THE REPUBLIC OF MOZAMBIQUE
NATIONAL FOREST MONITORING SYSTEM
(Version 1)

May 2021

Acknowledgements

The National Directorate of Forests (DINAF) under Ministry of Land and Environment would like to acknowledge the technical support and collaboration on development of the national forest monitoring system (NFMS) for Mozambique received from the various partners.

This document called "NFMS Mozambique" was developed under the overall coordination of the DINAF, FNDS MRV unit and ANAC as the members of the NFMS task force who are mandated to design, develop and operationalize the NFMS. Together with the NFMS TF, the NFMS Working Group was established as a group of stakeholders related to the NFMS with its role to provide related information, inputs and advice to the development and operationalization of the NFMS.

The advice and comments received from the Working Group members are reflected to this document to the extent possible.

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List of Abbreviations and Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
AD	Activity Data
AMOMA	Mozambican Association of Timber Operators
ANAC	National Administration of Conservation Areas
AQUA	National Agency for Environmental Quality Control
BUR	Biennial Update Report
COP	Conference Of the Parties
DBH	Diameter at Breast Height
DINAB	National Directorate of Environment
DINAF	National Directorate of Forests
DINAT	National Directorate of Lands
DIRF	Department of Forest Resources Inventory
DUATs	Land Use and Use Right
EF	Emission Factor
ERPA	Emissions Reduction Payment Agreement
ER Program	Emission Reduction Program
ESMF	Environmental and Social Management Framework
ESMP	Environment and Social Management Plan
EVI	Enhanced Vegetation Index
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FIRMS	Fire Information for Resource Management System
FIS	Forest Information System
FLOMOZ	Abbreviation of JICA project
FNDS	National Sustainable Development Fund
FPIS	Forest Policy and Implementation Strategy
FRA	Forest Resource Assessment
FREL	Forest Reference Emission Levels
FRIP	Forest Resources Information Platform
FRL	Forest Reference Level
FTP	File Transfer Protocol
GFW	Global Forest Watch
GFOI	Global Forest Observations Initiative
GHG	Green House Gases
GIS	Geographic Information System
GLAD	Global Land Analysis and Discovery
IIAM	Mozambique Institute for Agrarian Research
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
IUCN	The International Union for Conservation of Nature

JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency
JJ-FAST	JICA-JAXA Forest Early Warning System in the Tropics
NBPS	National Biodiversity Conservation Strategy
NBR	Normalized Burn Ratio
NCs	National Communications
NDCs	Nationally Determined Contributions
NDVI	Normalized difference vegetation index
NDWI	Normalized Difference Water Index
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NFP	National Forest Policy
NGO	Non-Governmental Organization
NRAP	National REDD+ Action Program
NRS	National REDD+ Strategy
NRSAP	National REDD+ Strategy Action Plan
LULC	Land Use and Land Cover
LULUCF	Land Use, Land-Use Change and Forestry
M&MRV	Monitoring and Measurement, Reporting and Verification
MADER	Ministry of Agriculture and Rural Development
MASA	Ministry of Agriculture and Healh Insuarance
MGD	Methods and Guidance Documentation
MIREME	Ministry of Mineral Resources and Energy
MITADER	Ministry of Land, Environment and Rural development
MTA	Ministry of Land, Environment and Rural Development
MMR	Monitoring, Measurement and Reporting
MODIS	Moderate Resolution Imaging Spectroradiometer
MozBio II	Mozambique Conservation Areas for Biodiversity and Development Project II
MozFIP	Mozambique Forest Investment Project
MRV	Measurement, Reporting, Verification
MtCO2e	Million tons of CO2 equivalent
OGC	Open Geospatial Consortium, Inc.
PaMs	Policies and Measures
PES	Payments for Environmental Services
PMRV	Participatory Measurement Reporting and Verification
PSP	Permanent Sample Plot
QA/QC	Quality Assurance/ Quality Control
RBP	Result Based Payment
REDD+	Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forests carbon stocks

	in developing countries
ROAM	Restoring Opportunities Assessment Methodology
SAVI	Soil Adjusted Vegetation Index
SDI	Spatial Data Infrastructure
SDRS	Satellite-based Deforestation Reference System
SEPAL	System for Earth Observation Data Access, Processing and Analysis for Land Monitoring
SIS	Safeguards Information System
SPFFB	Provincial Service of Forests and Wildlife
tCO2e	Tons of CO2 equivalent
TF	Task Force
TOR	Terms of Reference
UEM	Eduardo Mondlane University
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VIIRS	Visible Infrared Imaging Radiometer Suite
WB	World Bank
WG	Working Group
WMS	Web Map Service
WWF	World Wide Fund for Nature
ZILMP	Zambezia Integrated Landscape Management Program

Chapter 1 Background and Purpose

1.1 Background

The Government of Mozambique is proactively advancing activities toward implementation of REDD+, including the National REDD+ Strategy and National REDD+ Action Plan were both approved in 2016. In October 2018, modified version of the Forest Reference Emission Levels (FREL) was submitted to the UNFCCC as a baseline for the future measurement REDD+ performance and results-based payment. In January 2019, the Government of Mozambique and the Carbon Fund under the Forest Carbon Partnership Facility signed the Emissions Reduction Payment Agreement (ERPA) for Mozambique (ZILMP). The Forest Agenda 2035 and National Forestry Program (to be finalized in 2019) define the strategic pathways of the forestry sector towards 2035. All of these important milestones indicates the emerging roles of NFMS for sustainable management of forest and REDD+ results-based payment.

While there are several conditions, requirements and necessary preparation to implement REDD+ under UNFCCC, the development of a National Forest Monitoring System (NFMS) is one of the elements to be developed by developing country Parties implementing REDD+ activities (according to paragraph 71 of decision 1/CP.16). In addition, having the NFMS in place is one of the requirements in order to be eligible for results-based payments in accordance with decision 9/CP.19.

However, the definition and scope of NFMS can vary across countries, and to encourage to be developed step-wise. In fact: FAO suggests multi-purpose approach for NFMS[1]; GFOI defines NFMS as "the arrangements in a country to monitor forests" which meet MRV requirement and other objectives[2]; and many of the countries (e.g. Brazil, Cambodia, Ecuador, Zambia) are in process of/aiming to develop NFMS not exclusively for REDD+.

The Government of Mozambique is committed to build national forest monitoring system (NFMS) which enables long-term forest monitoring in order to enhance forest management in transparent, accurate, consistent and complete manner. Also NFMS is expected to contribute to the forest/REDD+ policy (e.g. NFP (National Forest Policy), NRS (National REDD+ Strategy)).

There are already several components in place, and gradually to be developed step-wise.

1.2 Purpose of this document

The realm of forest monitoring and the actors are diverse. The monitoring purposes can range widely from global level (e.g. climate change) to local level (smallholder timber production). It requires vertical coordination among national level to local level, and horizontal coordination among different entities.

In the above context, this document called as 'NFMS Mozambique (Document)' is developed as a shared vision for developing the NFMS and to enhance coordinated

[1] FAO (2018) Strengthening National Forest Monitoring Systems for REDD+

[2] GFOI (2016) Methods and Guidance from the Global Forest Observations Initiative, Edition 2.0.

actions among the stakeholders. The document is made through a consultative process and provide clear orientation for developing further and operationalizing NFMS for Mozambique which enables internal and international purpose.

This document mainly shows conceptual design of NFMS including the composition and phased approach, methodology of NFMS components such as Activity Data (AD), Emission Factor (EF), MRV function, forest cover change monitoring, operation of the IT system including MRV platform and Forest Resources Information Platform (FRIP) as data management system, institutional arrangement and calendar of NFMS, for implementing and managing NFMS in Mozambique.

This NFMS Document is a roadmap for NFMS development with its nature as a 'living document' which will be updated as necessary by reflecting the changes over time.

1.3 Process undertaken

The NFMS taskforce was established as a core team for designing, developing and operationalizing the NFMS. Technical officers of DINAF and FNDS (MRV unit) were appointed as its members. As its short-term task, the NFMS taskforce agreed to develop this NFMS document.

Together with the NFMS taskforce, the NFMS Working Group (WG) was established as a group of stakeholders related to the NFMS with its role to provide related information, inputs and advice to the development and operationalization of the NFMS. The initial members included DINAF, DINAB, DINAT, FNDS, UEM, IIAM, FAO FIS Project, WB, IUCN and AMOMA, however the WG is, in its nature, an open forum which the members can change flexibly depending on the needs and interests.

See Annex for the TOR.

The NFMS document was developed through a consultative process to the extent practical. A series of technical and consultative meetings were held as shown in below.

Table 1 : Technical and consultative meetings

Date	Meeting	Outcome
8 August, 2019	DINAF Technical Committee meeting	Overall vision for the development of NFMS, coordination mechanism and steps for the development of the NFMS document were agreed.
8 August, 2019	1st NFMS taskforce meeting	Overall outline and background of the NFMS document was agreed (Chp.1); objectives (Chp.2), communication processes and actions (Chp.3), and main features (Chp.5) of the NFMS were discussed.
15 November, 2019	2nd NFMS taskforce meeting	Draft of Chp.1 to 5 were presented, commented and generally agreed; technical processes (Chp.6), future improvements (Chp.7) and institutional arrangement (Chp.8) were discussed.
18 November, 2019	1st NFMS WG meeting	Purpose of the WG, overall vision for the development of NFMS were agreed; purpose and schedule for the development of NFMS document were explained;, activities by other stakeholders were shared; priority forest monitoring items were discussed.
28 November,	DINAF Technical	Interim version of NFMS document was explained in the DINAF Technical Committee meeting. Confirmed the contents and

2019	Committee meeting	progress of NFMS document by chair and participants.
24 August, 2020	3rd NFMS taskforce meeting	Explained and discusses about - Selection of PaMs (Policy and Measures) for NFMS - Integration of NFMS with FIS (Forest Information System) and SIS (Safeguard Information System) - Current plan of SDRS(Satellite-based Deforestation Reference System)
20 October 2020	SDRS user meeting	Explained and discusses about - Current plan of SDRS(Satellite-based Deforestation Reference System) - How to utilize the SDRS
5th April, 2021	4th NFMS taskforce meeting	Review the 'NFMS document version 1' from Chap 1 to chap 9 Explained and discusses about - Chap 3 Communication processes and action calendar - Chap 6 Technical process of current forest monitoring - Chap 8 Institutional arrangement Way forward to NFMS ver1 completion
21 June, 2021	2nd NFMS WG meeting	- Share the progress of the NFMS document version 1 - Discuss on the contents of NFMS document version 1 and approval by WG. - Share/Discuss the ideas of future plan

Chapter 2 Objectives of the NFMS

2.1 Objectives of the NFMS

Mozambique defines its NFMS as a system which enables accountable reporting of REDD+ results; monitoring the implementation and effectiveness of Policies and Measures (PaMs) for sustainable forest management which include national and international purposes and beyond REDD+; and builds on robust IT system to support data management and transparency.

As its principles:

- The NFMS shall be designed and operationalized under the full ownership of MTA, and in collaboration with related stakeholders;
- The NFMS should be target-driven, oriented towards specified sub-national, national and international objectives;
- The NFMS shall build on existing system as far as practical;
- The NFMS shall be developed through step-wise improvement, take into consideration the national circumstances, reflect the phased approach for the implementation of REDD+ activities, and sustainable in the long-run. The development shall be realistically feasible within the available time, financial and human resources; and
- The NFMS shall meet the international requirement under REDD+, and as appropriate, apply international and national good practices.

2.2 International purpose

NFMS is expected to form part of REDD+ that lead the result based payment (RBP) based on the decisions taken at the conference of the parties (COP). The principal COP decisions that have defined the requirements of an NFMS developed to implement REDD+ activities include:

- Decision 4 of COP 15 in 2009 in Copenhagen, Denmark
- Decision 1 of COP 16 in 2010 in Cancun, Mexico
- Decision 11 of COP 19 in 2013 in Warsaw, Poland

Mozambique intent to take a step-wise approach to its NFMS development as indicated by following Decision12/CP.17, Paragraph 10[3]. As such, the current NFMS reflects the latest available information. Its scope and methodologies may be modified if better data becomes available.

The corresponding payments will be strictly performance-based and released only when credible evidence exists that the agreed and announced goals have been achieved. This evidence is largely generated by NFMS.

Additionally, NFMS is expected to contribute for reporting, which is described in chapter 3.

2.3 Internal purpose

As an initial step, baseline data to enable the measurement of progress towards sustainable forest management shall be provided by the NFMS.

Mozambique has been promoting the implementation of sustainable management of all types of forests through implementation of various policies and actions, such as the Forest Agenda 2035 and National Forest Program (NFP) being developed, National REDD+ Strategy 2016-2030 and Action Plan for National REDD+ Strategy. Through NFMS, the effectiveness of such activities will be monitored with reliable data and information. A comprehensive, reliable and transparent database system is essential for enhancing decision-making supported by scientific data.

Also, interested general public and stakeholders including forest owners, forestry-based industries and communities, NGOs and academics, shall be able to access the information on the state of forests and its socio-environmental services.

The result of monitoring will be used for reporting to the agenda as listed out in chapter 3.1.

[3] Detail is shown in the following booklet(Key decisions relevant for reducing emissions from deforestation and forest degradation in developing countries (REDD+))
https://unfccc.int/files/land_use_and_climate_change/redd/application/pdf/compilation_redd_decision_booklet_v1.2.pdf

Chapter 3 Communication processes and action calendar

3.1 Reporting requirements and the role of NFMS

The NFMS of Mozambique aims to strengthen its national forest monitoring capacities in order to facilitate the implementation of sub-national, national and international agendas related to forestry and climate change. For these purposes, the NFMS shall help to understand forest resources and their changes, and facilitate accountable reporting and decision-making with increased transparency and long-term reliability,

3.1.1 International reporting

- **Nationally Determined Contribution**

The Paris Agreement (Article 4, paragraph 2) requires each Party country to prepare, communicate and maintain successive nationally determined contributions (NDCs). Mozambique submitted its NDC containing the post-2020 climate actions in October 2015[4] with a preliminary target of total reduction of about 76.5 MtCO2eq in the period from 2020 to 2030, with 23.0 MtCO2e by 2024 and 53.4 MtCO2e from 2025 to 2030 through actions in energy, LULUCF (including REDD+) and waste.

The next round of NDCs (new or updated) shall be submitted by 2020 and every five years thereafter (e.g. by 2020, 2025, 2030).

- **UNFCCC National Communications (NCs) and Biennial Update Reports (BURs)**

The UNFCCC requires non-Annex I Parties (including Mozambique) to submit their NCs every four years, and consistent with their capabilities and the level of support provided for reporting, should submit their first BUR by December 2014, and every two years thereafter. The least developed country Parties (including Mozambique) and small island developing States may submit BURs at their own discretion.

Greenhouse gas inventory (GHG-I) constitutes a major part of the above reports. Mozambique prepared its 1st National GHG-I in 1998 using data from 1990, and the 2nd National GHG-I in 2000 using data from 1994. Both of them used the methodologies of IPCC Guideline 1996. The results are summarized into the 1st National Communication submitted in 2003, and have not been updated since then. Under the lead of DINAB/MTA, the 1st Biennial Update Report (BUR) is being compiled and expected to be submitted to the UNFCCC within 2021.

It is important to note that FREL/FRL for REDD+ shall be in consistency with anthropogenic forest related GHG emissions and removals as contained in each country's greenhouse gas inventories (as assessed in the UNFCCC Technical Assessment of the Mozambique FREL).

- **UNFCCC REDD+**

An important role of NFMS is to facilitate transparency of countries reporting results of REDD+ implementation to the UNFCCC.

Under the UNFCCC REDD+, the developing country Parties are requested to establish,

[4]https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Mozambique/1/MOZ_INDC_Final_Version.pdf

according to national circumstances and capabilities, robust and transparent NFMS, and, if appropriate, sub-national systems as part of a NFMS that:

i. Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

ii. Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

iii. Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties

The NFMS typically supports this through generation of data for developing the **FREL/FRL** and quantified emission reductions that are subsequently reported in a Technical Annex to a country's **Biennial Update Report (BUR)**. It is equally important to remind that a systematically organized NFMS facilitates not only the measurement (M), but also efficient reporting (R) and verification (V) processes.

Mozambique submitted its initial national FREL in January 2018 and the modified version in October 2018 with the estimated level of emissions of 38,956,426 tCO2e/year over 2003-2013 period. The UNFCCC completed the Technical Assessment of FREL in November 2018 certifying that the data and information used by Mozambique in its FREL was largely transparent, complete and in accordance with the guidelines contained in the annex to decision 12/CP.17. At the same time, the report identifies areas for future technical improvements[5].

NFMS and benefit sharing

Mozambique does not yet have an authorized national benefit sharing system. For ZILMP, a benefit sharing plan is developed to distribute the monetary benefits from the payments made against the emissions reduction reported. NFMS will play an important role on deciding the recipient and the amount to be received through allocation methods pre-designed for the ZILMP or to be designed for other future results-based payment program(s).

NFMS and monitoring of safeguards

Mozambique is in the process of developing its national Safeguards Information System (SIS). Whether the NFMS may include the SIS and other functions in its design is still under discussion. Options will be reviewed as to how the SIS will be integrated into, or linked to the NFMS. Certain safeguards and local-level monitoring are outside the NFMS, but, will be rolled out in coordination with the monitoring under the NFMS to reduce costs for transactions. The ZILMP and its safeguard instruments (e.g. ESMF, ESMP) are the testing case to apply the safeguards monitoring and extend to the entire country step-wise.

NFMS and monitoring of non-carbon benefits

It is widely agreed that REDD+ should enhance generation of non-carbon benefits. The

[5] The country submission and Technical Assessment report are uploaded in https://redd.unfccc.int/submissions.html?country=moz

NFMS can also become a tool to monitor and evaluate the non-carbon benefits under its component, such as the land-use arrangements, biodiversity, and so forth.

