Lao People's Democratic Republic

NATIONAL FOREST MONITORING SYSTEM

Road map

October 2020

Department of Forestry

Ministry of Agriculture and Forestry, Lao PDR

Contents

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List of Abbreviations and Acronyms

AD	Activity Data
AE	Allometric Equation
ADB	Asian Development Bank
AGB	Above Ground Biomass
B	Bamboo
BCC	Biodiversity Conservation Corridors Project
BGB	Below Ground Biomass
BUR	Biennial Update Report
CF	Coniferous Forest
CI	Confidence Interval
CliPAD	Climate Protection through Avoided Deforestation programme
COP	Conference of Parties
DAFO	District Agriculture and forest Office
DALAM	Department of Agricultural Land Management
DB	Database
DBH	Diameter at Breast Height
DCC	Department of Climate Change
DD	Dry Dipterocarp Forest
DFIU	District Forest Inspection Unit
DMS	Data Management System
DOF	Department of Forestry
DOFI	Department of Forestry Inspection
DW	Dead Wood
EF	Emission Factor
EG	Evergreen Forest
E/R	Emission and Removal
ERs	Emission Reductions
ERPD	Emission Reductions Program Document
ESMF	Environmental Social Management Framework
ESMP	Environmental Social Management Plan
EU	European Union
FAO	the Food and Agriculture Organization of the United Nations
FCA	Forest Cover Assessment
FCPF	Forest Carbon Partnership Facility
FCPF-CF	FCPF's Carbon Fund
FIPD	Forestry Inventory and Planning Division
FLEGT	Forest Law Enforcement, Governance and Trade
FLR	Forest Landscape Restoration
FLUP	Forest and Land Use Planning
FOF	Faculty of Forestry
FRA	Global Forest Resources Assessment
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
F-REDD	Sustainable Forest Management and REDD+ Support Project in the LAO PDR
FS	Forest Strategy
FTM	Forest Type Map
GCF	Green Climate Fund
GDP	Gross Domestic Product
GFOI	Global Forest Observations Initiative

GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für internationale Zusammenarbeit
GL	Guideline
GLAD	Global Land Analysis and Discovery Group at UMD
GoL	Government of Lao PDR
ICBF	Integrated Conservation of Biodiversity and Forests
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
JICS	Japan International Cooperation System
KfW	Kreditanstalt für Wiederaufbau
Lao PDR	Lao People's Democratic Republic
LSB	Lao Statistics Bureau
LULC	Land Use Land Cover
M	Million (when used for expressing units)
MAF	Ministry of Agriculture and Forestry
MCB	Mixed Coniferous Broadleaved Forest
MD	Mixed Deciduous Forest
MMR	Measurement Monitoring Reporting
MONRE	Ministry of Natural Resources and Environment
MRV	Measurement, Reporting and Verification
NAFRI	National Agriculture and Forestry Research Institute
NCs	National Communications
NDCs	Nationally Determined Contributions
NFI	National forest Inventory
NFIS	National Forest Information System project
NFMS	National Forest Monitoring System
NGD	National Geographic Department
NRS	National REDD+ Strategy
NSCC	National Strategy on Climate Change
NSEDP	National Socio-Economic Development Plan
NTFP	Non-Timber Forest Product
NTV	Non-Tree Vegetation
OA	Other Agriculture
OLDM	Operational Logging and Degradation Monitoring System
P	Plantation
PAFO	Provincial Agriculture and Forest Office
PaMs	Policy and Measures
PDMS	Provincial Deforestation Monitoring System
PRAP	Provincial REDD+ Action Plan
ProFEB	Protection and Sustainable Use of Forest Ecosystems and Biodiversity project
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation of forests and enhancement of forest carbon stock
RF	Removal Factor
RL	Reference Level
R-PIN	Readiness Plan Idea Note
RS	Remote Sensing
RV	Regenerating Vegetation
SEPAL	System for Earth Observation, Data Access, Processing, Analysis and Land Monitoring
SFM	Sustainable Forest Management
SIS	Safeguards Information System
SOP	Standard Operating Procedure
TWG	Technical Working Group

UC	Upland Crop
UMD	University of Maryland
UNFCCC	United Nations Framework Convention on Climate Change
VPA	Voluntary Partnership Agreement
WWF	World Wild Fund for Nature

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Chapter 1 Background and Purpose

1.1 Background

Lao PDR became actively involved with REDD+ in 2008 with the submission of its R-PIN to the FCPF. The country has also benefited from the ongoing support of several REDD+-specific donor programs, including the Climate Protection through Avoided Deforestation (CliPAD) program, funded by KfW and GIZ, and the Sustainable Forest Management and REDD+ Program (F-REDD), funded by JICA. Lao PDR is currently preparing its National REDD+ Strategy and National REDD+ Action Plan.
The national Forest Reference Emission Level/Forest Reference Level (FREL/FRL) was submitted to the UNFCCC in 2018 and the technical assessment was completed in January 2019 and serve as the baseline for future results-based payments. All the information is published in the UNFCCC REDD+ web platform[1]. The first national MRV[2] was conducted in 2020 with the results communicated in the 2020 BUR[3] and will serve as a basis for the submission of the application for the GCF Results-based payment. In 2018, Lao PDR submitted the ERPD for FCPF's Carbon Fund for six provinces in the north of the country. Following the approval of the ERPD at the 18th Carbon Fund meeting, the Government of Lao PDR (GoL) and Worldbank are in the final stage of negotiating the Emission Reduction Purchase Agreement (as of October 2020).
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 the system is encouraged to be developed step-wise. In fact: FAO suggests multi-purpose approach for NFMS4; GFOI defines NFMS as "the arrangements in a country to monitor forests" which meet MRV requirement and other objectives5; and many of the countries (e.g. Brazil, Cambodia, Ecuador, Zambia) are in process of/aiming to develop NFMS not exclusively for REDD+.

The successful completion of Lao PDR first MRV in 2019 demonstrated that the NFMS is operational. As a result, the REDD+ results for the period of 2015-2018 is 12,805,253 tCO2e for reduced emissions and 1,873,301 tCO2e for increased removals respectively over 4 years.

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 titled as the 'NFMS Roadmap' is developed as a shared vision for developing the NFMS and to enhance coordinated actions among the stakeholders. The NFMS Roadmap is made through a consultative process and provides clear orientation for developing further and operationalizing NFMS for Lao PDR which enables internal and international purposes.
The roadmap document aims to describe the current NFMS, and also proposes potential improvements. 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), forest

[1] https://redd.unfccc.int/submissions.html?country=lao
[2] http://dof.maf.gov.la/en/publications/
[3] https://unfccc.int/documents/231736
[4] FAO (2018) Strengthening National Forest Monitoring Systems for REDD+
[5] GFOI (2016) Methods and Guidance from the Global Forest Observations Initiative, Edition 2.0.

cover change monitoring, operation of the IT system including the NFMS web-portal and NFMS database as data management system, institutional arrangement and action calendar of NFMS, for implementing and managing NFMS in Lao PDR.
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 Roadmap taskforce was established as a core team to draft, review and validate the NFMS Roadmap document. The FIPD is the designated focal point to oversee the process and FIPD leaders and technicians from the RS/GIS unit and the Survey unit were appointed as members of the taskforce. 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. Important meetings for the production of the NFMS Roadmap

Date	Meeting	Location	Outcome
2nd March 2020	Initial meeting with FIPD leaders	FIPD	Agreement on the NFMS Roadmap document timeline and assignment of the leader of the taskforce
3rd March 2020	1st meeting of the NFMS Roadmap taskforce	FIPD	Overall outline of the NFMS Roadmap document and work plan agreed. Composition of the taskforce agreed
18th March 2020	8th REL/MRV TWG meeting	DOF	Agreement on the NFMS Roadmap plan
3rd September 2020	9th REL/MRV TWG meeting	DOF	Review of the final draft of the NFMS Roadmap

Chapter 2 Objectives of the NFMS

Lao PDR 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 oversight of FIPD/DOF, and in collaboration with related stakeholders, in particular other governmental institutions involved with the forestry sector as DOFI, DALAM and DCC;
- The NFMS should be target-driven, oriented towards specified sub-national, national and international objectives;
- The NFMS shall build on existing systems as far as practicable;
- 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-term. 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.

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

Chapter 3 Communication processes and action calendar

3.1 Reporting requirements and the role of NFMS

The NFMS provides the framework to enable Lao PDR to fulfill its subnational, national and international commitments regarding forest monitoring and climate change mitigation. In that regards, the NFMS is the mean to follow the change in forest resources and facilitates accountable reporting and decision-making with increased transparency and long-term reliability.

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). Lao PDR submitted its Intended National Determined Contribution in October 2015. Following the National Strategy on Climate Change (NSCC) approved in 2010, Lao PDR main intended targets are an increase in renewable energy to 30% of total energy consumption by 2025 and as stated in the National Forestry Strategy to the Year 2020, increasing forest cover to a total of 70% of land area by 2020. In this scenario, the forests in the Lao PDR would be able to sequestrate about 60,000-69,000 ktCO2e by 2020.
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 and Biennial Update Reports**

The UNFCCC requires non-Annex I Parties (including Lao PDR) 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 Lao PDR) and small island developing States may submit BURs at their own discretion. To this date, Lao PDR has not yet submitted any BUR but it is currently under preparation by MONRE for a submission planned in 2020. However National Communication have been submitted in 2000 for the first one and in 2013 for the second one, and MONRE plans to submit the third also in 2020. The UNFCCC decision (Decision 12/CP.17, paragraph 8) requires the FRELs/FRLs to maintain consistency with each country's GHG inventories.

- **UNFCCC REDD+**

By setting the way forest monitoring and MRV should be conducted, NFMS facilitates the implementation and the reporting of REDD+. Lao PDR submitted its national FREL UNFCCC in May 2018.

- **NFMS and benefit sharing**

The draft NRS has so far outlined an indication on the REDD+ benefit sharing framework. It follows key principles such as effectiveness, efficiency, and equitable sharing. The REDD+ Benefit Sharing TWG has been examining the issue of benefit-sharing, to establish a framework that can be used by different REDD+ projects and programs.
The monitoring of performance for the distribution of results-based payment and/or conditional performance-based benefits based on proxy (e.g. using deforestation rate as being proposed under the Lao GCF Program) are crucial elements for implementing benefit sharing. Such a monitoring system is inherently linked to the NFMS.

- **NFMS and monitoring of safeguards**

Lao PDR is currently 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 and transactions. The ER Program 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.
The implementation of safeguard plans will be done in part through the NFMS elements particularly where the safeguards relate to geo-spatial concerns such as conversion of natural forests into other land uses.

- **Forest Resources Assessment**

The FRA is a global initiative under FAO to report in a consistent manner country's forest resource. In 2014, Lao PDR submitted its country report to FAO for the FRA2015. For the FRA2020, Lao PDR already sent its contribution to FAO. For the next FRA, FAO plans to develop tools to make the reporting more consistent and transparent. Such improvements may be included into the NFMS.

National reporting

- **Forest strategy**

The Forest Strategy to the year 2020 for Lao PDR is a document initiated in 2000 and endorsed by the Prime Minister's Office in 2005. It provides guidance to develop the forestry sector in accordance with national socio-economic development plans and environmental conservation measures. One target is to improve forest policy and management to eradicate poverty. It also sets the objective of regenerating six million ha of "unstocked forest" and planting trees up to 500,000 ha to attain a forest cover of 70% of the country.
The process of updating the Forest Strategy 2020 (FS 2020) in line with Government's Vision 2030 has started with a review of the implementation of the FS 2020 to establish a Forest Strategy towards 2030. The NFMS shall first contribute to the revision of the Forest Strategy, and then to its implementation and monitoring after the revision is completed.

- **National REDD+ Strategy**

With the support of FCPF financing, Lao PDR has drafted a National REDD+ Strategy (NRS) to 2025 and Vision to 2030.
The NRS aims to address five key sets of drivers of deforestation and forest degradation, concerning: 1) agricultural expansion onto forest land; 2) unauthorized expansion of infrastructure and mining on forest land; 3) poorly-managed tree plantations; 4) unsustainable or illegal logging and NTFP harvesting; and 5) shifting cultivation and forest fires. The NRS specifies programs and strategic interventions over three phases, (2018-2020), (2021-2025), and (2026-2030).

Sub-national reporting

- **ER-P FCPF**

Lao PDR's ERPD has been reviewed and approved at the FCPF-CF's 18th meeting (held in Paris in June 2018). The implementation of REDD+ activities in six northern provinces constituting approximately 35% of the national territory, may generate carbon credits during the period 2019-2025.
The ER Program aligns with the draft National REDD+ Strategy (NRS) to 2025 and Vision to 2030, and is intended to inform strategic and operational lessons for scaling up REDD+ nationwide. The ER Program is also strategically aligned with the Government's highest level development plan, the 8th National Socio-Economic Development Plan (NSEDP: 2016-2020).
The ER Program anticipates a potential income stream equivalent to 13.24million ERs (USD 66.2million based on USD 5/tCO2e).Such ex-ante estimation of emission reductions and removals are based on the areas of interventions to be implemented and a co-efficient applied to reflect efficiency rate for non-land-based interventions. This reflects net results of approximately 19.36 million tCO2e, against the 2005-2015 reference level (RL), to be achieved. Of this, 12.67 million tCO2e are from reduced emissions, and 6.69 million tCO2e are from enhanced removals. Emissions and removals will be accounted through MRV/MMR that follows the NFMS, for the period from January 2019 to December 2021 and

then from January 2022 to December 2024.
Under the ER Program, in addition to MRV/MMR, the drivers of forest cover change will be monitored. This system will eventually be scaled-up to the national level and be included into the NFMS. The NFMS hosts a central database for accessing the dataset necessary for the reconstruction of the RL, as well as both MRV/MMR and monitoring data.

- **PRAP**

Provincial REDD+ Action Plans have been prepared for the six provinces under the ER-P. In addition, the ADB BCC Project has also supported the development of PRAPs for the three southern provinces they are working in. PRAPs are plans which are designed to guide the implementation of Policies, Actions and Measures (PAM) to reduce emissions from deforestation and forest degradation. In other words, PRAPs are a tool to design and guide the implementation of REDD+ activities at provincial and local level.
Provincial level with PAFO and POFI is also involved in implementing forest monitoring activities which are part of the NFMS.

3.2 Action calendar for the NFMS

The 'NFMS Reporting Calendar' below in Table 2 summarizes the reporting actions which Lao PDR forestry sector shall undertake: the NFMS will play an essential role to fulfill the requirements. The Table 3 outlines the required data to be produced on time to stick with the calendar.

Table 2. NFMS reporting calendar

	International					National		Sub-National	
	NDC	FREL/FRL	NC/BUR	UNFCCC REDD+	FRA	FS	NRS	ER-P (FCPF)	PRAP
Status	Submitted INDC in 2015	Submitted in 2018	2nd NC in 2013	Submitted in 2018	Submitted in 2019	2005	Draft	Submitted in 2018	Submitted in 2018
Year									
2020	Updated submission		3rd NC 1st BUR	1st MRV (2015-2018)					
2021									
2022			2nd BUR					1st MMR	
2023									
2024			4th NC						
2025	Updated submission	New FREL		2nd MRV				2nd MMR	
2026			3rd BUR						
2027									
2028			5th NC						
2029									
2030	Updated submission		4th BUR						

Table 3. NFMS data requirement timeline

	LULC data			Biomass data
	Wall to wall		Sampling	NFI
Scale	National	ER-P	National	National
Latest dataset	FTM2019		FCA 2015	NFI 2019
Year				
2020			FCA2020	
2021				
2022	FTM2022	1st MMR		(4th NFI)*
2023				
2024				4th (or 5th) NFI
2025	FTM2025	2nd MMR		

*the need of 4th NFI for the 1st MMR of the ER-P is still under discussion.

Chapter 4 Forest in Laos

4.1 State of forests in Lao PDR

Institutional context

Management of forests in Laos is under the jurisdiction of the Department of Forestry (DOF) under the Ministry of Agriculture and Forestry (MAF). The Department of Forest Inspection (DOFI) under MAF as well, is responsible for inspection and law enforcement. The 8th National Socio-Economic Development Plan (2016-2020), the National Forest Strategy to the Year 2020 and the (Intended) Nationally Determined Contributions (NDC) include the commitment to increase forest cover to 70% by 2020 through sustainable forest management as well as reforestation and afforestation measures. The main law related to forestry in Laos is the 2019 Forestry Law. It defines all natural forestland, including communal village forestland, as the ultimate property of the national community, which is being represented by the State. In 2012, the Prime Minister's Order 13/PM suspended the consideration and approval for new investment projects related to mining prospecting and exploration, rubber and eucalyptus plantation concession, due to the expansion of concessions to the significant detriment of forests. However, this ban has been lifted in 2018 only for tree plantation with the PMO 09/2018. In 2016, the Prime Minister's Order 15/PM, aimed to combat illegal logging by prohibiting the export of round and sawn timber as well as semi-finished products. Only finished wood products can be exported. Also more recently, the Decree (247/GO 2019) has allowed the export of certain plantation round log.

Institutionally, REDD+ in Laos is overseen by the REDD+ Taskforce, an inter-ministerial body chaired by the Deputy Minister of MAF and representing 8 different ministries as well as the National University of Laos. Technical inputs and guidance to the REDD+ Taskforce is provided by six Technical Working Groups, representing the following key topical areas: REL/MRV, Land Use, Enforcement and Implementation of Mitigation, Legal Framework, Benefit Sharing and Social and Environmental Safeguard.

Lao PDR also benefits from the ongoing support of several REDD+-specific donor programs, including the Climate Protection through Avoided Deforestation (CliPAD) program, funded by KfW and GIZ for the first phase and GCF for the second phase starting in 2020, and the Sustainable Forest Management and REDD+ Program (F-REDD), funded by JICA. Targeted, in-kind support is also provided by FAO, primarily for the development of the country's ER-PD submission.

The Government has also marked further commitment to the forestry sector by starting its negotiations with the EU towards a Voluntary Partnership Agreement (VPA) for Forest Law Enforcement, Governance and Trade (FLEGT) in 2017, and initiated development of Timber Legality Assurance System, which will directly and indirectly support the REDD+ agenda. Different forest and biodiversity conservation initiatives also contribute to achieve targets related to the forestry sector.

Table 4. Main active Multi/bilateral projects in REDD+, FLEGT and forest sector

Name	Focus	Timeline	Focal point
Forest Carbon Partnership Facility – Carbon Fund	Supporting Emission Reduction Program implementation	2019 - 2025	DOF
Climate Protection through Avoided Deforestation (CliPAD)	GIZ and GCF co-funded project to provide policy advice and capacity development supporting the establishment of the national and provincial REDD+ framework and REDD+ planning processes. At the local level, mitigation activities are piloted and pro-poor REDD+ mechanisms and sustainable financing models are developed. The previous phase of CliPAD (funded by GIZ/KFW) ends at the end of 2020	2020 - 2025	DOF PAFO
Sustainable Forest Management and REDD+ Program (F-REDD)	JICA funded project aiming to strengthen capacity for clarification of REDD+ strategy and improve forest resource information with the purpose to promote sustainable forest management (SFM)	2018 - 2021	DOF
ProFEB Protection and sustainable use of forest ecosystems and biodiversity	Joint initiative of the Lao Government and German development cooperation, this GIZ project supports the VPA negotiation process between the EU and Laos.	2019 - 2021	MAF DOFI
ICBF Integrated Conservation of Biodiversity and Forests	Lao-German initiative funded by KfW. Effective management of selected target landscapes including protected areas and corridors to sustain biodiversity in forest ecosystems, while	2015 - 2022	MAF DOF/DOFI PAFO DAFO

	supporting livelihoods of forest-depending communities.”		
BCC Greater Mekong Subregion Biodiversity Conservation Corridors Project	BCC is funded by the ADB. The Project's impact is sustainable, climate resilient forest ecosystems benefiting local livelihoods.	2011 - 2020	MAF
CARBI-2 The Carbon and Biodiversity Phase 2 Project	Avoidance of Deforestation and Forest Degradation along the Border in Central Vietnam and Southern Lao PDR in Salavan and Sekong Provinces (CarBi Phase 2) is a transboundary project that contributes to the protection, restoration, and sustainable use of ecosystems and the conservation of biological diversity in the Central Annamites Landscape (CAL). CarBi 2 is implemented by WWF through KfW, and part of the International Climate Initiative (IKI)	2019 - 2025	DOF PAFO
Additional Financing for Scaling Up Sustainable Forest Management Project (AF-SUPSFM)	AF-SUPSFM is the final phase of a series of projects started in 2003. The objectives of AF-SUPSFM continue to be linked to REDD+ and climate change mitigation through improved governance and forest law enforcement as well as capacity in participatory sustainable forest management, forest restoration, reforestation and afforestation, and enhancing forest landscape management. AF-SUPSFM is implemented by DOF with financial support from the World Bank	2020-2021	DOF

Village Forest Management Project (VFMP)	VFMP is FC through KfW VFMP's intended Project Impact is that "The condition of forest ecosystems and the livelihood of the population in the project areas are improved by the sustainable management of village forests." The project works in the provinces Sayaboury (Phieng District) and Luang Prabang (Phonxai District)	2019 - 2026	DOF

Forest definition and forest characteristics

Lao PDR's forests are ecologically unique and of global importance for their biodiversity. Forest plays a crucial role in the economy of Lao PDR. According to the Forestry Strategy to 2020 (published in 2005), forests contributed 3.2 % of GDP in 2001. Around 80% of the population relies on the forest for timber, fuel, food, fibre, medicines and other products. In rural areas, forests provide one of the few possible economic activity alternatives and NTFPs often provide more than half a family's total income.

