaMais/ConsultasPublicas/Mozambique%20National%20Forest%20Inventory%20Guidelines.pdf

Regarding activity data, data was collected by a well-trained team of 5 forestry engineers who worked for 200 days on the data collection. QC/QA procedures were in place in order to ensure the consistent collection and transfer of data.

The consistency of the information of the emission factors and activity data are guaranteed by the guidelines[2], which provides procedures to collect the data. It also enforced by the supervision and QA/QC) and external audit.

4 DEFINITIONS

4.1 Forest definition and operationalization

In Mozambique forests are defined as lands with trees with the potential to reach a height of 3 m at maturity, a canopy cover equal or greater than 30%, and that occupy at least 1 ha. This includes temporarily cleared forest areas and areas where the continuity of land use would exceed the thresholds of the definition of forest, or trees capable of reaching these limits in situ (Falcao and Noa 2016[4]).

Mozambique's previous forest definition was land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. This definition was changed after a long consultation process that involved the relevant public sector institutions, NGO, private operators and research institutions. The area requirement was increased to facilitate the mapping using remote sensing techniques, with medium resolution satellites. With regards to the canopy cover, it was considered that the value of 10% leads to the inclusion of forested areas with low carbon stocks, lowers the rate of deforestation, increases the monitoring costs and makes projects less attractive to investors. The minimum height was reduced from 5 to 3 meters to include forests with shorter trees, but with significant carbon stocks, such as mangrove and mopane forests.

Thus, the forest definition used in this FREL will differ from the definition presented in the Forest Resources Assessment (FRA) 2015, which used the previous forest definition. It is

4 http://www.redd.org.mz/uploads/SaibaMais/ConsultasPublicas/Relatorio%20definicao%20de%20floresta%20V5_19.10.2016.pdf

expected that in the next FRA, the forest definition and the estimates will be updated with the newly collected activity data. The country's proposal to the CDM of the UNFCCC in 2012/13 was also different, having changed the minimum tree height from 3 to 5 meters, following the definition proposed at the time by the National Directorate of Land and Forests[5].

4.2 Land Use Land Cover classification system

The 2006 IPCC Guidelines considers the following land- use categories for greenhouse gas inventory reporting: forest land, cropland, grassland, wetland, settlements and other land. Mozambique uses a tiered land use land cover (LULC) classification system, nested within the IPCC system.

The IPCC system was used as a basis in the National Forest Inventory (NFI), activity data and in the LULC cartography that is being generated. However, the national system places emphasis on the forest class, differentiating between different major forests types present in the country. It includes two levels, considering level 1 as the IPCC system, level 2 which distinguishes between closed and open canopies, as well as evergreen or deciduous forests. It also includes a forest plantation class. At level 3 the forest types are further differentiated, with the evergreen forests including mountainous forest, gallery forest, mangrove, coastal forest and Mecrusse forest (dominated by *Androstachys johnsonii*). The deciduous forest types are miombo (dominated by *Brachystegia sp*. and *Julbernardia sp*.) and mopane (dominated by *Colophospermum mopane*).

A more detailed description of the LULC system is presented in Annex 1.

[5] http://cdm.unfccc.int/DNA/index.html

Table 1. Land use and Land Cover classification system used in the production of the maps, activity data and national forest inventory.

Level 1 IPCC	Level 2 National Classification	Level 3 National Classification
Crops	Tree crops	Tree crops
	Field crops	Shrub Plantation (Tea)
		Rainfed field crops
		Irrigated field crops
		Rice crop
	Shifting cultivation with open to closed forested areas	Shifting cultivation with open to closed forested areas
Forests	Forest Plantation	Forest Plantation
	Forest with shifting cultivation	Forest with shifting cultivation
	Broadleaved (Semi-) evergreen closed forest	Coastal dense woody vegetation
		Mangrove dense
		Mecrusse dense
		Gallery forest
		Closed broadleaved (Semi-) evergreen mountainous forest
	Broadleaved (Semi-) deciduous closed forest	Miombo dense
		Mopane dense
	Broadleaved (Semi-) evergreen open forest	Coastal open woody vegetation
		Mangrove open
		Mecrusse open
		Open broadleaved (Semi-) evergreen mountainous forest
	Broadleaved (Semi-) deciduous open forest	Mopane open
		Miombo open
Grassland	Grasslands	Grasslands
	Thicket	Broadleaved (Semi-) evergreen thicket
		Broadleaved (Semi-) deciduous thicket
	Shrubland	Broadleaved (Semi-) evergreen shrubland
		Broadleaved (Semi-) deciduous shrubland
Wetlands	Aquatic or regularly flooded shrublands	Aquatic or regularly flooded shrublands
	Aquatic or regularly flooded herbaceous vegetation	Aquatic or regularly flooded herbaceous vegetation
	Artificial water bodies	Artificial water bodies

Level 1 IPCC	Level 2 National Classification	Level 3 National Classification
	Natural water bodies	Natural water bodies
	Salt lake	Salt lake
Settlements	Settlements	Settlements
Other land	Bare soils	Bare soils
	Bare rocks	Bare rocks
	Dunes	Dunes

5 SCALE AND SCOPE

5.1 Scale

This scale of the presented FREL are all forests within Mozambique. However, Mozambique wishes to report estimates at the Provincial level and at the level of the sub-national REDD programs, as Mozambique wishes to implement REDD+ following a step-wise approach that eventually lead to a national REDD+ program and seek REDD+ result based payments for areas within Mozambique. This is important as the country does not have the capacity to implement investment activities and implement the REDD+ framework (e.g. Safeguard Information System) at full national scale at this time.

5.2 REDD+ activities

The five REDD+ activities are:

- Reducing emissions from Deforestation
- Reducing emissions from forest degradation
- Conservation of forest carbon stocks
- Sustainable forest management
- Enhancement of carbon stocks

Mozambique defines deforestation as the anthropogenic conversion of forest land to non-forest land. Afforestation is the conversion from non-forest to forest, includes new forest plantations as well as regrowth of natural forests on old cropland or grassland. Forest degradation is defined as the long-term reduction of forest canopy cover or carbon stock, which results in a reduction of the benefits obtained from the forest, including timber, biodiversity and other goods and services. This reduction can result from timber exploration, fires, cyclones and other causes, as long as the canopy cover remains above 30%. Enhancement of forest carbon stocks is an activity that refers to the increase in carbon stocks on forest land that remains forest land.

For the purposes of this FREL, the **only activity included is reducing emissions from deforestation**. The main activities to reduce emissions from deforestation are sustainable agriculture, Agroforestry, improved kilns for charcoal, improved cook stoves and land use planning.

Although estimates of activity data for afforestation/reforestation are available, and activities that enhance carbon stocks are being developed in the country (e.g. MozFIP and MozBIO) **this activity is not included** in the meantime due to the lack of removal factors that would allow to estimate GHG removals.

Although degradation is thought to be an important component of GHG emissions in Mozambique's forests (CEAGRE and Winrock International 2016), the country is still developing the methodology to estimate emissions from forest degradation so this activity **is not included**. This development will take place throughout 2018 and is expected to be finalized by 2019. Nevertheless, there is no indication that measures intended to reduce deforestation would result in leakage towards degradation. As a result, excluding forest degradation in the current submission is conservative, i.e. underestimates GHG emissions which in turn underestimates emission reductions.

Regarding conservation of forest carbon stocks, the main activities are establishment of conservation areas in community areas, maintenance and protection of Reserves and Parks, but it is assumed that the source of GHG emissions are included in deforestation and forest degradation, so it is not selected as activity. Moreover, Sustainable forest management includes as main activities monitoring the management plans, law enforcement QA/QC for management plans of concessions, but in terms of GHG emissions it will be assumed as part of deforestation and forest degradation.

The selection of the activities must be based on information on drivers of deforestation, as well as based on regional and national priorities.

5.3 Carbon pools

This report includes information on aboveground biomass (AGB) and belowground biomass (BGB) before and after conversion. The information on AGB before conversion is sourced from the NFI for all forests except for mangrove, which was not covered by the NFI. For this forest type, IPCC default values for Mangrove (Tier 1) have been used instead. Although Tier 2 values exist for Mozambique based on peer reviewed studies, the use of one or other value would not have any impact as deforestation in Mangrove is so little. Information on BGB before conversion was obtained from allometric equations, where available, or root to shoot ratios (R: S). for more details see Table 7 in section 9.

The information on aboveground biomass (AGB) and belowground biomass (BGB) after conversion was based in Tier 1 following the 2006 IPCC Guidelines.

The information on dead organic matter (DOM), including litter and dead wood, obtained from the NFI is still being processed and so will not be included in this report. It is expected to be included to the modified submission so this will be subject to future revisions.

The analysis of soil samples collected during the NFI is still ongoing and is expected to be concluded during 2018. It is not expected to be finished in time for soil organic carbon (SOC) to be added to the modified submission so this will be subject to future revisions.

5.4 Gases

Carbon Dioxide (CO_2) is the only GHG included in Mozambique's FREL. Methane (CH_4) is emitted from clearance and conversion of peat land and wetlands or from forest fires. Considering that no peatlands and very few organic soils exist in Mozambique (concentrated in Mangroves) and the little deforestation in wetlands, CH_4 emissions from anaerobic decomposition is considered null.

CH_4 Emissions from forest fires, including N_2O emissions, may be significant. A significant portion of Mozambique burns annually, since it is a common practice during the clearing of agricultural fields, hunting wild game and gathering of honey (Sitoe *et al.* 2012). However, there currently is no validated information on burnt area for the country nor the emissions resulting from those fires. The inclusion of emissions from fires is something that will be studied and, if found to be significant, it will be included in subsequent FRELs.