- **Forest Resource Assessment (FRA) Programme**[6]

The FRA is a global initiative under FAO with an aim to provide consistent approach to describing the world's forests and how they are changing. The reporting framework adopts seven thematic elements which are acknowledged by the UN Forum on Forests[7]:

a. Extent of forest resources

b. Forest biological diversity

c. Forest health and vitality

d. Productive functions of forest resources

e. Protective functions of forest resources

f. Socio-economic functions of forests

g. Legal, policy and institutional framework.

FRA is now produced every five years with the forest resource data collected through a global network of officially nominated National Correspondents and other contributors. The reporting content has been streamlined, and a new online platform has been developed to make reporting both easier and more transparent.

Mozambique submitted its country data in 2019 and the FRA2020 Country Report was published in 2020[8]. The NFMS is expected to help reducing the cost for collecting information and reporting parameters, and also enhance consistency in reporting to the FRA.

3.1.2 National reporting

- **Forest Agenda 2035 and National Forest Program**

As a strategic document of the forestry sector for the next 16 years, the Government of Mozambique is developing the Forest Agenda 2035 and National Forest Program (NFP). This document provides background analysis of the state of forests in Mozambique and the actions to be taken including the responsible entity and indicative cost.

The objective of the NFP is to "**Develop sustainable value chains, capabilities and resilience to climate change and natural disasters contributing to the achievement of the Sustainable Development Goals.**" (p.55). Three areas of strategic objectives are agreed on for its implementation with respective sub-objectives (p.55-58), and need of an integrated national forest monitoring system is specified as one of the sub-objectives under OBJECTIVE 3 as a mean to enhance forest governance[9]:

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[6] http://www.fao.org/forest-resources-assessment/en/

[7] FAO (2017) Voluntary Guidelines on National Forest Monitoring, p.5.

[8] http://www.fao.org/3/cb0034en/cb0034en.pdf

[9] "Improve forest monitoring for informed decision-making: This approach involves the need for monitoring of forests to respond to the technical scientific dimension to produce relevant data, high quality and credible and the political dimension of data for decision making and evaluation performance,

1. OBECTIVE 1 - Strengthen the socio-economic development and food security with a focus on community involvement;
2. OBJECTIVE 2 - Enhancing resilience to climate change and natural disasters;
3. OBJECTIVE 3 - To build capacity and integrate the principles of good governance in forest development;

The NFP also expects community-based organizations to be involved further in forest monitoring and also emphasizes the need of strengthened forest inspection (e.g. technology and equipment, stakeholder participation, illegal logging, tax, vertical collaboration). The NFMS shall contribute to the implementation of the NFP by providing forest monitoring information for supporting evidence and science base decision-making

- **National REDD+ Strategy 2016-2030 (2016) and Action Plan for National REDD+ Strategy (2016)**

Mozambique approved its NRS and NRAP both in November 2016. The NRS identifies six (6) Strategic Objectives and each Strategic Objective identifies a list of Strategic Actions to implement. The NFMS relates to various actions such as land-use zoning (under Strategic Objective 1), tree plantation management and restoration/rehabilitation of degraded forest lands (under Strategic Objective 2), sustainable use of biomass energy (under Strategic Objective 3), conservation area management (under Strategic Objective 4), sustainable forest management practices (under Strategic Objective 5), and development of sustainable tree plantation supply chain (under Strategic Objective 6).

It should be noted that the NRAP defines "M&MRV and SIS" as one set of action component (Strategic Objective 1-7). In fact, Mozambique is in the process of designing its national SIS (Safeguards Information System). The NFMS can include or inter-link with SIS particularly on monitoring forest-related parameters, therefore, coordinated designing of the two systems is important.

3.1.3 Sub-national reporting

- Emission Reduction Program for the FCPF Carbon Fund (ZILMP)

The Government of Mozambique and the World Bank as the trustee of the FCPF Carbon Fund entered into the Emission Reduction Purchase Agreement (ERPA) for the Emission Reduction Program (ER Program) titled *Zambezia Integrated Landscape Management Program (ZILMP)* in February 2019[10]. The ambition of the ER Program is to reduce emissions due to deforestation in the accounting area by 30% below the reference level from 2018-2019 and by 40% from 2020 to 2024 in 9 districts of Zambezia province. The

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achievement of goals and impacts of actions taken. Aspects such as the development of a national integrated forest monitoring system (forests/climate/conservation) for monitoring national results and international treaties to reduce additional efforts and share resources are considered. Strengthening supervisory capacities and encouraging the involvement of local communities in forest monitoring and supervision at the local level are also considered."

[10] https://www.forestcarbonpartnership.org/country/mozambique

https://www.forestcarbonpartnership.org/system/files/documents/FMT%20Assessment%20Note%20on%20revised%20ERPD%20MOZA_23April_clean.pdf

ERPA agrees the World Bank to purchase 10,000,000 Emission Reductions (ERs) with the price of USD 5/unit as set out in the schedule below. The payments will be made through two different means: verified ERs through MRV (MMR in Carbon fund terms), and interim advance payments for ERs monitored and reported through Interim Progress Reports in accordance with the schedule agreed in the ERPA as below[11]. It should be noted that payment schedule can change in the future in accordance with the negotiation between the Government of Mozambique and the World Bank.

Table 2 : ER reporting schedule

Reporting item	Reporting period	Reporting deadline
2018 Monitoring Report	January 1, 2018 – December 31, 2018	Submitted in August 2020 Under validation
2019 Interim Report	January 1 – December 31, 2019	To be submitted by August 31, 2021.
2020 Monitoring Report	January 1, 2019 – December 31, 2020	To be submitted by August 31, 2021.
2021 Interim Report	January 1 – December 31, 2021	To be set in due course.
2022 Monitoring Report	January 1, 2021 – December 31, 2022	Ditto
2023 Interim Report	January 1 – December 31, 2023	Ditto
2024 Monitoring Report	January 1, 2023 – December 31, 2024	Ditto

For the generation of Activity Data, forest cover change maps will be used for stratification and reference sampling units will be used for estimating activity data and reporting associated confidence intervals[12]. Mozambique has updated the Emission factors (EFs) for the ZILMP by using the data for Zambézia obtained from the NFI + Zambézia inventory in 2018. The monetary results purchased through the ERPA will be shared primarily on performance-based which will be calculated using forest monitoring data and the pre-agreed formula (i.e. mitigation of deforestation) among the ZILMP stakeholders following the benefit sharing plan.

The ERPA (Section 7.01) requires the ZILMP to also provide information on emissions from deforestation in Zambezia districts outside of the ZILMP Accounting Area based on the NFMS, and take reasonable countermeasures in case such emissions have occurred as a consequence of the ZILMP Program activities (management of displacements).

The implementation of the ZILMP, including forest monitoring, is technically and financially supported by MozFIP and collaborates with the other initiatives (e.g. MozBio II, FAO PES project). The ZILMP recognizes the areas for future improvement, such as monitoring of forest degradation, measurement of additional carbon pools, and

[11] https://forestcarbonpartnership.org/country/mozambique

[12] Assessment Note of Mozambique Revised Emission Reductions Program Document for the Emission Reductions Program, Prepared by the Facility Management Team (FMT) of the Forest Carbon Partnership Facility (FCPF), April 17, 2018, p.2.

establishment of national net of permanent NFI plots, among others.

3.2 Action calendar for the NFMS

3.2.1 NFMS Reporting Calendar

The 'NFMS Reporting Calendar' below summarizes the reporting actions which the Mozambique forestry sector shall undertake: the NFMS will play an essential role to fulfill the requirements.

Table 3 : NFMS Reporting Calendar

Year	International					National		Sub-national	
	NDC	FREL/FRL	NC/BUR	REDD+ Technical Annex	FRA	NFP(2019-35)	NRS&AP(2016-30)	ZILMP	Provincial forest management plans
Status	INDC submitted in 2015	Submitted in 2018 (2003-13)	1st NC submitted in 2006	No plan so far	FRA2020 published in 2020.	Formulation in progress.	Approved in 2016	ERPA singed 2019, ammended in 2020	Pilot formulation for Niassa province.
2020						Documentation in progress	Annual deforestation, etc	ER Report 1 submitted.	
2021	NDC update		1st BUR* 2nd NC**			M&E. Update as necessary.	ditto	*Refer to Table 2*	
2022		End of 10 years validity period					ditto	*ditto*	aaa province, bbb province...
2023		Update?					ditto	*ditto*	ccc province, ddd province…
2024			2nd BUR?		tbc		ditto	*ditto*	
2025	new submission or updating						ditto	*ditto*	
2026			3rd NC?				ditto		
2027							ditto		
2028			3rd BUR?				ditto		
2029					tbc		ditto		
2030	new submission or updating		4th NC?				ditto		

*1st BUR reports the GHG inventory 2000-2016
**2nd NC reports the recalculated GHG inventory 1995 - 2004

3.2.2 NFMS Data Requirement Table

The 'NFMS Data Requirement Table' below summarizes the required data and their timing for producing greenhouse gas inventory to estimate emission and removals in line with the reporting requirement scheduled in the 'NFMS Reporting Calendar'.

Table 4 : NFMS Data Requirement Table

Year	LULC data					Biomass data		PMRV
	Wall-to-wall	Sampling		Annual deforestation		NFI	PSP	
Scale	National	National	ZILMP	National	ZILMP	National	National	Under piloting by FNDS
Latest data	2016	2016	2018	2018	2018	Completed in 2018	IIAM, DINAF, FNDS, UEM	
2020			Refer to Table 2	x	Refer to Table 2		to be developed step-wise	
2021	to be further discussed	to be further discussed	ditto	x	ditto		↓	
2022	↓	↓	ditto	x	ditto		↓	
2023	↓	↓	ditto	x	ditto		↓	
2024	↓	↓	ditto	↓	ditto		↓	
2025	↓	↓	ditto	↓	ditto			
2026				↓				
2027				↓				
2028						x		
2029								
2030	?							

Chapter 4 Forest in Mozambique

4.1 State of forests in Mozambique

4.1.1 Forest and ecosystem

Mozambique is a country with a land area of 786,380 km^2 and a population of 28.8 million inhabitants, with 40% of the land territory covered by natural forests. Forests in Mozambique provide ecosystem services of both global and local value. These include climate change mitigation through carbon sequestration and storage; climate change resilience against storm, flooding, coastal erosion/intrusion and drought; protection of nearly 104 watersheds across the country; provision of basic livelihood needs such as sources for food, energy, construction materials and diverse income; and habitat for wildlife including globally important species.

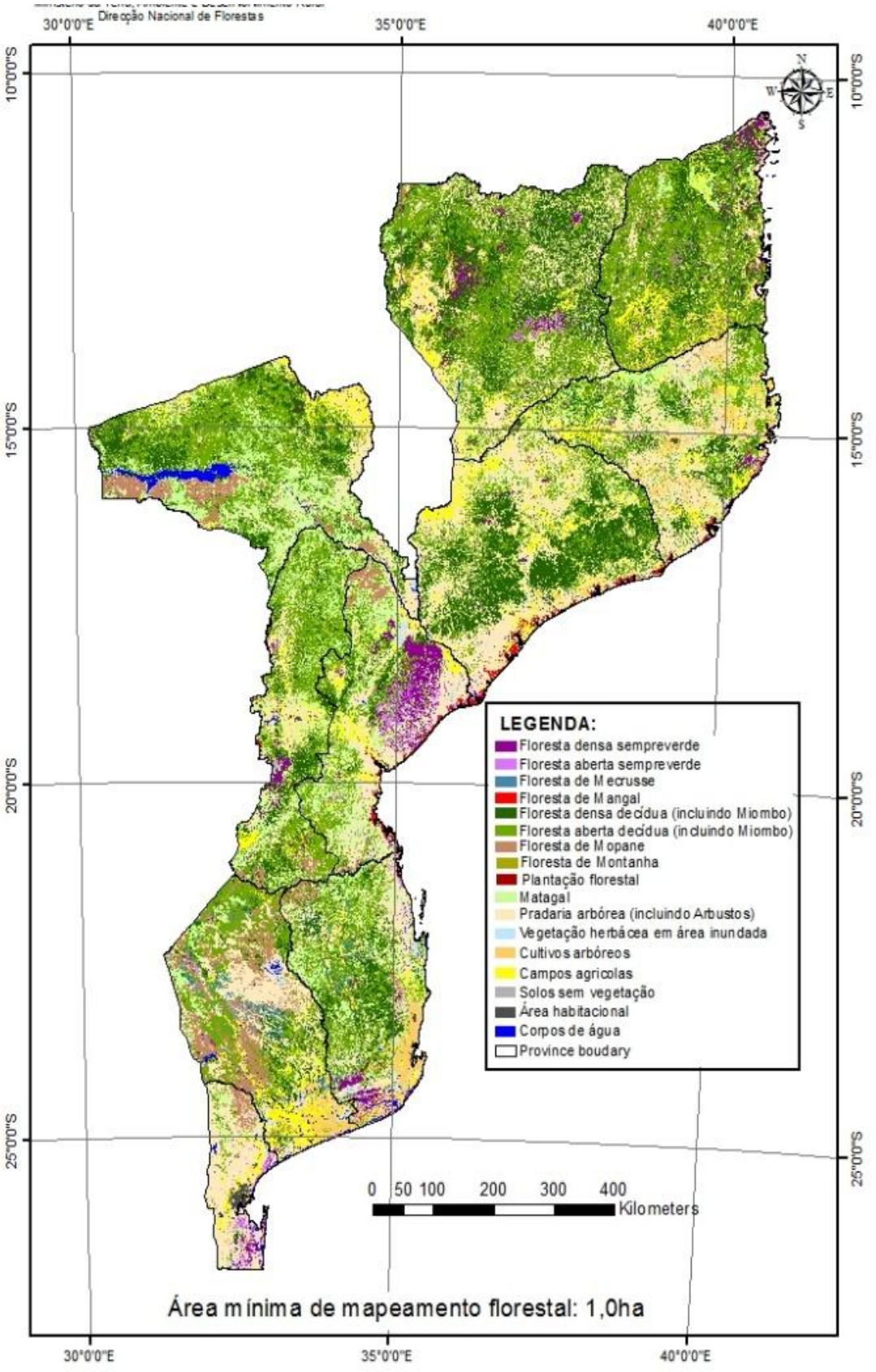


Figure 1 : Forest cover and land use map 2013

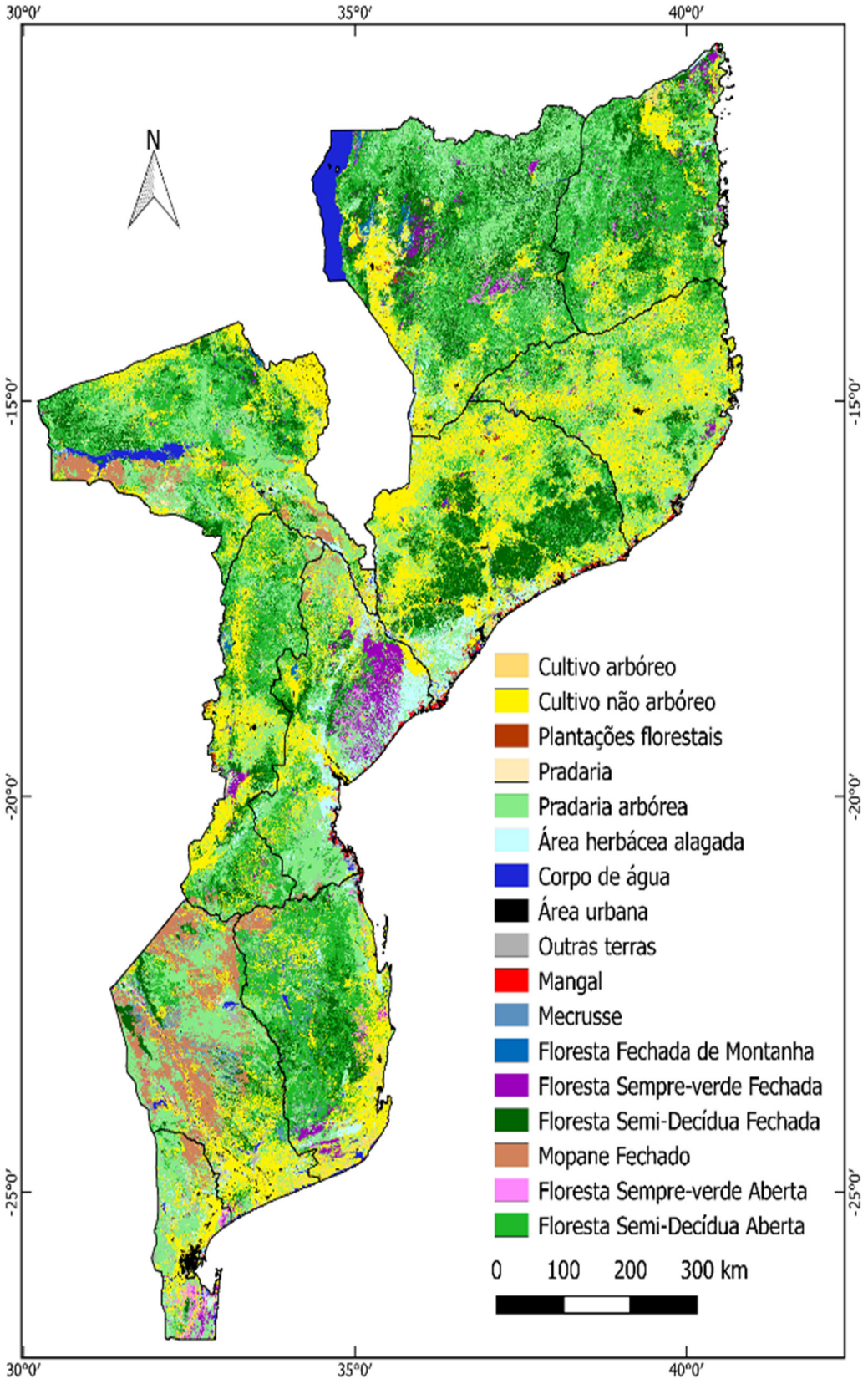


Figure 2 : Forest cover and land use map 2016(Draft[13])

- **Forest ecosystem types**

In Mozambique, (semi-)deciduous forest covers 2/3 of the forest areas and the rest is the occupied by mopane (Chanato), mecrusse (*Androstachys johnsonii*, cimbirre), mangrove and mountainous forests. Table 5 below summarizes the area and distribution of the forest types.