The land and forest classification system of Lao PDR as initially outlined in the National REDD+ Strategy, then further developed and endorsed by MAF in December 2017 describes its Level 1 (the most aggregated), IPCC Forest Land classes as "Current Forest" and "Potential Forest". "Current Forest" means the natural forest and forest plantation having a tree cover with a crown density of at least 20 %, a contiguous area of more than 0.5 ha, and trees with a DBH more than 10 cm. "Potential Forest" is Land previously forested, but presently not meeting the definition of "Current Forest" due to various disturbances, and expected to be restored to "Current Forest" status if continuously left undisturbed. At the first level of disaggregation, Level 2, the "Current Forest" is further classified into five different natural forest types and forest plantation. "Potential Forest" in Level 2 is composed of Regenerating vegetation and Bamboo classes as shown on Table 5 below.
The "Regenerating Vegetation" class reflects the temporarily un-stocked forests or forest fallow that are often a consequence of shifting-cultivation practices. Field surveys demonstrated that eight years are required for a fallow land to regenerate to forest.
The Forest Inventory and Planning Division (FIPD) under DOF, produces the national Forest Type Map. According to the 2019 Forest Type Map shown in Figure 1, land with forest covers nearly 13.25 million ha, equivalent to 57.5 % of the total country land area .
The predominant forest type in Laos is mixed deciduous and can be found throughout the country. In this forest type, half of the species would be deciduous, with bamboo also being present.
Evergreen forest is a richer and denser type of forest found in higher elevated areas such the Annamite mountains along the Laos-Vietnam border or in the north-west in Bokeo province. Various species of rosewood trees like Pterocarpus macrocarpus are usually the target of illegal loggers.
Dry Dipterocarp forest are commonly found in flat land with shallow soil and is composed of rather small trees that are fire resistant (Dipterocarpus Obtusifolius). This forest type is found in the south of the country in Savannakhet, Salavan, Champassak and Sekong provinces.

Coniferous forest and mixed coniferous and broadleaved forest can be found in very specific places in the country such as Xiengkhouang plateau, the Nakai plateau and Sekong province near the Vietnamese border.

Table 5. Land and forest classification system in Lao PDR

Level 1	Level 2	Strata
Current Forest	Evergreen Forest (EG)	1
	Mixed Deciduous Forest (MD)	2
	Coniferous Forest (CF)	
	Mixed Coniferous/Broadleaved Forest (MCB)	
	Dry Dipterocarp (DD)	3
	Forest Plantation	4
Potential Forest	Bamboo (B)	
	Regenerating Vegetation (RV)	
Other Vegetated Areas	Savannah (SA)	5
	Scrub (SR)	
	Grassland (G)	
Cropland	Upland Agriculture (UC)	
	Rice Paddy (RP)	
	Other Agriculture (OA)	
	Agriculture Plantation (AP)	
Settlements	Urban (U)	
Other Land	Barren Land (BR)	
	Other (O)	
Wetlands	Water (W)	
	Swamp/Wetland (SW)	

Regenerating vegetation is mainly found in the northern part of the country where shifting cultivation practices are dominant.
Plantation forests which have considerably expanded during the last decade, only represent 1.7% of the current forest. Rubber plantations have been developed in the north (Luang Namtha and Oudomxay provinces) and in the south (Champassak and Attapeu provinces) respectively by Chinese and Vietnamese investors. Acacia or Eucalyptus plantations were developed for the need of the paper industry mainly in the central provinces like Bolikhamxai and Khammouane provinces.
For the purpose of the REDD+ MRV including the MRV/MMR for the ER Program and to reduce uncertainty of emissions and removals while balancing the accuracy of sampling and the cost/efforts required, the national land and forest classes are condensed into five strata according to their carbon stock measured by the National Forest Inventory.

- Evergreen Forest (EG) has distinctly high carbon stocks (205.00tC), thus, separated as an

independent stratum – Stratum 1 (expanse: 2,594,961 ha, 11.3% of the total land area).

- Mix Deciduous Forest (MD), Conifer Forest (CF) and Mixed Coniferous and Broadleaved Forest (MCB) will form one stratum on the basis of similarity in carbon stocks per hectare (87.9tC, 77.1tC, 87.6tc). – Stratum 2 (expanse: 9,267,624 ha, 40.2% of the total land area).
- Dry Dipterocarp Forest (DD) will form one stratum due to the difference in carbon stock from other forest classes (50.8tC), and also due to the fact that they are mostly distributed in the low‐lands and prone to conversion to other land use – Stratum 3 (expanse: 1,171,873 ha, 5.1% of the total land area).
- Plantation (P), Bamboo (B) and Regenerating Vegetation (RV) will form one strata on the basis of similarity in average carbon stock (37.2tC, 24.4tC, 17.4tC) and the limited area of P and B – Stratum 4 (expanse: 6,385,287 ha, 27.7% of the total land area).
- The remaining 12 non‐forest classes form one stratum – Stratum 5 (expanse: 3,634,513 ha, 15.8% of the total land area.

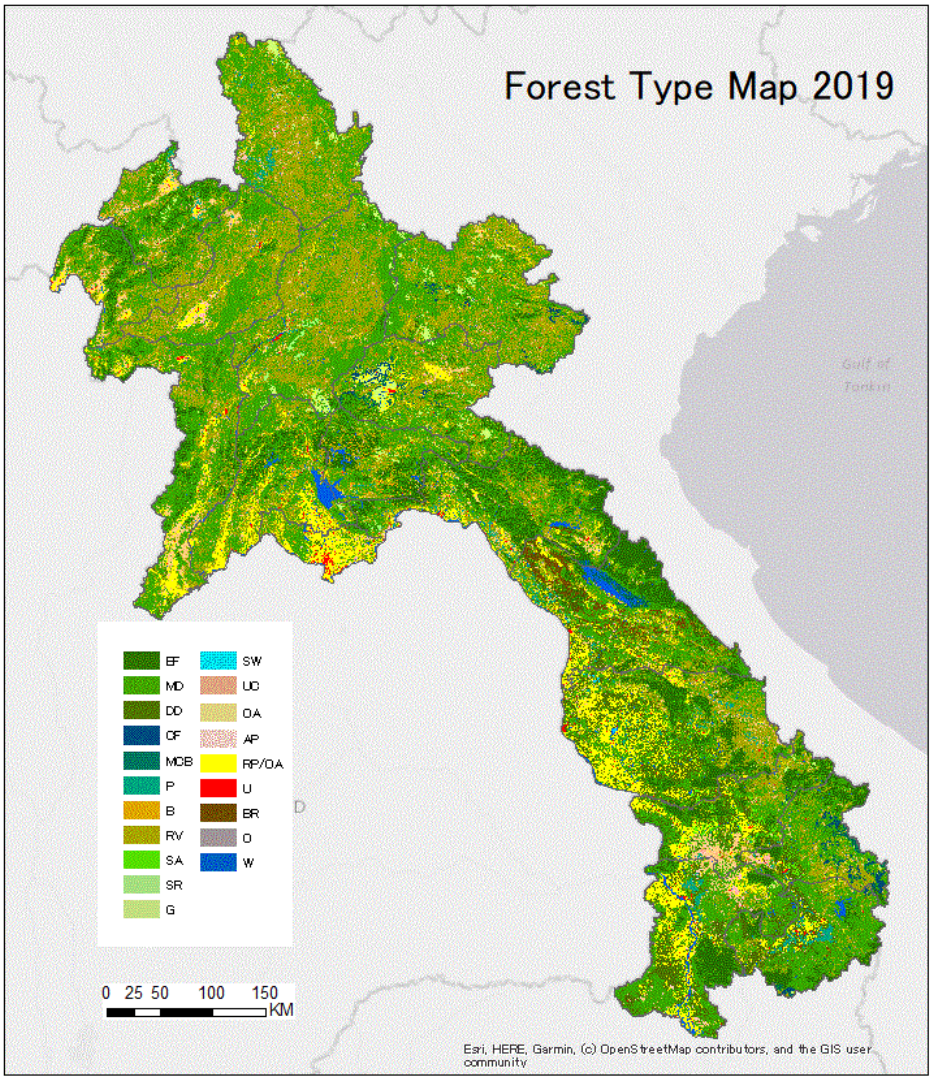


Figure 1 Forest Type Map 2019

Forest use rights and management

The article 4 of the 2019 revised Forestry Law describes the ownership of forest land as below:
Natural forest and forestland is the property of the Lao Nation. The State is the designated authority to centrally manage forest and forestlands in a uniform manner throughout the country with the

participation of all organizations and the people in the management, protection and utilization of forests and forestland in accordance with the law.

Forests and trees planted in designated areas by individuals, legal entities, organizations, and investors, using their own labor and/or funds, are legally recognized by the State Forestry and Forestland Management Organization, and shall become the property of the planters or investors.

Naturally occurring trees in rice paddies, gardens and the residential land of individuals, legal entities or organizations that have received the rights to use the land in accordance with the law and regulations, are the property of these individuals, legal entities or organizations. Trees naturally occurring or planted on public land are the property of the State.

The Article 44 (amended) from the Land Law on the Use of Forest Land says that Forest lands can be used for public purpose, family and businesses without causing adverse impacts on forest, soil quality, environment and society.

The State acknowledges the use of land by people who have been living and earning for their living in forest lands before the area is classified as forest lands by tasking the Ministry of Agriculture and Forestry to coordinate with the Ministry of Natural Resources and Environment, other line Ministries and local administrative authorities to conduct surveys, data collection and re-allocate the forest lands and then issue land use certificates in accordance with the Law to individuals or families and encourage them to contribute to the protection of forests in accordance with Forestry Law and other relevant Laws.

Rights to use forests, including natural forest, forestland, planted forest and forest plantation areas, may be acquired through:
1. The provision of rights to use State forest and forestland;
2. The transfer of rights to use planted forest and forest plantation areas;
3. Inheritance of rights to use planted forest and forest plantation areas.

The chapter III of the 2019 revised Forestry Law identifies three categories of forests based on their functions. The table below indicates the definition of each category under the Forestry Law.
According to GIS datasets from the FIPD in 2016, about 14.5 million ha (more than 50% of the country's land area) is delineated as forests under a national level forest category. The areas indicated in the table below derive from the FIPD dataset and describe only national level categorized forests.
All of these forest areas may include land cover that is not forest.

Table 6. Forest Categories

Category	Functions
Conservation forests	Conservation Forests are forests classified for the purposes of conserving nature, preserving and propagating plant species, aquatic animals and wildlife species, protecting forest ecosystems and sites of natural, historical, cultural, touristic, environmental and educational value and for scientific research experiments. Conservation Forests consist of national, provincial, district and village conservation forests which as specified in a specific regulation Conservation Forest areas are rich in biodiversity, have unique natural scenery, are of outstanding importance at national, regional and global levels and may be proposed as wildlife conservation areas, national parks, regional or world heritage sites.

	These are subdivided into total protection zones (all land uses prohibited), controlled use zones (permanent agriculture, non-commercial logging and collection of forest products allowed), corridor zones (collection of forest products allowed) and buffer zones (non-commercial logging and collection of forest products allowed). There are 24 areas covering 3.8 million ha
Protection forests	Protection Forests are forests classified for the function of maintaining water resources, river banks and road sides, for preventing soil erosion and improving soil quality, for protecting strategic areas for national defence and security, safeguarding against natural disasters and providing environmental protection and other functions. Protection Forests comprise national, provincial, district and village Protection Forests, as specified in a specific regulation. 7.4 million ha are delineated as national Protection Forest.
Production forests	Production Forests are forests including natural forests and planted forests designated for the supply of wood and NTFPs as commodities to satisfy the requirements of national socio-economic development and people's livelihoods. There are 51 areas covering 3.1 million ha.

4.2 Drivers of forest cover change

The draft NRS (2018) identifies five drivers of forest cover change listed below:

- Expansion of agriculture land into the forest,
- Conversion of forest and for infrastructure development (including mining, hydro-power, resettlement, urban expansion),
- Forest degradation from unsustainable timber harvesting and NTFP collection,
- Shifting cultivation and forest fires,
- Conversion of natural forest to commercial tree plantation areas.

The main underlying causes of deforestation and forest degradation can be grouped as following: (1) The formulation of policies for the development of the relevant sectors is not yet centralized, inconsistent and inclusive; (2) Forest management and law enforcement are not strict; the legislation that is a tool for forest management is not yet complete; and the high demand for natural forest timber from domestic and foreign markets is high, leading to illegal logging; (3) Demand for agricultural products in the domestic and external markets is increasing, but the efficiency of agricultural production is still low as traditional methods are still used in agricultural production; (4) Most upland people are still poor and lack of livelihood alternatives other than shifting cultivation; (5) Land allocation and planning to accommodate population growth and investment have not been completed, which in many cases has led to encroachment on forestland.

For the ER-Program, four key drivers of forest cover change were identified through three means, i)

wall-to-wall mapping based on change detection using remote sensing, ii) a spatial drivers analysis based on Hansen tree cover loss data and attribution of disturbances for change, and iii) stakeholder consultations held through a number of workshops conducted at provincial and local levels. The key drivers are:

- Loss of forests to permanent agriculture due to the expansion of permanent agriculture, particularly for cash crops (including maize, rubber, banana, sugar cane, jobs tear, cassava, coffee and tea among others).
- Loss of forests/trees to shifting cultivation landscapes. The primary issue with shifting cultivation is in pioneering shifting cultivation, where shifting cultivation encroaches on forests that have previously not been cultivated in known history. Another issue is the continuous use of these upland shifting cultivation plots with reduced years of fallow, and thereby reducing the chance of regenerating back into the current forest status.
- Loss of forests/trees to infrastructure and other developments. The development of infrastructure, especially roads and electricity lines, has limited direct impact on deforestation; in fact, improved infrastructure has larger impact as an underlying cause of subsequent degradation and deforestation by improving access to previously remote places.
- Unsustainable and illegal wood harvesting. Illegal logging for commercial purposes is considered one of the main drivers of forest degradation. Fuelwood collection for the purpose of household cooking and heating is not considered as a significant driver considering the low population density as well as the association of fuelwood collection from bush fallow, and not intact forests.

4.3 Forest cover change

Data suggest that as of the late 1970s Lao PDR was predominantly forested and has been reduced to its current forest cover of approximately 57.5 % (as of 2019), with accelerated pace of forest loss towards the late 1990s[6] and 2000s. In Lao PDR, the Forest Type Maps were developed for the national level for years 2005, 2010, 2015 and 2019. Importantly, Forest Type Maps are developed applying the 'Level 2' of land/forest classification system, and then further stratified into the five land/forest strata (Table [7]7). The maps for 2005, 2010 and 2015 were used to calculate the FREL while the one from 2019 was used to conduct the first MRV.

Table 7. Strata areas for year 2005, 2010, 2015 and 2019

IPCC Land Use Class	Strata	2005		2010		2015		2019	
		Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Forest Land	Strata 1	2,618,169	11.4	2,613,226	11.3	2,605,557	11.3	2,594,961	11.3
	Strata 2	9,961,368	43.2	9,721,635	42.2	9,437,688	40.9	9,267,624	40.2
	Strata 3	1,272,006	5.5	1,215,712	5.3	1,188,198	5.2	1,171,873	5.1
	Strata 4	6,183,370	26.8	6,042,075	26.2	6,300,445	27.3	6,385,287	27.7
	Sub-total	20,034,913	86.9	19,592,648	85.0	19,531,888	84.7	19,419,745	84.2

[6] Prior the production of the Forest Type Maps, the forest cover in Lao PDR was assessed using a sample-based approach called Forest Resources Assessment. For each sample location distributed with a four by four kilometer grid, the forest cover was assessed by visual interpretation of satellite imagery.

[7] The Forest Type Maps use the national boundary provided by the National Geographic Department in 2010. The total area corresponds to the area given by the geographical layer using the UTM WGS84 coordinate system.

Other	**Strata 5**	3,019,344	13.1	3,461,610	15.0	3,522,370	15.3	3,634,513	15.8
Total		**23,054,258**	**100**	**23,054,258**	**100**	**23,054,258**	**100**	**23,054,258**	**100**

4.4 FREL and MRV

The Table 8 below summarize the approach for both FREL and MRV

Table 8. FREL and MRV elements

Elements	National REL	1st National MRV
Forest definition	"Current Forest": DBH >10cm, Crown cover >20%, Min. >0.5 ha, and "Potential Forest"	Same.
Land/forest classification	Follow national land/forest classification "level 2" for mapping. Then, stratified in to 5 strata.	Same.
Stratification	National land/forest classification condensed into five strata.	Same.
Scope (Activity)	(1) Deforestation; (2) Forest degradation including selective logging; (3) Forest enhancement (restoration); (4)Forest enhancement (reforestation)	Same
Carbon Pools	Included: AGB, BGB Not included: Deadwood, Litter, Soil	Same.
Gases	Only CO2 included.	Same.
Scale	National	Same.
Reference period and validity	2005-2014 (10 years) The validity is for 2015–2025 (11 years)	2015-2018 (4 years) and within the validity period of the FREL/FRL.
Emission Factor	2nd NFI; Country-specific allometric equation: IPCC default values; Vietnam. Stratified into 5 strata to calculate amount of changes in carbon stock.	Using updated data from 3rd NF and RV survey. The rest remain unchanged.
Activity Data	National-scale FTM2005, 2010 and 2015. Stratified in to 5 strata to calculate amount of changes in areas. Final estimation through reference sampling.	Using national-scale FTM2019. Then, stratified in to 5 strata. The rest remain unchanged.
Model applied	Historical average	Same.
Adjustment	No.	Same.

The calculation of the Activity Data uses the wall-to-wall Forest Type Maps stratified in five strata. In addition to the forest degradation assessed by the strata change, forest degradation from selective logging is assessed using stump measurement made during the NFI. The Table 9 below display each activity for the FREL period and the MRV period.

Table 9. Activity Data for FREL and MRV period (ha/year)

	2015-2018	REL
Deforestation	80,768	102,574
Degradation	65,309	81,115
Reforestation	55,075	75,844
Restoration	22,134	84,066

Chapter 5 Summary of the technical scope of NFMS

The NFMS in Lao PDR is composed of three main functions: MRV, forest monitoring and data management. The NFMS was initially developed to support the MRV as illustrated in Figure 2 below.

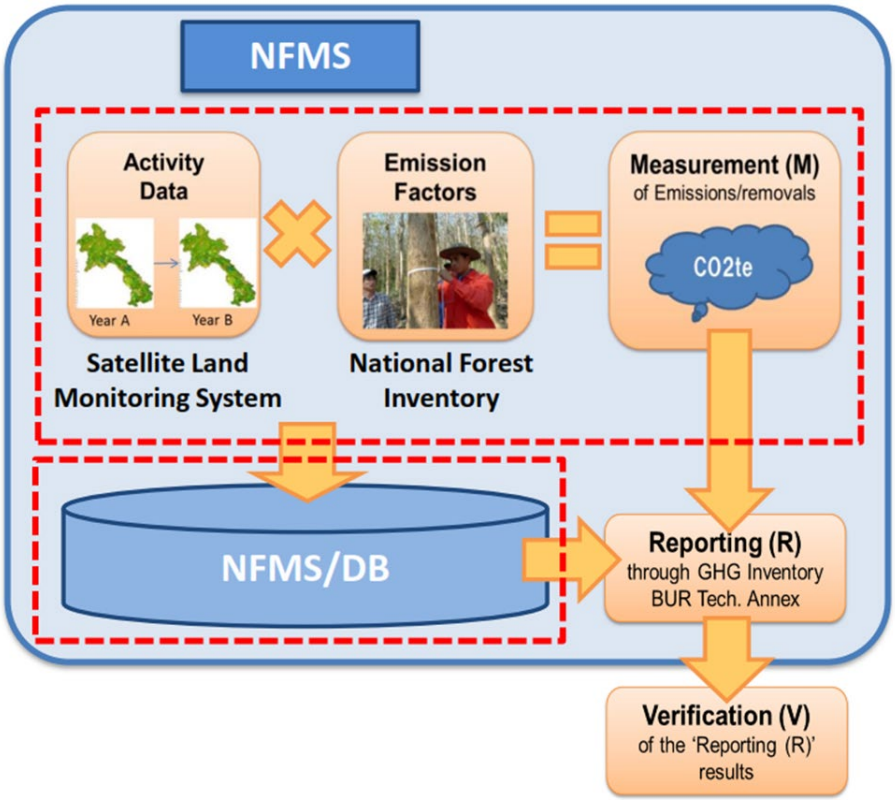


Figure 2. Initial NFMS design that supports MRV

5.1 Scope of MRV

The MRV function monitors the performance of the implementation of the National REDD+ Strategy by measuring periodically the emissions and removals against the FREL. For this purpose, activity data and emissions factors are developed by updating the Forest Type Map and conducting NFI. The MRV/MMR for the ER-P is also covered by this function.

The Forest Type Map are developed using medium and high resolution satellite imagery such as Sentinel-2 and PlanetScope, and a change analysis approach supported by the GLAD dataset. Emission factors are derived from the carbon stocks calculated from the field data collected during the NFI based on surveys of random plots and allometric equations specifically developed for local forest types.

These measurements are reported to UNFCCC through the technical annex of the BUR.

The data and outputs of the measurements supports the monitoring function as well as designing policies on sustainable forest management.