6 REFERENCE PERIOD AND VALIDITY PERIOD

6.1 Reference period

The UNFCCC does not give any directives with regards to the reference period for the FREL. However, both The Forest Carbon Partnership Facility (FCPF) and Green Climate Fund (GCF) have specific guidelines. FCPF sets a minimum of 10 years and a maximum of 15 years, while GCF gives a better score for a reference period between 10 and 15 years but allows the reference period to be set from 5 to 20 years.

The chosen period for the definition of the FREL is from **2003 to 2013**. This was the period chosen by the National Directorate of Forests, when they initiated a project to produce LULC change maps for Gaza and Cabo Delgado Provinces. This period is also consistent with previous periods of analysis of deforestation. The previous NFI was conducted in 2007, and the period of analysis for the deforestation was from 1991 to 2002. Although activity data has been collected for all years in the period from 2001 to 2016, only activity data for the period 2003-2013 was considered for the FREL.

6.2 FREL validity period

The FREL will be valid for 10 years. However, the FREL will be updated as new information becomes available, such as activity data for forest degradation, data on other carbon pools, data on fires and others. It is currently planned to conduct a reevaluation of the 4x4 km grid at the mid-point of the FREL, corresponding to the period between 2013-2018.

7 METHODOLOGICAL CHOICES

7.1 Approach to set FREL

The FREL is based on a historical average during the defined reference period. Based on the data collected, there is no trend observed in terms of deforestation (and enhancement of carbon stocks), and it is expected that the national circumstances will not change significantly with regard to the reference period. Therefore, the historical average is deemed as a good proxy of future GHG emissions.

7.2 IPCC methods used

In accordance with the UNFCCC decisions, the FREL was developed following the rules and methods proposed by the 2006 IPCC Good Practice Guidelines for National Greenhouse Gas Inventories.

Annual GHG emissions or removals over the reference period in the region of interest (FREL) are estimated as the sum of annual change in total carbon stocks over the reference period in the Accounting Area ($\mathit{\Delta} C_{B_t}$):

$$\text{FREL} = \frac{\sum_{t=1}^{T} \mathit{\Delta} C_{B_t}}{T}$$

Where:

$\mathit{\Delta} C_{B_t}$	Annual change in total carbon stocks at year *t*; and
T	Number of years during the reference period; a dimensional

Following the 2006 IPCC Guidelines, the annual change in carbon stocks in biomass on forestland converted to other land-use category (ΔC_B) would be estimated through the following equation:

$$\Delta C_B = \Delta C_G + \Delta C_{CONVERSION} - \Delta C_L \qquad \textbf{Equation 1}$$

Where:

ΔC_B	Annual change of total carbon stocks during the reference period, in tC per year.
ΔC_G	Annual increase in carbon stocks in biomass due to growth on land converted to another land-use category, in tC per hectare and year;
$\Delta C_{CONVERSION}$	Initial change in carbon stocks in biomass on land converted to other land-use category, in tC per hectare and year;

ΔC_L	Annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category, in tC per hectare and year.

Following the recommendations set in chapter 2.2.1 of the GFOI Methods Guidance Document for applying IPCC Guidelines and guidance in the context of REDD+[6], the above equation will be simplified and it will be assumed that:

- The annual change in carbon stocks in biomass (ΔC_B) is equal to the initial change in carbon stocks ($\Delta C_{CONVERSION}$);

Considering equation 2.16 of the 2006 IPCC GL for estimating $\Delta C_{CONVERSION}$ and considering 2.8 b for the estimation of carbon stocks, the change of biomass stocks could be expressed with the following equation.

$$\Delta C_B = \sum_{j,i}\left(B_{Before,j} - B_{After,i}\right) x CF x \frac{44}{12} \times A(j,i)$$ **Equation 2**

Where:

$A(j,i)$ Area converted from forest type *j* to non-forest type *i* during the reference period, in hectare per year. In this case, five possible conversions are possible:

- **Broadleaved (Semi-) deciduous including Miombo to Non Forest;**
- **Broadleaved (Semi-) evergreen to Non-Forest;**
- **Mangrove to Non-Forest;**
- **Mecrusse to Non-Forest;**
- **Mopane to Non-Forest**

$B_{Before,j}$ Total biomass of forest type *j* before conversion, in tonne of dry matter per ha. This is equal to the sum of aboveground biomass and below ground biomass of the following five types of forest:

- **Broadleaved (Semi-) deciduous including Miombo;**
- **Broadleaved (Semi-) evergreen;**
- **Mangrove;**
- **Mecrusse;**
- **Mopane;**

$B_{After,i}$ Total biomass of non-forest type *i* after conversion, in tonnes dry matter per ha.

CF Carbon fraction of dry matter in tC per ton dry matter. The value used is **0.47**, based on the IPCC 2006 GL

$44/12$ Conversion of C to CO_2

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6 https://www.reddcompass.org/documents/184/0/MGD2.0_English/c2061b53-79c0-4606-859f-ccf6c8cc6a83

8 ACTIVITY DATA

8.1 Source

Activity data used for the construction of Mozambique's FREL were obtained from an annual historical time series analysis of land use, land-use change and forestry (LULUCF) carried out by the MRV Unit for the period of 2001 – 2016, using the Collect Earth Open tool. However, these activity data for the construction of Mozambique's FREL were adjusted to the period of 2003 – 2013 filtering out the years that are of interest.

Activity data have been generated following IPCC Approach 3 for representing the activity data as described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.13), i.e., using spatially-explicit observations of land-use categories and land-use conversions over time, derived from sampling of geographically located points. Following this approach, a systematic 4 x 4 km grid sampling at national level (the same grid used to allocate the NFI clusters from the Stratified Random Sampling design) was used to generate the national annual historical activity data for the entire area of the country. The result was forest cover data for 2016 and forest cover change data for every year from 2001 to 2016.

8.2 Sampling design

A systematic 4 x 4 km grid consisting of a total of 48 894 points was established at a national level to generate the historical activity data. Each point was visually evaluated and its information was collected and entered in a complete database on LULC changes at the national level.

Therefore, a **systematic sampling design** was established nationally which allows to estimate the variable of interest using accepted unbiased estimators. However, we must remind that the main drawback of systematic sampling is the absence of an unbiased estimator for the variance. Then the variance estimation formulae for simple random sampling are used as a conservative option. This, generally, overestimates the variance and the overestimation is much more for denser grids).

8.3 Response design

8.3.1 Spatial sampling unit

The spatial sampling unit from each point was defined as a 100m x 100m plot (1 ha), where an internal grid of 5 x 5 points (20m x 20m grid) is overlapped. Each point from the internal grid has a weight coverage of 4%.

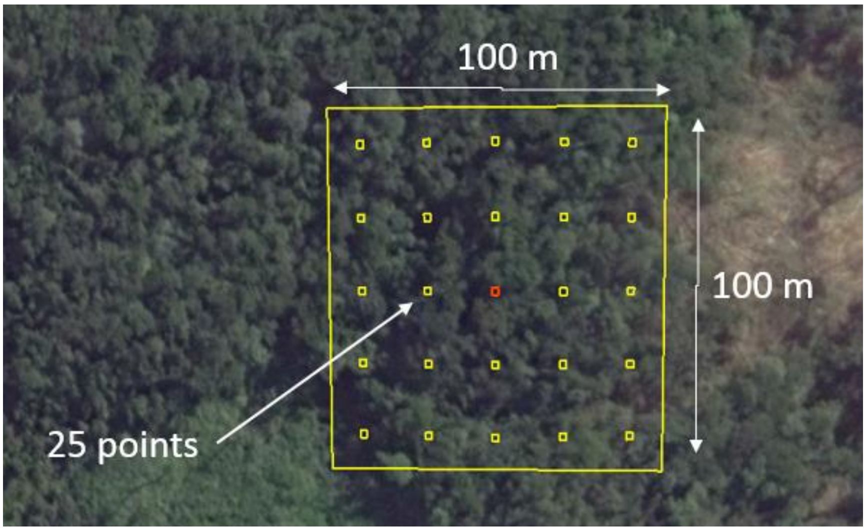

Figure 2. Image of the spatial sampling unit

8.3.2 Source of reference data

The sampling approach for national historical AD calculation based on the systematic 4 x 4 km grid sampling was conducted using Collect Earth (www.openforis.org). This tool takes enables access to high resolution images in Google Earth and Bing Maps, as well as a medium resolution image repository available through Earth Engine Explorer and Code Editor. The tool provides a form designed to collect the LULC information on the points of the grid (described in Annex 1) (Figure 3). The Earth Engine Code Editor facilitates the interpretation of the vegetation type and the determination of LULC changes, by displaying the MOD13Q1 (NDVI 16-day Global Modis 250 m) graphic from 2001-2016, the most recent Sentinel-2 image, most recent Landsat-8 pan sharpened image and Landsat-7 pan sharpened image (2000, 2004, 2008, 2012). Additionally, the Earth Engine (Explorer and Code Editor) ensures the completeness of the series through RS products from medium resolution imagery repositories from 2001 (Reflectance composites and vegetation indices, from Landsat 5-8).