Table 5 : Forest ecosystem type, area and distribution

Forest type	Estimated area (ha)
(semi-)deciduous forest	21,290,014
Mopane	4,620,078
(semi-)Evergreen forest	3,732,468
Mecrusse	485,645
Mangrove	286,360
Mountaineous forest	182,131

Source: information in NFP summarized by the author
Source: Relatório do mapa de cobertura florestal 2016 (FNDS).

- **Forest and biodiversity**

Forests of Mozambique host 5,500 species of plants, of which 250 are endemic, a terrestrial fauna with 740 species of birds, at least 80 species of reptiles and amphibians, of which 28 are endemic, and 3,000 species of insects. This include 3,186 threatened native species, 386 plants and 2,797 animals listed as threatened species in the IUCN list. (Biofund[14]).

- **Conservation areas**

Mozambique is covered by a network of conservation areas that make up 25% of its land surface and of which forests are an essential component. The network consists of 7 national parks, 12 national reserves, 20 official hunting reserves, 51 game farms and 13 forestry reserves among others (Biofund[15]). The conservation areas are not only the key for the protection of biodiversity, but also seen as an opportunity to explore nature-based tourism to become one of the country's largest growth sectors (GoM, 2018[16]).

4.1.2 Forest and socio-economy

Mozambique government acknowledges the importance of sustainable use of forests and forest resources to promote integrated and inclusive territorial development based on diversification of the economy. The forestry sector is said to annually contribute about 2% of GDP, 2% of direct jobs and 200 million USD of foreign exchange in exports (AGRIPRO, 2019). However, the figure likely underestimates the actual contribution of the sector because of the incompleteness in dataset due to under-developed statistical

[13] FNDS developed Forest cover and land use map 2016. This map is under assessment by DINAF

[14] http://www.biofund.org.mz/en/

[15] Ibid.

[16] Government of Mozambique (2018) Nature-Based Tourism 2018.

system and difficulties in quantifying particularly illegal loggings and trades.

Wood from forests are exploited mainly for two purposes: as a source for wood fuel and timber:

- Fuelwood and charcoal are critical to national and household energy needs, with almost the entire rural population (95%) and most of the urban population (75%) depending on it for cooking. This is recognized as main cause of deforestation and forest degradation, or barriers to forest regeneration.
- Meanwhile, timbers are produced from native forests and tree plantations. There are 17.2 million hectares of productive forests with potential for timber production. Around 1,000 forest operators exist as of 2018 of which most of them are classified as small/medium scale business. Controlling the complex timber supply chain built on numbers of small/medium operators is a big challenge.

1.1.1 Forest ownership and use rights (NFP p.35-36)

Under the forestry governance regime of Mozambique, native forests belong to the state while planted trees belong to those who planted them. The actual ownership and use rights arrangements can be complex as summarized in Table 6 below. However, lack of clarity in the legal system as well as the understanding of the stakeholders has been hindering effective forest management and use. This is also a challenge for the NFMS for implementing forest monitoring with clear purposes and responsibilities.

Table 6 : Forest type and predominant owner

Type of forests	Predominant Owner
Native forests in conservation areas	**State**. Use rights restricted to domestic consumption purpose.
Native forests in productive forests (private concessions or simple licenses)	**Tripartite among state, private entity and community**. Community have the use rights for domestic consumption and the state can grant concession or simple license for commercial use.
Native forests in multiple-use area – mosaic of agriculture/forest	**Tripartite among state, private entity and community**. Unclear due to variety in community's interests and mode of actual land use. Potential areas for establishing forest plantations if issues on ownership and use rights are cleared.
Planted forests (exotic, natural or native species)	**Private.** Must have DUATs. Private investments could be promoted if conflicts related to land ownership (including customary use) are cleared.
Planted forests – family agroforestry system	**Private** (as a customary rights although unclear under the legal system).
Planted forest in protected areas	**State**. It is necessary to clarify that planted trees also belong to the state if planted in conservation areas.
Planted forests in production forest areas – restoration and enrichment (native species)	**State after the completion of concession or simple license**.

4.2 Drivers of deforestation and forest degradation

Historical deforestation data for the period 2003-2013 indicate a rate of annual deforestation of 0.79% or 267,000ha, resulting in 40 million tons of greenhouse gas emission which is equivalent to 57% of the total greenhouse gas emissions of the country. If the historical deforestation trends continues, annual deforestation is estimated to be 155,800 ha/year until 2035 (Mabilana, 2019).

There had been intensive discussions on the drivers of deforestation and forest degradation during the national REDD+ readiness processes (GoM, 2017)[17]. It was concluded that the major drivers of forest loss and degradation occur both within the forest sector and in other non-forest sectors, namely in agriculture and energy. Within the forest sector, the direct causes are unsustainable commercial timber exploration and unsustainable extraction of wood for domestic uses, particularly charcoal. Selective and unsustainable illegal logging leads to the degradation of native forest stands. Outside of the sector, forest conversion into agriculture is the dominant driver of deforestation outside of the sector. This includes commercial agricultural expansion, shifting subsistence cultivation and livestock. In fact, these drivers are complex, often interacting each other and are difficult to separate

Small-scale agriculture (65% of total emissions) mostly in the form of **s**hifting cultivation, both for subsistence farming and cash cropping, is the dominant direct deforestation driver[18]. When accompanied by a growing population and increased demand for food in the rural areas, small-scale agriculture increases pressure on arable land, leading to the opening of forest areas. Limited access to markets and technologies that enhance productivity exacerbate demand on the land. The practice of using fires to prepare fields has often resulted in uncontrolled fires, leading to biodiversity and carbon loss.

Natural Forest Timber Production (8% of the total emissions) is exceeding the annual allowable cut volumes, caused by a variety of unsustainable forest management practices in the sector. These include illegal logging, lack of adherence to management plans by concessionaires and license holders, and weak enforcement in the forest sector. While the direct impact from natural forest exploration is degradation, this can enable deforestation, for instance through the opening of access roads. The export-oriented illegal logging is also an issue when it relates an economic loss of foregone government revenues as well as to the losses of local communities who are entitled to receive 20% of concession taxes.

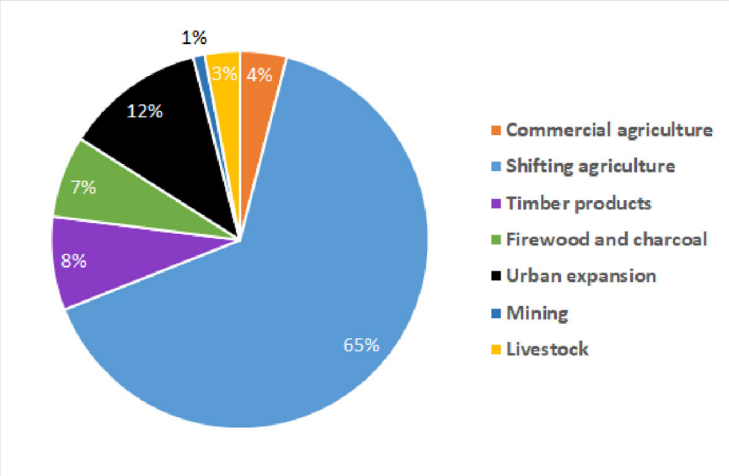
Unsustainable exploitation of wood for charcoal (7% of the total emissions) in the rural areas are driven by the informal markets for biomass energy in the urban areas (in addition to in the rural areas). The annual consumption volume of fuelwood and charcoal is estimated at 14.8 million tons nationally, an amount that is even higher than the allowable cut volume for commercial wood. The difficulty in verifying production and transport licenses for charcoal, and the local, informal channels established for the flow of the products makes regulation and control difficult.

Mozambique has not yet considered emissions from forest degradation in their carbon accounting presented to neither the national FREL nor the FCFP Carbon Fund. According to the national FREL (p.13), a first order estimation of emissions resulting from the three most important causes of forest degradation (timber exploration,

[17] R-Package Multi-stakeholder Self-Assessment of REDD+ Readiness in Mozambique, January 2017.

[18] The activity data analysis for the national FREL report showed that 86% of all deforestation events were due to conversion to agriculture.

production of firewood and charcoal, and wildfires), predicted that forest degradation is responsible for almost 30% of total emissions.



Source: CEAGRE & Winrock (2016)

Figure 3 : Proportion of deforestation and forest degradation drivers

4.3 National policies, legal frameworks and institutional arrangement

4.3.1 Recent advancement in forestry sector reform

Government of Mozambique has been in the process of reforming the forestry sector through revising and updating of national forestry policy and legal framework. Some of the key processes and outcomes are listed below (WB, 2018)[19]. The NFMS will be developed step-wised in a manner which will contribute to the planning, implementation and monitoring of such important national policies and legal frameworks

- Strategic Agenda 2019 -2035 and National Forest Program of Mozambique (under development)
- Revision of Forestry Law and related legislations (planned)
- Two-year suspension of new licenses and concessions (Decree 40/2015) and nation-wide audit.
- New law on timber exports, including log export ban on all native species (Law 14/2016); New export regulation of processed wood (Decree 42/2017, following Law 14/2016).
- National REDD+ Strategy 2016-2030 (2016) and Action Plan for National REDD+ Strategy (2016).
- REDD+ Decree (2018)

4.3.2 Responsible institutions for forestry sector (NFPp.36-37)

The National Directorate of Forests (DINAF) under MTA is responsible for deciding the

[19] World Bank (2018) Mozambique Country Forest Note.

overall direction, planning, control and ensuring the implementation and harmonization of sector-related policies. This includes the development and operationalization of the NFMS in collaboration with related partner agencies.

Several ministries and agencies collaborate with DINAF in their responsible thematic areas: MASA is responsible for management of forest plantations as well as research activities conducted by IIAM; MSIF is responsible for management of mangroves; MIREME is responsible for sustainable biomass energy use; and wildlife conservation remains somewhat unclear. AQUA was established as an independent agency under MTA to enforce environmental control and audit. ANAC is another independent of MTA responsible for the management of conservation areas.

FNDS was a fund originally established under MITADER with an objective to mobilize financial resources for land, environment and forests. Although FNDS has moved to MADER as a result of the government restructuring in 2020, they continue to have the same responsibilities in forestry sector and REDD+. They also implement activities using the mobilized financial resources. This includes the role of the MRV Unit of FNDS in conducting annual monitoring of deforestation and emissions for the whole country (by province) and for specific areas of projects being implemented by FNDS. Most of the financial resources are used for project-based or pilot actions: the need of supporting national level programs and actions has been discussed.

The forestry stakeholders agreed to establish the "Forest Consultation Forum" in 2002, however, it has been dormant since 2011. Since then, coordination in the forestry sector are said to be weakened and recognized as an important issue.

Chapter 5 Summary of the technical scope of NFMS

The NFMS to be applied in Mozambique is composed of three main functions: MRV, monitoring and data management function. The MRV function contribute the measurement of emission and removal including GHGi. Then, the output will be utilized for reporting and verification. The monitoring is to be performed for monitor the state of forest and the effect of Policy and Measures. This function has three different method; Satellite based, Field based and Activity based monitoring. The data management is to be performed on the basis of a database in which information/data collected through monitoring and MRV are loaded. Necessary information/data are then identified and provided for monitoring and MRV purposes according to the monitoring and MRV methodology. The following figure depicts the composition of the NFMS drafted for Mozambique.

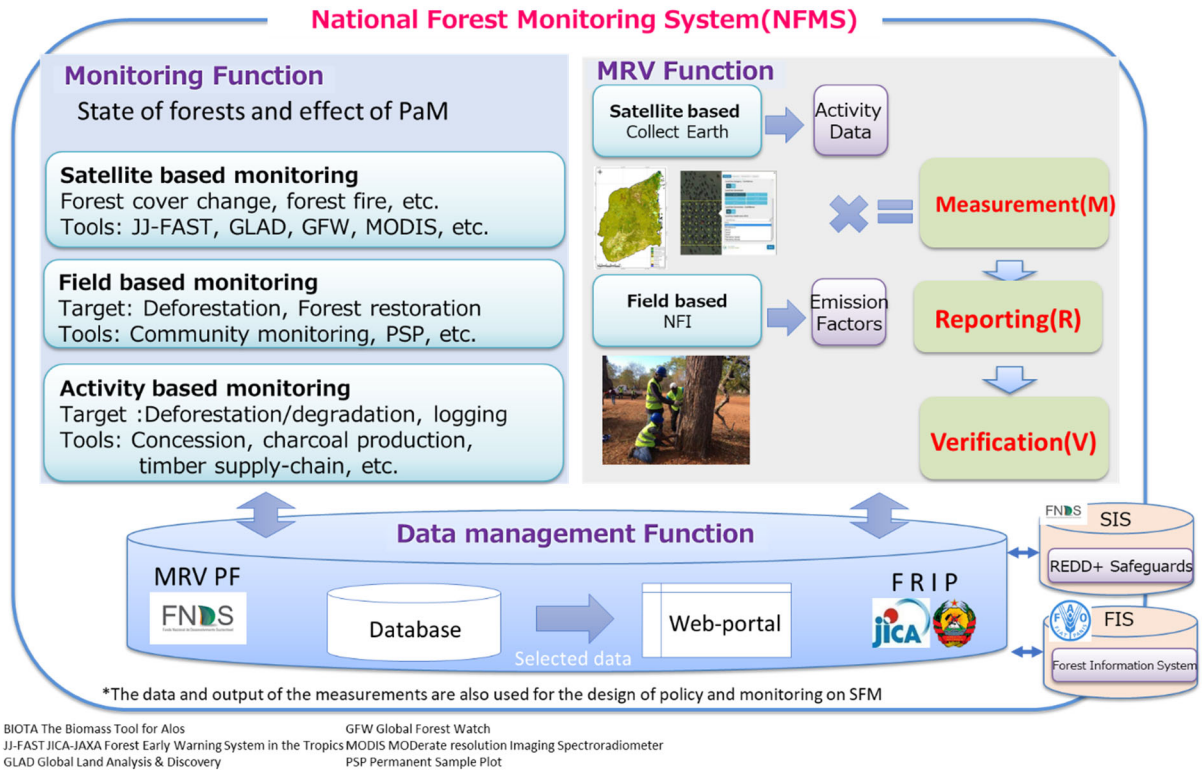


Figure 4 : Conceptual design of NFMS

5.1 Scope of Forest Monitoring

Monitoring Function works to monitor forests to identify forest area change (e.g. deforestation, forest degradation, forest restoration) through several method. This function monitor the effect of the Policy and Measures (PAMs) and basic condition of forest. Selection of proper PaMs as monitoring target is on the process. Reference documents are NFP, NRS, Forest policy and implementation strategy, etc.

5.1.1 Satellite based monitoring

This monitoring focuses on the deforestation, forest degradation and forest fire (TBD) as target through observing satellite. The current observing tools are JJ-FAST, GLAD, GFW (Hansen), MODIS, FNDS's deforestation monitoring approach and forest cover land use map.

5.1.2 Field based monitoring

This monitoring focuses on the deforestation and forest restoration as target through field based activity. The candidate methodologies are community monitoring and permanent sample plot (PSP).

5.1.3 Activity based monitoring

This monitoring focuses on the deforestation, forest degradation and logging (TBD) as

target through several activities. Forest restoration could also be monitored through tracking tree plantation and assisted natural regeneration records. The candidate methodologies are analyzing concession data, charcoal production data and timber supply-chain data, and data on forest restoration implemented by various entities.

5.2 Scope of MRV

MRV Function works to monitor greenhouse gas emissions by sources and removals by sink from the implementation of REDD+ activities to identify deforestation and enhancement of forest carbon stocks through developing activity data and emission factors.

In Mozambique, Activity data are developed by measuring land use/cover changes based on the sampling survey by using Collect Earth tool[20]. Emission factors are developed on the basis of forest carbon stock information which is derived from results of National Forest Inventory, Permanent Sampling Plot (PSP) and allometric equations. In addition, supplemental QA/QC activities should be considered to improve accuracy and reduce uncertainties of Activity Data and Emission Factors.

And then, the result will be reported to each focal points of REDD+ scheme. In case of UNFCCC, countries are expected to report these estimates to the UNFCCC Secretariat through an annex to their Biennial Update Reports (BURs) in a transparent and timely manner. The UNFCCC Secretariat then coordinates a process of verification of the estimates by a team of independent technical experts in Land Use, Land-Use Change and Forestry (LULUCF).

The data and output of the measurements are also used for designing policies on sustainable management of forests as well as its monitoring.

5.3 Scope of Data management

Data produced and/or collected through the NFMS shall be managed with the support of the IT infrastructures (e.g. FNDS platform and FRIP). FIS (Forest Information System) and SIS (Safeguard Information System) will be linked to the IT infrastructures mentioned above. NFMS will contribute data/information required by SIS. Within information system harmonization means efforts to agree on common definitions of concepts and classification systems in order to make data exchangeable among systems (SIS, FIS and NFMS). For spatial data this may include data models, metadata, reference systems, quality specifications, exchange formats, etc. Efforts to harmonize can be organized in *national working groups* contributing to create a framework called Spatial Data Infrastructure (SDI). Ambitions to create better interoperability between systems can be included in the group of measures to improve harmonization. The idea is that certain software, for instance ArcGIS, can read data generated by other software, for instance Excel, without a need for export or import operations between systems.

Potential to link information collection for SIS with NFMS efforts, for example, using remotely sensed information on forest cover to observe developments related to natural forests, important areas for biodiversity & ecosystem services. On the other hand, SIS can be linked to the FIS using national forest inventories to collect relevant field

[20] Collect Earth is a tool that enables data collection through Google Earth developed by FAO

information. These reports using spatial information can be used to support decisions on safeguards and multiple benefits for REDD+ in Mozambique.

