Forest Carbon Partnership Facility (FCPF)
Carbon Fund

ER Monitoring Report (ER-MR)

ER Program Name and Country:	Promoting REDD+ through Governance, Forest Landscapes & Livelihoods in Northern Lao PDR
Reporting Period covered in this report:	01-01-2019 to 31-12-2021
Number of FCPF ERs:	3,204,614 tCO2e
Quantity of ERs allocated to the Uncertainty Buffer:	665,317 tCO2e
Quantity of ERs to allocated to the Reversal Buffer:	377,014 tCO2e
Quantity of ERs to allocated to the Reversal Pooled Reversal buffer:	188,506 tCO2e
Date of Submission:	14 October 2023
Version	Version 4.2

Table of Contents

List of Tables and Figures

List of Acronyms

Acronym	Meaning
AD	Activity Data
AGB	Above Ground Biomass
BGB	Below Ground Biomass
CATS	Carbon Assets Tracking System
CCDC-SMA	Continuous Change Detection and Classification – Spectral Mixture Analysis
CliPAD	Climate Protection through Avoided Deforestation, supported by GIZ and KfW
COMTRADE	United Nations International Trade Statistics Database
CSA	Climate-Smart Agriculture
DAFO	District Agriculture and Forestry Office
DBH	Diameter at Breast Height
DCC	Department of Climate Change (under MONRE)
DOF	Department of Forestry (under MAF)
DOFI	Department of Forest Inspection (under MAF)
DW	Dead Wood
EF	Emission factor
EGPF	Ethnic Group Policy Framework
E/R factors	Emission and Removal factors
ER	Emissions Reduction
ER-MR	Emissions Reduction Monitoring Report
ERPA	Emissions Reduction Project Agreement
ERPD	Emissions Reduction Project Document
ESMF	Environmental and Social Management Framework
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FIPD	Forest Inventory and Planning Division (under DOF)
FLEGT	Forest Law Enforcement, Governance and Trade
FPIC	Free, prior and informed consent
F-REDD	Sustainable Forest Management and REDD+ Support Project (JICA)
F-REDD 2	The Project for Enhancing Sustainable Forest Management in collaboration with REDD+ programs and REDD+ funds (JICA)
FREL	Forest reference emission level
FRL	Forest reference level
FS 2020	Forest Strategy 2005 to 2020
FS 2035	Forest Strategy 2035
GCF	Green Climate Fund
GHG	Greenhouse Gas
GFLL	Governance of Forest Landscapes and Livelihoods Project (as known as La PDR Emissions Reduction Program)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit [German technical assistance]
GOL	Government of Lao PDR
ICBF	Integrated Conservation of Biodiversity and Forests project (KfW)
I-GFLL	Implementation of Governance of Forest Landscapes and Livelihoods Project, supported by Green Climate Fund and CliPAD/GIZ
IPCC	Intergovernmental Panel and Climate Change
IPCC GL	Intergovernmental Panel and Climate Change Guidelines
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency

KfW	KfW Entwicklungsbank [German Development Bank]
Lao PDR	Lao People's Democratic Republic
LENS2	Second Lao Environment and Social Project, supported by the World Bank
LLL	Lao Landscapes and Livelihoods, supported by the World Bank
LNSIS	Lao National Safeguards Information System
LULUCF	Land Use, Land-Use Change and Forestry
LWU	Lao Women's Union
MAF	Ministry of Agriculture and Forestry
MMR	Measurement, Monitoring and Reporting
MoNRE	Ministry of Natural Resources and Environment
MRV	Measurement, reporting and verification
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NPMU	National Project Management Unit
NRS	National REDD+ Strategy
NRTF	National REDD+ Task Force
NTFPs	Non-timber forest products
OLDM	Operational Logging and Degradation Monitoring
PAFO	Provincial Agriculture and Forestry Office
PDMS	Provincial Deforestation Monitoring System
PF	Process Framework
PICSA	Partnerships for Irrigation and Commercialization of Smallholder Agriculture, IFAD supported
PPMC	Provincial Project Management Committee
PPMU	Provincial Project Management Unit
ProFEB	Protection and Sustainable Use of Forest Ecosystems and Biodiversity, supported by GIZ
PRTF	Provincial REDD+ Task Force
QA/QC	Quality Assurance / Quality Control
REDD+	Reducing emissions from deforestation and forest degradation plus
REL	Reference emission level
RF	Removal factor
RL	Reference level
RPF	Resettlement Policy Framework
SESA	Strategic Environmental and Social Assessment
SOP	Standard Operating [Operation] Procedures
SPOT 4	Satellite pour l'Observation de la Terre, Satellite 4, European Space Agency
SRIWSM	Sustainable Rural Infrastructure and Watershed Management Sector Project, supported by the Asian Development Bank (SDB), European Union (EU), and German Government (BMZ)
tCO2e	[Metric] tonnes of carbon dioxide equivalent
TWG	Technical working group
UNFCCC	United Nations Framework Convention on Climate Change
USFS	United States Forest Service
VCS	Verified Carbon Standard
VFMP	Village Forest Management Project in Lao PDR, supported by KfW