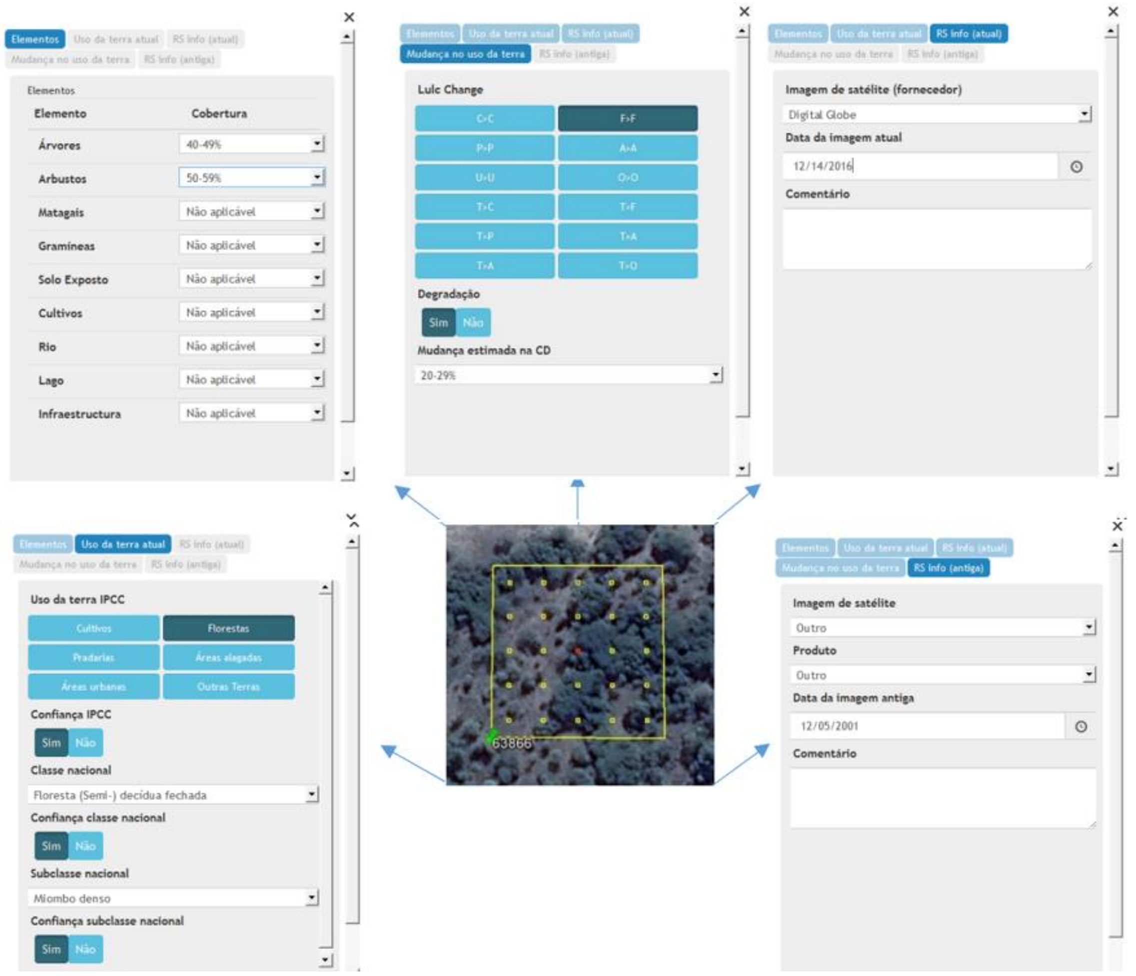

Figure 3. LULC changes detection using Collect Earth Tool. (www.openforis.org). Forms designed with Collect Tool.

8.3.3 Reference labelling protocol

The classification of each plot followed a set of hierarchical rules (Figure 5), where the proportional cover of each element was determined, based on how many of the 25 points were assigned to each element. In general, for most of the country there is at least 1 high resolution image for the period of 2001-2016. This allowed the determination of current cover, with the aid of the latest Sentinel-2 image. For some areas, images from earlier periods were available, which facilitated the determination of previous land use. In cases where high resolution images were not available and to pinpoint the year of change, annual and monthly Landsat composites were used. The historical activity data was carried out considering the land use and land cover classification system described in Table 1.

Figure 4. A temporal analysis of LULC changes of one point from national 4km x 4 km grid sampling.

A set of hierarchical rules were established and used to determine the land use category based on a certain percentage and taking into account the forest definition as well. A single land use class is easier to classify, but it becomes challenging when there is a combination of two or more land use classes within the area of interest. Thus, this is where the hierarchical rules are important to determine the land use. Any plot that has 30% of tree canopy is considered a forest, according to the national forest definition, even if it has more than 20% of settlements, agriculture or other land use, the forest has priority.

In the case the sampling unit was classified as forestland and different forest types were present in the sample, a majority rule was used in this case, i.e. the largest forest class is the winner.

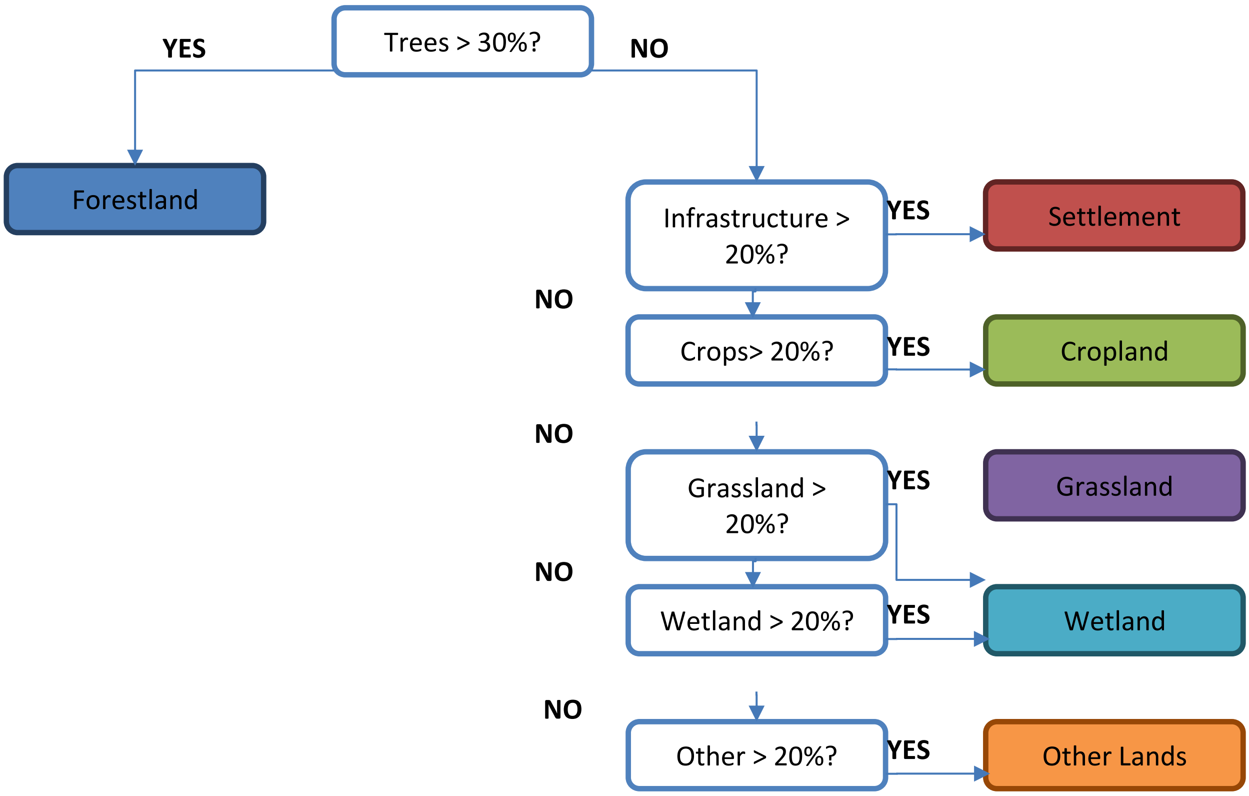

Figure 5. Decision tree for the allocation of the IPCC Land Use category based on the cover of the objects present in the sampling unit

8.4 Analysis and results

8.4.1 Analysis design

The estimation of the areas corresponding to land- use and land- use changes categories in the framework of this systematic sampling approach (based on the visual assessment of the nodes of a 4 x 4 km national grid) was based on assessments of area proportions. According to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.33), the proportion of each land- use or land- use change category is calculated by dividing the number of points located in the specific category by the total number of points, and area estimates for each land- use or land- use change category are obtained by multiplying the proportion of each category by the total area of interest.

Systematic sampling is generally more efficient than simple random sampling to estimate areas. Systematic sampling is optimal if the autocorrelation is positive, decreasing and convex but the main drawback of systematic sampling is the absence of an unbiased estimator for the variance. Then the variance estimation formulae for simple random sampling are used (2006 IPCC Guidelines for National Greenhouse Gas Inventories, warns that it is an approximate formula). This, generally, overestimates the variance (the overestimation is much more for denser grids), so we can consider the application of this formula as a conservative option (other options are variance estimators that compare each sample element with neighbors, pair differences techniques, etc.).

The standard error (ha) of an area estimate is obtained as (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 3, Section 3.33):

$$e = A \times \sqrt{\frac{p_i \times (1 - p_i)}{n - 1}}$$ **Equation 3**

Where:

A	Region of interest, ha.
p_i	Proportion of points on land use change category i, dimensionless.
n	Number of sampling units, number.

The 95% confidence interval for A_i, the estimated area of land-use category i, will be given approximately by ±2 times the standard error.