Identifying, assessing and strengthening existing systems and sources of information - given the array of themes covered by the safeguards, one information system or source is unlikely to be able to provide all of the information needed for a SIS, reason why this data integration is *primordial*. Assessing information systems and sources can not only help to identify what information is already available in country, but can also point to gaps in the availability of existing information to meet identified information needs (i.e. information relevant to the risks and benefits of the country's REDD+ actions). Where an assessment of existing information sources or systems highlights that some information needs cannot be met on the basis of what is already available, suitable arrangements may need to be found for closing those gaps. Existing information systems can be assessed to determine whether modifications to accommodate new information needs are feasible, such as adding or amending indicators, or adjusting information collection methods. Some illustrative examples of information systems and sources which could be relevant for a SIS are presented in the table below.

Table 7 : Potential information and data that allows SIS, FIS and NFMS integration

Type of information system or source	Example of safeguard-relevant information
National Forest Monitoring System	❖ Information on population distribution, users of forests and trees outside forests ❖ Information on land parcels; land use; demarcation/boundaries; documentation of tenure rights and rights-holders; value of land; taxation; disputes over tenure rights; etc. (available on the MRV web platform at FNDS) ❖ Geospatial and field-based information on forest cover and land use change; the extent of forest resources; forest ecosystem health; tree species biodiversity; ❖ Natural resources use and management, biodiversity and ecosystem services information, ❖ Primary information on: a) forest cover change, forest quality (including information on biological diversity) and drivers of deforestation and forest degradation (i.e. threats to forest resources) b) changes in rural livelihoods (e.g. financial, human, natural, physical and social assets), livelihood strategies, human well-being, local governance procedures, etc.
Forest Information System	❖ Information on sectoral employment ❖ forest management practices and law enforcement ❖ Information on legality of timber production: a) national timber legality definition, including relevant laws and

	criteria and indicators to assess legality of timber production b) geo-referenced information on conservation and production forests, including information on timber production and timber product movements (at the level of individual forest management units) c) information on compliance within the supply chain when applicable ❖ Information on conservation protected areas and relevant procedures; forest harvesting practices and planning; management guidelines for reduced/low impact logging; utilization of wood and non-wood forest products; institutional framework; employment in the forest sector; community participation; etc. ❖ productive, protective and socio-economic functions of forests; etc.
Grievance redress mechanisms	❖ Feedback and information from relevant stakeholders, including those more marginalized, such as local communities, women, youth and the disabled regarding the impacts of REDD+ actions and the effectiveness of safeguards implementation

Chapter 6 Chapter 6 Technical process of current forest monitoring

6.1 Forest Monitoring

As described in chapter 5, the role of forest monitoring is to identify forest area change through several methods and contribute to measure the effect of PaMs. In this section, details of the three types of monitoring initiatives (i.e. satellite-based, field-based and activity-based) being implemented or under development are described. Other monitoring items which are still in their early conceptualization/development stages are described only briefly and further described in Chapter 7 as areas for future improvement.

6.1.1 PaMs (Policy and Measures)

As described above, NFMS will measure the effect of PaMs. In this context, there is a need to select existing PaMs in various instruments related to the reduction of emissions due to deforestation and forest degradation and to sustainable forest management. The PaMs to be selected should be possible to analyze and record the changes that have taken place in order to be able to verify whether they are being followed and to contribute directly or indirectly to REDD+ and sustainable forest management.

Mozambique has produced several instruments that present different policies and measures that contribute to REDD + and sustainable forest management. Within these instruments, the following stand out:

- National REDD+ Strategy (NRS): Promoting integrated multisectoral interventions to reduce carbon emissions associated with land use and land use change through adherence to the principles of sustainable management of forest ecosystems (natural and planted) contributing to global mitigation and adaptation efforts integrated rural development.
- National Forest Program (NFP): Develop sustainable value chains, capacities and resilience to climate change and natural disasters contributing to the achievement of the Sustainable Development Goals
- Forest Policy and Implementation Strategy (FPIS): guarantee the perpetuation of the national forest heritage and the generation of benefits derived from environmental goods and services through the sustainable use and added value of forest products, encouraging inclusive and participative management, for the economic, social and environmental benefit of current and future generations.
- National Biodiversity Conservation Strategy (NBPS): definition of strategic measures for the management and conservation of national biodiversity
- National Reference Emission Level (FREL): Mozambique's Forest Reference Emission Level for Reducing Emissions from Deforestation in Natural Forests was submit to UNFCCC in October 2018.
- Forest Investment Program (MozFip): to improve the enabling environment for, and practices of, forest and land management in targeted landscapes in Mozambique

Based on these instruments, PaMs were selected, which, directly or indirectly, contribute to the reduction of deforestation (consequently to the reduction of emissions from deforestation) and to ensure sustainable forest management. In this sense, long list of PaMs that can be used as a basis for forest monitoring was prepared.

The list is shown as annex 2.

The following criteria was used to prioritize PaMs for developing short list are:

- How importance for forest management,
- Feasibility of monitoring
  - Actions whose monitoring is already underway,
  - Existence of the capacity to carry out monitoring,
- Lower the priority of PaMs where it is difficult to set quantitative indicators
- Cost of monitoring (Considered roughly).

Selected PaMs will be monitored through NFMS.

Note: PaMs not on the short list will be monitored in the future

The following table shows the outline of short list of PaMs.

Table 8 : Short list of PaMs

No.	Category	Instrument	Policies and Measures (PaMs)	Coverage		Feasibility of monitoring methodology of PaMs	Importance for forest management	Suggested Methodology for Monitoring	Baseline Sytem
				REDD	SFM				
1	Deforestation	NRS (pg 21); FREL (pg 20)	Reduction of emissions from **deforestation**	x	x	Yes	High	Satellite image monitoring; plataform for deforestation analysis (FNDS)	yes; First FREL(38.9 mtco2/ano)
2	Plantation	NFP (Annex 4, Pg 5)	Zoning for forest **plantations** (2 million hectares zoned)	x		Yes	Medium	Maps and reports of zoning	Yes (strategy for afforestation)
3		NFP (Annex 4, pg 5), MozFip (pg 94)	Promote establishment of **plantations** (300 thousand ha planted by 2024)	x		Yes	Medium	Plantations report	Yes (MozFip work in Zambezia)
4		NRS, NFP (A4, pg 10)	increase in carbon sequestration (establishment of conservation **plantations**)	x		Yes	High	Maps and collected field information	No
5	Management Plan	FPIS, NRS, NFP(P61), MozFip	Forest inventories and management plans for productive forests		x	Yes	High	Forest inventories and management plans produced	Yes; NFI
6	Timber tracking	NFP (Annex 4, pg 3)	**Timber tracking**: functional timber tracking system	x	x	Yes	High	Reports from SPFFB	ITTO pilot project
7	Restoration	NRSAP (pg 11)	Restoration of degraded forests using ROAM (Restoring Opportunnities Assessment Methodology): restore 150 thousand ha	x		Yes	High	Restoration reports and maps	Yes (Mecuburi Foret Reserve)
8		NRS, MozFip Pg 94)	Establishment of agroforestry systems to reduce deforestation (at least 18,000 ha established by 2024)	x		Yes	High	Maps and collected field information	

The following tables show the outline of each PaMs and monitoring methodology based on the category.

【Deforestation】

PaMs	Reduction of emissions from deforestation through several activities
Instrument	NRS (P 21); REDD+ strategy aims to reduce emissions from deforestation and forest degradation, improve the conservation of forest ecosystems and increase forest carbon stocks, thus avoiding the emission of 170 MtCO2/ until year 2030 Note: Target was estimated without baseline FREL (P 20) The main activities to reduce emissions from deforestation are sustainable agriculture, Agroforestry, improved kilns for charcoal, improved cook stoves and land use planning.
Indicators	Emission(tCO2/year)
Methodology	Annual Deforestation monitoring by satellite image
Implementing agency	FNDS
Frequency	Once a year　Note: MRV will be conducted time by time
Baseline(System)	National FREL(38.9 MtCO2/year)

【Plantation】

PaMs	①Promote the establishment of plantations with fast growing species to support a modern forest industry in the country (1 M ha by 2035 at least 0.3 M ha established by 2024) ②Encouraging conservation plantations under REDD（Establish 3,000ha by 2035 or 1,000 ha by 2024）

Instrument	NFP (Annex 4, P5 and 9)
Indicators	Area of plantation(ha)
Methodology	- Report - LULC map(If developed continuously)
Implementing agency	DINAF
Frequency	Once a year,2024 and 2030
Baseline(System)	None

【Management plans for productive forests】

PaMs	Develop management plans for productive forest Set 17 M ha of permanent native production forest by 2023
Instrument	NRS, NFP(P61),MozFIP and NRSAP(P.32)
Indicators	Management plan/ Area of production forest
Methodology	- Report - Forest classification data approved by government
Implementing agency	DINAF, FNDS and others
Frequency	Once a year
Baseline(System)	- 26.9 M ha are categorized as productive forests(MozFIP P14),

【Timber tracking】

PaMs	Forest law enforcement with timber tracking
Instrument	NFP (p65; A4, 1.17)
Indicators	Assumed amount of illegal logging
Methodology	Forest law enforcement reports
Implementing agency	DINAF/AQUA/SPFFB
Frequency	Yearly
Baseline(System)	ITTO pilot project (work in progress)

【Restoration】

PaMs	Restoration of degraded forests using ROAM (Restoring Opportunities Assessment Methodology) developed by IUCN: restore 150 thousand ha of degraded forest. Restoration of 1 M ha (Bonn Challenge) Establishment of agroforestry systems to reduce deforestation (at least 18,000 ha established by 2024)
Instrument	NRSAP(P11), NFP (P65); NFP (A4, P10)
Indicators	Restoration area and area of agroforestry

Methodology	Verification reports, restoration maps?, satellite images
Implementing agency	FNDS (service providers), IUCN, WWF, FAO
Frequency	TBD
Baseline(System)	None

Five categories and eight PaMs will be monitored through NFMS. Other PaMs will be monitored in the future.

6.1.2 Satellite based monitoring

(a) Deforestation monitoring function using early warning systems and relevant systems into NFMS

The objective of developing deforestation monitoring function using early warning systems and relevant systems into NFMS is to aggregate deforested area detected by the existing early warning systems and relevant systems operated by each organization, and monitor the general condition of the forest and to utilize for the monitoring of forest areas to be conserved, operation of logging concessions, and possibly detect road expansion for transportation of illegally-logged timbers, etc.

At present, there are several monitoring systems for the detection of deforestation (tree loss) areas. Those are (1) the JICA-JAXA Forest Early Warning System in the Tropics (JJ-FAST), (2) the Global Land Analysis and Discovery by the University of Maryland (GLAD Alert), (3) the Annual Deforestation Data in FNDS (FNDS), (4) the Global Forest Change by Hansen, Potapov, Moore, Hancher et al (Hansen Tree Loss), and (5) the Fire Information for Resource Management System (FIRMS). The JJ-FAST intends to detect areas of deforestation in the tropical regions using the ALOS-2/PALSAR-2 data every 1.5 months. The GLAD Alert intends to detect areas of tree loss in all countries between the latitudes 30 degrees north and 30 degrees south every sixteen days. The Annual Deforestation Data in FNDS intends to detect areas of deforestation in Mozambique. The Hansen Tree Loss intends to extract the areas of vegetation reduction once a year using the LANDSAT data at a global scale. The FIRMS intends to detect Near Real-Time active fire data within 3 hours of satellite observation from both the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Visible Infrared Imaging Radiometer Suite (VIIRS) (Table 9).

Table 9 : Comparison of the Existing Monitoring Systems (As of September 2020)

Item	Early warning systems (periodically)	
	(1) JJ-FAST	(2) GLAD Alert
General Descriptions (Objectives)	To constantly monitor the conditions of decreasing tropical forests and detect the change areas.	To estimate and show areas with possible tree cover loss.
Satellites/ Imageries	ALOS-2/PALSAR-2, ScanSAR	LANDSAT 7 and 8
Target Area	Natural tropical forest areas (Artificial forest areas are excluded.)	All countries between the latitudes 30 degrees north and 30 degrees south
Observation Frequency	Every 1.5 months (Quick look products: 3-4 days after the observation)	16 days or more to detect confirmed loss (Depending on cloud conditions,

	(Quality checked products: 1-2 weeks after the observation)	observation intervals can be extended by several weeks or even several months.
Spatial Resolution	50m-> 10m(under development)	30m
Observation Period	2016 to the present	2017 to the present
Data Format	Shape file and KML	Raster

Item	Yearly deforestation system (annual)		Equivalent system (near real-time)
	(3) FNDS	(4) Hansen Tree Loss	(5) FIRMS
General Descriptions (Objectives)	To estimate area of deforestation and emissions.	To estimate tree loss and gain by time-series analysis and visualize the global forest extent and their changes.	To distribute near real-time active fire data within 3 hours of satellite observation from NASA.
Satellites/ Imageries	Sentinel-2/Planet Labs/Google Earth/Bing Maps/Landsat	LANDSAT	MODIS/VIIRS
Target Area	Mozambique	Whole world	Whole world
Observation Frequency	Every year	Every year	MODIS: 2 times per a day
Spatial Resolution	20m	30m	MODIS: 1km VIIRS: 375m
Observation Period	2017 to the present	2001 to the present	MODIS: 2000 to the present VIIRS: 2012 to the present
Data Format	Raster	Raster	Shape file, Text, KML and WMS

Of all the features of the five systems given in, the observation frequency varies the most. For example, while the Hansen Tree loss and the FNDS are only provided once a year, those from the JJ-FAST are provided every 1.5 months. The GLAD Alert examines 30m x 30m Landsat images taken from satellites orbiting the globe ever week. As the satellites relay the images back to earth, they are compared to past data, assessed for tree cover loss and added to Global Forest Watch. We can use the tree cover loss data after 16 days or more to detect confirmed loss.

Because of these unique characteristics, five monitoring systems can be utilized for different purposes or can be utilized complementarily for strengthening the NFMS function. For instance, unlike the JJ-FAST and the GLAD Alert, the FIRMS can provide analysis data in a (near-real-time) manner and this feature makes it possible to utilize these two systems for such activities as (detection of illegal deforestation activities including logging and large-scale forest fires）.

Figure 5 shows the work flow using the five monitoring system. First, the tree loss data and alert data published on the website or FTP site are collected. Since the JJ-FAST and

the GLAD Alert are frequently updated, a function that can be collected automatically or semi-automatically will be developed. Annual data will be used as reference information, of which the Hansen Tree Loss will be stored in the FRIP's database and the FNDS will refer to the FNDS's web site, "Visualizador de Dados da Unidatade MRV", directly as the web map service (WMS) map layer. The FIRMS will be obtained directly from the web application server as well as the FNDS. The collected data are processed into formats that can be easy handling for users in GIS software and uploaded into a FRIP. The structure and attribute items of each layer will be designed according to the purpose of use. The usage method (On-line or off-line) and the disclosure range (public or private) will be set according to user's environment.

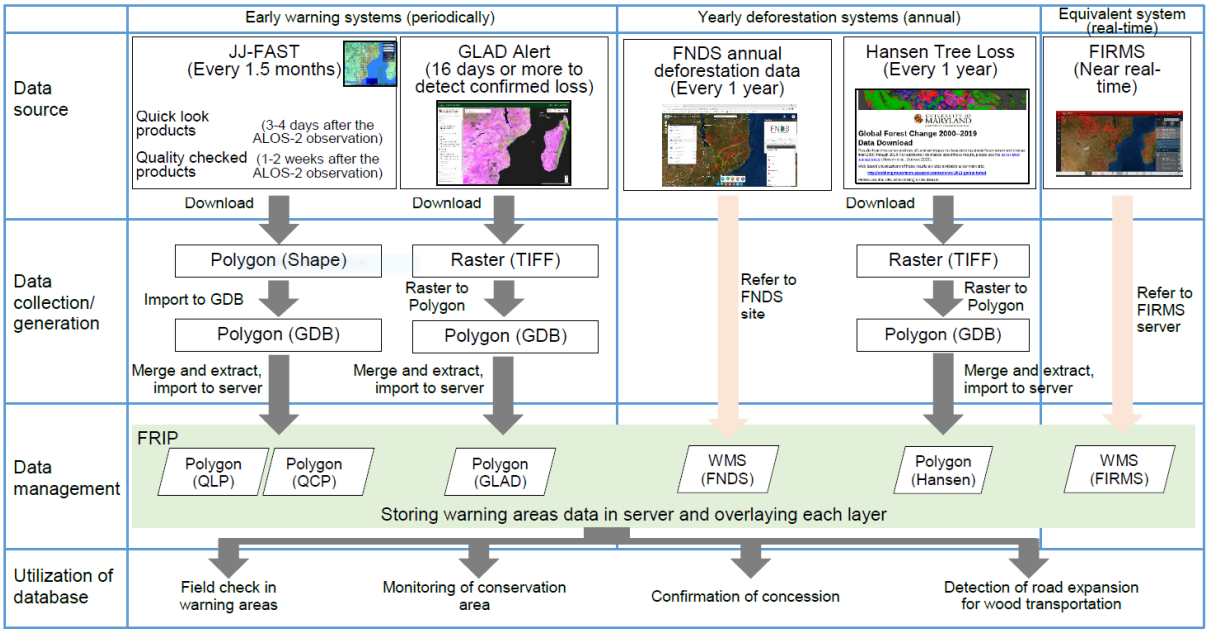


Figure 5 : Work flow of SDRS (Satellite-based Deforestation Reference System)

The role of assumed users in the SDRS is shown in Figure 6. The role of data provider is to publish deforestation areas and active fire locations. The data administrator will collect data from the existing web sites, aggregate and analyze the extent of deforestation areas and upload them into the FRIP database. The users will utilize the extracted deforestation areas for monitoring, field verification survey and so on. The system administrator will operate and manage the FRIP including the SDRS.