NOTES:

- Abbreviations for forest and land types used for the Lao PDR Forest Type Maps are defined on pages 17-18.
- Additional abbreviations are defined on pages 20- 23, where they are used in equations for the calculations of emissions and removal factors.

1 IMPLEMENTATION AND OPERATION OF THE ER PROGRAM DURING THE REPORTING PERIOD

1.1 Implementation status of the ER Program and changes compared to the ER-PD

Lao PDR has made substantial progress on implementation of its Emissions Reduction Program (ER Program) during the initial reporting period, 2019-2021. The ER Program aims to reduce emissions in six northern provinces through work on developing the enabling conditions (i.e., policies, strategies, laws, regulations, land use planning, improved forest monitoring and forest-related law enforcement). The ER Program builds upon the six provincial REDD+ strategies. The Program supports alternative livelihoods for the rural people in these provinces, emphasising climate-smart agriculture, and sustainable forest management practices.

The ER Program is being implemented through six major projects, which are supported with funding from the Governments and international donors:

- The **Governance of Forest Landscapes and Livelihoods (GFLL) Project** has support from the Forest Carbon Partnership (FCPF) Carbon Fund through the World Bank. During the reporting period, the GFLL transitioned from the FCPF Readiness grant to ER results-based payment. The Emission Reductions Payment Agreement (ERPA) was signed on 30th December 2020 and became effective on 8th December, 2021. The GFLL received the first advance payment in June 2022 and is now focusing of developing systems and tools, building capacity, and selecting target villages
- The **Implementation of Governance of Forest Landscapes and Livelihoods (I-GFLL) Project**, which has support from the Green Climate Fund (GCF), the German-supported Climate Protection through Avoided Deforestation (CliPAD) project, and German technical assistance, Deutsche Gesellschaft für Internationale Zusammenarbeit (GiZ). The initial GCF grant has supported work in three ER provinces; a second GCF project, to extend support to all six provinces, was approved by the GCF Board in March 2023
- The **Integrated Conservation of Biodiversity and Forests (ICBF) Project**, supported by the German development bank, KfW Entwicklungsbank (KfW), working in two ER Program provinces
- The **Village Forest Management Project (VFMP)**, supported by KfW, working in two ER Program provinces
- The **Lao Landscapes and Livelihoods (LLL) Project**, with support from the World Bank, works in central Lao PDR, including two ER Program provinces. The LLL Project is working on five landscapes, including eight provinces and one prefecture, of which Houaphan and Luang Prabang are common with the ER Program; and
- The **Second Lao Environment and Social Project (LENS2)**, supported by the World Bank.

Additional support is being provided to the ER Program by:

- The **Sustainable Forest Management and REDD+ Projects (F-REDD),** and **The Project for Enhancing Sustainable Forest Management in collaboration with REDD+ programs and REDD+ funds (F-REDD2)**, supported by the Japan International Cooperation Agency (JICA). These projects are focused on supporting measurement, monitoring, and reporting (MMR) for the ER Program, near-real time forest monitoring at both the national and provincial levels, including the ER Program area, as well as field activities in two ER Program provinces.