8.4.2 Results for activity data

Figure 6 shows forest losses in Mozambique for the period of 2003 - 2013. Annual areas of forest loss estimated for each type of forest are shown in Tables 2 and 3. The annual areas of forest loss estimated for each Province of Mozambique are shown in Annex 2. On average, **267,029 ha/year** were deforested between 2003 and 2013. The 95% half width confidence interval of the area of forest loss is **± 12,329 ha/year** and the relative margin of error at 95% confidence level is ± **4.6**%.

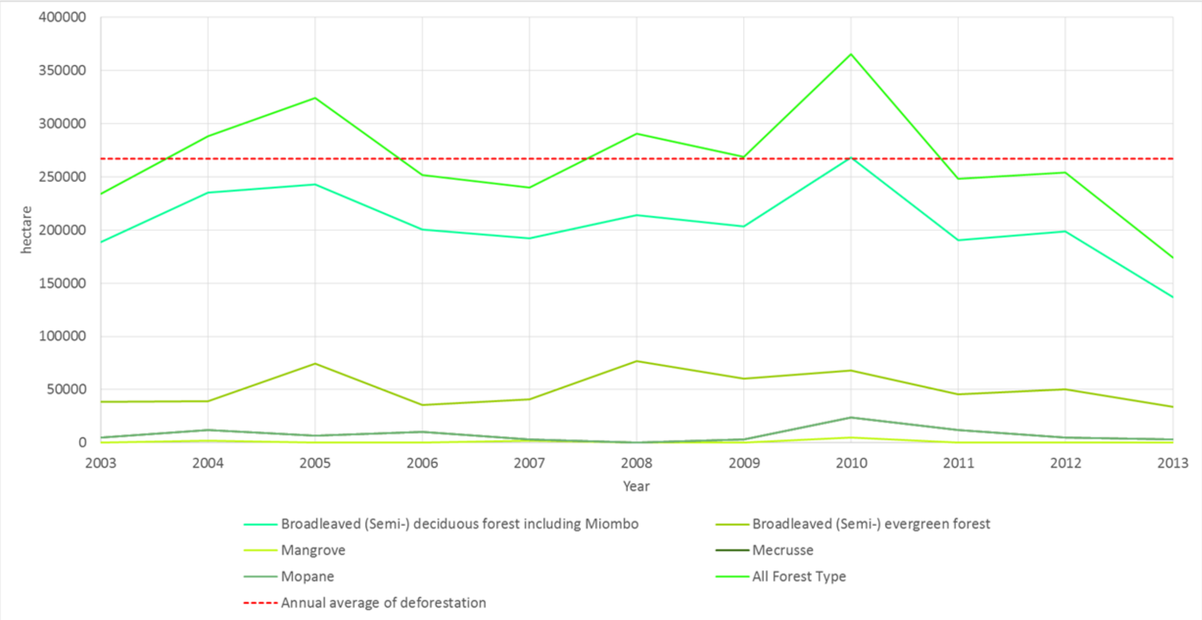

Figure 6. Deforestation in Mozambique between 2003 and 2013

Table 2. Overview of the LULUCF between 2003 and 2013 per forest stratum and forest type

Forest stratum	Deforestation (2003 - 2013)			
	ha	ha*yr^{-1}	C.I. (ha*yr^{-1})	Error (%)
Broadleaved (Semi-) deciduous forest including Miombo	**2 277 941**	**207 086**	**± 10 910**	**± 5.27**
Miombo open	1 657 554	150 687	± 9 352	± 6.21
Miombo dense	441 785	40 162	± 4 836	± 12.04
Forest with shifting cultivation	178 602	16 237	± 3 101	± 19.10
Broadleaved (Semi-) evergreen forest	**561 665**	**51 060**	**± 5 466**	**± 10.71**
Open broadleaved (Semi-) evergreen mountainous forest	121 430	11 039	± 2 545	± 23.05
Closed broadleaved (Semi-) evergreen mountainous forest	93 000	8 455	± 2 225	± 26.31
Coastal open woody vegetation	11 916	1 083	± 794	± 73.30
Coastal dense woody vegetation	16 655	1 514	± 949	± 62.68
Gallery forest	318 663	28 969	± 4 129	± 14.25
Mangrove	**8 572**	**779**	**± 671**	**± 86.12**

Forest stratum	Deforestation (2003 - 2013)			
	ha	ha*yr^{-1}	C.I. (ha*yr^{-1})	Error (%)
Mangrove open	3 432	312	± 424	± 136.06
Mangrove dense	5 140	467	± 520	± 111.24
Mopane	**80 435**	**7 312**	**± 2 057**	**± 28.13**
Mopane open	75 302	6 846	± 1 990	± 29.07
Mopane dense	5 133	467	± 520	± 111.41
Mecrusse	**8 709**	**792**	**± 671**	**± 84.76**
Mecrusse open	5 255	478	± 520	± 108.82
Mecrusse dense	3 454	314	± 424	± 135.16
All forest strata	**2 937 322**	**267 029**	**± 12 329**	**± 4.62**

C.I. – Confidence Interval

Table 3. Land Use, Land Use Change and Forestry between 2003 and 2013

LULUCF categories	Area (ha)	Standard Error (ha)	C. I. (ha)	Error (%)
Forest land remaining Forest Land*	34 292 728	183 741	± 360 133	± 1.05
Non-Forest Land converted to Forest Land**	124 393	14 479	± 28 379	± 22.81
Forest Land converted to Non-Forest Land	2 937 322	69 193	± 135 619	± 4.62
Non-Forest Land remaining Non-Forest Land	45 004 433	185 503	± 363 587	± 0.81
Total	82 358 875			

C.I. – Confidence Interval

** Includes forest plantations*

*** Includes conversion of non-forest land to forest plantations*

9 EMISSION FACTORS

9.1 Source

The National Forest Inventory (NFI) is an indispensable tool for generating statistical information about the forest resources of a country. Its data are used to support decision-making on sustainable forest management based on scientific evidence, as well as support from government, private sector, civil society and academia, for a sustainable forestry policy. Mozambique conducted a National Forest Inventory (NFI) from 2015 to 2017. The NFI consisted of two provincial inventories, conducted in the Provinces of Gaza (2015) and Cabo Delgado (2016), as well as a national scale inventory on the remaining eight Provinces of the country (2016-2017). The inventory of the eight Provinces was divided in two phases. The first phase took place in 2016 covering the Provinces of Maputo, Nampula and Inhambane. The second phase took place in 2017 covering the Provinces of Tete, Manica, Sofala, Zambézia and Niassa. There are 55 sampling units that were not measured in the Province of Zambezia and are expected to be measured in 2018.

9.2 Sampling design

The sampling design was initially conceived as a stratified sampling design. The criterion of stratification used in the sampling design was the strata of the agro-ecological zones map of Mozambique but knowing that the stratification would be replaced by a new stratification once new data on forest area would be available. The sample size was estimated based on the Coefficients of Variation (CVs) given by the third national forest inventory. The sample size was 620 units, which were increased by 10% giving a total of 681 units.

Table 4 Number of sampling units in NFI.

N	Strata	Area (ha)	N/ha	AB/ha	Vt/ha	Cv	Supplementary Clusters
1	Semi-deciduous dense forest (+Miombo dense)	7 547 903	88.2	6.4	60.9	57	140
2	Mopane	2 183 139	77.4	2.8	20.9	50	108
3	Semi-evergreen forest (+Gallery Forest)	1 662 652	91.0	5.2	47.9	50	107
4	Mecrusse	526 349	58.5	3.1	26.3	40.6	73
5	Semi-evergreen mountainous forest	884 858	58.3	4.0	39.2	38.4	64
6	Semi-deciduous open forest (+Miombo open + Tree savanna)	29 725 985	81.9	4.3	33.3	71.9	99

N	Strata	Area (ha)	N/ha	AB/ha	Vt/ha	Cv	Supplementary Clusters
7	Semi-evergreen open forest	2 421 296	73.6	3.4	24.8	68.3	90
	Total	44 952 183					681

Later on the random locations were selected out from seven strata of the agro-ecological zones map of Mozambique. The sample locations were later displaced to the closest point of the national 4x4 grid so as to allow geographical overlap between the national grid used to obtain the land cover information and the ground data.

The provincial inventories of Cabo Delgado and Gaza followed a similar approach as shown above. The combination of all sampling units give a total of 855 sampling units distributed across all Provinces as shown below (in Table 5).