5.2 Scope of forest monitoring

The goal of the monitoring function is to support the sustainable management of forest resources in Lao PDR. In complement to the MRV function outlined above, the monitoring of forest cover change and drivers is implemented through several methods and by various stakeholders or institutions. This function supports the design and the assessment of the effect of the Policy and Measures (PaMs).

Forest monitoring can be conducted at various levels and scales to ultimately enhance the country's forest management as per the on-going examples below:

- Village level monitoring implemented by the villagers with support from donor projects (e.g. CliPAD, SUFORD, CARBI, F-REDD). Remote-sensing based monitoring tool combined with field verification enables the villages and other stakeholders (e.g. local authorities) to objectively monitor the land-use/land-cover, and to receive payment (if such arrangement exists) based on their performance.
- Provincial and district deforestation monitoring using Sentinel-2 imagery, supports law enforcement to protect delineated conservation or protection forest areas.
- Provincial monitoring of forest degradation conducted in coordination with DOFI to prevent illegal selective logging outside the demarcated areas of conversion areas as part of Timber Legality Assurance System for FLEGT.

As described in chapter 7, future development of the NFMS will expand the monitoring function to activities that have an impact on forest resources such as the analysis of concessions data, tree plantations, charcoal production data and the timber supply-chain.
Also, the objective of the NFMS and the monitoring function is to organize and coordinate the various forest monitoring initiatives.

5.3 Scope of data management

In the current NFMS, the database is located at FIPD and managed by its RS/GIS unit. It stores the data required and produced to enable the NFMS MRV and monitoring functions. It consists of:

- Satellite imagery
- Forest Type Maps
- National Forest Inventory data
- Ground truthing and other survey data
- Forest categories and concessions boundaries.

A web-portal is currently under development to provide access to information on forest cover change, emissions and removals, and projects. Discussions are still on-going for the official release.
Future planned development of the web-portal will link it to the SIS as in Figure 3 below.

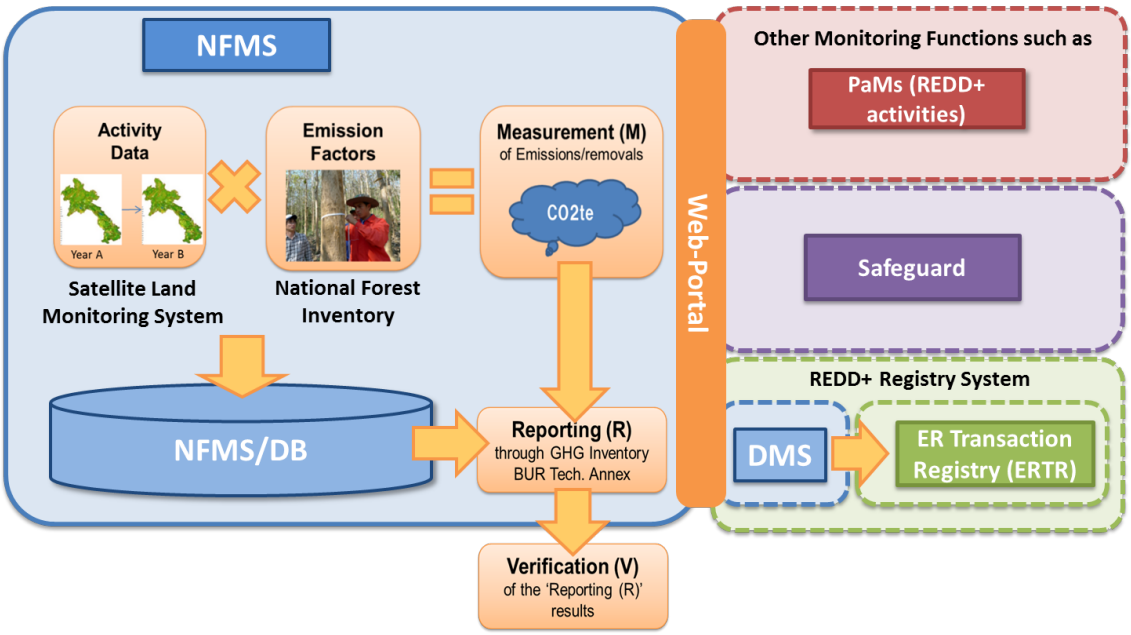


Figure 3. Planned development of the NFMS

Chapter 6 Technical implementation of NFMS functions

6.1 Technical process of current 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 Lao PDR besides the ER-P and the National REDD+ programmes, there are several projects that also monitor the forest and contribute to the sustainable management of forest resources. This chapter describes the main initiatives.

Near Real Time Provincial Deforestation Monitoring System
The F-REDD project supported by JICA, has developed a system to support PAFO and DAFO to monitor deforestation caused by agricultural practices and strengthen law enforcement. It will help to monitor the effect of the PaMs described in the Provincial REDD+ Action Plans (PRAP).
The system has been tested first in Luang Prabang Province in 2019 and is deployed in Oudomxay Province as well since 2020. A plan for roll-out to the northern provinces in collaboration with the GIZ/GCF Project and ER-Program is under discussion.

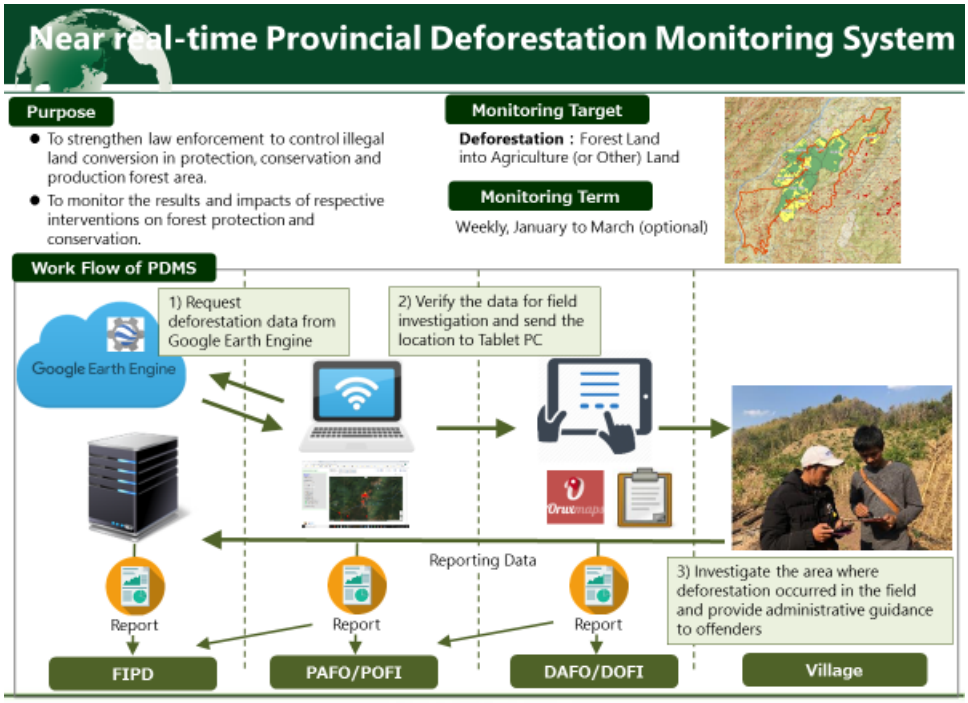


Figure 4. Provincial Deforestation Monitoring System

As shown on Figure 4, the system is built upon a change detection process that uses Sentinel-2 imagery through Google Earth Engine. It enables the PAFO team to visualize locations that are deforested every week. The PAFO team identifies the locations that need to be checked on the ground and digitize polygons of those areas on a dedicated web application that sends the polygons to the DAFO teams by e-mail to their tablets. Once on their tablets, the DAFO sends teams to investigate and collect data on the field. Key information that is collected is:

- Plot number, date of survey
- Province, District, Village name
- Forest function category, Village forest function categories
- Purpose/Reason of land conversion, person/organization involved, Official permission available,
- Measures to offender

- Deforestation place, area (ha), waypoint, polygon, picture

On site, the DAFO officers provide administrative guidance to the offenders.

The collected data is stored automatically in the server in FIPD and can be used for reporting.

This system might be deployed in other provinces and serve other purpose such as land concession monitoring. In the case such system covers the whole country, this could also support the national MRV.

Operational Logging and Degradation Monitoring (OLDM) System

With the support of ProFEB (GIZ), ICBF (KfW) and BCC (ADB) projects, the OLDM System has been developed and implemented in six provinces (Luang Namtha, Bokeo, Khammouane, Champassak, Sekong and Attapeu) since 2018. It is planned to test OLDM during another dry season in 2020/21 (3rd phase) to further train staff and improve technical and procedural aspects before conclusions will be drawn for an institutionalization of OLDM under the government system. This system provides a comprehensive and integrated set of tools that leads users from identification of potential disturbance (similar to the PDMS) through assessment, targeting, mission planning, inspection/survey/interdiction and reporting. The objective for OLDM is to provide a flexible and modular system that can be adapted to a range of forest management activities including law enforcement, management of protected areas, concessions management, infrastructure monitoring, REDD+, forest cover mapping and Forest and Land Use Planning (FLUP). The ProFEB project tests OLDM for the Verification of logging operations in conversion areas (as part of future Lao Timber Legality Assurance System (TLAS) / FLEGT – DOFI), while ADB BCC and ICBF use it for law enforcement, patrol and management of forest zones including National Conservation Areas, and to support monitoring of Forest and Land Use Planning and Village Conservation and Reafforestation Agreements.

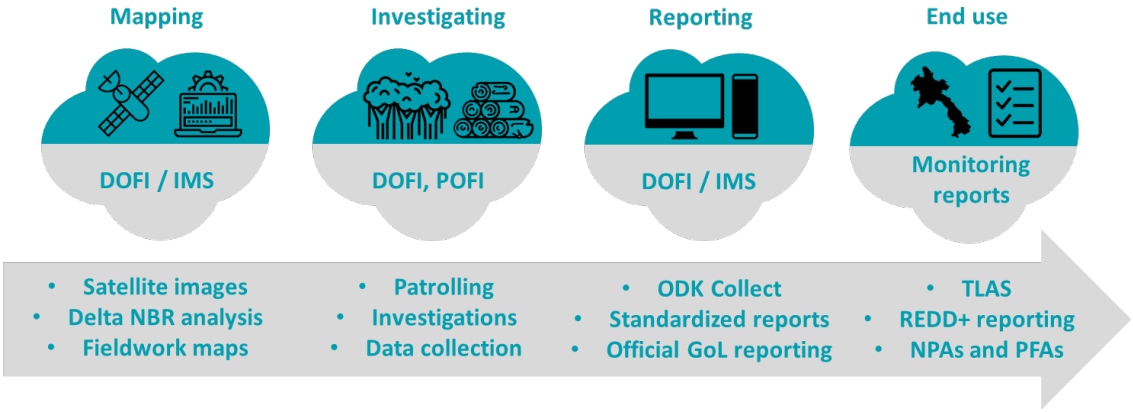


Figure 5. OLDM workflow

As shown on Figure 5, the first step of the system consists of detecting canopy disturbance with the support of the Delta r-NBR script combined with visual inspection of very high resolution imagery such as Planetscope (3 meters resolution). Knowledge of the terrain and communication with local authority help the remote sensing technicians at DOFI to identify human induced forest degradation. Officers from POFI are sent in identified places to investigate and collect data on the ground.

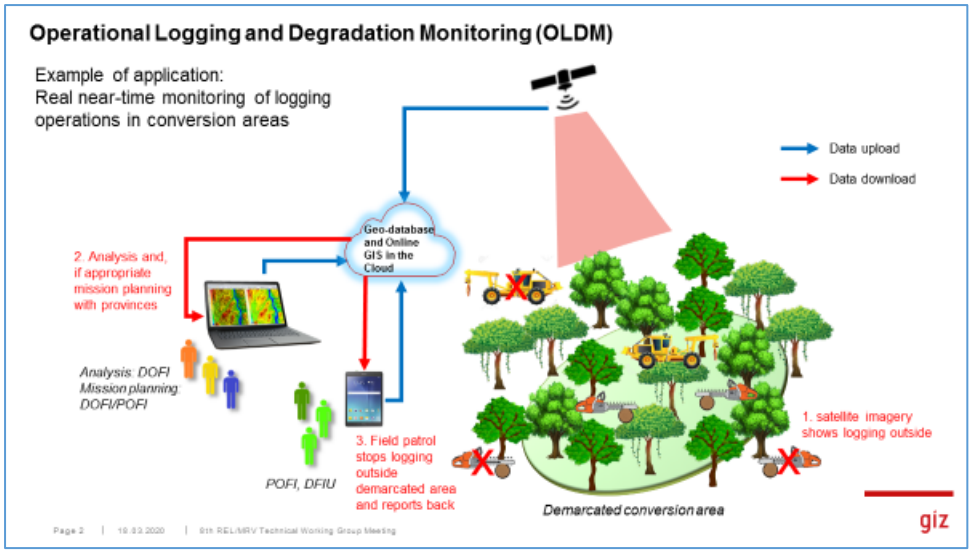


Figure 6. OLDM applied to monitoring of logging operations in conversions areas (Courtesy of ProFEB)

Tracking Forest Crime including illegal logging

With support from the SUFORD projects funded by the Finnish Government and the World Bank, the Department of Forest Inspection (DOFI has developed a national, centralized Smart Phone Information Reporting and Intelligence Tracking System (SPIRIT system). Information collected includes the source of illegal goods and where these goods were to be sold, and owners. The system is in active use in selected provinces, efforts to implement it nationwide continue.

Provincial monitoring with Collect Earth

In 2016 and 2017, The FAO promoted the use of Collect Earth at the provincial level (for the 6 provinces involved in the ER-P) which aimed at helping provincial authorities to tackle deforestation and forest degradation. More specifically the use of such approaches can help to design intervention to address the four drivers outlines in the Laos Emissions Reduction Program (ER-P). Training and testing were conducted in the provinces that lead to encouraging results and feedback

Village Forest contracted management and monitoring

The CliPAD project (GIZ/KFW) supports the development and implementation of Village Forest Management Planning (VFMP) in 70 target villages in two districts of Houaphan province, one of the six provinces covered by the ER-P. Village Forest Management covers the protection and sustainable use of all categories of village forests. In close collaboration with the relevant district authorities, Village Forest Management Agreements (VilFoMA) with the villages are being developed through a consultative Free, Prior, and Informed Consent (FPIC) process. The project already developed village forest management guidelines and a manual about the implementation of forest management related activities, which are feeding into the current development of a national guideline on village forestry. Under this component the Village Forestry and NTFP Division under the Department of Forestry (DOF) is also being advised on improved coordination and harmonization of the different approaches to village forest management in Laos. The Forest cover monitoring in CliPAD is based on system described in Figure 7. Technically it follows the same principles than the previous mentioned systems targeting to use similar non-commercial software available for free. The main objective of the forest cover monitoring in CliPAD is to enable the performance-based payments to the villages. The monitoring system targets to detect changes inside forest areas agreed in VilFoMa (conservation, protection and village use). Certain thresholds (percentage of the change) are applied to decide if the village is eligible for the payments. Currently (July 2020), the first payments have been made to the villages.

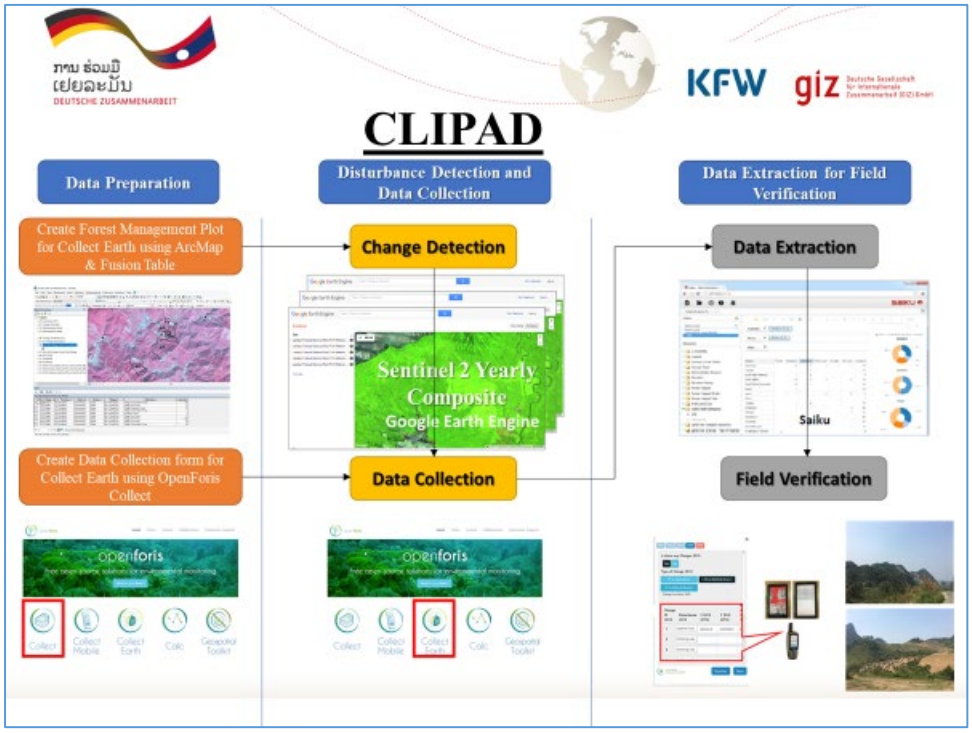


Figure 7. CliPAD Village monitoring system

6.2 Technical process of the MRV

As required under the UNFCCC, REDD+ MRV shall provide estimates in a consistent manner in line with how the FREL was established. The implementation of MRV should be accurate, transparent and consider national capabilities and capacities. This chapter describes in detail how Emission Factor (EF) and Activity Data (AD) were calculated for both FREL submitted in 2018 and the 1st MRV conducted in 2019. The elements of the FREL and MRV were outlined in the previous chapter in Table 8.

Emission Factor (EF)

The development of the EF is based on the three main following inputs:

- National Forest Inventory (NFI) that measures carbon stock of the five natural forest classes: Evergreen Forest (EG), Mixed Deciduous Forest (MD), Dry Dipterocarp Forest (DD), Coniferous Forest (CF), and Mixed Coniferous and Broadleaf Forest (MCB).
- Regenerating Vegetation Survey that study the years for a forest fallow (classified as "regenerating vegetation": RV) to reach the forest status according to Lao's forest definition, as well as to measure the biomass of this vegetation class.
- Country-specific allometric equations for the three major forest classes: EG, MD and DD. Other land/forest classes use IPCC default values or biomass data from neighboring Vietnam.

National Forest Inventory

Lao PDR conducted its 1st NFI in 1991-1999, covering the entire country, however the methodologies applied, and the resulting data were not suitable for the use under REDD+. Improved NFI methodologies were developed and full campaigns were conducted in 2016-2017 and in 2019 for the 2nd and 3rd NFI.

The measured carbon pools are listed in the Table 10 below. The 2nd NFI measurements showed that lying dead wood, litter, sapling and bamboo were contributing only a very small fraction of carbon

stock.
Therefore, measurements focus on Above Ground Biomass (AGB, standing trees) and Dead Wood (standing and tree stumps). Saplings, Non-Tree Vegetation (NTV), Bamboo and lying deadwood were not measured due its small contribution to the total carbon stock and the significant time requirement for measurement: instead the data from the 2nd NFI are used for the estimation.

The 2nd NFI measured Dead Wood (DW) in the five forest classes (EG, MD, DD, CF, MCB). The result showed that DW are not significant source of emissions (approximately 2.3% of the total emissions in the national area). Also, the biomass survey of RV (different from the 2nd NFI) did not measure DW which makes the estimation inconsistent. Therefore, it was concluded not to account DW in the development of E/R factors.
Stump measurement is used to estimate emissions from selective logging.

Table 10. NFI carbon pools

Pool	Survey
Aboveground biomass	
Tree	Yes
Saplings	No
Belowground biomass	IPCC default Ratio
Dead Wood	
Standing/Lying	Yes/No
Stumps	Yes
Litter	No
Soil	No

Measurements occurs in floating cluster nested circular plots. The nested design displayed on Figure 8 ensures an efficient and cost-effective survey.

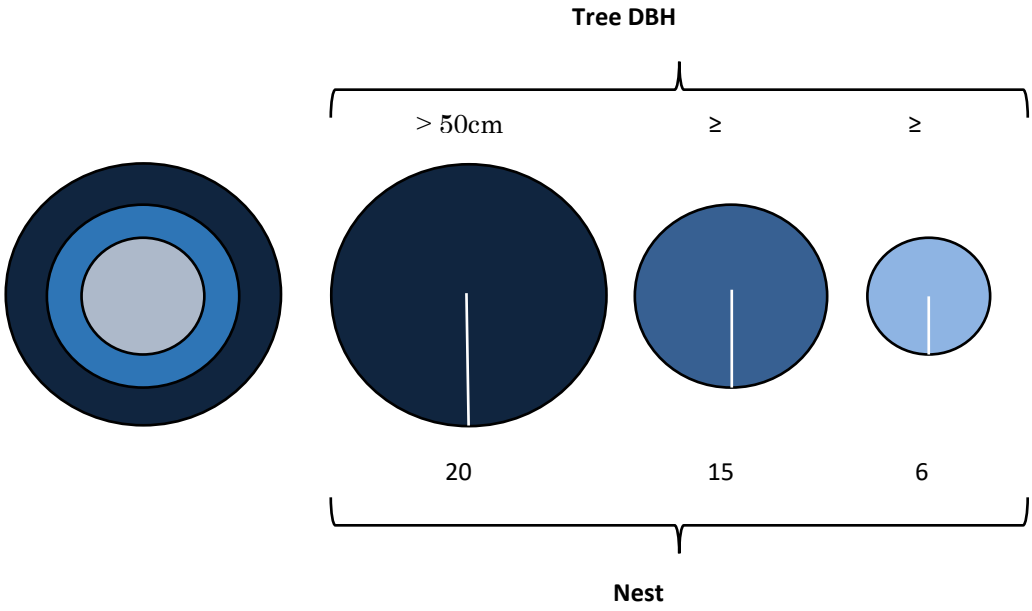


Figure 8. NFI nested plot design

One cluster plot consists of six to ten circular sub-plots to offer more potential locations for the survey

teams as shown on Figure 9. Teams were assigned to survey the tree-plots (new denomination for sub-plot) until four tree-plots are found in natural forest and three tree-plots have the same forest type.