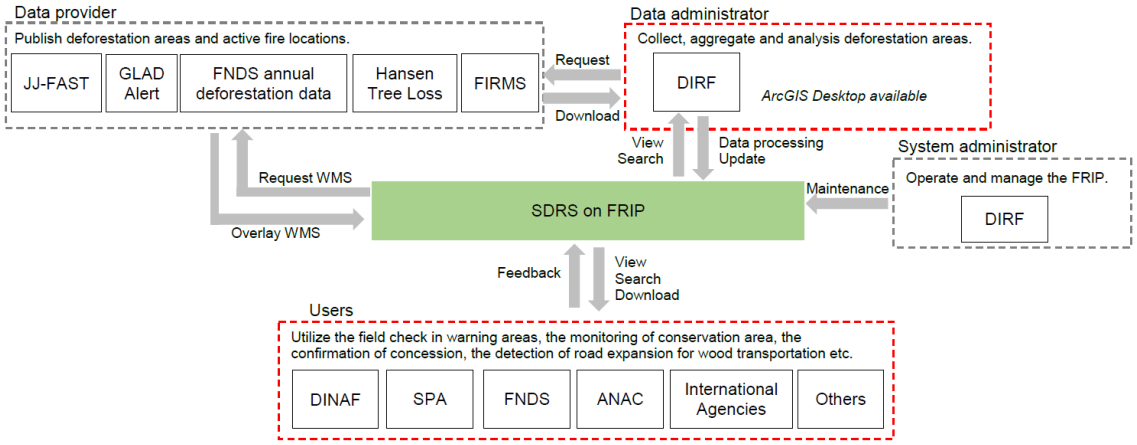


Figure 6 : Role of users

(b) Annual deforestation monitoring

The objective of the annual deforestation monitoring is to generate annual estimates of deforestation, at project, provincial and national level. These estimates can be used for results-based payment accounting, reporting of project indicators and will also be included in the annual reports by the National Institute of Statistics.

The workflow used to produce the estimates of annual deforestation follows the steps below:

A. Produce two Sentinel-2 satellite imagery composites for the monitoring area, containing all images of wet season (i.e. January - May) for the reference period (1 year) and current period (year 2). The reason behind the selection of January - May as a reference and actual period of monitoring resides on the fact that it is the wet season, where the NDVI stability is very high in relation to the dry season, which starts in June to October, when most trees lose their foliage and makes it difficult the analysis of deforestation.

B. Generate image features from reference period and actual period from the composites generated in previous step, to identify changes in forest cover. The image features have different vegetation indexes, namely, NDVI, EVI, SAVI, NBR, NDWI with respective sub-products such as NDVI 90th percentile, Normalized NDVI, and variation on NDVI.

C. Collect training data on classes of deforestation, stable forest and stable non-forest by visual interpretation of composites from the reference and actual periods, and NDVI change detection image. The NDVI change detection image is a result of the difference of NDVI from the composites of reference and actual periods. The calculated NDVI change detection image helps the interpreter to locate where the changes of forest cover are occurring.

D. Produce a categorical deforestation map by combination of the training data and image features through a process of classification using Random Forest classifier. The Categorical deforestation map includes non-forest stable and stable forest classes. Because errors of omission of deforestation have a very large impact on the final estimates, it is important to reduce these errors as much as possible.

E. To improve the efficacy of the sampling the deforestation class on the map is reclassified as:

- High probability deforestation (cluster of more than 10 pixels of deforestation, corresponding to at least 40% of one hectare);
- Low probability of deforestation (cluster of less than 10 pixels and greater than 6 pixels, corresponding at least 24%- to 40% of one hectare) and;
- Non-forest (cluster of less than 6 pixels, corresponding to less than 20% of a hectare).

F. To reduce the risk of omission errors, a Buffer of 40 meters is added around the high probability of deforestation class. The result is a deforestation map with five classes: High probability of deforestation; buffer; low probability of deforestation; stable forest and stable non-forest.

G. Following the best practices for estimating area described in Olofsson *et al.* (2014)[21], a stratified random sampling is conducted in each class/stratum from the map of deforestation. Each sampling point is assessed using Collect Earth tool, to determine current and previous land use and land cover, resulting in estimates of deforested area for the reference year, with confidence intervals.

(c) Forest Cover and Land Use map (also called as Land Use Land Cover map)

Purpose

Forest cover and land use maps shall be developed to achieve the following purpose:

- To provide information about the areas of each forest cover and land cover class and their changes overtime;
- To understand drivers of deforestation and forest degradation;
- To make plan for sustainable forest management;
- To provide a basis for stratified sampling for forest inventories

Forest Cover and Land Use Classification

Table 10 illustrates classes used for map and show consistencies with defined IPCC six categories.

Table 10 : Classes of the LULC map

Category	Classes
Cropland	Tree crops
	Field crops
Forest land	(Semi-) evergreen closed forest
	(Semi-) evergreen open forest
	Mountainous forest
	Mecrusse
	Mangrove
	(Semi-) deciduous closed forest)
	(Semi-) deciduous open forest
	Mopane

[21] Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E., Wulder, M. A. 2014. Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment, 148:42–57.

	Forest plantations
Grassland	Thickets
	Non-Forest Woodland and Grasslands
Wetlands	Aquatic grasslands (incl. Aquatic shrub lands)
	Water bodies
Settlements	Settlements
Other land	Bare areas

To prepare forest cover and land use map for Mozambique, optical satellite imagery are used for classification. Forest cover and land use maps for 2013 were developed for the entire country with the object-based classification analysis. They included the forest cover and land use maps for the Gaza and Cabo Delgado Provinces by the JICA project and those for the remaining eight provinces by the Japan's Grant Aid. These data are/will be stored in FRIP. After that, FNDS developed map 2016 by keeping the same forest land classes with the map 2013.

Forest cover and land use map 2013

As base maps of Cabo Delgado and Gaza provinces have been developed using the ALOS satellite images for 2008.This map was updated by change detecting methodology for year 2013. Furthermore, the base maps of the remaining 8 provinces have also been developed using the Landsat 8 satellite images for 2013. The Remote Sensing Analysis Guideline (Will be attached in Version 1) can be used as a technical reference for developing the base maps and reference year maps. In order to develop these maps, field surveys also need to be carried out to collect necessary ground data. Method and procedure of implementing the field surveys are described in the Ground Truth Survey Guideline (Will be attached in Version 1).

Outline of forest cover and land use map 2013 can be referred to ATLAS DO MAPA DE REFERÊNCIA DE RECURSOS FLORESTAIS EM MOÇAMBIQUE 2013.

Forest cover and land use map 2016

Process of LULC map 2016 development is below:

- Draft LULC map 2016 was developed by FNDS MRV unit in year 2019.
- The map was presented to the technical team (IIAM, UEM, DIRF, BIOFUND, etc.) at a meeting by FNDS. And questions/comments were collected for map improvement.
- Corrections had been made and the final product was presented.
- DINAF has not completed the quality assessment of this map.

The LULC map 2016 was produced from Sentinel-2 images, which are freely accessible, have high spatial resolution (10-20 meters) and also high spectral resolution applicable to the monitoring of forests (especially in the infrared, with 8 bands). The production of the mosaics was through SEPAL platform. This platform was developed by FAO under the OpenForis initiative in order to allow easy access to the Google Earth Engine's cloud computing environment, through an intuitive graphical interface. This tool allowed to produce LULC map of Mozambique forest resources using two mosaics on a national scale (wet season and dry season), for the year 2016.

For training data, more than 57 000 regions of interest over the entire country were

collected, using ENVI software. A Random Forest classifier was used to produce a pixel based LULC map. The Figure 7 below shows the processing steps at the desktop level and the processing done in the sepal cloud

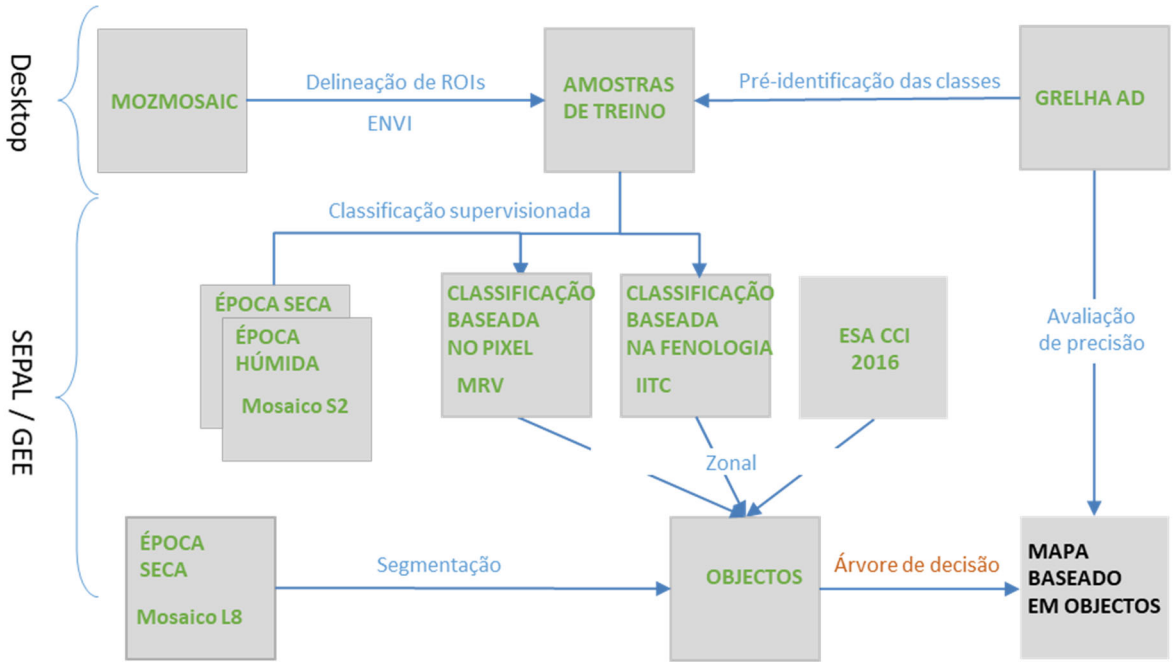


Figure 7 : Flowchart of automatic classification process based map objects

The map results and the report that explains in more details (Relatório do Mapa de Cobertura Florestal de Moçambique 2016) can be found on mrv website (www.fnds.gov.mz/mrv).

Future plan

Wall-to-wall forest cover and land use maps will be periodically updated by keeping the consistency with the past maps. The map creation method will need to be reconsidered.

6.1.3 Field based monitoring

(a) Permanent Sampling Plot

There are several studies and projects to do the survey on PSP. (1) DINAF, (2) IIAM, (3) UEM[22]. As a result, it was decided to create a National Network of Permanent Sampling Plots, which included representatives from these 3 institutions. This Network held several meetings to discuss how to harmonize the methodology for permanent sampling plots in Mozambique. A manual for the installation and monitoring of PSP was produced, which contained a detailed description of the methodology to be followed by any institution wishing to be included in the PSP network. This manual included

[22] Department of Forest Engineering, Faculty of Agronomy and Forest Engineering, Universidade Eduardo Mondlane

instructions on the shape and size of PSP, the coding system used, what variables to collect in the field, how to do the measurements, among other things.

The result will be shown in the systems and utilize for several report. As a future utilization, for example, estimated value of natural increment from PSP can be utilized for estimating the carbon of forest restoration though FREL report submitted in 2018 is not include forest restoration as target of REDD+ activity. Also, it contributes to sustainable forest management by using natural increment value for estimation of logging allowance.

Table 11 : Outline of PSP

Implementing agency	DINAF	IIAM	UEM
Support agency	JICA	FNDS	None
Survey province	Gaza and Cabo Delgado	Gaza	Niassa
Survey area	National parks	Coastal forests of Bilene-Macia, Limpopo National Park	Niassa National Reserve
Plot size	0.4 ha	1 ha	30m radius and 1 ha
Number of plot	96	Installed: 5 Planned: 19	50 (30m radius) +24 (1ha)
Survey items	DBH, Height, Height (Commercial), health status and altitude	Species name, DBH, Height, health status. Every measured tree is individually tagged. Every tree >10cm and trees between 5 and 10 cm for 10% of the plot are measured. Non-established regeneration/grassy layer measured in 15 mini-plots of $1m^2$.	DBH, Height, soils, controlled fires
Survey period	2015-2016	2020-2021	2005–2009, 2009,2015 and 2019
Monitoring	As of September 2020, second time survey has not been implemented.	Quality assurance conducted on 3 PSPs.	Several times.
Note	Plot was set considering with different vegetation types	Methodology described in the PSP manual	investigated miombo woodland's dynamics in terms of composition, structure and biomass

(b) Community based monitoring

The Community based monitoring approach consists of the process of sharing and discussing the deforestation maps at the district level and below. This methodology will be tested during the implementation of the Zambézia Emission Reduction Program,

being implemented by FNDS. It is planned to have annual meetings in each of the 9 districts of the Program Area, where stakeholders within the district will participate. The teams conducting these meetings will include representatives from the MRV Unit, Safeguards Unit as well as the Project implementation unit in Zambézia.

6.1.4 Activity based monitoring

Based on the records of forest management activities, status of forest could be also monitored. For example, by periodically analyzing such records (e.g. timber harvesting, tree planting, assisted natural regeneration in concession or simple license areas), information on the forested areas and loss/increase of biomass stock can support the monitoring of deforestation, forest degradation and forest restoration. Another example is that, if the charcoal production supply-chain can be monitored, it will also give some indications to the loss of forest biomass. Also, result of monitoring contribute to the followings;

- Compare the plan and practice of policies for sustainable forest management
- Prove the timber legality
- Show the actual usage of forest resource
- Others.

(a) Concession and Simple license

Concession is issued for logging through the process shown in the following flow.

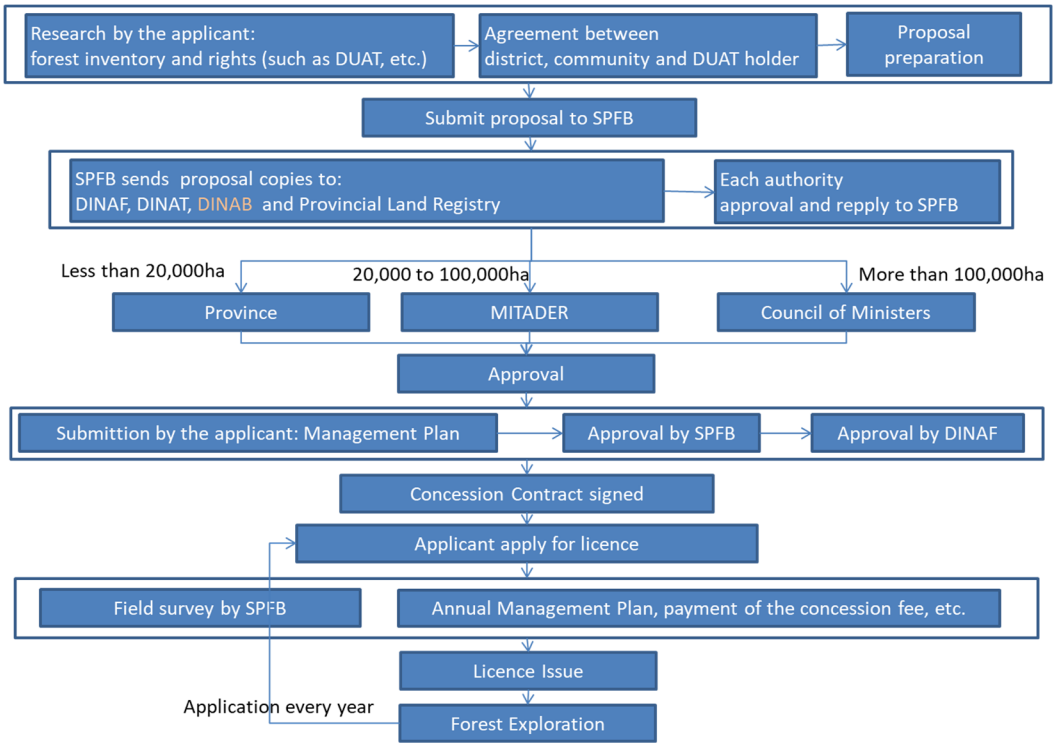


Figure 8 : Process of concession issue

In 2015, a total of 906 forestry operators, of which about 80% are operators on a single license basis and 20% operators under the forestry concession scheme were registered.

Those record will be analyzed province by province through the NFMS.

The Forest information system (FIS) will be developed through a modular approach including forest licensing (centralization and management of data related to forest licenses).

The Forest Information System (FIS) is envisaged as an integrated system which will be used to support the planning, implementation and monitoring of multi-objective forest management activities. The FIS in Mozambique will be used for strategic, tactical and operational planning and implementation, and operational control in and across administrative units and levels of the forest sector hierarchy. Besides the databases and models required to support decision-making in the many programs of the sector, the FIS also has the ability to maintain current forest inventories and generate maps of spatially-oriented data (e.g. attributes of entities depicted on a map, such as forest concessionaries, whose location can be fixed on a map).