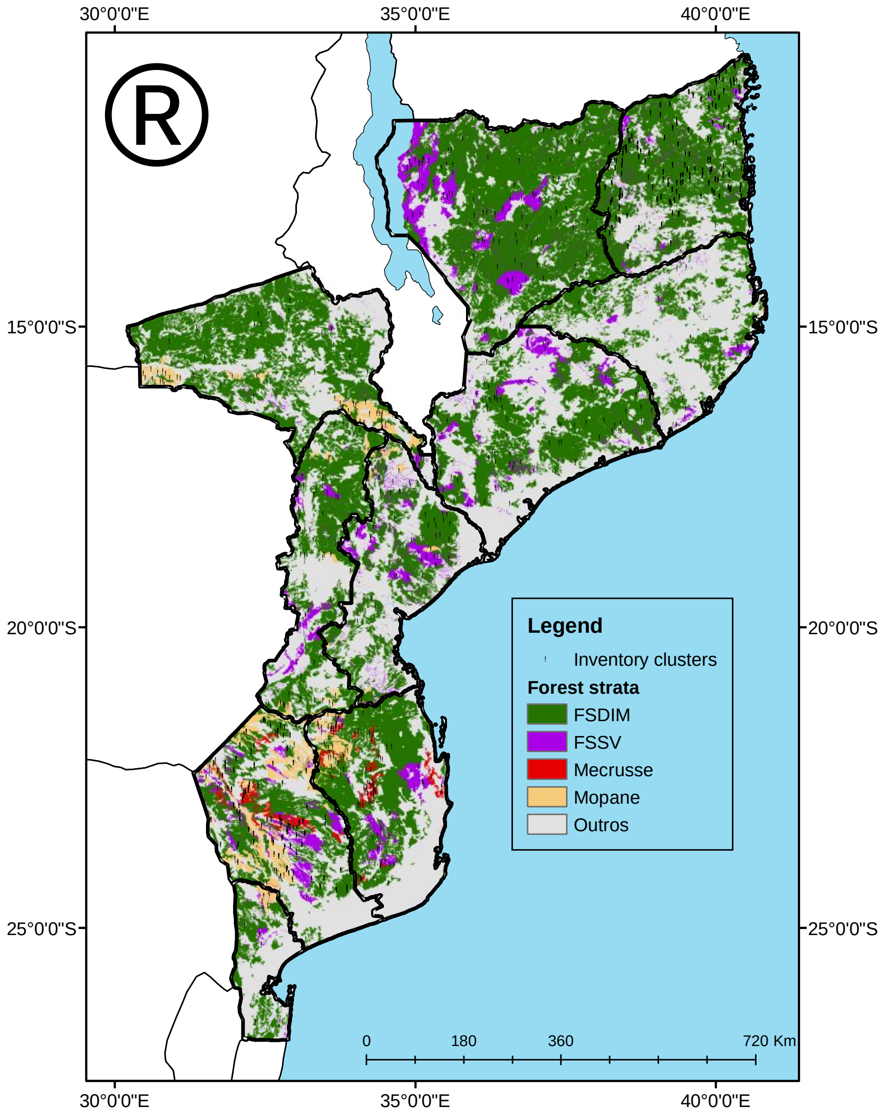

Figure 7. Forest strata and sampling locations of the NFI (FSDIM: Semi-deciduous forest including miombo. FSSV: Semi-evergreen forest.)

Table 5. Distribution of the Number of samples of NFI per Province

Province	Sample size
Maputo	12
Gaza	129
Inhambane	128
Manica	57
Sofala	66
Tete	70
Zambézia	102
Nampula	19
Cabo Delgado	161
Niassa	111
Total	**855**

9.3 Data collection

Each sampling unit was composed by a cluster of four plots located following the scheme shown in Figure 8. Each plot includes a number of quadrants. The trees with DBH greater than or equal to 5 cm were measured in the subplot (Block A) and the equal or greater than 10 cm were measured in the other blocks. The standing trees whose centers are within the plot were measured and recorded. Different protocols were followed to collect data on other carbon pools. The complete protocol of data collection is publicly available[7].

[7] http://www.redd.org.mz/uploads/SaibaMais/ConsultasPublicas/Mozambique%20National%20Forest%20Inventory%20Guidelines.pdf.

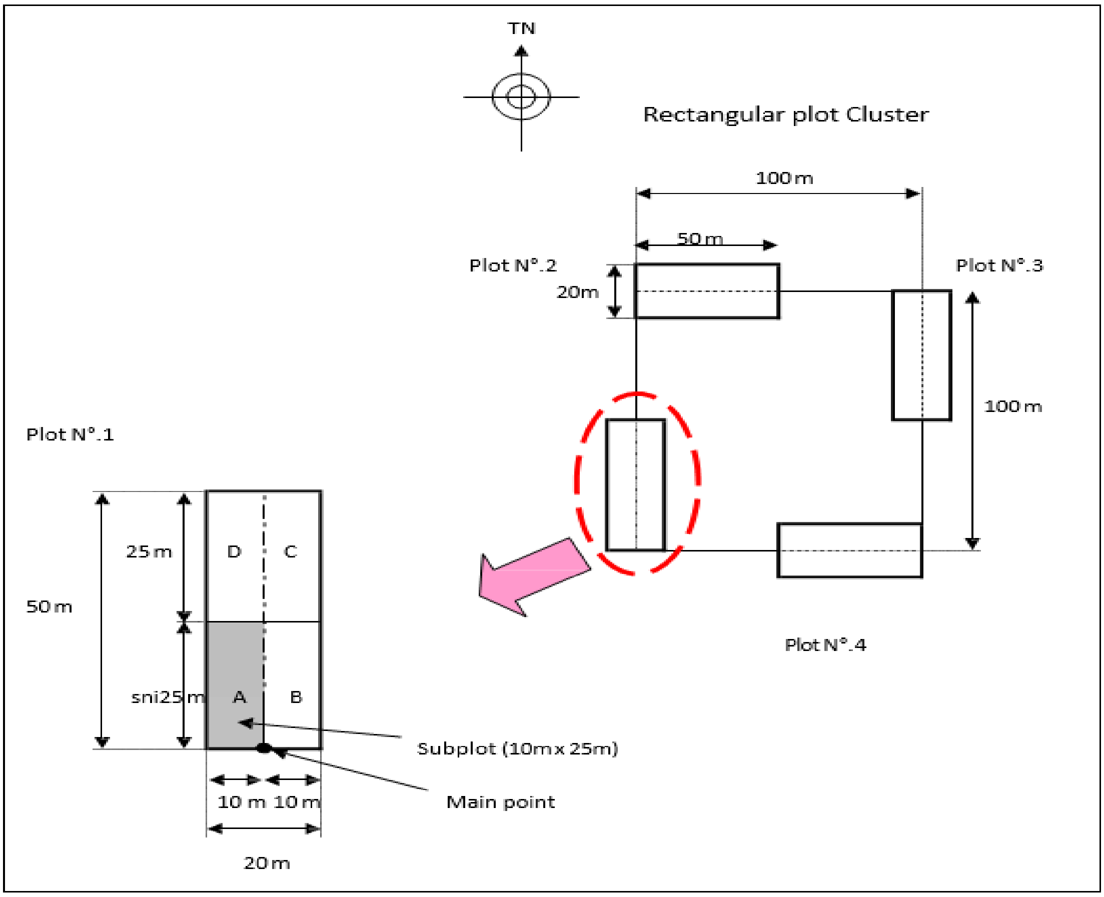

Figure 8. National Forest Inventory plot layout.

9.4 Estimation

Within each plot, trees with DBH ≥ 10 cm were measured for DBH and height. Trees with DBH between 5 and 10 cm were measured for DBH and height in the left bottom subplot of each plot. Above and belowground biomass was estimated using the equations indicated in the Table 6 (most of them country-specific). The carbon content was assumed to be 47% of dry biomass (IPCC, 2006).

Table 6. Models used to estimate biomass of each stratum and species.

Stratum/Species	AGB	BGB
Mopane	$\hat{Y} = 0.03325 \times d^{1.848} \times h^{1.241}$ (JICA, 2017)	$\hat{Y} = 0.09572 \times d^{1.7969} \times h^{0.3797}$ (JICA, 2017)
Mecrusse	$\hat{Y} = 1.1544 + 0.0398 \times d^2h$ (Magalhães, 2015a)	$\hat{Y} = 0.0185 \times d^{2.1990} \times h^{0.4699}$ (Magalhães, 2015b)
Broadleaved (Semi-) deciduous forest including Miombo	$\hat{Y} = 0.0763 \times d^{2.2046} \times h^{0.4918}$ (Mugasha *et al*., 2013)	$\hat{Y} = 0.1766 \times d^{1.7844} \times h^{0.3434}$ (Mugasha *et al*., 2013)
Broadleaved (Semi-) evergreen forest incluing Gallery	$\hat{Y} = \exp(-2.289 + 2.649\ln(d) -0.021(\ln(d))^2)$ (IPCC 2003)	R/S = 0.28 (Mokany *et al*., 2006)
M. stuhlmannii	$\hat{Y} = 5.7332 \times d^{1.4567}$ (Mate *et al*., 2014)	$\hat{Y} = 0.1766 \times d^{1.7844} \times h^{0.3434}$ (Mugasha *et al*., 2013)
Pterocarpus angolensis	$\hat{Y} = 0.2201 \times d^{2.1574}$ (Mate *et al*., 2014)	$\hat{Y} = 0.1766 \times d^{1.7844} \times h^{0.3434}$ (Mugasha *et al*. 2013)
Afzelia quanzensis	$\hat{Y} = 3.1256 \times d^{1.5833}$ (Mate *et al*., 2014)	$\hat{Y} = 0.1766 \times d^{1.7844} \times h^{0.3434}$ (Mugasha *et al*., 2013)

Where:

AGB	Aboveground biomass,
BGB	Belowground biomass,
d	Diameter at breast height (DBH),
R/S	Root:shoot ratio.

Note that for Miombo and Mecrusse species occurring in Mopane stratum, models by Mugasha *et al.* (2013) and Magalhães (2015a and 2015b) were used to estimate biomass; however for other non-mopane species the model by IPCC (2003) was applied. The same principle was applied for tree species of a specific stratum occurring in another stratum (e.g. Mecrusse and Mopane species occurring in Miombo, Miombo and Mopane species occurring in Mecrusse).