Further information and updates on these projects – as well as a couple of other related major projects operating in the ER Program area -- are provided in Table 1 (below) as well as in Annexes 1 to 3 (to this report).

a) Progress on the actions and interventions under the ER Program (including key dates and milestones):

The ER Program design and key assumptions that are described in the ER Program Document (ERPD) remain unchanged. The progress made is summarized below:

Component 1: Strengthening the enabling conditions for REDD+

Lao PDR has been making significant progress in strengthening the enabling conditions related to REDD+. In 2019 the Government of Lao PDR (GOL) revised its Land Law, Forestry Law and adopted a Decree on Climate Change. These regulatory reforms enhance opportunities for strengthening natural resource stewardship in Lao.

In 2020, the National Forest Monitoring System (NFMS) Roadmap was approved. The Government's First Nationally Determined Contribution (updated submission) was submitted to the UN Framework Convention on Climate Change (UNFCCC) in March 2021. Other key achievements include: the approval of the National REDD+ Strategy (NRS) in April 2021, and establishment of the Lao National Safeguards Information System (LNSIS), in September 2021. The Forest Strategy 2035 is under finalization and will integrate NRS options into its design.

Land-use planning and implementation have greatly progressed, with over 400 villages already implementing village-level activities based on their agreed land-use plans. The land use planning is conducted through a participatory process. This work is based upon the use of Free, Prior and Informed Consent (FPIC) principles. Additional villages will be implementing activities that will bring increased forest areas under management during the second reporting period (2022-2024).

Forest monitoring has been strengthened through introduction of near-real time monitoring systems and enhanced enforcement. A technical consortium, which draws specialist skills from different institutions, has been established and supports the Department of Forestry (DOF)'s Forest Inventory and Planning Division (FIPD) to carry out gradual improvement of estimates of the emissions reductions (ERs) including monitoring of reversals. These improvements are described in more detail in Section 2 and Annex 4.

1.1 Strengthening policies and the legal framework

The Lao Forestry Law from June 2019 established the legal framework for REDD+ in Lao PDR. The revised Law has now allowed for the commercial use of timber from village forests under certain conditions.

Provincial REDD+ Action Plan (PRAP) process, PRAP activities have been integrated into Provincial and District Annual Development Plans. REDD+ is explicitly incorporated into Lao PDR's NDC, the Socio-Economic Development Plans (SEDPs) for the three provinces and at least 12 Districts' Socio Economic Development Plans.

1.2 Improved provincial-level, district-level, and village-level land use planning

A new guideline on Participatory Land Use Planning (PLUP) with Forest Landscape Restoration (FLR) principles mainstreamed has been successfully implemented in 48 of the targeted villages. Furthermore, 25 Village Forest Management Plans (VFMPs) have been implemented in the targeted Provinces.

The new PLUP 2.0 guideline on Participatory Land Use Planning (PLUP), including mainstreamed principles for FLR, was finalized in December 2020 and is being applied in all new target villages.

As of December 2022, PLUP was completed in 150 villages, of which 60 villages were in Houaphan, 51 in Xayaboury, and 39 in Luang Prabang. The respective Village Land Use and Forest Management Committees were established and trained.

About 11,000 villagers across 150 villages, with 41% being women participants, were involved with PLUP 2.0. About 700,000 hectares (ha) are demarcated and under land use plans, with 60% designated as village forest land and 22% as fixed agriculture areas, while shifting cultivation and fallow land make up about 17%.

For guardian villages (i.e., villages with land areas in national protected areas, such as Nam-Et-Phou Louey, Nam Xam and Nam Poui), PLUP 2.0 supported the implementation of land use plans on about 159,000 ha.

In 2021, PLUP 2.0 was conducted in 48 villages. In the target Districts of Paklay in Xayaboury and Xone in Houaphan Province, the program enabled the PLUP 2.0 implementation in 14 villages. This implementation covers a total village land area of approximately 220,000 ha, of which 65% is designated as village forest land. 25% of the total village area is zoned as fixed agriculture areas, while shifting cultivation and fallow land make up about 10%.