The system will be comprised of 8 modules in which 5 represents the core modules of the system. Below is described the main functionalities of the 5 core modules:

- **Forest Licensing**
- **Sustainability**
- **Monitoring**
- **Planning**
- **Community Management**

The specifications of the modules can be found on the diagram below:

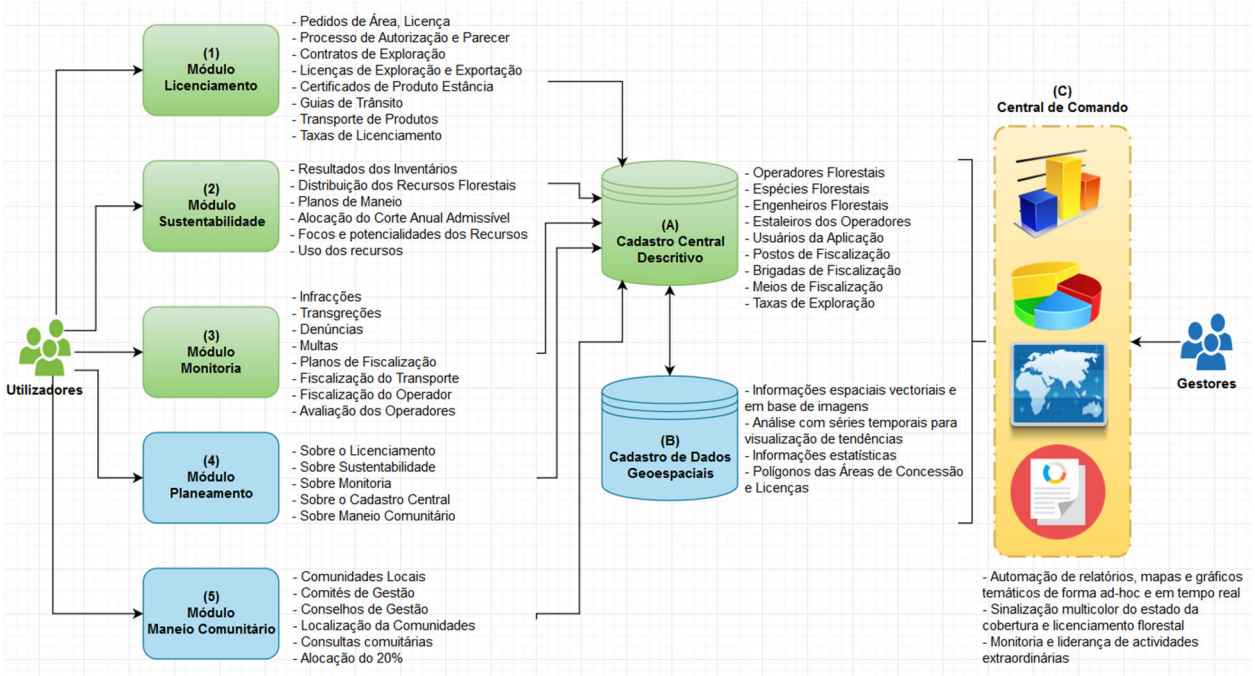


Figure 9 : Detailed information of each module

- **Forest Licensing**

This module will support centralization and management of data related to the applications and registration of forest licenses.

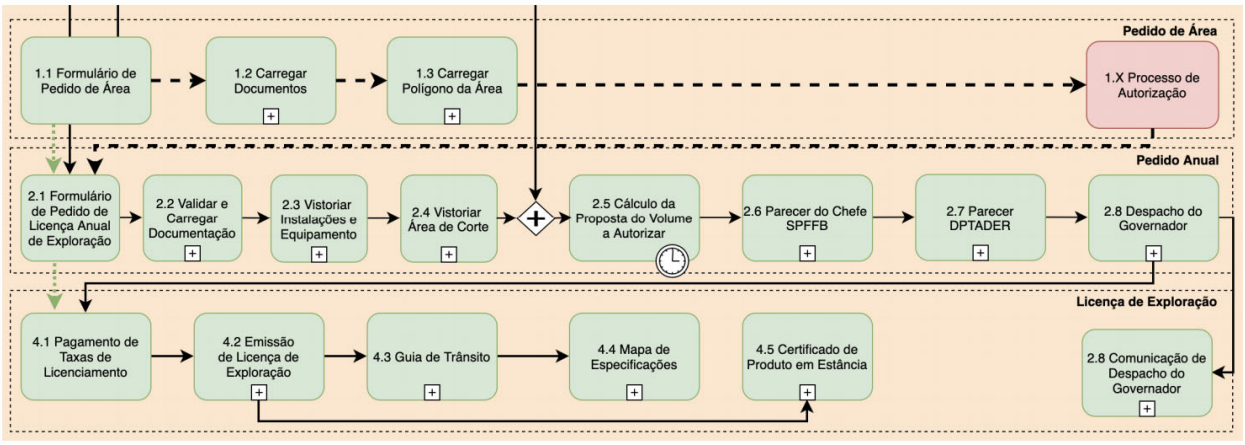


Figure 10 : Forest Licensing workflow on the FIS

- **Sustainability**

This module will provide information that can support decision making, planning and reporting processes.

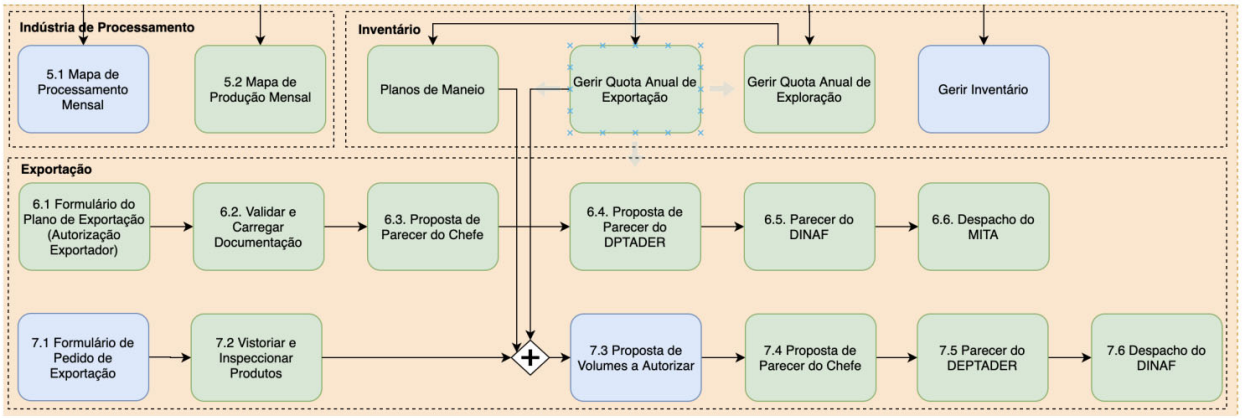


Figure 11 : Sustainability module workflow on the FIS

- **Monitoring**

This module will assist the monitoring of forest operations, volumes harvested and processed as well as obligations of the forest management plans, harvest transgressions and catalogue and display data on transgressions.

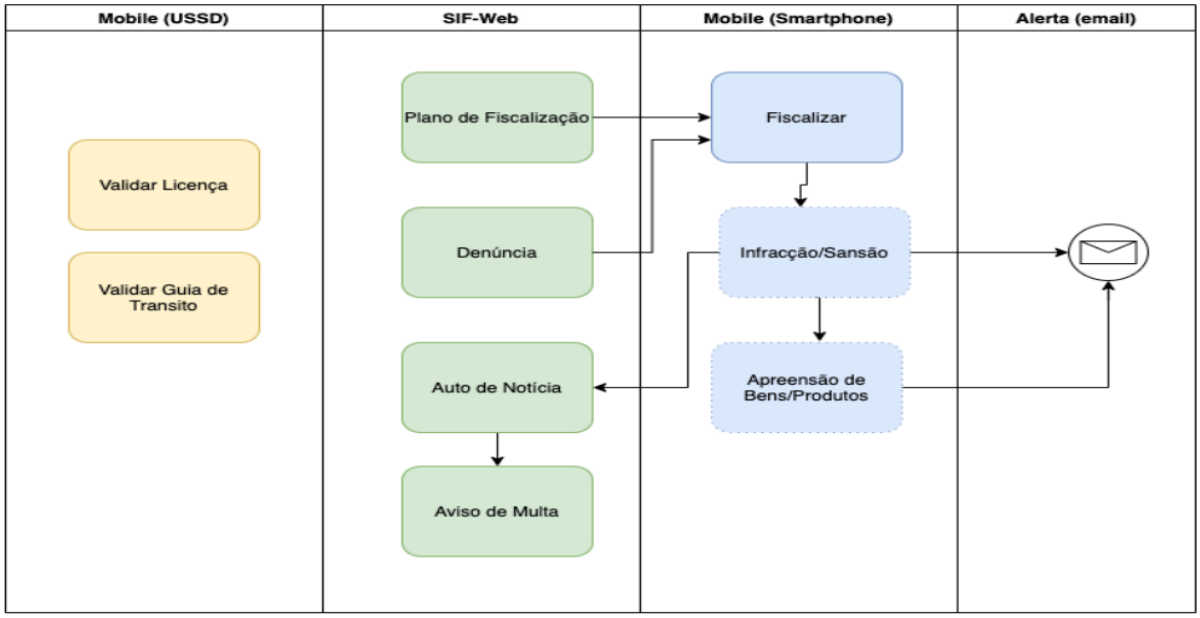


Figure 12 : Monitoring module workflow on the FIS

6.2 MRV

As required under the UNFCCC, REDD+ MRV shall be conducted with the support of a robust and transparent national/sub-national forest monitoring system for monitoring. REDD+ MRV shall provide estimates that is consistent over time and with the established Forest Reference Levels, and accurate to the extent possible taking into account national capabilities and capacities. All REDD+ results based actions should be fully measured, reported and verified.

In this chapter, Emission Factor (EF) and Activity Data (AD), which were used for modified version of the Forest Reference Emission Levels (FREL) submitted in October 2018, are described.

As of December 2019, there is no plan to conduct a national MRV against the modified national FREL submitted in October 2018. Under the UNFCCC, countries are expected to report these estimates to the UNFCCC Secretariat through an annex to their Biennial Update Reports (BURs) in a transparent and timely manner. The UNFCCC Secretariat then coordinates a process of verification of the estimates by a team of independent technical experts in Land Use, Land-Use Change and Forestry (LULUCF).

The 1st MRV (it is called MMR in terms of FCPF-CF) will be done in 2019 for ER-Program (i.e. ZILMP).

The following table shows the elements of national REL and ER-Program REL.

Table 12 : Elements of National FREL and ER-program FREL

Elements	National FREL	ER-Program FREL
Forest Definition	National definition (Height: >3m, Crown cover: >30%, Minimum area: >1 ha)	
Forest and Land use class	National classes (9 forest classes,8 non-forest land classes)	
Scope (Activity)	Deforestation	
Carbon Pools	Included: AGB, BGB Not included: Deadwood, Litter, Soil – lack of data, insignificant	
Gases	Only CO2 included.	
Scale	National(UNFCCC)	Project area in Zambézia
Reference period	2003-2013	2005-2015
REL model	Historical average	
Emission Factor	National data set derived from the NFI 2015-17	Zambézia data derived from NFI 2017 + additional clusters collected in Zambézia in 2018.
Activity Data	National LULC map	National LULC map for the project area
Uncertainty assessment	Same method applied.	

6.2.1 Emission Factor (EF)

- **Purpose**

Emission and removals resulting from land use conversion are manifested in changes in ecosystem carbon stocks, and for consistency with the IPCC Guidelines, units of carbon, specifically metric tons of carbon per hectare, shall be used to express emission factors for deforestation, forest degradation, forestation and forest improvement.

For the current Mozambique's carbon accounting, EF refers only to emissions of greenhouse gases per unit area (tCO2e/ha) as a result of deforestation. National level EFs were generated in 2015-17 by using the dataset from the NFI, and used for the construction of the national FREL. In 2018, additional field data was collected in Zambézia province. This dataset, together with the data collected in 2017 for Zambézia province from the NFI will be used as the basis for the updating the EFs for the FREL for ZILMP.

Carbon pools and gases included in the EF

In the current EF, carbon pools only include above ground biomass and below ground biomass. These two carbon pools consists a significant part of the forest carbon stocks, and there is no sufficient data yet for the remaining three carbon pools, namely litter, deadwood and soil organic matters. Only CO2 is accounted so far in the EF due to its significance and lack of robust dataset for accounting other gases.

In the future, EF could be updated through the NFIs (to be implemented every 10 years).

EF for forest degradation shall be developed if Mozambique decides to include forest degradation in its accounting of emissions. Similarly, removal factors for reforestation and forest improvement shall also be developed if Mozambique decides to include them in the accounting of removals. In such case, measurement data of the PSPs (to be implemented every 2 years) is expected to contribute to improve the accounting.

- **Methodology**

The current EF was developed using the data obtained from national forest inventory conducted in 2015-17. It shall be regularly updated using the data to be obtained from the future NFI campaigns. IPCC default values can be utilized for some forest and land classes in case of lack of dataset. The description below summarizes the outline of the NFI.

National forest inventory

National forest inventory (NFI) was implemented to obtain precise information on biomass volumes of forests of different types, ages, densities and locations. Elements of this NFI are described below and their details are given in the Forest Inventory Guideline (Will be attached in Version 1).

Calculation of the required number of sampling clusters

The NFI was designed using stratified random sampling method. For setting up the sampling clusters, the required total number of clusters was determined using the optimal allocation (assuming a maximum error of 10% for the total volume parameter, and 5% of confidence level), and the number of clusters for each stratum was calculated using the proportional allocation approach proposed by Husch, Beers, and Kershaw (2003).

Forest classification

Forests in Mozambique are divided into 6 classes. The following classification was adopted in the NFI conducted from 2015 - 2017. The following table shows the class name and details of 6 classifications.

Table 13 : Forest classes

Code	classes
11	Semi-evergreen closed forest
12	Semi-evergreen open forest
13	Marcuse forest
21	Semi-deciduous closed forest
22	Semi-deciduous open forest
23	Mopane forest

Plot shape (square plot and circular plot)

The shape of a cluster is a square of 100m x 100m. The four corners of a cluster were plot starting points. There are two types of plot shapes for forest and mangrove.

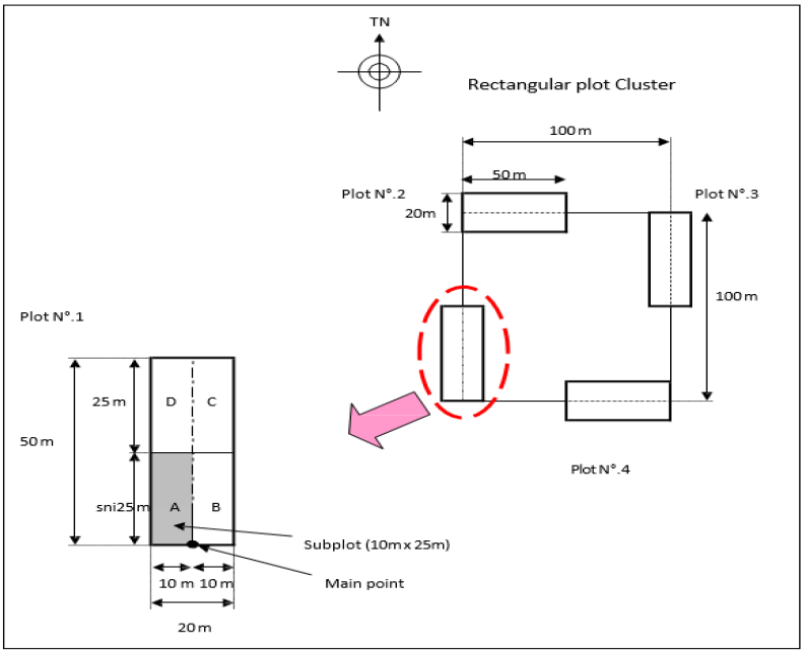


Figure 13 : Plot shape

Data items to be collected and recorded

Data items to be collected and recorded are described in below.

Table 14 : A part of field note to describe Land use of plot

LAND USE OF PLOT

Photo of 360° Image at the center of plot ☐

Forest type of plot on the land cover map *

		Forest type	Forest density
Actual land use of plot	Forest	☐ 1. Mopane forest ☐ 2. Mecrusse forest ☐ 3. Miombo forest ☐ 4. Deciduous forest ☐ 5. Evergreen forest ☐ 6. Mangrove forest ☐ 7. Mixed forest ( ) ☐ 8. Plantation ( ) ☐ 9. Other forest ( )	☐ 1. Open ☐ 2. Closed Crown density of upper story trees ☐ 1. 0-10% ☐ 6. 50-60% ☐ 2. 10-20% ☐ 7. 60-70% ☐ 3. 20-30% ☐ 8. 70-80% ☐ 4. 30-40% ☐ 9. 80-90% ☐ 5. 40-50% ☐ 10. 90-100%
	Non-forest	☐ 1. Bushed ☐ 2. Shrub land ☐ 3. Grassland ☐ 4. Bare area ☐ 5. Tree crops ☐ 6. Field crops ☐ 7. Other non forest ( )	
Felling in the plot	☐ 0. No existence ☐ 1. Existence	Slope Inclination of plot	°

HUMAN ACTIVITY IN THE SURROUNDING AREA OF PLOT

☐ 0. No human activity ☐ 1. Timber production ☐ 2. Fuel wood production
☐ 3. Non wood forest products ☐ 4. Hunting ☐ 5. Slash and burn cultivation
☐ 6. Agriculture ☐ 7. Grazing ☐ 8. Mining
☐ 9. Others ( )

LEGAL RESTRICTIONS

☐ 0. No legal restrictions ☐ 1. National park ☐ 2. Natural reserve ☐ 3. Concession
☐ 4. Others ( )

Note:

* This item should be filled out before field survey

QA/QC measures

A forest inventory manual has been developed for the standardizing survey methods. The manual helps the field crew to understand the survey methods and reduce any errors in conducting the survey. Independent QA/QC teams comprised of experienced specialists re-measures 10% of the entire plots, randomly selected, to estimate the measurement errors (to be used for the assessment of uncertainty) and also to provide feedbacks to improve the quality of NFI in the future.

Emission Factors for ZILMP

Unlike the NFI report which used the plot as a sampling unit for estimating the parameters of interest (mean and uncertainties) of the variables of interest (biomass, carbon and carbon dioxide equivalent), the emission factor for ZILMP used the cluster as a sampling unit, having been the approach of forest inventory data analysis proposed by Bechtold & Patterson (2005) chapter 4 of the book "*The Enhanced Forest Inventory and Analysis Program-National Sampling Design and Estimation Procedures*".

The Bechtold & Patterson (2005) approach was used to correct the problem of sample units (clusters) with variable areas, because the forest type information collected in each cluster at field level showed that the clusters transcend the limits of the strata (cluster with more than one stratum), culminating in sample units of variable area, as well as to solve problems of using a map for sample unit allocation and high resolution images for point movement.

In addition to the methodological aspect for estimating emission factors mentioned above, the emission factors for the ZILMP considered using two equations to estimate tree biomass for the evergreen stratum, which IPCC (2003) equation were used to estimate AGB in the semi evergreen forest, and the Lisbon *et al.* (2018) equation were used to estimate AGB in the semi evergreen mountain forest.