9.5 Analysis and results

9.5.1 Analysis

Although the sampling design was conceived as a stratified random sampling, this was based on the stratification provided by the agro-ecological zoning which was not accurate so it was foreseen to replace the stratification by a novel one using latest available data which is more accurate. Therefore, a post-stratified design is applied for the analysis where the stratification is given by the proportions of each forest type provided by the national grid. The provinces of Gaza and Cabo Delgado were not considered as separate strata.

Moreover, although the cluster was conceived as the sampling unit, it was observed that a significant number of clusters had theirs plots lying in different strata. Therefore, the plots were considered to be independent and all the computation was carried out using the plots as sampling units instead of clusters. Table 7 shows the number of plots allocated to each stratum, along with the area of each stratum.

Table 7. Area, proportion and sample size per stratum.

Stratum	Area (ha)	Proportion of total area (ph)	Number of plots (nh)
Mopane forest	3 148 377	0.098	401
Mecrusse forest	902 568	0.028	282
Semi-deciduous forest (+ Miombo)	21 151 847	0.657	1 973
Semi-evergreen forest (+ Gallery)	6 999 749	0.217	764
Total	**32 202 544***	**1**	**3 420**

**It doesn't include mangroves, forest with shifting cultivation and forest plantations; including these forests the total forest area of the country is estimated to be approximately 34 171 686 ha.*

Therefore, the average proportion of the variable of interest in the reference period will be estimated through the stratified random estimator of the mean ($\hat{\mu}_{STR}$)

$$\hat{\mu}_{STR} = \sum_{h}^{H} W_h \hat{\mu}_h \qquad \textbf{Equation 4}$$

Where:

W_h Weight per stratum h, dimensionless.

$\hat{\mu}_h$ Sample estimates within stratum h which is equal to $\hat{\mu}_h = \frac{1}{n_h}\sum_{k=1}^{n_h} y_{hk}$ where y_{hk} is the i^{th} sample observation in the h^{th} stratum

The 95% relative margin of error would be estimated with the following equations which correspond to the variance estimator of a stratified sampling design. This formula has been used instead that of a post-stratified estimator:

$$Error_{95\%} = 2 \cdot \sqrt{V\hat{a}r(\hat{\mu}_{STR})}$$ **Equation 5**

Where:

$V\hat{a}r(\hat{\mu}_{STR})$ Variance of the stratified estimate.

$\hat{\mu}_h$ Sample estimates within stratum h which is equal to $\hat{\mu}_h = \frac{1}{n_h}\sum_{k=1}^{n_h} y_{hk}$ where y_{hk} is the i^{th} sample observation in the h^{th} stratum

The variance of the stratified estimate is estimated as follows:

$$V\hat{a}r(\hat{\mu}_{STR}) = \sum_{h}^{H} W_h^2 x \hat{\sigma}_h^2$$

Where:

W_h Weight of stratum h;

$\hat{\sigma}_h^2$ Sample variance estimates within stratum h which is equal to $\hat{\sigma}_h^2 = \frac{1}{n_h - 1}\sum_{k=1}^{n_h} \hat{\mu}_h * (1 - \hat{\mu}_h)$ where $\hat{\mu}_h$ is the sample estimates within stratum h.

Calculations may be found in the spreadsheet that is provided together with this submission.

9.5.2 Results

Results are provided in the following tables.

Table 8. Above-ground biomass (AGB), above-ground carbon (AGC) and carbon dioxide equivalent or emission factor for AGB (CO2eq (A))

Stratum	AGB [t ha $^{-1}$] (IC)	AGC [t ha $^{-1}$] (IC)	$CO_2eq_{(A)}$ [t ha $^{-1}$] (IC)
Mopane	44.51 (40.65 – 48.36)	20.92 (19.11 – 22.73)	76.71 (66.87 – 83.34)
Mecrusse	78.65 (73.18 – 84.12)	36.97 (34.39 – 39.54)	135.54 (126.11 – 144.97)
Semi-deciduous forest including Miombo	62.24 (59.51 – 64.97)	29.25 (27.97 – 30.54)	107.26 (102.56 – 111.96)
Semi-evergreen forest including gallery forest	99.89 (93.98 – 105.81)	46.95 (44.17 – 49.73)	171.26 (161.96 – 182.35)
Population	69.15 (66.91 – 71.39)	32.50 (31.45 – 33.55)	119.17 (105.31 – 123.03)

Table 9. Below ground biomass (BGB), below ground carbon (BGC) and carbon dioxide equivalent or emission factor for BGB (CO2eq (B))

Stratum	BGB [t ha $^{-1}$] (IC)	BGC [t ha $^{-1}$] (IC)	$CO_2eq_{(B)}$ [t ha $^{-1}$] (IC)
Mopane	13.89 (12.83 – 14.95)	6.53 (6.03 – 7.02)	23.93 (22.11 – 25.76)
Mecrusse	20.58 (19.21 – 21.96)	9.67 (9.03 – 10.32)	35.47 (33.11 – 37.84)
Semi-deciduous forest including Miombo	24.82 (23.88 – 25.75)	11.66 (11.23 – 12.10)	42.77 (41.16 – 44.37)
Semi-evergreen forest including gallery forest	29.19 (27.53 – 30.86)	13.72 (12.94 – 14.50)	50.31 (47.44 – 53.18)
Population	24.58 (23.86 – 25.30)	11.55 (11.21 – 11.89)	42.36 (41.12 – 43.60)

Table 10. Total tree biomass (TB = AGB + BGB), total tree carbon (TC = AGC + BGC) and carbon dioxide equivalent or emission factor for TB (CO2eq (T))

Stratum	TB [t ha^{-1}] (IC)	TC [t ha^{-1}] (IC)	$CO_2eq_{(T)}$ [t ha^{-1}] (IC)
Mopane	58.40 (53.50 – 63.29)	27.45 (25.14 – 29.75)	100.64 (99.20 – 109.08)
Mecrusse	99.23 (92.40 – 106.07)	46.64 (43.43 – 49.85)	171.01 (159.24 – 182.79)
Semi-deciduous forest including Miombo	87.05 (83.40 – 90.70)	40.92 (39.20 – 42.63)	150.02 (143.74 – 156.31)
Semi-evergreen forest including gallery forest	129.09 (121.52 – 136.65)	60.67 (57.11 – 64.23)	222.46 (209.42 – 235.50)
Population	93.73 (90.78 – 96.68)	44.05 (42.67 – 45.44)	161.53 (156.44 – 166.61)

In addition to forest strata mentioned above, this FREL includes mangrove stratum. For this stratum there isn't sufficient information available on above- and below-ground biomass, so were applied the default values of IPCC Guidelines for national greenhouse gas inventories as shown in Table 11. In the future, these values should be replaced with the country specific values.

Table 11. Above- and below-ground biomass in mangroves

Domain	Region	Above-ground biomass (tDM.ha^{-1})	Ratio of below-ground biomass to above-ground biomass		Source
			tonne root d.m. (tonne shoot d.m.)-1	tDM.ha-1	
Tropical	Tropical Dry	92	0.29	26.68	IPCC (2013)

Table 12. Standard error and sampling error of estimates

Error	Stratum	AGB/AGC/ $CO_2eq_{(A)}$	BGB/BGC /$CO_2eq_{(B)}$	TB/TC/$CO_2eq_{(T)}$
Standard Error (%)	Mopane	4.42	3.88	4.28
	Mecrusse	3.55	3.41	3.51
	Semi-deciduous forest including Miombo	2.24	1.92	2.14
	Semi-evergreen forest including gallery forest	3.02	2.91	2.99
	Population	1.66	1.50	1.61
	Mopane	8.65	7.61	8.39

Error	Stratum	AGB/AGC/ $CO_2eq_{(A)}$	BGB/BGC / $CO_2eq_{(B)}$	TB/TC/ $CO_2eq_{(T)}$
Sampling Error (%)	Mecrusse	6.96	6.68	6.88
	Semi-deciduous forest including Miombo	4.39	3.76	4.19
	Semi-evergreen forest including gallery forest	5.92	5.70	5.86
	Population	3.25	2.93	3.15

For biomass stocks present on non-forestlands after conversion from forestlands was applied the IPCC default values, as can been in the table below.

Table 13. Default biomass stocks present on forest land converted to cropland or grassland

Forestland converted to	Above-ground biomass ($tDM.ha^{-1}$)	Ratio of below-ground biomass to above-ground biomass		Source
		tonne root d.m. (tonne shoot d.m.)-1	tDM.ha-1	
Cropland (Annual)	10	-	-	IPCC (2006)
Grassland	2.3	2.8	6.44	

10 FOREST REFERENCE LEVEL

10.1 National circumstances

Mozambique recorded very high deforestation (detailed in Annex 2) between 2003 and 2013, with 0.79% of the forest area being lost annually, which corresponds to 267 029 hectares per year.

10.2 Calculation

Mozambique's FREL has been estimated as the average annual GHG emissions from deforestation of the historical reference period of 2003-2013, aggregating the class of forest in stratum. Calculation methods are provided in section 7.2 and the calculations are provided in the spreadsheet that is provided together with this submission.

10.3 Proposed FREL

According to the table below (Table 15 and Figure 9), the annual and total of the period emissions are in the order of **38,956,426 tCO_2e** and **428,520,683 tCO_2e**, respectively. In the table below, we present the FREL proposal for Mozambique for REDD+ activity (deforestation).