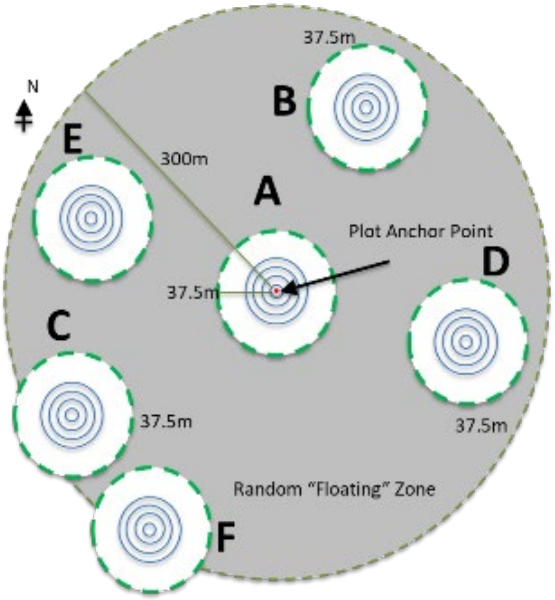


Figure 9. Floating cluster plot design

The number of required plots for each forest type or strata is calculated using the Winrock SamplePlot Calculator tool[8]. The calculation uses the standard deviation of the carbon stock measured for each strata from the previous NFI (the 3rd NFI uses standard deviation from the 2nd NFI), and the level of uncertainty targeted. For EG, MD and DD, the uncertainty target (level of error) is 10% at 90%CI, 20% for CF and MCB.

The plot distribution follows a two-stage stratified random sampling:

1. Each strata is divided in 3 X 3 km cell. The first stage randomly selects as many cells or PSU (Primary Sample Unit) as required number of plots per strata.
2. Within each PSU, the second stage randomly places the anchor point or the center of the plot.

To ensure that the randomly distributed plots fall in forested areas, a visual check is conducted using recent satellite imagery. If recent land cover changes made the plots fall in non-forested area, it is then required to re-run random distribution until the required number of plots is reached.

NFI field implementation is conducted by FIPD and the whole country is covered by six teams, including three staff from FIPD supported by one staff from PAFO, one from DAFO and guide to plot location by villagers. Measurements mainly consist of measuring DBH. The measurement of the height is required only for stumps and standing dead wood.
The teams use tablet or smartphone to navigate to the plots and record the measurements. ODK Collect is the App used for data collection and OruxMaps, the one used for the navigation. The data collected is aggregated on the website ONA and an R script combined with a shinyApp calculates and displays directly the carbon stocks as illustrated in Figure 10 below.

[8] https://www.winrock.org/document/winrock-sample-plot-calculator-spreadsheet-tool/

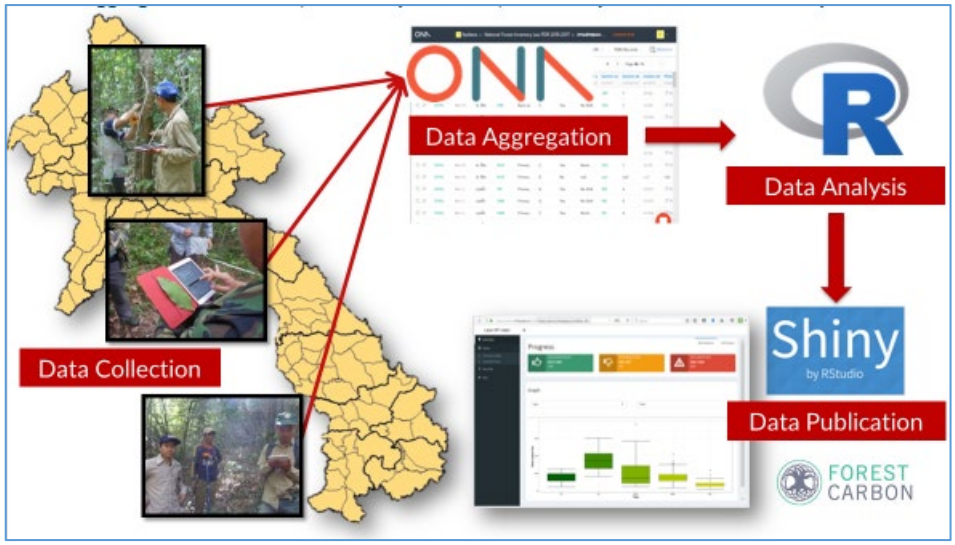


Figure 10. NFI data flow

QA/QC for NFI is ensured by a 7th team that re-measures between 10% and 15% of the surveyed plots. The carbon stocks for each forest types given by the survey teams and the QA/QC team are compared and statistically tested to assess any significant difference. If no statistical difference is found, the survey measurements are validated.

Regenerating Vegetation Survey

In Lao PDR, annually around 100,000-150,000 ha of forest lands are burned for shifting cultivation. The area is cultivated for a short period, often one year, and then left to as fallow to regenerate as "Regenerating Vegetation (RV)" which covered around 25% of the total area of Laos in 2015.

Survey clusters are selected using annual loss dataset from UMD[9] to identify locations with 1 to 9 years of fallow. The 1st RV survey conducted in 2017, measured 40 clusters and the 2nd RV survey conducted in 2019 had 63 clusters. As shown in Figure 11 below, plots are 10 X 10 meters square where all trees are recorded (DBH≧5 cm), and all other vegetation were cut at their base in the four corners of the sub-plots.

[9] Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

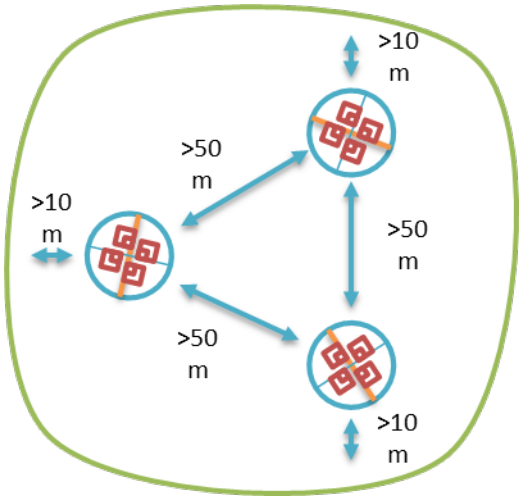


Figure 11. RV survey cluster plot design

Unmanned aerial vehicles (UAV) were used to take aerial photographs of the plots in order to estimate the crown cover rate, which was then used for identifying the number of years for RV to reach the forest threshold.

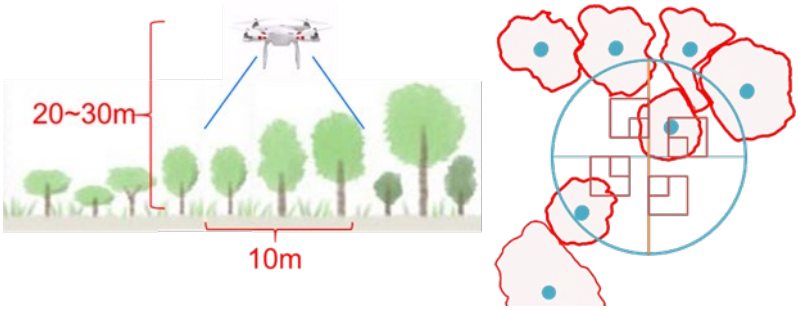


Figure 12. UAV use for RV survey

The survey showed that 7 years were required for a fallow to reach the forest definition of 20% canopy cover which means that a cropland could potentially regenerate into forest status in 8 years if left undisturbed. Therefore, only the biomass from RV plots which were below 7 years of fallow was counted in the calculation.

Allometric equations

The allometric equations were developed by taking a total of 36 sample trees from each forest class (i.e. EG, MD and DD) with a variety of DBH and regional balance.

All destructive field and laboratory sampling methods for trees, deadwood and saplings are based on Winrock International's standard operating procedures (Walker et al. 2014) and the FIPD survey teams were trained on the survey methods according to its procedures. The samples were dried at 100°C using drying ovens to measure the dry weight. Several regression models were applied to develop the allometric equations with R software.

Carbon stock calculation

The Table 11 below summarizes the allometric equations and root to shoot ratio used to calculate the carbon stocks.

Table 11. Carbon stock calculation formulas

C pool	Forest type	Equation/ Value	Source
AGB (living trees, kg/tree)	Evergreen Forest (EF)	0.3112*DBH^2.2331	JICS Forest Preservation Programme TA6 Final report
	Dry Deciduous Forest (DD)	0.2137*DBH^2.2575	JICS Forest Preservation Programme TA6 Final report
	Mixed Deciduous Forest (MDF)	0.523081*DBH^2	JICS Forest Preservation Programme TA6 Final report
	Coniferous Forest (CF)	0.1277*DBH^2.3944	UN-REDD Programme, Hanoi, Viet Nam(2012)
	Mixed Coniferous and Broadleaf Forest (MCB)	0.1277*DBH^2.3944	UN-REDD Programme, Hanoi, Viet Nam(2012)
AGB (Dead standing trees, class 1, kg/tree)	All forest types	0.6*EXP(-1.499+(2.148*LN(DBH))+(0.207*(LN(DBH))^2)-(0.0281*(LN(DBH))^3))*.97	Chave et al. (2005)
AGB (Dead standing trees, class 2 tall tree, kg/tree)	All forest types	$((pi * H)/12) * (D_{base}^2 + (D_{base} * (D_{base} – (H * ((D_{base} – DBH)/ 130 *100))) + (D_{base} – (H * ((D_{base} – DBH)/ 130 *100))^{2)} *0.6 * 0.001$	
AGB (Dead standing trees, class 2 short tree, kg/tree)	All forest types	(PI()*Heigth*100)/12)*(DB^2+(DB*DT)+DT^2))*0.6*0.001	
Stumps (kg/stump)	All forest types	(((Dmean/2)^2*PI())*H)*0.57*0.001	
BGB (Root-to-Shoot Ratio, RS)	EF, DD, MDF, and MCB; AGB < 125t/ha	R/S = 0.20	2006 IPCC Guidelines for National Greenhouse Gas Inventories (Chapter 4: Forest land, Table 4.4)

	EF, DD, MDF, and MCB; AGB > 125t/ha	R/S = 0.24	
	CF; AGB < 50t/ha	R/S = 0.46	2003 IPCC Good Practice Guidance for LULUCF (Chapter 3: LUCF Sector Good Practice Guidance, Table 3 A.1.8)
	CF; AGB = 50 - 150t/ha	R/S = 0.32	
	CF; AGB > 150t/ha	R/S = 0.23	

After the stratification of the Forest Type Map into five strata, the average carbon stock for the new strata was calculated by using weighted value as follows:

Cstrata (tC/ha) = $(C1*A1+ C2*A2+....+Cn*An)/(A1+A2+....+An)$
Where:
Cstrata = average carbon stock (tC/ha) of new strata calculated from biomass and area of land/forest class;
Ci = carbon stock of land/forest class (tC/ha);
Ai = area (ha) of land/forest class

Table 12. Emission Factor used for 2019 MRV

	Stratum 1 (EG)	Stratum 2 (MD/CF/MCB)	Stratum 3 (DD)	Stratum 4 (P/B/RV)	Stratum 5 (NF)
Stratum 1 (EG)	0.0	-432.8	-568.3	-712.4	-737.4
Stratum 2 (MD/CF/MCB)	432.8	0.0	-135.5	-279.6	-304.7
Stratum 3 (DD)	568.3	135.5	0.0	-144.1	-169.1
Stratum 4 (P/B/RV)	712.4	279.6	144.1	0.0	-25.0
Stratum 5 (NF)	737.4	304.7	169.1	25.0	0.0

Uncertainty Analysis
The IPCC GL 2006 for National Greenhouse Gas Inventories (Volume 1, Chapter 3), lists out eight broad causes of uncertainties. After review and analysis, the main causes of uncertainty of E/R factors are considered as follows:

1. Uncertainty of AGB originating from sampling error (3rd NFI data)
2. Uncertainty of AGB originating from biomass equation (See Allometric Equation development report)

3. Uncertainty of Root-to-Shoot ratios due to the use of IPCC default values (IPCC GL 2006)
4. Uncertainty of Carbon Fraction factor due to the use of IPCC default values (IPCC GL 2006)
5. Uncertainty of AGB originating from measurement error (QC of 3rd NFI)

In addition, there are potential systematic uncertainties listed below which are included in the approach applied, however, their impact on uncertainty are difficult to assess or reduce immediately through practical approaches, therefore, considered as an issue for future improvement:
Unknown age class and growth rates of forests, influencing both removals and emission estimates; and application of strata-specific E/R factors which do not explicitly estimate the emissions and removals based on their true dynamics. The resulting over-estimation of emissions from deforestation and degradation is addressed through the analysis of time-series.

The total uncertainty of carbon stock for each forest class estimated through the propagation of error approach.
Ultimately the uncertainty is calculated by sink and by source as shown in the table below.

Table 13. Uncertainty of Emission Factor by sink and source

	Uncertainty (%)
Deforestation	10.1%
Forest Degradation	6.5%
Reforestation	10.1%
Restoration	6.5%

Activity Data (AD)

Activity Data from wall-to-wall maps

Activity data for Lao PDR are generated following the good practices described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.3.1), i.e., using spatially-explicit observations of land-use categories and land-use conversions over time, derived from sampling of geographically located points. Following this approach, Lao PDR developed country-wide Forest Type Maps for year 2005, 2010, 2015 and 2019. As explicated in Chapter 4 Forest in Laos, the maps follow the level 2 of the national classification system and are stratified in 5 strata. The stratified Forest Type Maps are overlaid to create second Forest Cover Change Maps and Forest Cover Change Matrices to derive the AD.

The general process for the development of the FTM is based on change detection and a base map as shown in the below. The 2010 map is the base map. Then, the changed areas were overlaid with the Forest Type Map 2010 to develop Forest Type Map 2005 and 2015. The FTM 2019 is developed with a similar approach by detecting the change that occurred between 2015 and 2019.

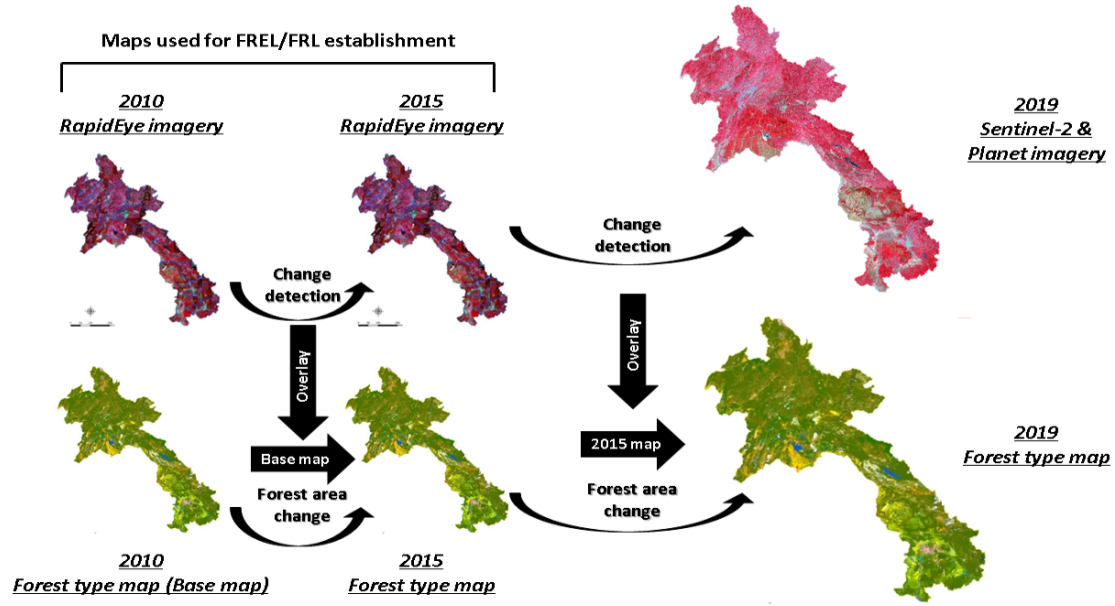


Figure 13. Approach for developing Forest Type Map

The base map 2010 was developed with an object-based approach that uses segmentation of the satellite imagery into polygons which generates a less noisy map than pixel-based approach. The segments or polygons were firstly classified with a supervised process and then corrected by a visual check.
For the MRV, the satellite imagery was acquired through Google Earth Engine.
The change detection is conducted with the support of UMD dataset. The segments of the maps where changes occurred are visually interpreted by FIPD technicians.
The accuracy of each FTM is assessed with 2,101 random plots that are visually checked.

The overlay of two maps enables to assess the areas of change related to the four sources and sinks for emission/removal as in the matrix below where the first year of the reference period is the row and the last year in column:

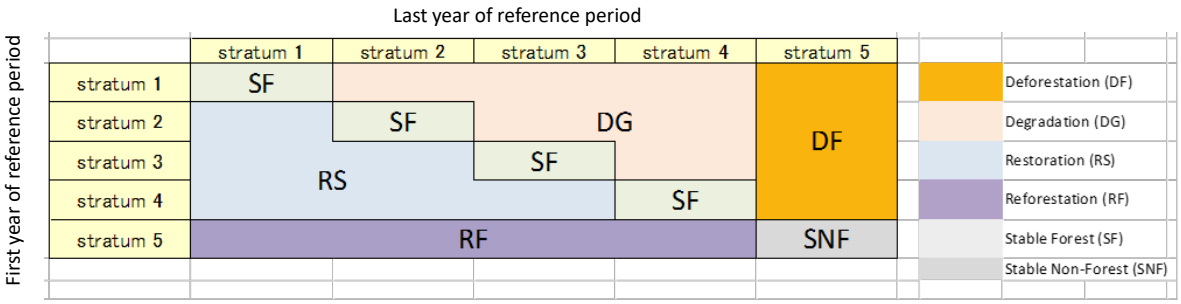


Figure 14. Matrix of change

- **Emissions from Deforestation (DF)**, caused by loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum;
- **Emissions from Forest Degradation (DG)**, caused by downward shift of a forest stratum from a higher carbon stock strata to another forest stratum with lower carbon stock ;
- **Removals from Forest Enhancement (Restoration) (RS)**, caused by upward shift of a forest land stratum with lower carbon stock to another forest/land stratum with higher carbon stock; and
- **Removals from Forest Enhancement (Reforestation) (RF)**, caused by gain of forest carbon stock due to conversion of non-forest land stratum to a forest land stratum.

- In addition, there are two (2) stable types of land/forest classes which do not impact emissions or removals, which are:

- **Stable Forest (SF)**, where there is no change in the forest stratum; and.
- **Stable Non-Forest (SNF)**, where there is no change in the non-forest land stratum.

The change map is then used to calculate the area estimates of the Activity Data. The method follows good practice recommended by GFOI 2016, (Chapter 5 Estimation and Uncertainty) which presents the stratification approach (Cochran, 1977[10]; Olofsson et al., 2013[11], 2014[12]) for generating statistically reliable estimates. Sample plots are generated following a stratified random sampling approach and using the formula below:

$$n = \frac{(\sum W_i S_i)^2}{[S(\widehat{O})]^2 + (1/N)\sum W_i S_i^2} \approx \left(\frac{\sum W_i S_i}{S(\widehat{O})}\right)^2 \qquad (1)$$

Where

n = number of sample points for the stratum of interest

= standard error of the estimated overall accuracy intended to be achieved

Wi = mapped proportion of area of stratum i,

Si = standard deviation of stratum i.

The calculation was done using FAO SEPAL which allows automated calculation of sampling size and distribution. The following value were used as target for allocating statistically sound sampling size using the default parameters of SEPAL:

- Standard error of 0.01 for the overall user accuracy;
- Standard error of 0.7 for Forest Degradation, Deforestation, Restoration and Reforestation;
- Standard error of 0.9 for Stable forest and Stable Non-Forest; and
- Minimum sample size for each stratum is 30.

The table below shows the number of plots required for the period 2010-2015 where a total of 954 plots were distributed.

Table 14. Sampling design for the area estimates computation 2015-2019

Source/Sink Category	Degradation	Deforestation	Restoration	Reforestation	Stable forest	Stable non-forest	Total
Stratum	DG	DF	RS	RF	SF	SNF	
Area (ha)	267,746	184,779	155,603	93,916	18,985,447	3,366,767	23,054,258
Expected User's Accuracy	0.70	0.70	0.70	0.70	0.90	0.90	
Wi (Mapped proportion)	0.01	0.01	0.01	0.00	0.82	0.15	

[10] Cochran, W. G., (1977) Sampling techniques. John Wiley & Sons. p98.