Permanent Sample Plot

Method of updating emission factors based on the results of measurement conducted in the permanent sampling plots will be provided after it is developed. Existing PSP information summary are described in chapter 6.1.2.

6.2.2 Activity Data (AD)

Activity data for Mozambique are to be generated following the good practices for IPCC Approach which are described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.13), i.e., applying the approach 3 that consists in spatially-explicit observations of land-use categories and land-use conversions over time. This approach considers three different options for obtaining the activity data: a) wall□to wall mapping techniques, b) sampling and c) hybrid method (a combination of the two methods). The last two options are the most desirable methods, in order to understand the drivers of deforestation and forest degradation and plan the adequate mitigation activities.

- **Sampling method**

Sampling usually involves a set of sampling units that are geographically located on a regular grid within the area of interest and assessed by remote sensing techniques or fieldworks. A land-use class is then assigned to each sampling unit. Sampling units can be used to derive the proportions of land-use categories within the inventory area. Multiplying the proportions by the total area provides estimates of the area of each land-

use category. Where the total area is not known it is assumed that each sampling unit represents a specific area. The area of the land-use category can then be estimated via the number of sampling units that fall into this category.

Where sampling for areas is repeated at successive occasions, area changes over time can be derived to construct land-use conversion matrices.

Applying a sample-based type for area assessment enables the calculation of sampling errors and confidence intervals that quantify the reliability of the area estimates in each category. Confidence intervals can be used to verify if observed category area changes are statistically significant and reflect meaningful changes.

Sampling concepts that allow for estimation procedures that are consistent and unbiased, and result in estimates that are precise, should be used.

Following this method, a systematic 4 x 4 km grid sampling points at national level consisting in 48,894 points (the same grid used to allocate the NFI sampling clusters based on stratified random sampling), is used to generate the historical activity data over a period of at least 10 years for the national and provincial levels. The same grid is used to generate the activity data for the ZILMP area.

Application: For regular updating (every 10 years) and periodic reporting the FREL (Forest reference emission levels) and National Greenhouse Gas Inventory for the Agriculture, Forestry and Other Land Use (AFOLU GHG Inventory).

- **Hybrid method**

Hybrid method involves a combination of an annual wall-to-wall deforestation map with sampling to estimate activity data for deforestation through an estimator for stratified random sampling.

Application: For annual deforestation monitoring report.

6.2.2.1 Response design

- **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%.

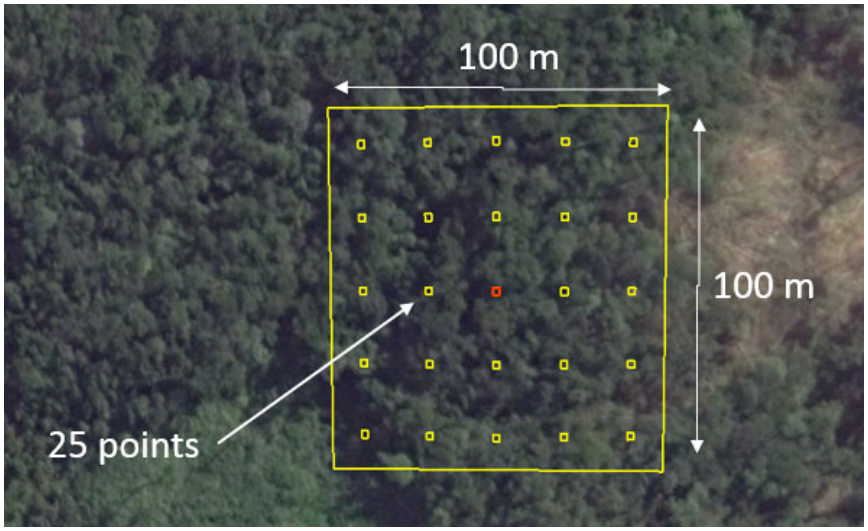


Figure 14 : Image of the spatial sampling unit

- **Source of reference data**

Each sampling unit is assessed using Collect Earth (www.openforis.org). This tool enables access to high resolution images in Google Earth, Bing Maps and Planet Labs, as well as a medium resolution image repository available through Earth Engine Explorer and Code Editor (Landsat and Sentinel-2). The tool enables to display digital forms designed to collect the Land-Use Land Cover Change and Forestry (LULCCF) information on the sampling points (Figure 14). 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 as well as monthly mosaics of Sentinel-2 image. The main source of data to identify changes in land cover, is Sentinel-2 monthly composites. However, Planet Labs data are also used in cases of doubt or excessive cloud cover with Sentinel-2.

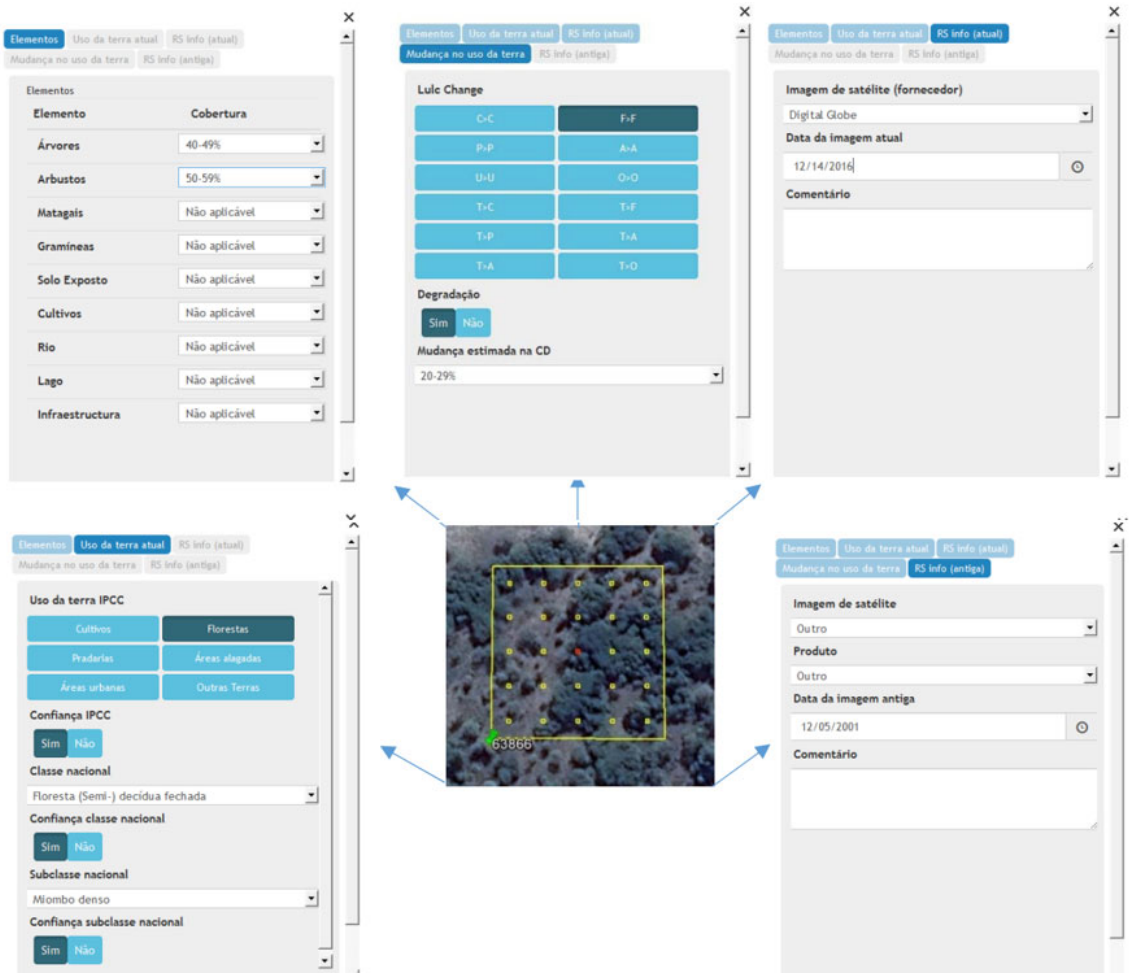


Figure 15 : LULC changes detection using Collect Earth Tool. (www.openforis.org). Forms designed with Collect Tool.

17/12/2005 27/07/2013 12/02/2016

Figure 16 : A temporal analysis of LULC changes of one point from national 4km x 4 km grid sampling.

- **Reference labelling protocol**

The activity data are generated considering the national land use and land cover classification system, which reflects the six broad IPCC Land Use categories.

A set of hierarchical rules were established and used to determine the LULCCF category based on a certain percentage and taking into account the national forest

definition as well (Figure 17. 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.

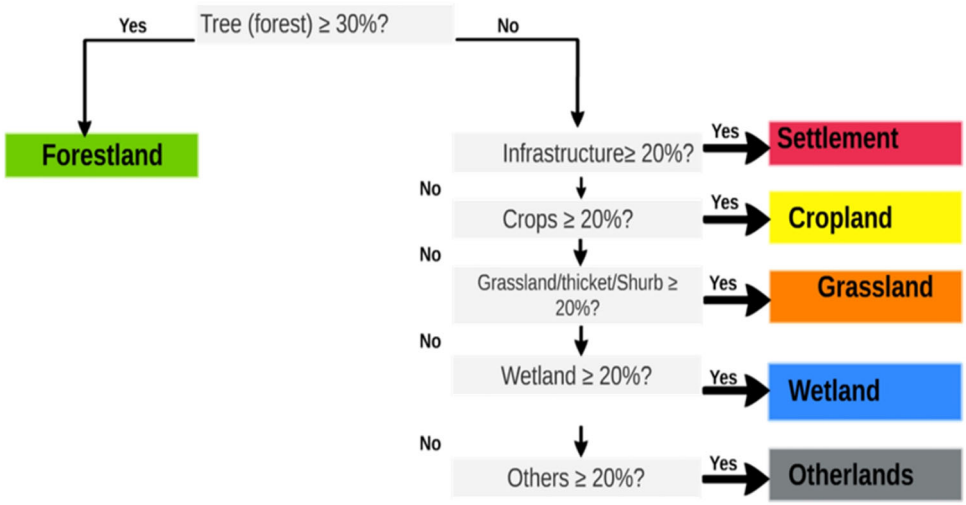


Figure 17 : Decision tree for the allocation of the IPCC Land Use category based on the cover of the objects present in the sampling unit

6.2.2.2 Estimating area and uncertainty

- **Sampling method**

The estimation of the areas corresponding to land- use and land- use changes categories in the systematic sampling framework (based on the visual assessment of the nodes of a 4 x 4 km national grid) is 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.

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):

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

Where:

A Area 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.

- **Hybrid Method**

Following the methodology described in Olofsson *et al.* (2014)[23] and the GFOI MGD .The estimations of the areas corresponding to land□use and land□cover change categories, more specifically the activity data for deforestation, in the stratified random sampling framework (based on the visual assessment of the 1 ha plots) are based on assessments of area proportions. A sample error matrix is constructed, where the map classes (h=1, 2,…,q) are represented by rows and the reference data (k=1, 2,…,q) by columns (Table 15).

Table 15 : Error matrix of area proportions

Map data	Reference data					Total	User's accuracy ($\hat{U}_i$)
	Deforestation			Stable forest	Stable non-forest		
	High probability of deforestation	40 m Buffer	Low probability of deforestation				
High probability of deforestation	$\hat{p}_{11}$	$\hat{p}_{12}$	$\hat{p}_{13}$	$\hat{p}_{14}$	$\hat{p}_{15}$	$\hat{p}_{1.}$	$\hat{p}_{11}/\hat{p}_{1.}$
40 m Buffer	$\hat{p}_{21}$	$\hat{p}_{22}$	$\hat{p}_{23}$	$\hat{p}_{24}$	$\hat{p}_{25}$	$\hat{p}_{2.}$	$\hat{p}_{22}/\hat{p}_{2.}$
Low probability of deforestation	$\hat{p}_{31}$	$\hat{p}_{32}$	$\hat{p}_{33}$	$\hat{p}_{34}$	$\hat{p}_{35}$	$\hat{p}_{3.}$	$\hat{p}_{33}/\hat{p}_{3.}$
Stable forest	$\hat{p}_{41}$	$\hat{p}_{42}$	$\hat{p}_{43}$	$\hat{p}_{44}$	$\hat{p}_{45}$	$\hat{p}_{4.}$	$\hat{p}_{44}/\hat{p}_{4.}$

[23] Olofsson, P., Foody, G.M., Herold, M., Stehman, S.V., Woodcock, C.E., & Wulder, M.A. 2014. Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment. 148:42-57.

Stable non-forest	$\hat{p}_{51}$	$\hat{p}_{52}$	$\hat{p}_{53}$	$\hat{p}_{54}$	$\hat{p}_{55}$	$\hat{p}_{5.}$	$\hat{p}_{55}/\hat{p}_{5.}$
Total	$\hat{p}_{.1}$	$\hat{p}_{.2}$	$\hat{p}_{.3}$	$\hat{p}_{.4}$	$\hat{p}_{.5}$	1	
Producer's accuracy (P_i)	$\hat{p}_{11}/\hat{p}_{.1}$	$\hat{p}_{22}/\hat{p}_{.2}$	$\hat{p}_{33}/\hat{p}_{.3}$	$\hat{p}_{44}/\hat{p}_{.4}$	$\hat{p}_{55}/\hat{p}_{.5}$		$Overall\ accuracy$ $(\hat{O})$ $= \hat{p}_{11} + \hat{p}_{22} + \hat{p}_{33} + \hat{p}_{44} + \hat{p}_{55}$

The mean estimator for the area of each class can be directly obtained from the error matrix. Unbiased stratified estimators are provided using reference data class/stratum area proportions ($\hat{p}_{.k}$):

$$\hat{p}_{.k} = \sum_{h=1}^{H} w_h \cdot \frac{n_{hk}}{n_{h.}} = \sum_{h=1}^{H} \hat{p}_{hk}$$

Where:

$\hat{p}_{.k}$	Area proportions of reference data class/stratum *k*;
w_h	Proportion of area mapped as class/stratum *h*;
n_{hk}	Sample count at cell (*h*,*k*);
$n_{h.}$	Sum of sample counts across row *h*; and
$\hat{p}_{hk}$	Proportion of area in cell (*h*,*k*).

Once the estimated reference class area proportions ($\hat{p}_{.k}$) are obtained, the mean total area per class is calculated by multiplying them with the total monitoring area ***a***:

$$\hat{A}_j = \hat{p}_{.k} \cdot a$$

The estimated standard error for the reference class area proportions is:

$$S(\hat{p}_{.j}) = \sqrt{\sum_{h=1}^{H} w_h^2 \cdot \frac{\hat{p}_{hj} \cdot (1 - \hat{p}_{hj})}{n_{h.} - 1}}$$

where the term inside the root is the variance of the reference class area proportion. Translated to actual area,

$$S(\hat{A}_j) = S(\hat{p}_{.j}) \cdot a$$

Given the confidence level (i.e., 95%, expressed as a fraction, that is, 0.95), the significance level is $\alpha = 1 - confidence\ level$, one must use Student's t given α and the degrees of freedom, $df = n_{h\cdot} - 1$. For large samples, $df \rightarrow 1.96$. Then the confidence interval of the estimated area per class is:

$$CI(\hat{A}_j) = t_{\alpha,df} \cdot S(\hat{p}_{\cdot j})$$

The uncertainty, usually represented as a percentage, then becomes:

$$U(\hat{A}_j) = \frac{CI(\hat{A}_j)}{\hat{A}_j} \cdot 100$$

6.3 Data management

6.3.1 Overview of data management

As presented in Section 5.3, the role of data management system on NFMS is to store information used for forest monitoring and MRV activities, and to publicize such information through the web-portal as a mean to communicate and disseminate with the interested users.

The requirements for data management consist mainly of four components, 1) data entry and management, 2) data analyses, 3) reporting and 4) communication and dissemination.

6.3.2 Current situation of data management system for a forest information

Several data management systems related to forest information have already been developed by DINAF and FNDS with support from partners, such as JICA, FAO and Worldbank. These systems mostly consist of publicizing websites which introduce the project activities and results, and geospatial platforms using web GIS application which publish the forest monitoring information, forest cover map and NFI data, etc.

Table 16 shows the publishing websites for a forest information system.

Table 16 : Publicizing websites of forest information (As of November 2019)

	Website name and URL	Managed by	Outline
1)	Forest Resource Information System (FRIP) http://www.dinaf.gov.mz/pirf_mreddplus/index.php/pt/	DINAF	FRIP is developed as the database system to enable the centrally management and sharing of information and data on forest, forestry and the related issues, and providing functions of searching, perusing and renewing them, with the overall objectives of contribute promoting REDD+ and developing sustainable forest management.
2)	MRV – Início http://www.fnds.gov.mz/mrv/	FNDS	Provide data, reports on activities related to the MRV component for REDD +.