Table 14. Total and annual average of emissions of C02 per stratum per year (FREL)

Stratum	Total (tCO2)	tCO2e/year
Broadleaved (Semi-) deciduous including Miombo	303 295 577	27 572 325
Broadleaved (Semi-) evergreen	115 479 142	10 498 104
Mangrove	1 675 766	152 342
Mopane	6 727 125	611 557
Mecrusse	1 343 072	122 097
Total	**428 520 683**	**38 956 426**

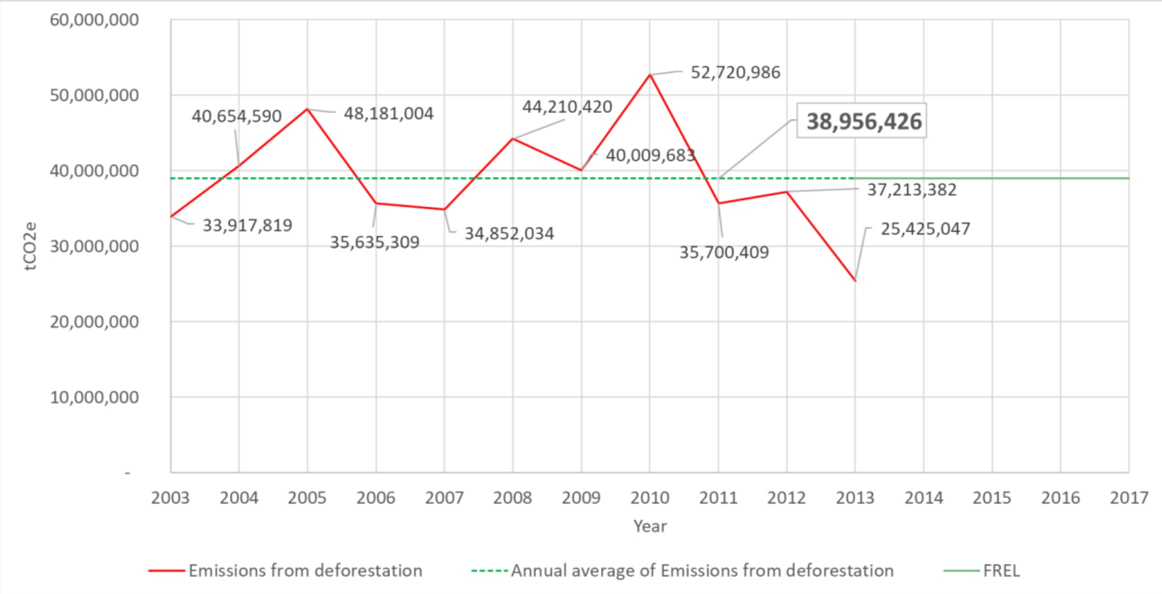

Figure 9. Graphical representation of emission from deforestation per year

10.4 Analysis of uncertainty

Sampling uncertainty was estimated for both activity data and emission factors as shown in sections 9.4 and 10.5. Uncertainties were propagated using the Tier 1 method of the 2006 IPCC GL, i.e. propagation of uncertainties. The following equations were used for addition or multiplication.

For addition or subtraction:

$$U_{total} = \frac{\sqrt{(U_1.x_1)^2 + (U_2.x_2)^2 + \cdots + (U_n.x_n)^2}}{|x_1 + x_2 + \cdots + x_n|} \qquad \textbf{Equation 6}$$

Where:

U_i	Percentage uncertainty associated with each of the parameters
X_i	The value of the parameter
U_{total}	The percentage uncertainty in the sum of parameters

For multiplication:

$$U_{total} = \sqrt{{U_1}^2 + {U_2}^2 + \cdots + {U_n}^2}$$

Where:

U_i	Percentage uncertainty associated with each of the parameters
X_i	The value of the parameter
U_{total}	The percentage uncertainty in the multiplication of parameters

Using these equations and the uncertainties reported previously, the uncertainty of the total emissions for deforestation is a 95% confidence interval of ±7% as shown in table 16.

Table 15. Uncertainty per stratum

Stratum	Uncertainty from emission
Broadleaved (Semi-) deciduous including Miombo	9%
Broadleaved (Semi-) evergreen	12%
Mangrove	86%
Mecrusse	85%
Mopane	30%
TOTAL	7%

10.5 Capacity building needs

The Government of Mozambique is as a result of the implementation of the National REDD+ strategy engaging different institutions in measuring and monitoring deforestation and forest degradation. There are some gaps identified that needs urgently to be addressed which are:

- Institutional coordination
- Development of methodologies and guidelines for monitoring GHG's
- Improvement of methodologies to estimate carbon
- Improvement of methodologies for quality control and quality assurance
- Inclusion of additional carbon pool in the estimation of carbon stocks

Institutional coordination is the main challenge for the M&MRV system for REDD+ as those with mandate in monitoring and measuring the carbon from REDD+ are not communicating effectively. It has been identified that some them are carrying the same activities that could be simplified if only one could do while others could do other activities. The main challenge is in the improvement of communication between them to reduce duplication of efforts. This intent will be achieved through memorandums of understanding, workshops for data sharing, production of papers, and harmonization of methodologies between institutions involved on the MRV system.

10.6 Areas of improvement

The following areas of improvement have been identified and will be addressed in the coming years:

- **Forest degradation:** It is expected that Mozambique will develop the methodology to calculate emissions from forest degradation throughout 2018. The country will develop an automated method to produce yearly forest biomass, biomass change and degradation maps for the periods 2007-2010 and 2015-2016, using the freely available ALOS PALSAR (1 and 2) mosaics. This will allow us to produce a benchmark for forest biomass and degradation estimates baseline.
- **Carbon pools:** SOC and DOM data collected during the NFI is still being processed. Once it is finalized, the FREL can be updated with these values.
- **Allometric equations:** We expect that the research institutions of Mozambique will continue developing and improving the allometric equations for different forest strata and species. Thus, updates to this FREL will include new equations developed, especially in the case where a generic equation was used.
- **Emission factors:** The 4th National Forest Inventory produced the emission factors used in this FRELs. It is expected that the National Permanent Sampling Plot Network will allow the updating of emission factors for different strata.
- **Emissions from fires:** Fires are very ubiquitous in Mozambique, and thus it is important to include information on the emissions resulting from fires. Although the MODIS sensor offers easy to use fire products, there is a limitation of insufficient validation data for these products. We plan on conducting a validation process to determine the suitability of these products for the purpose of calculating emissions from fires in Mozambique.

11 REFERENCES

CEAGRE, & Winrock International. 2016. Estudo sobre causas directas e indirectas do desmatamento e degradação florestal em Moçambique - Relatório final. In (p. 36 p). Maputo, Mozambique.

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories (eds. Eggleston, H.S. et al.). Institute for Global Environmental Strategies (IGES), Hayama, Japan.

IPCC. 2013. 2013 Supplement to the 2006 IPCC guideline for national greenhouse gas inventories: Wetlands. IGES. Hayama, Japan.

Magalhães T.M. 2015a. Live above- and belowground biomass of a Mozambican evergreen forest: a comparison of estimates based on regression equations and biomass expansion factors. Forest ecosystems 2:28.

Magalhães T.M. 2015b. Allometric equations for estimating belowground biomass of *Androstachys johnsonii* Prain. Carbon Balance and Management 10:16.

Mate R.S., Johansson T. 2014. Biomass Equations for Tropical Forest Tree Species in Mozambique. Forests 5: 535-556.

Mokany K., Raison J.R., Prokushkin A.S. 2006. Critical analysis of root: shoot ratios in terrestrial biomes. Global Change Biology 12: 84-96.

Sitoe, A., Salomão, A., & Wertz-Kanounnikoff, S. 2012. The context of REDD+ in Mozambique: Drivers, agents and institutions. Bogor, Indonesia: Center for International Forestry Research (CIFOR)

ANNEX

Annex 1. LULC classification system

The 2006 IPCC Guidelines considers the following land- use categories for greenhouse gas inventory reporting:

- Forest Land: This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category.
- Cropland: This category includes cropped land, including rice fields, and agroforestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.
- Grassland: This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non- grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi- pastoral systems, consistent with national definitions.
- Wetlands: This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub- division and natural rivers and lakes as unmanaged sub- divisions.
- Settlements: This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.
- Other Land: This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories

And the following land- use conversions:

FF = Forest Land Remaining Forest Land, LF = Land Converted to Forest Land

GG = Grassland Remaining Grassland, LG = Land Converted to Grassland

CC = Cropland Remaining Cropland, LC = Land Converted to Cropland

WW = Wetlands Remaining Wetlands, LW = Land Converted to Wetlands

SS = Settlements Remaining Settlements, LS = Land Converted to Settlements

OO = Other Land Remaining Other Land, LO = Land Converted to Other Land

Where detailed data about the origin of land converted to a category is available, countries can specify the land- use conversion activity we should define and measure (eg. monitoring and measuring deforestation involves considering: (i) FC: Forest Land to Cropland, (ii) FG: Forest land to Grassland, (iii) FW: Forest Land to Wetland, (iv) FS: Forest Land to Settlements and FO: Forest land to Others), but when applying these land-use category conversions, countries should classify land under end land use category to prevent double counting. If a country's national land- use classification system does not match categories (i) to (vi) as described above, the land- use classifications should be combined or disaggregated in order to represent the categories presented here.

The classification system, consistent with the national FREL and the GHG inventory, should be composed of non- overlapping LULC classes and forest strata, with an independent class for forest systems where cyclical changes in forest cover are present, to be in compliance with both methodological frameworks (FCPF CF and VCS JNR).

The LULC classes used in Mozambique (level 2) and national subclasses (level 3) and their correspondence with the IPCC classes (level 1) are shown in table below.