[11] Olofsson, P., Foody, G.M., Stehman, S.V., & Woodcock, C.E. (2013). Making better use of accuracy data in land change studies: estimating accuracy and area and quantifying uncertainty using stratified estimation. Remote Sensing of Environment. 129:122-131.

[12] 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.

Si (Standard Deviation)	0.46	0.46	0.46	0.46	0.30	0.30	
Wi*Si	0.01	0.00	0.00	0.00	0.25	0.04	0.30
					$S(\hat{P})$	(SE overall accuracy)	0.01
					$\left(\frac{\sum W_i S_i}{S(\hat{P})}\right)^2$		929.15
					Total Number of Samples		931
					Sample size per stratum		Total
Equal	155.17	155.17	155.17	155.17	155.17	155.17	931
Proportional	11	7	6	4	767	136	931
Minimum sample size	30	30	30	30	30	30	
Adjusted	**30**	**30**	**30**	**30**	**689**	**122**	931

For the interpretation of changes for each sample plot, we set the spatial assessment unit as 1 ha (100 x 100 m), and square plots laid out with an internal grid and 5 x 5 = 25 reference points (to guide the interpretation) were prepared. The square plots were visually (manually) interpreted using high and medium resolution satellite imagery as the reference data obtained from repositories accessible through Google Earth, Bing Maps and Google Earth Engine, as well as the satellite WMS layers (Landsat2000, SPOT 2005, RapidEye 2010, and RapidEye 2015) of FIPD.

Table 15. Source and sink error matrix 2015-2019

	Reference data						
	DF	**DG**	**RF**	**RS**	**SF**	**SNF**	Total
DF	26	1	1	0	1	1	30
DG	1	19	2	0	8	0	30
RF	0	24	1	1	0	4	30
RS	1	3	23	2	1	0	30
SF	2	5	5	11	686	21	730
SNF	1	2	1	23	2	1	30
Total	31	33	29	26	692	120	931

The visual interpretation is summarized in error matrix that is used to calculate the estimated area proportions to adjust the area for each source and sink and obtain the final AD.

The estimated area proportion is calculated by multiplying the proportion of the source category with the user's accuracy found in the error matrix.
For instance for Deforestation:
Area proportion is 184,779/23,054,208 = 0.008
DF user's accuracy is 26/30 = 0.86
*DF estimated area proportion is 0.008 * 0.86 = 0.068*

Table 16.Area estimates and area proportions for AD computation for the period 2015-2019

Class	**DF**	**DG**	**RF**	**RS**	**SF**	**SNF**
DF	0.0229	0.0031	0.0010	0.0000	0.0021	0.0021
DG	0.0004	0.0067	0.0007	0.0000	0.0028	0.0000
RF	0.0000	0.0000	0.0084	0.0000	0.0008	0.0028
RS	0.0001	0.0000	0.0001	0.0031	0.0002	0.0001
SF	0.0023	0.0056	0.0056	0.0124	0.7739	0.0237
SNF	0.0011	0.0022	0.0000	0.0022	0.0090	0.1044
Reference Class Proportion	0.0267	0.0177	0.0159	0.0178	0.7888	0.1331
Standard error	0.00324	0.00357	0.00295	0.00405	0.00808	0.00659
95% CI	0.00635	0.00699	0.00578	0.00793	0.01584	0.01293
Area	616,370	407,553	367,038	409,422	18,186,260	3,067,614

From the error matrix, user accuracy and producer accuracy of the Forest Type Maps were estimated for the four (4) sources and sinks and the two (2) stable land/forest classes. Finally, the uncertainty of AD was estimated as show in below:

Table 17. Map accuracy and Uncertainty of AD of 2015-2019

Class	DF	DG	RF	RS	SF	SNF
AD uncertainty	30.9%	38.5%	44.7%	26.6%	1.6%	9.4%
User accuracy	86.7%	80.0%	76.7%	76.7%	97.4%	82.8%
Producer accuracy	83.9%	72.7%	79.3%	88.5%	97.0%	84.2%
Overall accuracy	93.2%					

Estimation of emissions from selective logging

Emissions from selective logging in addition to degradation accounted through the land/forest-use change matrix, predominately associated with rotational agriculture, makes forest degradation a significant source of emissions for Lao PDR. Government statistics related to logging, UN-COMTRADE statistics on timber export and research literatures are not adequate to provide reasonable estimates. In addition, the remote sensing technology applied in Lao PDR at the time of establishment of the FREL did not allow reasonable assessment of the historical biomass loss caused by selective logging. Therefore, stump measurements from the NFI are used to estimate this biomass loss.

The NFI procedure measures stumps with the parameters below:

- Height (H) - this will be below 1.3m
- Smallest Diameter (D1) – this is the smallest diameter across the top of the stump
- D2 – the diameter at a 90° angle to D1.
- Locational information (Latitude / Longitude)
- Instrument used for tree felling (e.g. machine, saw axe)

Procedure followed for biomass loss estimation for the FREL:

1. Calculate average diameter (D) from D1 and D2 for each stump
2. Exclude stumps that were not felled by "machine" or "saw axe" (to exclude incidents of natural disturbances)
3. Estimate the DBH from the diameter at the base and height by using the following equation

developed in Cambodia .
DBH=D – (-C1 ln (H+1.0)-C1 ln (2.3))
Where:
D=Average Diameter of stump, H=Height of stump,
*Ln (|C1|)=d0+d1*D+d2*H+d3*D*H*
d0=1.68, d1=0.0146, d2=-0.82, d3=0.0068

4. Estimate the AGB by using the allometric equation used in the 2nd NFI.
5. Convert the AGB loss by using an area ratio (t/ha)
6. Sum up the AGB loss by sub-plot
7. Estimate plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot)
8. Estimate average AGB loss(t/ha) for each forest type by dividing the total number of plots of each forest type
9. Estimate BGB loss by using default conversion factor found in the IPCC 2006 Guidelines
10. Convert biomass to CO2 with the same conversion factor to estimate carbon stock
11. Estimate total loss tCO2 by multiplying above value by the area of forest type map 2015 for each forest type.

The above method allows an estimation of the biomass loss (and thereby, the emissions) from selective logging. However, it does not give information on when the trees were felled, which is essential for accounting the results in the FREL.
An equation which allows the estimation of years required for wood materials to decompose from the experimental study in Pasoh in the Malaysian Peninsula (Yoneda et al. 2016) was referenced. Considering the average temperature and precipitation in Lao PDR, it was concluded that the observed stumps were at the most felled 12 years before the survey. Thus, the total biomass loss calculated from the observed stumps was divided by 12 to obtain a yearly loss rate.

6.3 Technical aspect of the Data management

To fulfill the Data management function of the NFMS, Lao PDR developed in parallel with the production of the Forest Types Maps required for the establishment of the FREL, a database with a web-portal interface. The system is physically hosted at FIPD.
The database is a SQL Server linked to a GIS that stores data and enables mapping functions and data analysis as follow:

- Mapping functions
    - Display background map such as satellite imagery (RapidEye, Sentinel-2, Google Earth)
    - Display thematic map such as Forest Type Map, Forest Categories
    - Zoom, measure area and length
    - Print map
- Analysis functions
    - Calculate forest area and change
    - Display Emission Factor and NFI data
    - Calculate carbon stock and carbon stock change

As shown in Figure 15 below, users can display satellite imagery, forest cover maps, forest cover change maps and the various forest categories. The next figure illustrates the analysis functions available through the web interface which enable the users to get areas for forest cover and forest cover change as well as Emissions/Removals. However, this web-portal is still not publicly available. As mentioned in Scope of data management, the web-portal is still under development to link with SiS and DMS by providing specific information on the various REDD+ on-going projects in Lao PDR as shown on Figure 17.

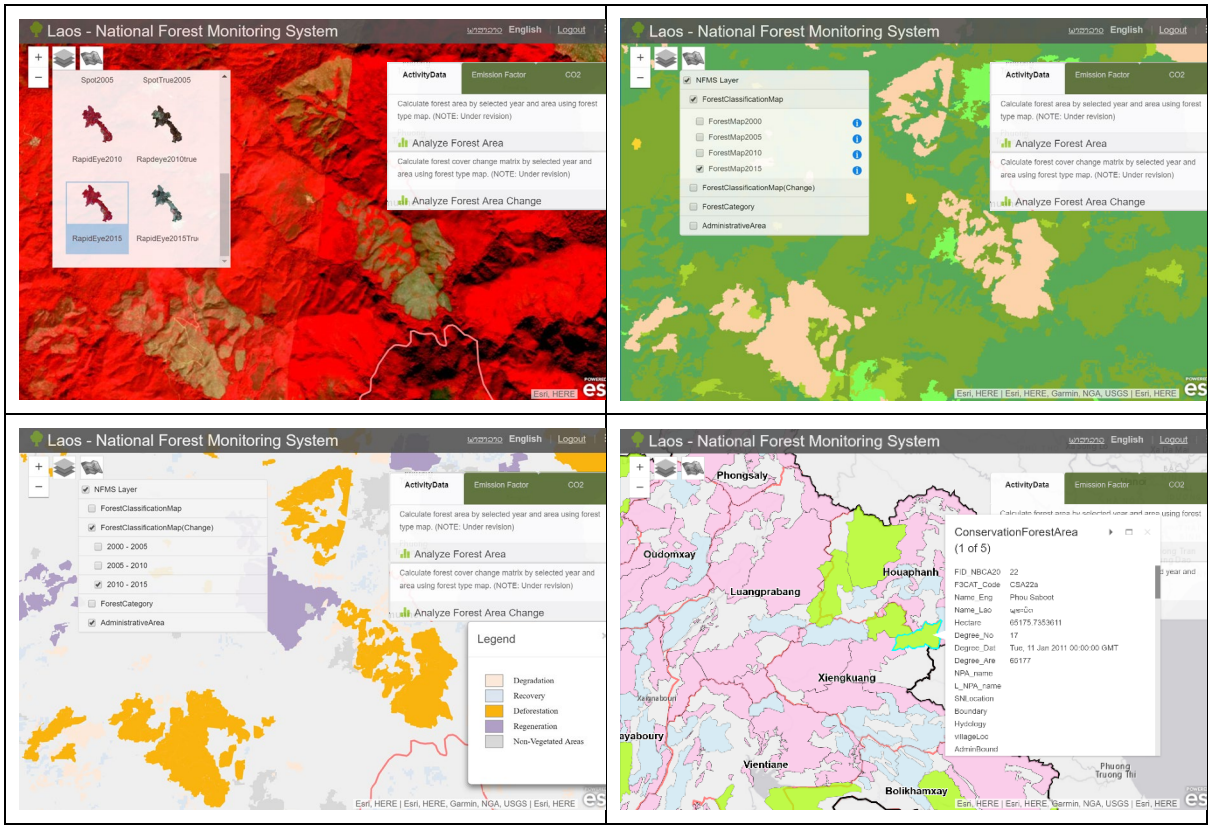
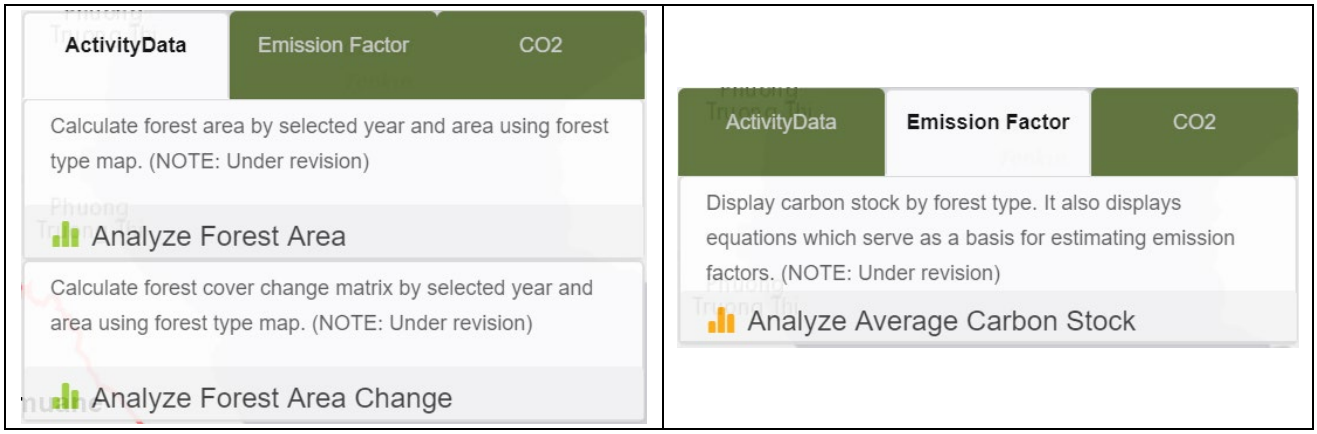
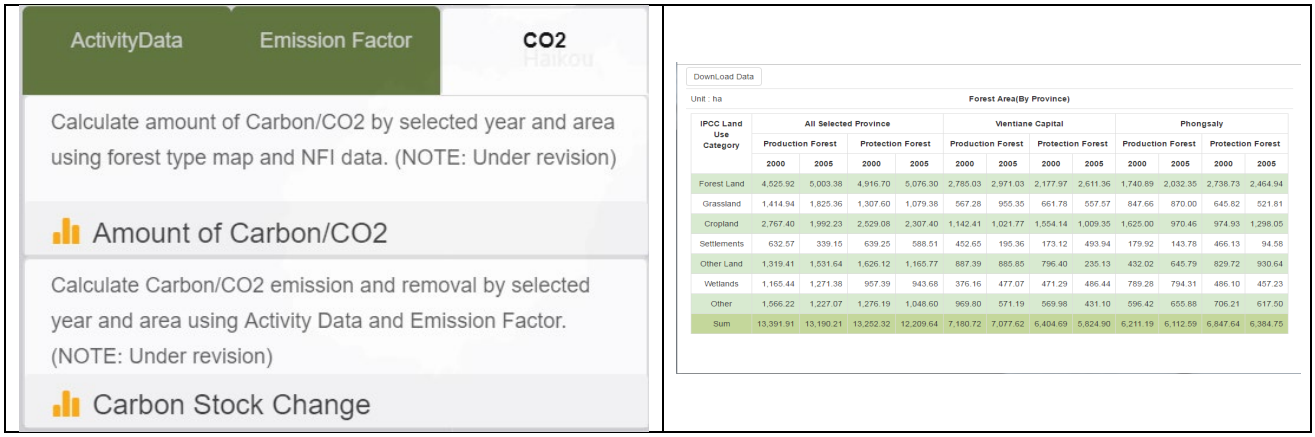


Figure 15. NFMS web interface: Mapping functions





IPCC Land Use Category	All Selected Province				Vientiane Capital				Phongsaly			
	Production Forest		Protection Forest		Production Forest		Protection Forest		Production Forest		Protection Forest	
	2000	2005	2000	2005	2000	2005	2000	2005	2000	2005	2000	2005
Forest Land	4,525.92	5,003.38	4,916.70	5,076.30	2,785.03	2,971.03	2,177.97	2,611.36	1,740.89	2,032.35	2,738.73	2,464.94
Grassland	1,414.94	1,825.36	1,307.60	1,079.38	567.28	955.35	661.78	557.57	847.66	870.00	645.82	521.81
Cropland	2,767.40	1,992.23	2,529.08	2,307.40	1,142.41	1,021.77	1,554.14	1,009.35	1,625.00	970.46	974.93	1,298.05
Settlements	632.57	339.15	639.25	588.51	452.65	195.36	173.12	493.94	179.92	143.78	466.13	94.58
Other Land	1,319.41	1,531.64	1,626.12	1,165.77	887.39	885.85	796.40	235.13	432.02	645.79	829.72	930.64
Wetlands	1,165.44	1,271.38	957.39	943.68	376.16	477.07	471.29	486.44	789.28	794.31	486.10	457.23
Other	1,566.22	1,227.07	1,276.19	1,048.60	969.80	571.19	569.98	431.10	596.42	655.88	706.21	617.50
Sum	13,391.91	13,190.21	13,252.32	12,209.64	7,180.72	7,077.62	6,404.69	5,824.90	6,211.19	6,112.59	6,847.64	6,384.75

Figure 16. NFMS web interface: Analysis functions

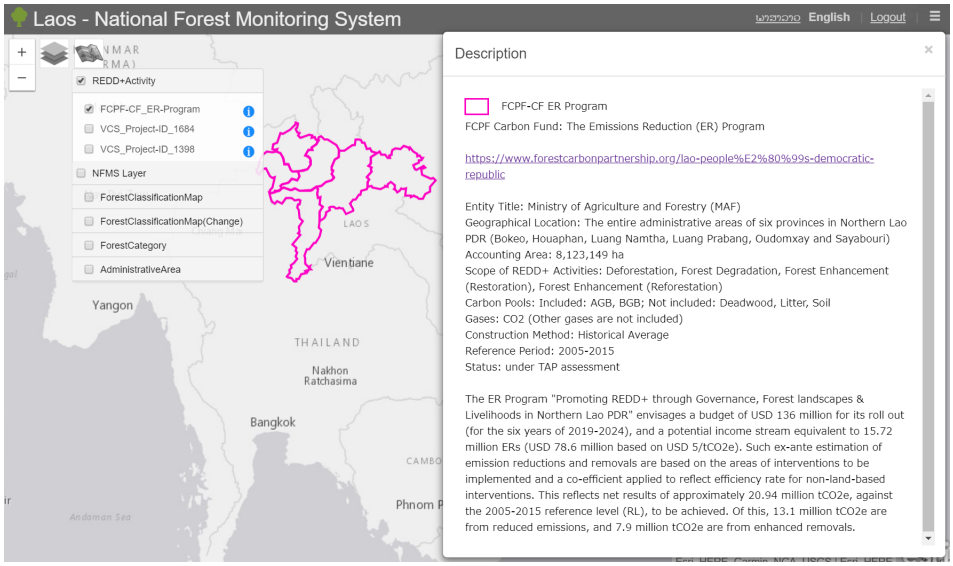


Figure 17. NFMS web interface: Link to DMS

Chapter 7 Future improvement

The NFMS, as outlined in previous chapters, provides a framework for the forestry sector in Lao PDR to ensure the three main following functions; conducting MRV, enabling forest monitoring for sustainable management, and managing data related to the previous functions.
The establishment of the FREL/REL and the completion of the first MRV, as well as the preparation of the ER-P (FCPF), shaped the current architecture and determined the operational procedure of the NFMS which are described in chapter 6. Throughout this process, reviews from either UNFCCC or the FCPF, and experts from FIPD and the F-REDD project identified several points that need to be addressed to enhance the individual functions and the entire system.

Also, the present NFMS Roadmap aims to describe the options for improving the NFMS and how it will be implemented until 2030. Thus, based on the assessment of the current approach, this chapter highlights the expected step-wise improvements to the current NFMS to conduct future MRV and MMR for the ER-P, to further develop forest monitoring and to envision the update of the FREL/REL by year 2026, the current FREL/REL being valid until 2025.

7.1 Assessment of current approach and areas for improvement

The establishment of the FREL/REL and the first MRV required the production of the Forest Type Maps, the implementation of the National Forest Inventory (NFI), and the Regenerating Vegetation survey (RV survey). The process to produce these outputs are all documented with SOP and the reports submitted to UNFCCC outline areas for improvement.

For instance, the Activity Data report points out the challenges of mapping accurately the shifting cultivation landscape which involves various stages of regenerating vegetation (RV) and makes it difficult to distinguish from Mixed Deciduous forest (MD). Also separating Upland Crop (UC) from Other Agriculture (OA) is challenging.
During the field survey for the 2nd NFI, mismatches between the forest types shown on the map and the identification in the field showed that the plot distribution needed to be revised to allow enough plots for all forest types. The number of plots was adjusted in the 3rd NFI.
The RV survey serves the purpose to estimate the emission factor for Regenerating Vegetation. The first RV survey did not measure the Dead Wood carbon pool. For consistency with NFI and to include eventually Dead Wood in the update of the FREL/REL, Dead Wood was measured in the second RV survey.

Following the Technical Assessment team from UNFCCC and the assessment conducted by the Carbon Fund, priority areas for improvement were identified as follow:

1. Improve Carbon accounting for Regenerating Vegetation (RV) forest type
2. Improve Carbon accounting from selective logging
3. Include of all the emissions and removals from the forest land remaining forest land areas
4. Monitor from shifting cultivation and forest fires and assess the impact on carbon stock including non-CO2 gases
5. Scale-up forest monitoring tools and approaches

Table 18. Potential improvements to NFMS

NFMS Function	Main actors	Main Action	Assessed gaps	Proposed action	Support
MRV and MMR	FIPD/DOF	Update FTM and generate AD	Improve mapping of shifting cultivation landscape Improve mapping of forest plantations Improve distinction between UC and OA	Use time-series analysis	F-REDD SilvaCarbon World Bank (FCPF)
		NFI (EF for natural forest types)	Remediate the high uncertainty of the estimates of emissions from forest degradation due to selective logging	Consider stratifying the canopy disturbance	
		RV survey (EF for Regenerating Vegetation)	Refine the EF	Consider a larger sampling	
		Emission/Removals calculation	Improve uncertainty estimates	Review the process	
		Update FREL/REL	Restratify base forest type map		
			Include carbon loss and gain from forest remaining forest		
			Include Non-CO2 gases from forest fire		
Forest monitoring	DOF DOFI PAFO POFI DAFO DFIU	Deforestation monitoring	Need a better coordination	Redefine the institutional arrangement	F-REDD, CliPAD, ProFEB, ICBF, BCC, WWF
		Degradation monitoring			
		Village forest monitoring			
	FoF	Forest mapping, forest regeneration monitoring			

	DALAM	Forest fire	Need to involve DOF		
	DOF, PAFO, DAFO, DOFI, DFIU DALAM FoF	Shifting cultivation Land/forest concessions Forest Landscape Restoration	Launch initiative Need to identify responsibilities		
Data management	DOF	NFMS Web-portal and NFMS database related to MRV/MMR function	Web-portal not publicly available	Launch the web-portal and expand functions	F-REDD
	DOFI	MangoMap Web portal and OLDM GeoDatabase	OLDM for FLUP Web-portal public		OLDM

Following the Table 18 above, the next sub-chapters introduce how Lao PDR foresees to improve carbon accounting and forest monitoring in the coming years.