3)	MozFIP - Projecto de Investimento Florestal em Moçambique http://www.fnds.gov.mz/index.php/en/our-projects/project-list/mozfip	FNDS	Part of the National Sustainable Development Program and the "Standing Forest" Project to promote integrated rural development, prioritizing actions to reduce deforestation through the sustainable use of forest resources, land organization and environmental management.
4)	REDD+ (Redução de Emissões por Desmatamento e Degradação Florestal) http://www.fnds.gov.mz/index.php/en/our-projects/project-list/redd	FNDS	REDD + related information, documents (e.g.REDD + national strategies) and related laws are also available.
5)	Forest Information System (FIS) (Under development)	FAO	Concession data

Table 17 : Geo-portal sites for monitoring information (As of November 2019)

	Geo-portal site name and URL	Managed by	Platform	Contents
1)	Forest Resource Information Platform http://www.dinaf.gov.mz/pirf_mreddplus/flexviewers/Retest2/	DINAF	ArcGIS Server	Forest cover map, AIFM data (Agriculture, Ecological Zoning, Soil), Inventory survey, Protection area, etc.
2)	Plataforma de acompanhamento dos Projectos do FNDS http://www.arcgis.com/apps/MapSeries/index.html?appid=6602939f39ad4626a10f87bf6253af1e	FNDS	ArcGIS Online	NFI data, Collect Earth data, deforested area, CO2 emissions, etc.
3)	Visualizador de Dados da Unidade MRV https://www.fndsgis.gov.mz/arcgis/apps/webappviewer/index.html?id=789c4d776cba4e3bb2c32a1a5bc79c4d	FNDS	ArcGIS Server	Biomass energy, Inventory data, LULC Map 2016,MOZFIP project area, MODIS Fires (Past 7 days)
4)	Sistema de Registo de Programas e Projectos REDD+ https://www.fndsgis.gov.mz/arcgis/apps/webappviewer/index.html?id=a593734e1d7948e8abc25fcad51ee0c5	FNDS	ArcGIS Server	Project REDD+
5)	Forest Information System (FIS)	FAO	PostGIS?	Concession data (Under development)

6.3.3 Basic concept of establishment of data management

Based on the fact that several systems have been already in operation, principles of data management will be as follows:

(1) Utilize functions and systems that have been already developed to the extent practical;

(2) Set link exchanges between the websites;

(3) Identify and clarify the information source (metadata information);

(4) Share web layers using ArcGIS for Server map services or OGC (Open Geospatial Consortium, Inc.) services. (Be enable to show the data, which is shown in another Arc GIS for server. Not able to download and edit the data.); and

(5) Clarify the role of each organization and operate it responsibly.

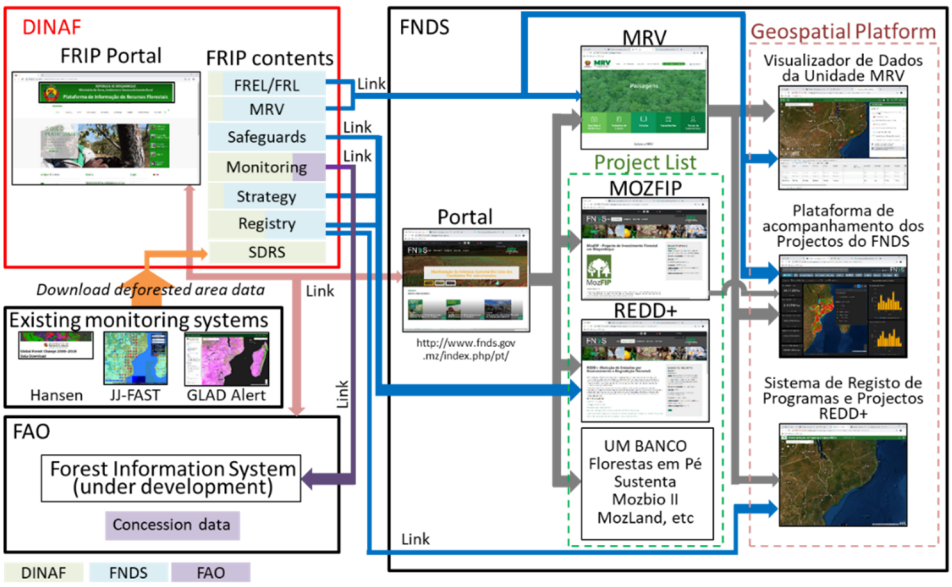


Figure 18 : Relationship with FRIP and related systems (As of Nov. 2019)

Chapter 7 Future improvement

As described in previous chapters, NFMS will be developed step-wise through phases. 1st phase of NFMS mainly focus on periodic estimation of emissions and removals (MRV). In the 2nd phase of NFMS, it demonstrate Measurement & MRV through established mechanism. This chapter clarifies the areas to be further developed or improved for the 1st phase, and describe the contents, methodologies, tools and systems for future phases.

a) Additional contents, methodologies and tools for monitoring

In addition to the monitoring items described in chapter 6.1, additional contents, methodologies and tools for monitoring will be determined and continuously modified along with the evolving discussion and advancement in monitoring technologies. The followings are the candidates for additional monitoring.

Importance for monitoring, capacity of the Mozambique government, cost and others will be a criteria for selecting the appropriate monitoring targets:

- Charcoal producers & production data
- Communities in forest production areas
- Forest sector financing and benefits sharing
- Logging data from concession/single license using FIS
- Tree planting/ restoration data
- Timber legality & law enforcement data
- Forest fire data (

b) Design and development(arrange) of IT systems

As described in Chapter 6.3, existing systems will be utilized for building the NFMS IT system. The bottom-line is to establish URL links between the websites in order to enhance user accessibility and avoid duplication of the contents to be shown among each other. On the other hand, some data could be shared through Arc GIS service or OGC.

The next step is to clarify and agree in details, the data to be stored in each IT system, and the access level to download/edit/use those data. It is also necessary to clarify the roles and responsibility of each organizations.

c) Utilization of the SDRS(Satellite-based Deforestation Reference System)

In parallel to the development prototype of the SDRS (Satellite-based Deforestation Reference System), it is important to identify how the system will be used. In principle, the output from SDRS (except the annual deforestation data in FNDS) is not suitable to be used directly for statistical report, as the original data used for the system are global dataset which are not tailored to the condition of forest in Mozambique. The limitation in accuracy level of detecting deforestation need to be understood. On the other hand, it can be used as reference data to analyze the deforestation hotspots, time-series trends, etc.

As desk-based monitoring, followings are the initial ideas:

- Analyze deforestation areas and their size by province every one to three months and provide the information from central to province; and
- Analyze deforestation areas and their forest types to analyze the time-series trend of deforestation.

As field-based monitoring, followings are the initial ideas:

- Monitor illegal loggings for selecting the priority patrol areas and guide the rangers to field-check:
- Monitor conservation areas. Produce automated alerts from the system for the areas of interest as soon as deforestation events occurred;
- Monitor the concession area to check whether logging is practiced as planned in the allowed areas. For example, concession area data and deforestation

data from the system can be overlaid by collaborating with FIS; and

- Collaborate with community-based monitoring being tested by ZILMP.

Discussion including above points are ongoing through SDRS user meeting. The contents, interface and utilization of the SDRS might be changed based on the above meeting.

d) New Forest law

The new forest law is under preparation as of April 2021, and NFMS monitoring will be clearly stated in the new forest law; The aim is to create an integrated forest monitoring system with several subsystems that will provide a comprehensive view and information for reporting progress of forest sector at national and international level.

Chapter 8 Chapter 8 Institutional arrangement

8.1 Overall responsibility and coordination mechanism

At the time when development of this NFMS document started in 2019, the Mozambique NFMS was agreed to be administered under the political leadership of MTA, technically designed and coordinated through collaboration of DINAF and FNDS.

The government restructuring in 2020 resulted in extinction of MITADER with the creation of Ministry of Land and Environment (MTA), and extinction of MASA with the creation of the Ministry of Agriculture and Rural Development (MADER). As a result, DINAF has moved to MTA and FNDS has moved to MADER. However, DINAF and FNDS confirm to continue collaboration through the agreed institutional arrangement.

The Mozambique NFMS will be implemented through participation of related government agencies (e.g. DINAB, DINAT, DINAMC), research institutions (e.g. IIAM, UEM) and development partners and their projects (e.g. WB, FAO). For such purposes, the NFMS Taskforce and NFMS Working Group are established.

- **NFMS Taskforce**

Under the authority of DINAF, the NFMS taskforce was established in 2019 as a core team for designing, developing and operationalizing the NFMS. The responsibilities of the NFMS taskforce are listed below and:

- Analyze the international and national discussions related to the NFMS and reflect them into the NFMS design.
- Define the definition, scope and elements of the NFMS.
- Define, to the extent practical, the technical details of the elements of the NFMS.
- Define the institutional arrangement for operating the NFMS.
- Define the key milestones of actions related to the NFMS.
- Identify priority capacity needs and capacity building plan.
- Estimate and collaborate with related entities to mobilize the budget required for developing the NFMS.

- Periodically monitor and evaluate the progress of the NFMS development and modify as necessary.
- Facilitate communication and collaboration among stakeholders, e.g. related government agencies, development partners, academia, NGOs and private sectors.
- Facilitate coordination between forestry sector and other sectors (e.g. land sector, climate change sector) and government programs for consistency and synergy.
- Report the progress to DINAF.
- The NFMS taskforce shall, as a principle, meet every 3 months to discuss the progresses and issues related to the NFMS, and agree on the future actions.

• **NFMS Working Group**

NFMS Working Group was established in 2019 as a group of stakeholders related to the NFMS with its role to provide related information, inputs and advice to the development and operationalization of the NFMS.

- The NFMS taskforce will nominate the members of the NFMS Working Group. Good representation of stakeholders shall be ensured and the members can be modified reflecting the needs and changing environment.
- Participation to the Working Group is voluntary.
- The NFMS Working Group shall, as a principle, meet every 6 months upon request by DINAF to advise, support and collaborate in the development of NFMS.

The following figure shows the relationship between TF and WG.

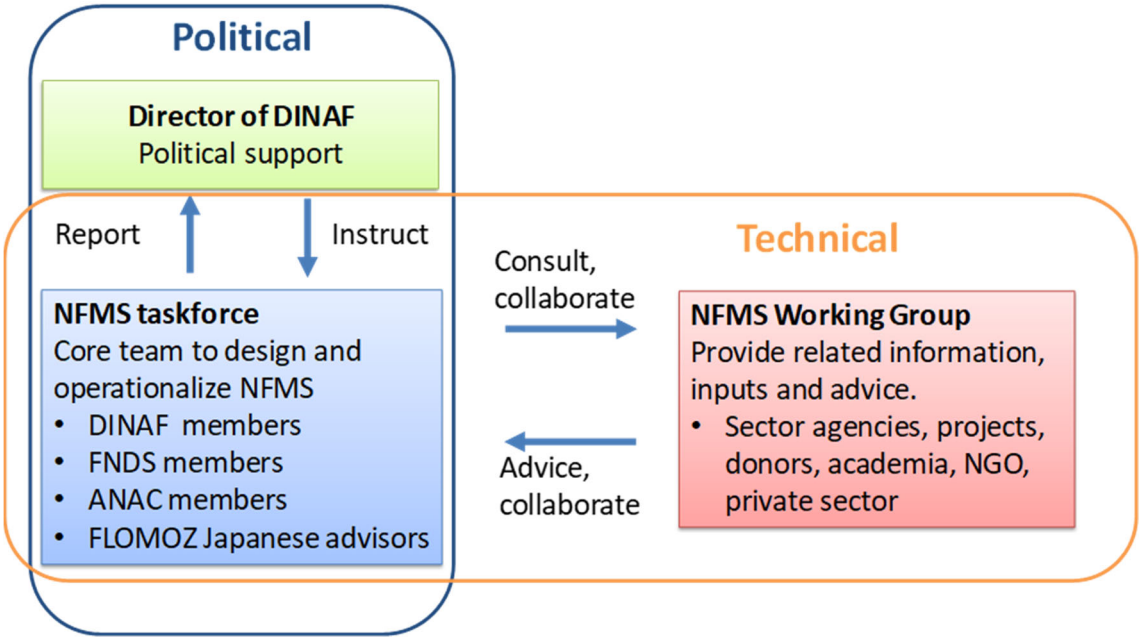


Figure 19 : Relationship between Task force (TF) and Working group(WG)

8.2 Competencies of the key agencies and partners in relation to the NFMS

DINAF, MTA
DINAF is the national agency responsible for the development and operationalization of the NFMS in collaboration with related partner agencies. This includes some roles related to data generation, quality assurance, data management and dissemination through their IT infrastructure, and obtaining necessary authorization from MTA. DIRF under DINAF shall play a key technical role and also a secretarial role to organize the NFSM taskforce and Working Group activities.
FNDS, MADER
FNDS is responsible for collaborating with DINAF in developing and operationalizing the NFMS. Mobilization of financial resources for the NFMS is also expected. Their role includes data generation and quality assurance for forest monitoring, MRV (national, sub-national), and data management and dissemination through their IT infrastructure. MRV Unit under FNDS shall play a key technical role and work as member of the NFMS taskforce.
ANAC, MTA
ANAC is an independent agency established under MTA responsible for the management of conservation areas. They play an important role on protecting the biological resources, controlling licensed hunting and ecotourism activities in conservation areas, and managing and training the personnel such as park rangers. ANAC shall play a key technical role and work as member of the NFMS taskforce.
DINAB, MTA
DINAB has the primary responsibility for managing biodiversity (e.g. ecosystem and biological resources) and coordinates alignment of state actions with related bilateral and multilateral agreements on biodiversity. DINAB is a member of the NFMS Working Group.
DINAMC, MTA
DINAMC is responsible managing issues related to climate change, such as mitigation and adaptation actions as well as information management. As the national focal point to the UNFCCC is responsible for communicating climate change actions including reporting of the national greenhouse gas emissions to the UNFCCC. DINAMC is a member of the NFMS Working Group.
DINAT, MTA
DINAT is responsible for the management of the national cadastre, the attribution of DUATs

and the delimitation of community lands. Land-use planning with clear recognition of land tenure or use rights are crucial for the sustainable management and use of land and forest resources. DINAT is a member of the NFMS Working Group.
AQUA: Agência Nacional para o Controlo da Qualidade Ambiental, MTA
AQUA is an independent agency under MTA responsible for law enforcement related to environment, such as forest law, environmental law among others. They conduct forest patrolling and inspection of timber supply-chain to prevent and detect illegal acts against forest and environment conservation. AQUA is a member of the NFMS Working Group.
IIAM, MADER
IIAM is national research institute under MADER. The Department of Natural Resources of IIAM carries out research and development activities including forestry, gene bank, water management and soil management. IIAM's capacity on soil analysis could be used for assessing the soil carbon stocks and their changes due to the changes in land-use. They are also one of the entities for the PSP network being discussed with financial support from the FNDS. IIAM is a member of the NFMS Working Group.
UEM
UEM (particularly the Faculty of Agronomy and Forest Engineering) has researchers and practitioners competent in various areas related to forestry including remote sensing and forest inventory. UEM also offers training to institutions at national and local level, including districts and communities on forest monitoring and MRV. UEM is a member of the NFMS Working Group.
AMOMA
AMOMA (Mozambican Association of forest operators – now in the process of transforming into a federation) is a national level association for the forestry operators which represents the interests of their members. They advocate for matters such as streamlining of license issuance, increase in sustainable harvesting quota, fine system and so forth. They also suggest incentive policies to promote sustainable management and use of forests such as financing, tax reduction and other advantages for investment in industrial tree plantations.

Data management responsibility

It is important to ensure that each data produced as a part of the NFMS go through an established steps (i.e. data generation, quality assurance and authorization) to become an official data (regardless whether they are to be published or not). This will give confidence to both the data producers and data users, and also helps Mozambique to enhance transparency and accountability on their datasets. Table 18 below shows how

the data (mainly for REDD+ MRV and monitoring) should be managed.

Table 18 : Data management responsibility

	Data generation	Quality Assurance	Authorization
LULC data	Sampling	DINAF and UEM (as a technical resource)	MTA-DINAF
	FNDS MRV Unit		
	Wall-to-wall		
	FNDS MRV Unit and DINAF(DIRF)		
	Annual deforestation		
	FNDS MRV Unit		
Biomass data	NFI	DINAF	MTA-DINAF
	DINAF (DIRF) and FNDS MRV Unit		
	PSP		
	Led by IIAM, collaborate with FNDS, DINAF, UEM		
PMRV[24]	Local community with support from FNDS	DINAF	MTA-DINAF

Reporting process

As explained in Chapter 3, one importance of the NFMS is to support efficient reporting of the theme in subject. A clear reporting process helps each of the entities to understand their roles and responsibilities, and avoid unnecessary confusions at the time of reporting. This will also help each entities to prepare their budget, time and human resources required. Table 19 below shows the suggested reporting process for the reporting items identified in Chapter 3.

Table 19 : Reporting process

	Report compilation	Report validation	Authorization	Submission
UNFCCC (FREL/FRL, NC/BUR, REDD+ TA)	FNDS MRV Unit and DINAF (DIRF)	DINAF and UEM (as a technical resource)	MTA	DINAMC
FRA	DINAF (DIRF)	DINAF	MTA	DINAF
NFP	DINAF	DINAF	MTA	n.a.
NRS&AP	FNDS	DINAF	MTA	n.a.
ZILMP	FNDS MRV Unit	FNDS	MADER	FNDS

[24] PMRV has been piloted in ZILMP and the results are being summarized as a report. The PMRV has potential to become a tool for various purposes, such as for validating the satellite-based forest monitoring, for enhancing community-based forest management, etc. Further discussions are expected following the completion of the report.

Chapter 9 Budget

	Action	Type	Scale	Year							Sub-total	Fund source	Remarks
				2020	2021	2022	2023	2024	2025	2025-2030			
MRV	LULC data	Wall-to-wall	National				260,000		60,000	60,000	380,000	to be sought out	(to be further discussed) Wall-to-wall base map x 1 Change detection x 2
		Sampling for activity data	National								-	ditto	ditto
			ZILMP		100,000	100,000	100,000	100,000	100,000		500,000	FNDS	Budget from MOZFIP and ERPA payment
		Annual deforestation monitoring	National	included in above							included in above	FNDS	ditto
			ZILMP	ditto							included in above	FNDS	ditto
	Biomass data	NFI	National							2,700,000	2,700,000	to be sought out	timing to be discussed.
		PSP	National		180,000	180,000	180,000				540,000	to be sought out	to be further discussed
Forest monitoring	Community monitoring	PMRV	Under planning								-	FNDS	
	Near-real time deforestation monitoring	SDRS									-		
	Degradation monitoring										-		
	Concession monitoring										-		
	...										-		
Data management	DINAF IT system	FRIP	National		49,000	49,000	49,000	49,000	49,000	195,000	440,000	to be sought out	
	FNDS IT system	FNDS MRV platform	National/sub-national/project								-	to be defined by FNDS	
	Sub total				329,000	329,000	589,000	149,000	209,000	2,955,000	4,560,000		