1A. Land use and Land Cover classification system used in the production of the maps, activity data and national forest inventory.

Level 1		Level 2		Level 3	
Class	**Description**	**Class**	**Description**	**Class**	**Description**
Forests	1 ha area with more than 30% canopy cover of trees with at least 3 m in height	Forest Plantation	Forest plantations with exotic species, including pines and eucalyptus.		
		Forest with shifting cultivation	Forest area which contains at least 10% cover of crops.		
		Broadleaved (Semi-) evergreen closed forest	(Semi-) evergreen forest with at least 70% canopy cover.	Coastal dense woody vegetation	Evergreen forests found close to the coast.
				Mangrove dense	Forest type that occurs in the coastal intertidal zone.
				Mecrusse dense	Evergreen forest type characterised by dense stands of *Androstachys johnsonii*
				Gallery forest	Forest type found along rivers or in wetlands.
				Closed broadleaved (Semi-) evergreen mountainous forest	Evergreen forests found above 300 m altitude.
		Broadleaved (Semi-) deciduous closed forest	(Semi-) deciduous forest with at least 70% canopy cover.	Miombo dense	Deciduous forest type characterised by the dominance of *Brachystegia* and *Julbernardia* species.
				Mopane dense	Deciduous forest type characterised by the dominance of *Colophospermum mopane*

Level 1		Level 2		Level 3	
Class	**Description**	**Class**	**Description**	**Class**	**Description**
		Broadleaved (Semi-) evergreen open forest	(Semi-) evergreen forest with less than 70% canopy cover.	Coastal open woody vegetation	Evergreen forests found close to the coast.
				Mangrove open	Forest type that occurs in the coastal intertidal zone.
				Mecrusse open	Evergreen forest type characterised by dense stands of *Androstachys johnsonii*
				Open broadleaved (Semi-) evergreen mountainous forest	Evergreen forests found above 300 m altitude.
		Broadleaved (Semi-) deciduous open forest	(Semi-) deciduous forest with less than 70% canopy cover.	Mopane open	Deciduous forest type characterised by the dominance of *Colophospermum mopane*
				Miombo open	Deciduous forest type characterised by the dominance of *Brachystegia* and *Julbernardia* species.
Crops	1 ha area with more than 20% cover of any type of planted crop, but less than 30% cover of forest or 20% cover of infrastructure.	Tree crops	Planted tree crops, including coconut, mango and cashew trees		
		Field crops	Field crops with less than 20% cover of tree crops.	Shrub plantation	Including tea, banana and cane.
				Rainfed crops	Including shifting agriculture.
				Irrigated crops	Including commercial agriculture

Level 1		Level 2		Level 3	
Class	**Description**	**Class**	**Description**	**Class**	**Description**
				Rice crops	
		Shifting cultivation with open to closed forested areas	Planted crop area with more than 10% forest cover.		
Grassland	1 ha area dominated by grasses and shrubs or woodlands with less than 30% tree cover. Also less than 20% cover of crops or infrastructure.	Grasslands	Area dominated by grasses, with less than 20% cover of trees or shrubs		
		Thicket	Area with more than 20% cover of shrubs or trees.	Broadleaved (Semi-) evergreen thicket	
			Area with more than 20% cover of shrubs or trees.	Broadleaved (Semi-) deciduous thicket	
		Shrubland	Area with more than 20% cover of shrubs or trees.	Broadleaved (Semi-) evergreen shrubland	
				Broadleaved (Semi-) deciduous shrubland	
Wetlands	1 ha area permanently flooded or temporarily flooded with or without shrubby or herbaceous vegetation.	Aquatic or regularly flooded shrublands	Aquatic or regularly flooded with more than 20% cover of shrubs or trees	Aquatic or regularly flooded shrublands	
		Aquatic or regularly flooded herbaceous vegetation	Aquatic or regularly flooded area dominated by grasses, with less than 20% cover of trees or shrubs	Aquatic or regularly flooded herbaceous vegetation	
		Artificial water bodies	Artificial water body with less than 20% cover of trees, shrubs or grasses.	Artificial water bodies	

Level 1		Level 2		Level 3	
Class	**Description**	**Class**	**Description**	**Class**	**Description**
		Natural water bodies	Natural water body with less than 20% cover of trees, shrubs or grasses.	Natural water bodies	
		Salt lake		Salt lake	
Settlements	1 ha area with at least 20% cover of infrastructure (houses, roads, etc), but less than 30% forest canopy cover.				
Other land	Bare area with less than 20% cover of grasses, shrubs, trees, wetland, crops or infrastructure	Bare soils	Bare area consisting of soil	Bare soils	
		Bare rocks	Bare area consisting of rocks	Bare rocks	
		Dunes	Bare area consisting of sand dunes	Dunes	

Annex 2. Activity data detailed results

2A. Historic of deforestation per Province

Province	Years											Total (ha)	ha/yr
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013		
Cabo Delgado	16 476	9 886	13 181	21 419	29 658	16 476	14 829	13 181	18 124	9 886	3 295	166 412	15 128
Gaza	7 018	12 282	3 509	15 791	3 509	1 755	1 755	10 527	7 018	3 509	3 509	70 183	6 380
Inhambane	10 475	6 983	15 712	8 729	3 492	1 746	3 492	1 746	5 237	3 492	3 492	64 593	5 872
Manica	39 183	51 108	64 737	35 776	22 147	49 404	42 590	39 183	28 961	11 925	25 554	410 568	37 324
Maputo	3 561	-	7 122	-	-	1 780	-	-	1 780	-	1 780	16 024	1 457
Maputo City	-	-	-	-	-	-	-	-	-	-	-	-	-
Nampula	63 487	115 279	75 182	53 463	75 182	80 194	60 146	76 853	86 877	76 853	50 121	813 637	73 967
Niassa	19 063	17 474	31 772	23 829	23 829	36 537	36 537	82 606	30 183	50 835	31 772	384 437	34 949
Sofala	34 173	44 425	47 843	30 756	32 465	32 465	15 378	35 882	10 252	37 591	6 835	328 064	29 824
Tete	15 024	10 016	11 686	5 008	6 678	15 024	16 694	33 388	21 702	15 024	16 694	166 938	15 176
Zambézia	25 737	20 590	53 191	56 622	42 896	54 907	77 212	72 065	37 748	44 612	30 885	516 466	46 951
Annual deforestation	234 198	288 044	323 934	251 393	239 854	290 289	268 632	365 431	247 884	253 726	173 937	2 937 322	267 029

2B. Historic deforestation per stratum

Stratum	Years											Total (ha)	ha/yr
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013		
Broadleaved (Semi-) deciduous forest including Miombo	192 108	235 354	242 940	200 388	192 401	213 758	206 592	268 354	190 519	198 476	137 050	2 277 941	207 086
Broadleaved (Semi-) evergreen forest	38 633	38 874	74 239	35 283	40 605	76 531	60 370	68 104	45 389	50 123	33 514	561 665	51 060
Mangrove	-	1 716	-	-	1 716	-	-	5 140	-	-	-	8 572	779
Mecrusse	1 755	-	-	5 246	1 709	-	-	-	-	-	-	8 709	792
Mopane	1 704	12 100	6 754	10 476	3 424	-	1 669	23 831	11 975	5 128	3 373	80 435	7 312
Annual deforestation	234 198	288 044	323 934	251 393	239 854	290 289	268 632	365 431	247 884	253 726	173 937	2 937 322	267 029

2C. Historic emissions from deforestation by province

Province	Years											Total (tCO_2e)	tCO_2e/yr
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013		
Cabo Delgado	2 325 279	1 320 002	1 754 039	2 869 544	3 956 427	2 437 437	2 222 207	2 003 399	2 688 217	1 435 737	556 929	23 569 219	2 142 656
Gaza	972 637	1 415 277	469 824	1 704 374	383 164	360 063	233 007	964 745	672 050	383 164	593 070	8 151 377	741 034
Inhambane	1 398 610	927 352	2 011 690	1 236 209	463 676	231 838	463 676	231 838	699 305	467 467	463 676	8 595 335	781 394
Manica	5 859 536	7 820 700	10 596 804	4 920 995	3 318 595	7 435 572	6 769 950	5 489 439	4 135 708	1 622 893	3 806 596	61 776 788	5 616 072
Maputo	472 876	-	953 485	-	-	369 231	-	-	240 304	-	365 365	2 401 262	218 297
Maputo City	-	-	-	-	-	-	-	-	-	-	-	-	-
Nampula	8 555 701	15 711 940	10 955 683	7 605 567	10 486 259	11 496 684	8 958 846	10 836 369	12 875 357	11 448 313	7 634 877	116 565 596	10 596 872
Niassa	2 991 710	2 554 123	4 825 283	3 624 602	3 397 978	4 907 358	5 563 081	12 594 422	4 252 182	7 458 305	4 571 283	56 740 327	5 158 212
Sofala	5 299 161	6 445 082	7 485 644	4 721 607	5 348 130	6 185 839	2 537 126	5 994 087	1 612 640	6 041 024	911 354	52 581 692	4 780 154
Tete	2 247 890	1 493 108	1 308 124	665 080	925 209	2 357 902	2 134 483	3 785 129	2 641 909	1 916 414	2 255 370	21 730 617	1 975 511
Zambézia	3 794 420	2 967 006	7 820 429	8 287 331	6 572 595	8 428 496	11 127 306	10 821 557	5 882 738	6 440 064	4 266 527	76 408 469	6 946 224