7.2 Enhance Emissions/Removals estimates for MRV and MMR

Improve estimates for forest degradation and forest regeneration

As outlined in the FREL/REL submission report, the interpretation of the satellite imagery requires trained and skilled technicians. Among the various challenges, the classification between MD and RV is the most challenging because the regeneration of the fallow land is a continuous process. To address this issue, the remote sensing team from FIPD used the conclusions of the field surveys conducted in several RV areas of various age that assessed that fallow lands reach the forest definition threshold (minimum DBH 10cm, minimum crown density 20%, and a minimum area 0.5ha) after 8 years from the conversion to Upland Crop. Annual Tree Cover Loss from the UMD was partially used for the MRV to address this specific point.
However, these challenges still have implications on the estimates of Emissions/Removals especially the uncertainty for the forest degradation and forest regeneration as most of these dynamics come from the regeneration of fallow land to forest or the degradation of natural forest to fallow land. Five years interval of the Forest Type Maps 2005, 2010 and 2015 used for the FREL/FRL had some limitations to accurately monitoring such dynamics.
For the ER-PD, the FCPF review raised their concern on the abovementioned issues, and considered the current Carbon accounting as a proxy, rather than direct measurement, requiring the application of a 15% conservativeness factor to estimates of forest degradation emissions.

Improving the estimates could be achieved with the following means:

- Refine the mapping of the shifting cultivation landscape which includes MD, RV and UC, to reduce the uncertainty of the Activity Data,
- Reduce the uncertainty of the Emission Factor related to RV,
- Make visual interpretation required for the calculation of the Area Estimates more robust.

To refine the map, one option is to use other GIS data or tools that could support the mapping as the use of data on land concessions, commercial forest plantations or land-use plans.
Systems such as the PDMS and OLDM described in Chapter 6, if deployed throughout the country could

be a mean to validate changes and improve the map.
Lao PDR has been exploring using options, such as the technologies to analyze ‘big data’, multi-temporal satellite datasets that are available. Accordingly, SilvaCarbon demonstrated tools and approaches that may help FIPD to better map the shifting cultivation land use dynamic. It mainly uses time-series analysis and datasets developed by the UMD/GLAD and available at SERVIR Mekong website as part of their regional land cover monitoring system (RLCMS). The combined use of yearly tree cover loss with the Tree canopy height and agricultural map could enable to map Shifting agriculture as a distinct landscape where there is an increase in the probability land cover map of agriculture immediately following a forest loss event.
Also a Google Earth Engine script that uses Landsat archive, enables the user to easily understand the historical trajectory of a pixel, visualize with a chart the number of rotational cropping during the analysis period as shown on the figure below.
Those approaches will be integrated in the SOP for the update of the Forest Type Map will make the mapping more robust by reducing the “variability” in the visual interpretation between various technicians.

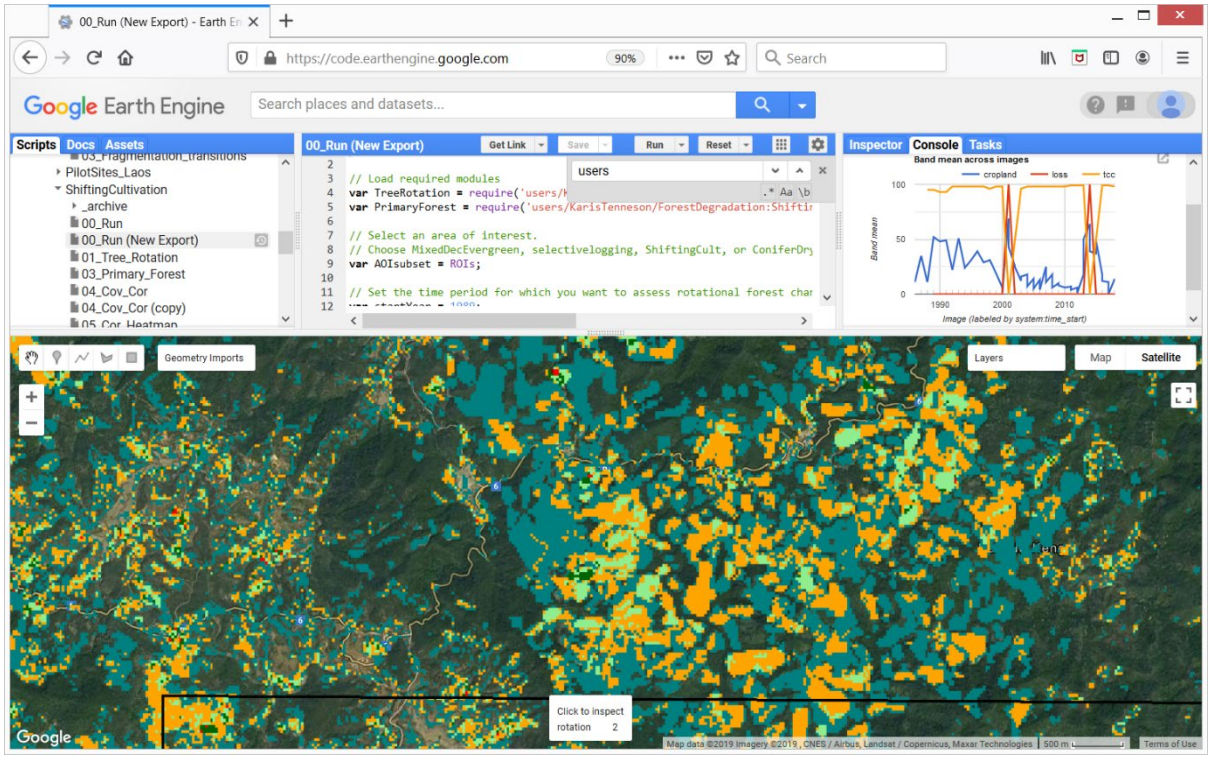


Figure 18. GEE Shifting cultivation script

As part of the OLDM System, historical annual land cover change map has been produced using the Delta-rNBR script. The resulting dataset can help to separate “Intact Forest”, forest land that has never been used for upland agriculture, and land that has at some point been used for agriculture.

Reducing the uncertainty of the Emission Factor related to RV has already been achieved by conducting additional survey in 2019. However extended survey may be implemented to collect statistically reliable and high confidence samples of RV plots.

The visual interpretation that is part of the calculation of the area estimates has been conducted for the FREL/REL and MRV jointly by FIPD and experts from the F-REDD project. The next exercise will be implemented by the FIPD team and will be the opportunity to use tools such as AREA2 (CODED) that is based on the Landsat archive and provides an interface dedicated to these kind of tasks. However, this tool will be very useful when it will integrate with the Sentinel-2 archive as well.

Enhance estimates for emissions from selective logging

The emissions from selective logging are derived from the NFI measurements. This was the best available option considered at the time of FREL/FRL (for national scale and for ER Program) construction as the remote sensing technology applied then in Lao PDR did not allow reasonable assessment of the historical biomass loss caused by selective logging.

Though this approach has been reviewed and endorsed following the respective FREL/REL submission, several limitations were acknowledged, such as the high uncertainty of the estimates due to few data collected for some forest classes. Also, the approach relied on an indirect method to estimate the time of logging, by using a rate of biomass decay from a study[13] in Malaysia.
Due to such limitations, the review of the ER-PD considered this estimation approach as a proxy estimate of forest degradation emissions and were therefore subjected to a 15% conservativeness factor.

To further improve this approach, country-specific equations could be developed to estimate the biomass decay and the DBH from stumps measurements.
However, in a longer term, repetition of the same survey may not be a feasible or reasonable option due to time and cost required.
Therefore, the use of new remote sensing approaches must be considered. As described in the previous chapter, the use of change analysis that focuses on canopy disturbance such as Delta-rNBR is being implemented by the OLDM to support the monitoring of legal and illegal selective logging. The combined use of Delta-rNBR with high resolution imagery (PlanetScope) and analysis with knowledge of the terrain and villagers' practices has proven to be efficient and produces an archive of field data points as result of the work
There is a consensus to further test the use of Delta-rNBR (now called FCDM, Forest Canopy Disturbance Monitoring) to generate a yearly time-series analysis of the canopy disturbance that could help to stratify the land between disturbed and non-disturbed forest from selective logging.
The resulting map of disturbed forest canopy becomes an Activity Data for selective logging on which random sampling plots can be distributed and visually checked with AREA2 to calculate area estimates. The related Emission Factor would be refined by surveying locations where recent disturbance occurred.
As such no extensive NFI-like survey would be required periodically.

Improve the efficiency/cost of the MRV/MMR process

To meet the shorter MMR timeframe for the ER-P, the interpretation work will be conducted in priority for the ER-P (6 provinces) area. Fine tuning of the SOP could be considered to work only with six "classes" corresponding to the strata I, II, III, V, Forest plantations and RV/Bamboo from the strata IV. The use of the GLAD data would make the change detection more robust. In the longer run, following the improvements in the approaches, the mapping SOP might also be improved without hindering the consistency with the previous approach by automatizing further the change interpretation.
The planned support from World Bank (FCPF) to prepare the MMR will provide support to Lao PDR to first address the issue listed earlier but also to ensure that the timeline will be followed.

[13] Yoneda et al. 2016. Inter-annual variations of net ecosystem productivity of a primeval tropical forest basing on a biometric method with a long-term data in Pasoh, Peninsular Malaysia. TROPICS Vol. 25 (1) 1-12.

7.3 Anticipate the update of the FREL/FRL

As mentioned earlier, the current FREL/REL is valid until 2025. Updating the FREL/REL may require specific actions as described below.

The left column of the following table shows the contents of FREL/FRL and REDD+ result in each scope. The right column shows the options to consider for updating the FREL/FRL, noting that this assessment is still preliminary and options will be further explored by reflecting the national circumstances as well as the emerging forest monitoring technology before the decisions are made.

Table 19: Contents of FREL/FRL and REDD+ result and update options of the FREL/FRL

Scope	FREL/FRL and REDD+ result	Update options of the FREL/FRL
Forest definition	"Current Forest" with - Stand DBH: minimum of 10cm - Crown density: minimum of 20% - Minimum area of 0.5ha. and "Potential Forest" defined as lands previously forested, but presently not meeting the definition of "Current Forest" due to various disturbances, and expected to be restored to "Current Forest" status if continuously left undisturbed.	Use the same definition to keep consistency with past FREL/FRL.
Land and forest classification system	National land and forest classification system with two levels of classification: - Level 1 consisting of seven classes including "Current Forest" and "Potential Forest"; and - Level 2 which further classifies "Current forest" class under Level 1 into six natural and plantation forest classes.	Basically, use the same classification to keep consistency with past FREL/FRL. On the other hand, addressing the issue about the classification discrepancy between FTM and NFI field survey needs to be considered. Then, re-stratification of the FTM classification can happen.
Stratification	For the purpose of REDD+, the national land and forest classification explained above are condensed into five land/forest strata.	Use the same stratification to keep consistency with past FREL/FRL.
Activities included	Deforestation Forest degradation including selective logging Forest enhancement (restoration) Forest enhancement (reforestation)	Use the same activities basically. And, It may require inclusion of all the emissions and removals from the forest land remaining forest land areas by applying the default method provided in the 2006 IPCC Guidelines together with above-ground biomass increment factors appropriate to its national circumstances from local or regional scientific research
Carbon Pools	Included: AGB, BGB Not included: Deadwood, Litter, Soil – lack of data, insignificant	Include AGB and BGB continuously. Dead wood may be included for estimating emissions and removals as much as

		possible, because deadwood was measured since 2nd RV survey.
Gases	Only CO2 included. (Non-CO2 gases from field burning approx. 2.9% of all forest-related CO2).	Include CO2 continuously. Non-CO2 gases can be included, if country specific combustion factor will be acquired and amount of emission from Non-CO2 gases is enough to include. From the view of keeping consistency with GHGi, it is better to include Non-CO2 gases.
Scale	National	Depend on the REDD+ policy of Lao PDR.
Reference period and proposed validity	2005-2014 (10 years) The validity of FREL/FRL is for the period 2015–2025 (11 years) The REDD+ result period is 2015-2018 (4 years) and within the validity period of the FREL/FRL.	Depend on the fund for REDD+ and REDD+ policy of Lao PDR.
Emission Factor	Data source(FREL/FRL): 2nd NFI; country-specific allometric equation; IPCC default values; data of Vietnam. Then, stratified into five strata. Calculation: Amount of changes in carbon stock of among the five strata. Data source(REDD+ result): 3rd NFI; Otherwise same.	According to ERP-MMR, 4th NFI and 3rd RV survey will be conducted in 2024-2025and will be a data source of next Emission Factor. Non-country specific data and equations are expected to create new one for decreasing uncertainty of emission factor.
Activity Data	Data source(FREL/FRL): National-scale forest type maps for year 2005, 2010 and 2015. Then, stratified in to five strata. Calculation: Amount of changes in areas among the five strata. Estimated through reference sampling ('Design-Based Area Estimation') Data source(REDD+ result): National-scale forest type maps for year 2019. Otherwise same.	According to ERP-MMR, FTM 2022 will be developed and will be a data source of new Activity Data. This FTM will be a new base map. It may consider that proper approach of area estimation. Detail methodologies are described in Chapter 7.2
Model applied	Historical average	Depends on the Emissions/Removals trend and REDD+ scheme Lao PDR apply for.
Adjustment	No.	Depends on the National Circumstance

Produce a new base map

As described in chapter 6, the methodology followed to update the Forest Type Map is based on change detection from the previous map. The "base" map on which the changes have been applied to produce the updated maps dates from 2010.

Monitor natural forest growth and degradation

The current FREL/FRL does not account for gain and loss in biomass in forest remaining in the same category due to the lack of datasets, except in the case of emissions from selective logging estimated through measurement of tree stumps as a proxy indicator. Biomass gain may come from forest restoration as a result of improved management or from natural growth in living biomass pools. Biomass loss may be caused by firewood collection or natural disturbance.

The monitoring approach could consist of establishing permanent sample plots throughout the forest land in the country to enable the collection of biomass data. Other approaches may include, such as activity-based monitoring (e.g. wood harvesting and collection, assisted natural regeneration activities being practiced…), statistical data (e.g. timber flow statistics...), and so on.

The experience of the Faculty of Forestry of the NUOL (National University of Laos) gained through its collaboration to the ENRICH project supported by SNV which studied forest carbon stock enhancement, may be useful to implement such monitoring.

Re-stratification of the Forest Type Map

The 2nd and 3rd NFI survey showed that there was mismatch between the forest type identified on the ground by the survey teams and the forest type interpreted on the Forest Type Map that was used to distribute the plots. As the calculation of the carbon stock is using the forest type identified by the survey team at the sub-plot level, the discrepancy mentioned earlier had implications on the plot distribution because the number of plots needed to be adjusted to reach the required number of plots for each forest type. This was particularly an issue for Evergreen Forest, where many plots were identified as Mixed Deciduous forest (MD) on the ground, and Coniferous Forest (CF) plots that were mismatched with Mixed Coniferous and Broadleaved Forest (MCB).

One option to address this issue is to consider the forest type from the map for the carbon calculation and disregard the team's assessment on the ground. However, efforts need to be taken to make coincident the field forest type assessment with the FTM. First, additional training on forest type identification based on tree species might be extensively provided to the survey technicians. Secondly a re-stratification of the Forest Type Map might be considered, eventually for the update of the FREL/FRL and the update of the base map. As such, scripts that are looking at the deciduousness of the forest canopy may be tested to better distinguish the forest types.

Enhance consistency with the GHG Inventory

According to the UNFCCC decision 12/CP.17, paragraph 8, the FREL/FRL shall be established taking into account decision 4/CP.15, paragraph 7, while maintaining consistency with anthropogenic forest-related greenhouse gas (GHG) emissions by sources and removals by sinks as contained in each country's GHG inventories.

Lao PDR has so far submitted two National Communications (NCs) and its 1st Biennial Update Report (BUR) to the UNFCCC including GHG inventories. There is a plan to submit the 3rd NC in 2020 to the UNFCCC in 2020:

- The 1st NC submitted in year 2000 for the GHG Inventory of 1990;
- The 2nd NC submitted in year 2013 for the GHG Inventory of 2000;
- The 3rd NC to be submitted in year 2020 for the GHG Inventory of 2010; and
- The 1st BUR submitted in year 2020 for the GHG Inventory of 2014.

There is an attempt to harmonize the FREL/FRL and GHG Inventory for the AFOLU sector approaches and estimations to the extent possible (e.g. using the same Gain-Loss method, forest definition, land/forest classification, and land/forest cover change dataset as the data source for generating the AD, country-specific biomass dataset) but with differences in parts of the scope (e.g. activities, sources of emissions/removals included). The most significant difference between the FREL/FRL and the GHG Inventory is the inclusion of biomass increase in forest remaining in the same category in the latter,

which resulted in forestlands to be a sink opposed to the FREL/FRL.
The GHG Inventory Division of DCC under MONRE is responsible for coordinating the compilation of the GHG Inventory. Therefore, coordination between DOF and DCC will continue to be important to maintain consistency between FREL/FRL (and MRV) and GHG Inventory in the future. Several avenues exist that will facilitate this process such as DCC being a member of the REL/MRV TWG and the NRTF, and FIPD being a member of the GHG Inventory Task Force coordinated by DCC.

7.4 Develop forest monitoring

Induced by the requirements of program or initiative such as FLEGT, innovative forest monitoring approaches are being developed and tested as mentioned in Chapter 6. This section proposes how forest monitoring can be broadened to cover supplementary components of the forest cover change dynamic such as forest fires and integrate more stakeholders including especially villagers, with the goal of supporting Sustainable Forest Management (SFM).

As such, monitoring can address various issues and have different purposes. Thus, forest monitoring can have different timeline actions, different scale, or geographical focus. For instance, for the need of MRV and forest resources management, forest monitoring helps to comprehend the drivers of forest change, the use of forest resources, understand the dynamic in place and support carbon measurements. For that purpose, monitoring looks at large landscape and at a relative long-term pace (annual or near-real time).
For the need of inspection and law enforcement, the monitoring focuses on specific areas with a short pace.
In general, forest monitoring supports the design and mainly the implementation of Policies and Measures (PAMs).
In addition, the growing need for a clearer institutional arrangement between the various stakeholders and the various institutional levels to enable SFM, is identified. Propositions are outlined below and more broadly in chapter 8 to address this last point.

Expand the scope of forest monitoring

Monitor natural forest fire

In Lao PDR, during the dry season, uncontrolled wild forest fires that are often resulting from agricultural practices, can spread and heavily degrade forest land. For instance, in 2020, forest fires were reported [14]in Phongsaly, Luang Namtha, Oudomay and Luang Prabang provinces destroying more than 100,000 ha.
They are another source of emissions and a barrier for forest restoration. The Department of Agricultural Land Management (DALAM under MAF) developed since 2015, with the Asian Institute of Technology (AIT) a system based on MODIS Terra/Aqua fire products to monitor the occurrence of forest fire. However, DOF is not involved with this system and therefore it does not contribute yet to the NFMS. At such, more coordination is needed between DALAM, DOF and DOFI to set-up an integrated national system to accurately monitor forest fires and their affected areas It is also a challenge to distinguish whether the fires are anthropogenic or naturally caused.
Near Real Time forest fire detection is made available by The Fire Information for Resource Management System (FIRMS) developed by the NASA using the VIIRS sensor (375 meters resolution, two pass per day). It gives every day the location of fire occurrence. Used in combination with the GLAD Alert system that provides extent of vegetation loss every week or the PDMS described in Chapter 6, wild forest fires could be mapped on a weekly basis. Field surveys in recently burnt areas could measure the loss of biomass to estimate an emission factor related to forest fire.

[14] Vientiane Times 23rd April 2020 and 1st May 2020

Assessing the impact of those events on the carbon stock of the forest and estimated related emissions, could eventually be integrated in MRV/MMR calculations or the update of the FREL.
To enable the authority to implement law enforcement and prevent the occurrence of fires that have both economic and environmental impact, the monitoring of forest fires must look at prediction model but also to evidences of forest thinning that is conducted prior to fire and showed by canopy disturbance script.

Monitor shifting cultivation practices

A large part of Lao PDR's landscape is shifting cultivation, particularly in the ER Program area, and it was a challenge for the five-year interval maps (2005, 2010 and 2015) to accurately track the dynamic changes in landscapes and carbon stocks as a result. Also, due to the lack of reliable data (Activity Data and Emission/Removal factors including biomass combustion factor which can be applied for swidden agriculture activities), non-CO2 gas emission from shifting cultivation and consequent uncontrolled spreading of fire are not accounted for the current estimation.
In relation with the monitoring of fires described above, a similar approach may have the broader scope of monitoring the dynamics of shifting cultivation landscape and its carbon stock changes including estimation of non-CO2 gas emission. A dedicated survey would need to be conducted to estimate the Lao PDR country specific combustion factor. Then, the combination of Near Real Time analysis tools, time-series analysis over long period and field surveys with random and permanent plots would enable assessment of the extent this agricultural practice, the periodicity of slash and burn and measurement of biomass loss and gain.
Overall, such monitoring will enable Lao PDR to improve the management of this landscape and the overall accuracy of estimation.

Monitor concessions for commercial crops, forest plantations, mining and infrastructure

FIPD has data on commercial land concessions from CDE (Centre for Development and Environment University of Bern, Switzerland) that follow this topic and provide data through the Lao Decide website[15]. However, there is not a systematic monitoring of land concessions linked with the update of the Forest Type Map. Based on the already existing dataset, an annual update and visual screening of the land use would be useful as a forest and land management tool.

FIPD is also involved in implementing or supporting pre-harvest inventory in conversions areas. Data collected during those surveys could be integrated in the NFMS server and support forest management and be provided to DoFI to support their monitoring of logging to ensure that the concession operator doesn't encroach into areas they have not gotten permission to log.

Analyze suitable areas for carbon enhancement and forest landscape restoration (FLR)

The historical and latest Forest Type Maps show that there is a large area (around 6 million ha) of Regenerating Vegetation (RV) that remained RV over the reference and the MRV periods. This land cover has a huge potential for carbon enhancement and to become a GHG sink. Alongside the monitoring of shifting cultivation practices mentioned above, scrutinizing the probability of these lands to be used again as cropland, or to further regenerate, would help to identify suitable areas for FLR. By combining the historical forest cover change with land-use information such as FLUP, and terrain data such as slope, FIPD could model the likelihood for RV land to regenerate to forest and thus help to target FLR. This country wide analysis may be supported by on the ground surveying.

Enable Sustainable Forest Management with support of innovative Information and Communications Technology

[15] www.decide.la

Integrate village level in forest monitoring

As described in Chapter 6, OLDM and PDMS are being tested in a combined total of 8 provinces. These systems enable POFI and PAFO to focus monitoring on specific areas and command field survey to provincial and district officers and sometimes working alongside with villagers and the military. In short, these systems follow a top-down approach to improve law enforcement on the ground. To complement these tools based on remote sensing, a bottom-up approach may be considered to improve reporting of disturbances witnessed on the ground. Based on the use of smartphones and ODK Collect forms, village heads could report on illegal actions that occur in their area to the higher levels. In addition, camera traps, as used in wildlife tracking, may another way to enforce protection for specific conservation or protection forest.

One of the objectives of the NFMS is to support Sustainable Forest Management (SFM). Involving villagers is a means to make possible SFM. Following the example of the CliPAD project in Houaphan Province, villages can be compelled to report disturbances but also on how they manage and enhance their forest resources. Having a defined data flow from village to central level is crucial to ensure transparency for the reporting. FIPD might be the designated agency that would aggregate the village's reports. Linking the Forest Type Map and remote-sensing based monitoring with the information collected on the ground would be decisive to comprehend the forest cover change dynamic.

Enhance the combined use of the various monitoring tools

As described in Chapter 6, OLDM and PDMS are being implemented in several provinces and might be deployed nationally. The OLDM system focuses on monitoring forest degradation and primarily involves DOFI and its provincial (POFI) and district (DFIU) level agencies. The PDMS, that monitors deforestation, is handled first at provincial level, through both PAFO and POFI, then involves the district and village level who then report to DOF and store data in the FIPD server.

The main objective of the PDMS is to identify land conversion in designated forest categories. The result of field investigations may provide ground truthing data that eventually could support the update of the Forest Type Map.

The main output of the OLDM system is to provide a flexible modular system for forest degradation monitoring, investigation, reporting and action. For instance, the OLDM system enables to point where high value illegal logging occurs and collect on the ground information on stumps.

These systems are not currently deployed in the same provinces therefore there is no feedback yet on how the provincial and district offices would manage with both systems.

Ideally those two systems should be streamlined to make their use efficient while not overloading the capacity of the various teams.

An assessment could determine which component of each system could be combined. For instance, the neat web-interface of the PDMS could integrate the change detection analysis from the OLDM and provide two streams of analysis, deforestation and forest degradation.

Also the implementation of such a tool might be a good opportunity for collaboration between DOF and DOFI, and especially between the DOFI RS/GIS unit and FIPD.

In addition, the stump records collected by DOFI might support the NFI and the assessment of emissions due to selective logging.

Streamline the forest monitoring

As mentioned above, organizing the role of the various stakeholders is a crucial task of the NFMS.

First the governmental institutions in charge of forest management are the Department of Forest (DOF) and the Department of Forest Inspection (DOFI) both under the Ministry of Agriculture and Forestry (MAF). Those two Departments have clear respective mission: DOF oversee the monitoring of forest resources and use while DOFI conduct law enforcement in regard with forest management. In practice there may be some overlap. As mentioned earlier, the Department of Agricultural Land

Management (DALAM) also monitors land-use practices that impact forest. A good coordination and combined use of the information owned by the three institutions, can help the monitoring of land-use and make sure that the various delineated forest categories, FLUP (Forest and Land-Use Planning) and agricultural land are consistent and followed.

The paragraph below proposes a practical organization for DOF and DOFI roles.
In regards to forest monitoring and illegal logging, this may be taken in charge by the DOFI and its offices in the province and districts. The provincial level would play an important role in supervising the monitoring while the district level oversees surveying on the ground. Illegal land-use would be witnessed with villagers who will then be reported to upper levels. Provincial reports would be sent to DOFI.
Then DOFI would share this information to DOF and be stored in the FIPD server.
Regarding forest management or protection which also includes law enforcement on the ground, this could be a task that is jointly implemented by DOF and DOFI. In the eventuality that PDMS is used, data collected during the field surveys is directly stored on FIPD server.
FIPD/DOF being in charge of the mapping of forest and hosting the NFMS server, shall remain the ultimate data aggregator to store, retrieve and analyze the information. One objective of the DOF and DOFI collaboration would be to develop data standards and establish protocols for data sharing.

Secondly the projects supported by the bilateral cooperation or donors or NGOs play an important role in Lao PDR to support forest monitoring. In general, these projects have various geographical extent, timelines and types of support. Therefore, the challenge resides in coordinating the respective efforts and maintaining the outcomes when projects end.

Table 20. Main active initiatives for forest monitoring

Project Name	Organization	Counterpart	Objective	Geographical extent	Timeline
PDMS (Provincial Deforestation Monitoring System)	F-REDD	PAFO/DAFO	Near Real Time Deforestation monitoring	Luang Prabang and Oudomxai	2018 – 2020 (next phase being discussed)
OLDM System (Operational Logging and Degradation Monitoring)	KfW-ICBF, ADB-BCC and GIZ-ProFEB	DOFI/POFI	Near real-time monitoring of selective logging	Luang Namtha, Bokeo, Khammouane, Sekong, Champassak and Attapeu	2018 - 2021
Village Forest Monitoring	GIZ CliPAD/I-GFLL	POFI/PAFO	Monitoring of village activities	Houaphan (7 districts), Luang Prabang (5 districts) and Sayaboury (5 districts)	2020 - 2024
CARBI-2	WWF	PAFO/DAFO	Village forest	Salavan	2020
Sustainable Livelihoods and Forest Management Project (SLFM)	UNDP	PAFO/DAFO	Landscape management of Dry Dipterocarp forest	Savannakhet	2020-??

7.5 Deploy the NFMS web-portal and link to SIS

NFMS web-portal and database

As explained in Chapter 5, the NFMS web-portal and database has been partially developed to meet the one of the requirements for NFMS under UNFCCC: Decision 1/CP.16 Cancun (c) A robust and transparent national forest monitoring system for the monitoring and reporting of the REDD + activities (interim measure, sub national). Under FCPF Carbon Fund Methodological Framework; 6.2 Data Management and ER Transaction Registries, The information contained in a national or centralized REDD+ Programs and Projects Data Management System is available to the public via the internet.

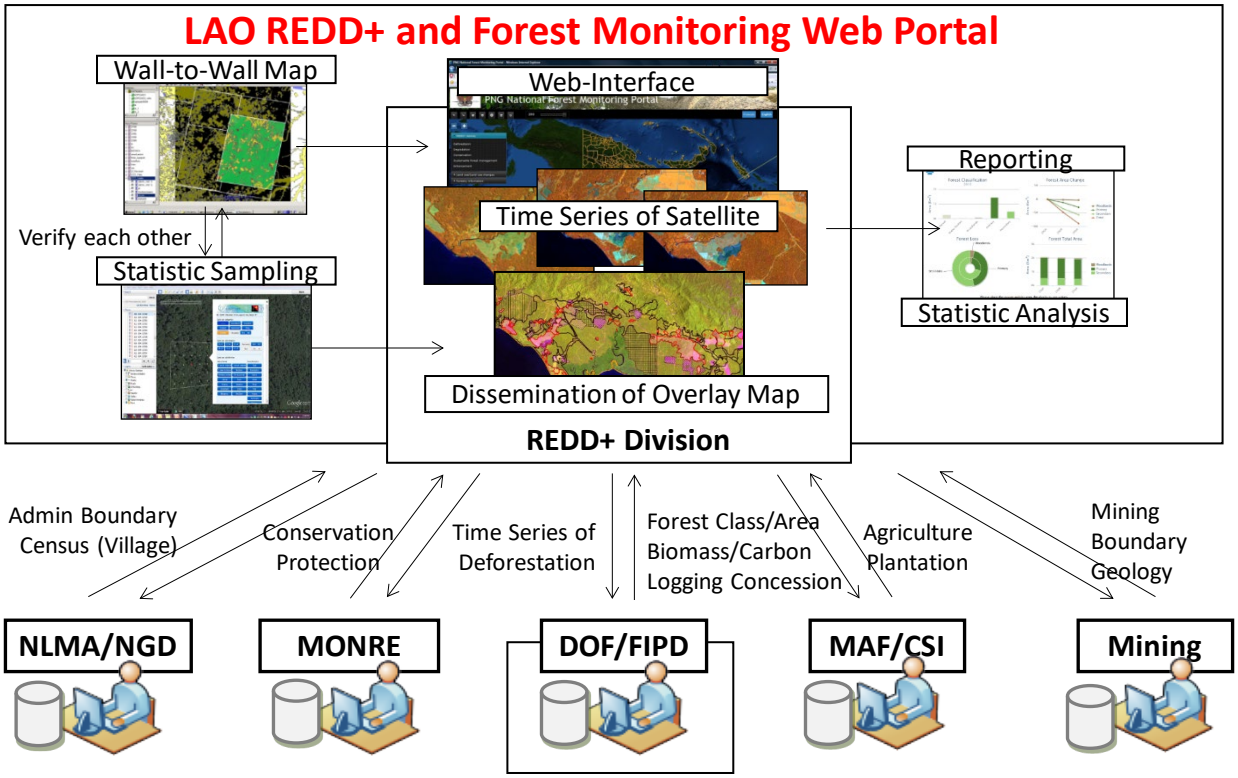


Figure 19. Image of NFMS Web-Portal available to the public via the internet

The current NFMS-DB (Database) has been developed with the priority focus on its MRV function (mainly 'Measurement'), namely the information related to (1) Activity Data, (2) Emission Factors, and (3) CO2 Emissions. In the future, further capacity building will be required for NFMS-DB Operation & Management, and also for extending the Monitoring functions, such as (1) Monitoring the Drivers of Deforestation and Degradation, (2) MRV Support and Enhancement, (3) Carbon Registry Development, and (4) Supporting Functions for SIS. Some activities, such as (1) Monitoring the Drivers have been already implemented partially and explained in the other sections of this document. (3) Carbon Registry Development as a GoL owned and customized national system will be considered further based on progress and discussion of international development (note that for the FCPF ERP, the GoL decided to use the FCPF ER transaction registry which may be scaled-up to the use for the national level). The plan and progress of (4) Supporting functions for SIS will be explained in the next section.

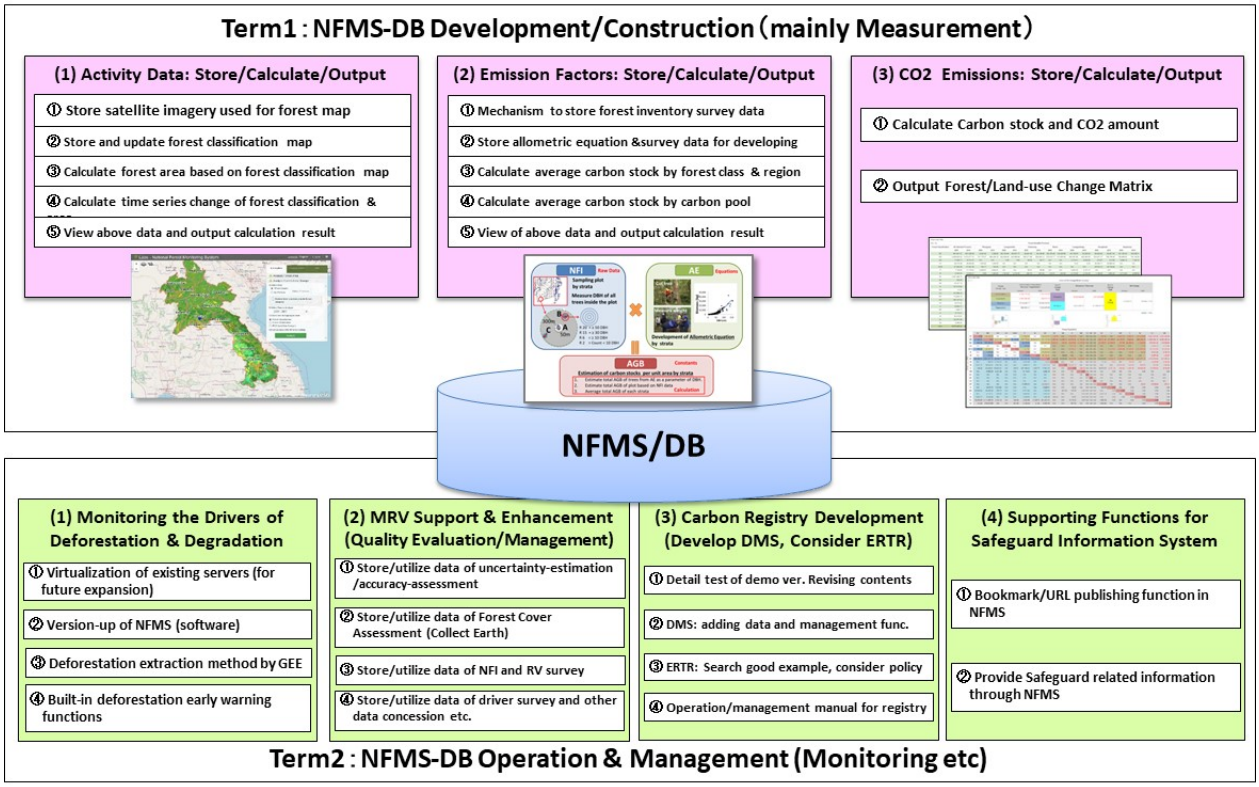


Figure 20. NFMS development and enhancement plan (draft) as future improvement

How the NFMS may relate to the SIS

An SIS is a system that that provides information on how safeguards are being addressed and respected, and would be responsible for reviewing policies, laws, and regulations relevant to safeguards, maintain data and information, undertake capacity building, and prepare a report on the implementation of REDD+ safeguards.

(as of June 2020) Lao PDR is developing a Terms of Reference (ToR) for its SIS which will be then approved by DOF/MAF (target QTR III 2020). The scope of the SIS to be established is national and covers all the forest areas of Lao PDR. A national Social and Environmental Safeguards Unit (SESU) would be established with its mandate to establish mechanisms for safeguards management, at the national level for Cancun safeguards, and for other projects as appropriate. After DoF/MAF approval and decision to establish the SIS the following steps would be taken: preparation of a work plan to operationalize SIS; preparation of an SIS Operations Manual; and capacity buildings.

As such, how the NFMS relates to the SIS is not yet clear at this moment. However, a general expectation is that the NFMS may be able to contribute to the SIS through its function and information collected, such as through providing information on forest cover change that would be relevant to the Cancun safeguards (e) - natural forests and biological diversity, (f) – reversals, and (g) - displacement. It is important to note that possible contributions of the NFMS to SIS should be assessed jointly by teams working on each system, taking into account associated costs, capacities and institutional arrangements.

Table 21. Elements of SIS

	Key Elements	Agreement in Cancun Safeguards
(a)	National Forest Programs	actions consistent with the objectives of national forest programs;
(b)	Transparent Governance	transparent and effective national forest governance structures;
(c)	Knowledge and Rights	respect for the knowledge and rights of indigenous peoples and members of local communities;
(d)	Participation of Stakeholders	the full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities;
(e)	Natural Forest Biodiversity	actions are consistent with the conservation of natural forests and biological diversity, ensuring that REDD+ actions… enhance other social and environmental benefits
(f)	Permanence	actions to address the risks of reversals (i.e., permanence);
(g)	Leakage	actions to reduce displacement of emissions (i.e., leakage).

Once REDD+ activities commence, countries need to periodically submit a summary of information on how the Cancun safeguards, have been addressed and respected in their specific national context. The extent to which a NFMS can contribute information relevant to safeguards also depends on country circumstances, the design of the SIS and its relation to the NFMS.

One established function which the Lao NFMS may relate to the SIS is providing safeguard relevant spatial information through Lao NFMS Web-Portal. The Bookmark/URL publishing function in NFMS had been developed to be able to provide URL to the other web-sites (including SIS).

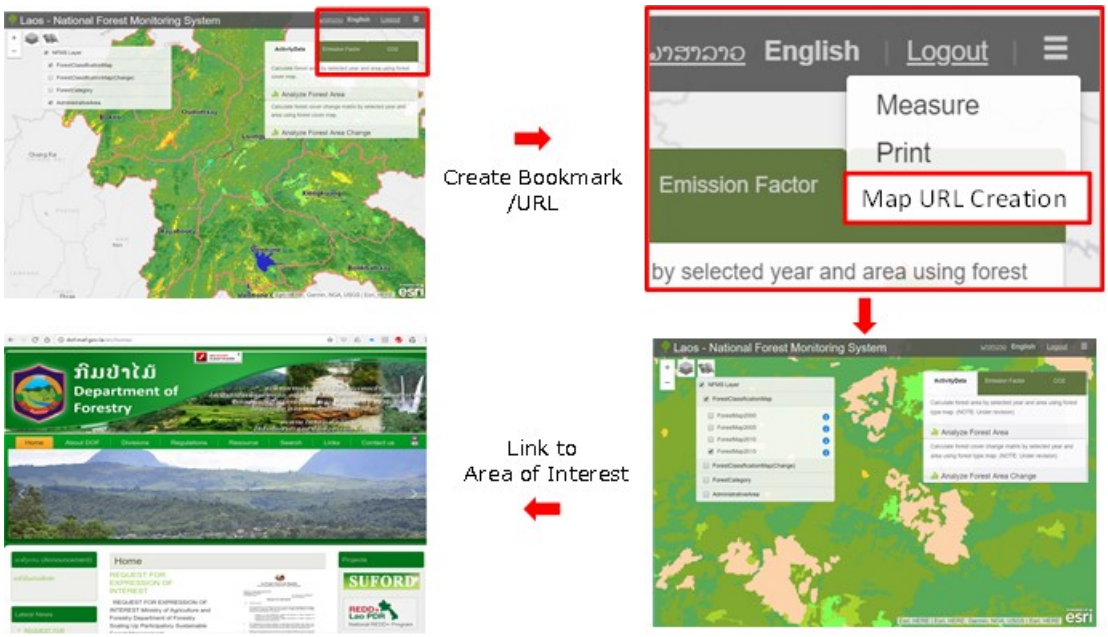


Figure 21. Bookmark/URL publishing function in NFMS

Although the NFMS potential supporting function to the SIS has been already developed, the training session to the potential users (such as general REDD+ web-site management users) should be organized.

7.6 Build the capacity

The capacity of the FIPD was continuously supported during the establishment of the FREL/REL and the implementation of the first MRV supported by the F-REDD project. FIPD staff also benefited from trainings from various projects such as F-REDD project, SilvaCarbon (USAID) and RECAREDD (Joint Research Centre from European Commission or JRC). Through support from the FAO, FIPD conducted trainings on the use of Collect Earth in the six northern provinces of the ER-P. The implementation of the forest monitoring systems deployed in some provinces as mentioned above, channels trainings for the local staff.
As these trainings focused essentially on the technical aspects of the Measurement of emissions/removals from forest cover change, next development of the capacity building support might focus more on the Reporting and Verification aspects of the MRV. Although FREL/REL and MRV reporting duties were supported by international experts from the F-REDD project, the reporting process should be streamlined and build on national capacities. For report such as the Biennial Update Report (BUR), that involve several Lao institutions like the Ministry of Agriculture and Forestry (MAF), the Ministry of Natural Resources and Environment (MONRE), coordination on the GHG Inventory could be improved.
QA/QC and verification processes are also topics on which training will be required.

One of the means to build and maintain capacity is the production of training manuals and Standard Operation Procedures (SOP). SOPs are currently available for NFI, calculation of carbon stocks from NFI measurements, mapping of Activity Data, calculation of area estimates and emissions/removals. SOP for reporting and verification would need to be produced as well.

The need of organized streams for reporting is identified: from the technical FIPD level to higher policy level at MAF or MONRE. The development of the NFMS web-portal may facilitate the communication toward Non-State actors and civil society.

To support the effort on Sustainable Forest Management and conservation of forest resources, officers working in the various institutional levels could be trained on raising the awareness of villagers and civil society.

In general, the capacity building effort would be enhanced with reinforced coordination and collaboration between the governmental institutions, like DOF and DOFI, to share the knowledge and skills, but also with the external projects in order to provide a structured set of support and opportunities for to gain field experience and knowledge.

Chapter 8 Institutional arrangement

8.1 **Responsibilities and interaction of the key stakeholders in relation to the NFMS**

This chapter lists and describes the main stakeholders involved with the NFMS. From the current situation summarized in the Table 22 below, improvements to the institutional arrangement are proposed to clarify the responsibilities of each players and ensure the further development of the NFMS.

DOF: DOF is charge of the management of forest within the three categories; Production, Conservation and Protection. DOF oversees the implementation of REDD+ with the REDD+ Division. DOF monitors the development of the NFMS with the operational management delegated to FIPD.

FIPD: FIPD plays a central and crucial role as being the technical manager of the NFMS. FIPD conducts MRV, oversees forest monitoring and centralizes the related data in its server. FIPD manages the NFMS web-portal and oversees the dissemination of information and communication.

DOFI: The Department of Forestry Inspection was established in 2008. DOFI is the direct authority to the MAF (Ministry of Agriculture and Forestry) for Forest Resources Inspection, Investigation and Prosecution of violators of the Forestry, Fisheries and Wildlife Regulations. DOFI is the national focal point for the implementation of the VPA (Voluntary Partnership Agreement) with EU for the FLEGT (Forest Law Enforcement, Governance and Trade) Action Plan. DOFI monitors illegal logging activity and is the only agency authorized to inspect and prosecute violators of the law. Thus, DOFI and DOF can collaborate to implement forest monitoring and enhance law enforcement and forest resource protection on the ground. The information collected by DOFI might be shared to FIPD/DOF to support the NFMS.

MONRE: The Department of Climate Change under the MONRE is the national focal point for the UNFCCC and is responsible for communicating reports on national GHG emissions that include the National Communication (NC) and the Biennial Update Report (BUR). As such, the Department of Climate Change collaborates with DOF to share the MRV results.

FoF: The Faculty of Forestry of the National University of Laos (NUoL) is involved in projects related to forest restoration, forest mapping with its Remote Sensing Laboratory, and surveying smallholder commercial tree plantations. With its capacity to procure its own source of funding, the FoF plays a unique role of an independent research pole that can conduct pilot actions or specific projects. As such, FoF is involved in forest monitoring and can share information or knowledge to governmental institutions like FIPD.

DALAM: The Department of Agricultural Land Management under MAF, monitors the land use of the agricultural land. Land-use plan can help to delineate clearly forested areas. For the NFMS, the DALAM can provide inputs in regards with watershed approach and synergy between forest, agriculture and livelihood aspects. DALAM has monitored forest fire since 2012 using multi-temporal Terra/Aqua MODIS fire products. Recently in 2019, DOFI requested DALAM to monitor forest fire in the three forest categories.

External Projects/Donors and NGOs: As outlined in chapters 6 and 7, Projects play an important role in forest monitoring although it can be limited in time and in the geographical extent. However, they are critical to support the forestry sector in general and the NFMS by providing information and advice on its development.

Table 22. Description of the main actors involved in the three functions of the NFMS

NFMS Function	Main actors	Main Action	Involved actors	Collaboration and output	Institutional improvements required
MRV and MMR	DOF	Generate AD and EF including background data (e.g. NFI, AE) and estimate emissions/removals	DCC	DCC uses report from DOF to produce NDC, GHG Inventory, DCC being the focal point to the UNFCCC.	Closer collaboration of DOF and DCC for: REDD+ estimates and GHG Inventory; reporting to the UNFCCC.
			FAO	FAO uses report from FIPD/DOF to produce the FRA	Closer collaboration between FIPD and FAO
			DOFI	Regular field data and analysis on selective logging and forest degradation useful for calculation of emissions	Need to set-up the collaboration relationship and identify areas for integration
			Projects (F-REDD, Silva Carbon)	Technical support to FIPD/DOF	
Forest monitoring ***On-going initiatives***	DOF, DOFI PAFO/DAFO/POFI/DFIU	Deforestation monitoring design, pilot and roll out the monitoring actions	JICA	Technical, financial support and capacity building	Need clearer division of role and mechanism for implementation
		Degradation monitoring design, pilot and roll out the monitoring actions	KfW, ADB, GIZ		
		Village forest monitoring design, pilot and roll out the monitoring actions	GIZ/CliPAD		
	FoF	Forest mapping,	Donors		

		forest regeneration monitoring			
	DALAM	Fire monitoring	DOFI		DOF which is not currently involved, should play a bigger role
Forest monitoring ***Potential future initiatives***	DOF, PAFO, DAFO	Forest fire Shifting cultivation Land/forest concessions Forest Landscape Restoration	DOFI DALAM FoF		Need to identify responsibilities
Data management	DOF	NFMS Web-portal and NFMS database related to MRV/MMR function	JICA	Technical and financial support	Need to streamline the data flow between the various institutions
	DOFI, PAFO	Cloud-based geo-database, GCP Form archive, MangoMap Web-portal for OLDM for FLUP	KfW, ADB, GIZ	Technical and financial support	

There is a need for a stronger collaboration between stakeholders and especially the governmental institutions. For instance, DOFI needs to be associated with the NFMS management and development, and in the meantime, the respective role of DOF and DOFI must be clearly identified to prevent any overlap in their actions.

As outlined in the Table 22, the MRV/MMR function is under the responsibility of DOF and the technical implementation ensured by FIPD.
The Department of Climate Change (under MONRE), uses the data produced by FIPD/DOF to report on GHG and produce the National Contribution (NC) to UNFCCC and the Biennial Update Report (BUR). Currently, the collaboration between DOF and MONRE is not strong, thereby causing delays for the reporting process. Both institutions should be more connected for a smooth coordination on GHG reporting.
To collect the necessary information for the Forest Resources Assessment report, the FAO contacts FIPD. A closer collaboration between the FAO and FIPD would ensure that the appropriate data are reported to the FRA.
DOFI, with the OLDM system, is developing its capacity to monitor legal and illegal use of forest resources. The data collected in the field could support the remote sensing mapping for the MRV/MMR, as well as the calculation of emissions from selective logging in the case the measurements are conducted in the same way as for the NFI. A transparent relationship for collaboration must be defined between DOF and DOFI, and more especially between the FIPD and the DOFI RS/GIS Support Unit, to enable data exchange, coordination of the actions, cross-integration of beneficial technology and methods and mutual capacity building.

In regard with the Forest Monitoring function of the NFMS, there are several on-going initiatives that would benefit from more coordination to avoid overlap, confusion for the users and duplication of datasets. For instance, the forest fire monitoring conducted by DALAM is currently not related to the

NFMS as DOF is not part of this initiative. DOF needs to play a central role to make sure that such initiatives contribute to the NFMS as well as supporting the land-use monitoring.

For the Data Management, DOF hosts a server that stores the data used and produced for the MRV/MMR and some forest monitoring tools (PDMS). DOFI has now its own storage capacity, mainly relying on cloud, related to its monitoring actions. Connection between these teams could be set-up to enable data exchange.

8.2 **Set-up dedicated structure to manage NFMS**

Currently, the FREL/MRV Technical Working Group (TWG) plays the role of the common assembly where the various stakeholders share their contribution to MRV and forest monitoring. All the stakeholders mentioned in the previous chapter are member of this TWG at the exception of DOFI.

To reinforce the management of the NFMS, the transformation of the current FREL/MRV TWG into a NFMS TWG that will include DOFI is one option that can be considered and proposed to the MAF that would ultimately validate the change. To make the TWG more operational and efficient, small sub-groups focused on each NFMS function could be organized as shown on the figure below.

To make the NFMS fully functional, cooperation is needed with a broader set of stakeholders such as governmental institutions in charge of land management, statistics and geographical information that would support the NFMS by providing data or provide advice on a wider scope.
As such, a "Broad Partners" sub-group might be part of the TWG and have working cooperation especially with FIPD/DOF.

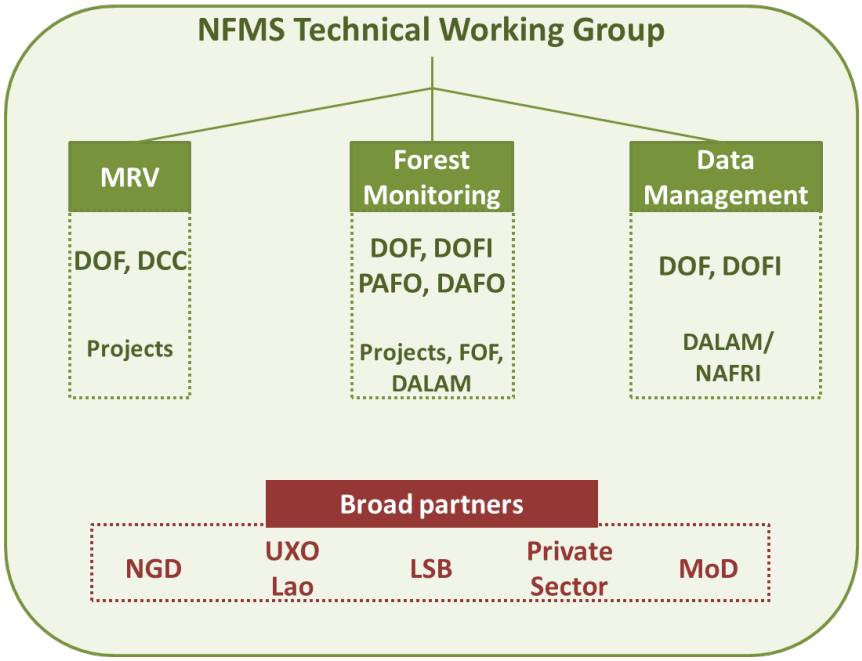


Figure 22. Structure of the proposed NFMS TWG

Broad Advisors Sub-group: It is an extended group of stakeholders not necessarily directly involved in the forestry sector but that can support NFMS by providing information. Potential attendees may be the following: National Geographic Department, Lao Statistics Bureau, the National Agriculture and

Forestry Research Institute (NAFRI), and private sector (forest plantation companies).

NGD: The National Geographic Department maps the administrative boundaries and collects information such as the road network from the Department of Roads to establish the national topographic map. This information is important to report forest status and MRV. A straightforward data exchange collaboration should be established between NGD and FIPD/DOF.

LSB: The Lao Statistics Bureau conducts the national census. Socio-economic indicators as well as demographic trends can support the monitoring, the understanding of the drivers of forest change and ultimately the design of adapted PaMs.

NAFRI: NAFRI is a research institute that support MAF to achieve the Agriculture Development Strategy 2025. Though its focus is more centered in agriculture, its expertise can help the design and advise the development of the NFMS.

Private Sector: Commercial tree plantations, essentially rubber tree and acacia or eucalyptus for the pulp industry or teak for furniture production, blossomed in the mid-2000s. In 2012, the government placed a temporary ban on concessions for some new plantations (Prime Minister's Order 13, PMO13), including rubber; in 2018, the ban was lifted for eucalyptus and acacia (Prime Minister's Order 9, PMO9) and there is renewed vigor in these sub-sectors for both companies and smallholders, resulting in the approval of Decree 247 on Promotion of Commercial Tree Plantations(2019). Land allocation are given in degraded land in the PFAs (Production Forest Areas). Therefore, the monitoring of these lands which is under the responsibility of DOF, is crucial for the investors. Collaboration with FIPD and support to the NFMS can be an option to involve the private sector into SFM (Sustainable Forest Management).

UXO Lao and Ministry of Defence (MoD): For forest monitoring and inspection, knowing where it is unsafe to go but also have authorization to survey into military zones is crucial. Establishing a partnership with UXO Lao (Lao national Unexploded Ordnance Programme) should provide access to the latest information on UXO to foresters. The Ministry of Defence with the Ministry of Agriculture and Forest could come to an agreement to authorize foresters to conduct survey throughout the country with no restriction.

Chapter 9 Budget and timeframe

The forest sector and more particularly the NFMS receive and benefit from funding provided by external donors either from the bilateral and multilateral cooperation, NGOs, or global programs and organizations.
(as of June) The National REDD+ Strategy (NRS) provides the strategic direction for implementing REDD+ in the country and summarizes the status and the roles of the NFMS in Chapter 5. The government and donor funds will be aligned to the implementation of the NRS.
The Emission Reduction Program (called GFLL) for the northern 6 provinces was accepted by the FCPF Carbon Fund as sub-national REDD+ program and opens a door for Lao PDR to receive results-based payment based on the performance of emissions reduction and enhanced removals of CO2 in the program area which can then be re-invested to strengthen the NFMS. Implementation of the ER-P will be technically and financially supported by the GCF funded GIZ project (called I-GFLL) and other partners including IFAD, ADB, KfW and JICA.
As outlined in chapter 4, various projects support the monitoring and management of forest resources, notably GIZ-CliPAD, GIZ-ProFEB, KfW-VFMP, KfW-ICBF, and ADB-BCC.
Lao PDR has a plan to submit a proposal for the GCF pilot programme for REDD+ results-based payments which can also invested into further developing the NFMS.

Conducting a cost estimation and preparing budget is crucial to ensure the long-term development of the NFMS. The Table 23 below outlines the actions and activities that would need to be engaged to sustain the NFMS. However, note that information presented may change time-to-time reflecting the progress of the NFMS implementation as well as conditions of the involved parties.

In addition, GFLL plans to mobilze three specialists related to the NFMS (i.e. NFMS Specialist, Land Use Change Assessment Specialist and MRV Support Specialist) with the total budget of USD 442,035 for 2020-2025. The tasks of these specialists will be discussed and coordinated under the framework of the Lao NFMS.

Table 23. Action calendar and associated budget

NFMS Function and task	Donors	Timeline	Budget (M US$)	Responsible Agency	Notes	2020	2021	2022	2023	2024	2025	2026 - 2030
MMR for the FCPF Carbon Fund												
Reporting Period 1		**2021 - 2022**		**DOF-FIPD/REDD+ Division**								
Activity Data	TA by JICA GT cost by I-GFLL	2022	31,500	Ditto	Ground Truthing			31,500				
E/R Factors (in case 3rd NFI data is not to be used)	TA by JICA, NFI cost by I-GFLL	2021-2022	531,000	Ditto	4th NFI (assuming national scale)		215,500	215,500				
ER monitoring Report	TA by JICA, World Bank (FCPF)	2022	n.a.	Ditto								
Reporting Period 2		**2024 – 2025**		**DOF-FIPD/REDD+ Division**								
Activity Data	TA by JICA, GT cost by FCPF CF payment	2025	31,500	Ditto	Ground Truthing						31,500	
E/R Factors	TA by JICA, NFI cost by FCPF CF payment	2024-2025	531,000	Ditto	5th NFI (assuming national scale)					215,500	215,500	
ER monitoring Report	TA by JICA	2025	n.a.	Ditto								

NFMS Function and task	Donors	Timeline	Budget (M US$)	Responsible Agency	Notes	2020	2021	2022	2023	2024	2025	2026 - 2030
National FREL/FRL and MRV												
2nd National MRV (tbd)	**tbd**	tbd	Tbd	DOF-FIPD/REDD+ Division	Coordinate with DCC							
Capacity building	TA by JICA, Silva Carbon	2020 - 2021	n.a.	Ditto								
Activity Data	No fund yet			Ditto								
E/R Factors (consult with 4th and 5th NFIs above)	tbd	tbd	Included in the MMR.	Ditto								
Reporting to UNFCCC				Ditto								
Update FREL/REL (tbd)	tbd	tbd	tbd	DOF-FIPD/REDD+ Division	Coordinate with DCC							
Forest Monitoring												
Deforestation Monitoring (PDMS)	JICA											
Phase 1 – Development in Oudomxay and Luangprabang	JICA	completed		PAFO, POFI								

NFMS Function and task	Donors	Timeline	Budget (M US$)	Responsible Agency	Notes	2020	2021	2022	2023	2024	2025	2026 - 2030
Phase 2 – deployment in other provinces (Houaphan, Luang Prabang, Xayabury etc.)	TA by JICA, cost by I-GFLL	2020 - 2024	JICA 266,400 I-GFLL 324,600	DOF, DOFI, PAFO, POFI			197,000	197,000	197,000			
OLDM for forest degradation monitoring	GIZ,KfW, ADB	In progress	In progress	DOF, DOFI, PAFO, POFI								
VilFoMa	CliPAD GIZ	2016 - 2020	242,500	DOF								
Fire/Shifting cultivation												
Data Management												
Finalization of the NFMS web-portal	JICA	-2021		DOF-FIPD								
Development of the SIS	(FCPF Readiness)			DOF-REDD+ Division								
Local contract for system development and O&M	I-GFLL	2020-2023	141,600	DOF, DOFI		47,200	47,200	47,200				
Funded/planned to be funded												
Not funded												

Annexes

Annex I – Comparison matrix OLDM – PDMS

Acronym		**OLDM**	**PDMS**
Full name		Operational Logging and Forest Degradation Monitoring	Near Real Time Provincial Deforestation Monitoring System
Objective		Track forest degradation from selective logging	Track deforestation from agriculture practices
Target users		Central and Province	Province and District
Staff skill at Central Level		GIS, Visual Interpretation, Delta-rNBR	N/A
Staff skill at Province Level		GIS, Visual Interpretation, Delta-rNBR	Visual image intepretation (no GIS), General Computer, email
Staff skill at District Level		Smart Phone/Tablet operation, GPS, OruxMap, ODK, email	Smart Phone/ Table operation, GPS, OruxMap, ODK, email
Target forest area		Project-based (NPAs, Corridors, Conservation Zones, Village Land Use Plans, TLAS, Infrastructure Areas)	Village protection and conservation forest in agreed Village Land Use Plan
Step 1: Change detection	Tool	Google Earth Engine script: FCDM tool (Forest Canopy Disturbance Monitoring)	Google Earth Engine Script: Developed by KKC
	Sensors	Landsat-8, Sentinel-1 and-2, PlanetScope, RapidEye	Sentinel-2
	Interim production	Fully automatic change detection in GEE script	Fully automatic change detection in GEE script
	Conducted by	DOFI GIS/RS unit, some Provinces	PAFO/POFI
	Geo. Extent	Priority Forest Areas (Intact Forest)	Province
	Basemap	Planet Explorer (ADB BCC), existing PlanetScope/RapidEye Data (ICBF, ProFEB), QGIS VHR Open Source Imagery, Delta-rNBR Historical Composite	Monthly cloud free mosaic map before weekly change detection
	Periodicity	3 Annual Cycles plus Event Report and Project-specific monitoring	Weekly
	Workforce and timelines	Project System Administrators/Assistant System Administrators prepare Annual Change Maps (L8 and S2) in May, OLDM Cycle Change Maps in Nov/Dec/Feb/Mar	1 staff - 0.5 hours to RUN GEE SCRIPT every week from Jan. to Apr.
Step 2: Verification/interpretation of change	Approach	Reduce Areas of Interest through updated Annual Intact Forest Map and overlay simplified PLUP Plans, known Concessions and roads. Identify likely Delta-rNBR change patterns and filter for accessibility and artifacts. Visual interpretation of filtered locations with Planet Explorer Compare Function (ADB BCC) or QGIS with Sentinel-2 (ICBF/ProFEB). Confirm with visual interpretation of downloaded PlanetScope imagery.	Visual - Refering forest loss estimated result with GEE and cloud free weekly Sentinel-2 images, and draw polygons of AOI on the web-application
	Imagery	Sentinel-2 and Landsat8 - VHR archive data and PlanetScope	Sentinel-2 and Google Map
	Software	QGIS	Web-application developped by KKC
	Conducted by	DoFI, PAM/DoF, PAFO, POFI, NPA Staff	PAFO/POFI
	Workforce and timelines	3 Annual Cycles plus Event Report and Project-specific monitoring - part of 2-week cycle by OLDM Teams	1 staff - 2 hours per every week from Jan. to Apr.
Step 3: Identification of field survey sites	Conducted by	Central and Provincial Project Teams	PAFO/POFI
	Map Interface	QGIS and Mango Map	Web-application developped by KKC
	Approach	Confirm location access, security and permissions and load Delta-rNBR and PlanetScope image data into Oruxmaps with target area and access route overlays.	Verified and validate the drawing polygons of AOI on the web-application KML of polygons are sent by email to the tablets
	Workforce and timelines	OLDM Teams under	1 staff - 2 hours per every week from Jan. to Apr.
Step 4: Field verification	Conducted by	DoFI, PAM/DoF, PAFO, POFI, NPA Staff, District Staff, Villagers and Military Staff	DAFO/DOFI
	Navigation tool	OruxMaps	OruxMaps
	Survey form	Oruxmaps and ODK Collect	ODK Collect
	Server	KoBoToolbox	KKC server - FIPD server in the future
	Field team	Joint OLDM Teams from all levels depending on mission	2-3 staffs of DAFO/DOFI from each District
Step 5: Reporting	Conducted by	Participating Staff	Semi-automatic reporting / DAFO-PAFO
	interface	Standard GCP Survey Forms (Word Documents)	Web-application developped by KKC
	Storage	OLDM Cloud-based Storage (Google Drive and Dropbox)	KKC server - FIPD server in the future