1.3 Improved forest law enforcement and monitoring

The Provincial Deforestation Monitoring System (PDMS) is the key system for improving forest law enforcement and monitoring. The PDMS have been already introduced to all six provinces. Provincial Agriculture and Forestry Office (PAFO) and District Agriculture and Forestry Office (DAFO) are responsible for applying the PDMS to monitor the deforestation events in their target areas.

Training on PDMS was provided in 2022 in the three provinces of Bokeo, Louangnamtha and Oudomxai that included participation of technical staff from FIPD, REDD+ Division, Department of Forest Inspection (DOFI) and staff from Forestry Unit and Forest Inspection Unit from 16 DAFOs. Houaphan, Luang Prabang, Xayaboury and Oudomxai are more advanced in implementing the PDMS owing to support from Development Partners. They already have experience of using the system for monitoring their forests with a cumulative total of approximately 180 staff have been trained. Meanwhile, Bokeo, Louangnamtha and Oudomxai were newly trained with the PDMS in 2022, and approximately 60 staff have been trained and starting to implement forest monitoring from 2023. Apart from the provincial and district levels, Department of Forestry, DOFI are also involved in its training and implementation.

1.4 Enhanced land and resource tenure security through land registration and other processes

The ER Program also supports land-use planning and measures to improve tenure security (PLUP guidelines have been developed, mainstreaming Forest Landscape Restoration) and will strengthen the forest and forest carbon measurement, reporting, and verification (MRV) system (Technical Assessment of the Forest Reference Emission Level (FREL) was completed and submitted by the DoF to the UNFCCC; National Forest Monitoring System (NFMS) was developed in collaboration with the support from JICA).

Component 2: Climate Smart Agriculture (CSA) and sustainable livelihoods for forest dependent people

An enabling environment to promote responsible, sustainable, deforestation-free and climate-smart agriculture is under creation, with stakeholder participation at all levels. CSA models are being implemented to address market demand, lack of income-generating alternatives, low productivity, and land and soil degradation. Typical interventions include promotion of sustainable and deforestation-free agricultural practices, revolving loan funds for different eligible options, and support to Non-Timber Forest Product (NTFP) management plans, which include NTFP processing and marketing.

2.1 *Establishment of an enabling environment to promote CSA and REDD+*

The promotion of Climate Smart Agriculture (CSA) implementation is based on the results of the PLUP 2.0 conducted in each target village. Training on the CSA approach for provincial and district Teams was conducted in Luang Prabang, Xayaboury, and Houaphan, with a total of 63 participants (19% of which were women).

CSA has been initiated in 144 villages; 3,929 households registered to participate and dedicated 5,530 ha to the implementation. Major activities chosen by farmers include paddy fields (39%), livestock grazing and forage (27%), rubber plantation (10%) and fishponds (8%). Up to now, 144 VFMPs have been implemented in the three Provinces (38 in Luang Prabang, 48 in Xayaboury, and 58 in Houaphan), covering a forest area of about 315,000 ha.

The CSA investment plans have been developed in 144 villages. 117 villages have been supported for implementing village investment activities through upfront investment payment with 71 villages already progressing investment plans

The ER Program has conducted a Value Chain and Market Study on nine promising commodities, such as Bong Bark, Rattan products, Sachai inchi, Tung oil, Zanthoxylum rhetsa, Styrax tpnkinensis, Bamboo products, Mulberry paper, and Sesame. The aim of these studies is to identify gaps to strengthen the value chain with interventions that would enhance farmer incomes.

2.2 Implementation of climate-smart agricultural models

Community-managed financial schemes: At the end of 2022, 170 villages from 13 districts in Luang Prabang, Xayaboury, and Houaphan have set up the Village Forest and Agriculture Grant (VFAG) committees, with a total of 510 members (three per village), and bylaw approvals. Financial management training on the operation of the VFAG (including fund requests, fund management and reporting) were provided to these committees, and village bank accounts were opened in 170 villages.

Component 3: Sustainable forest management

Targeted forest areas (e.g., those high in conservation and ecosystem values, carbon stock, production potential, and "deforestation high-risk" forests) have been strategically selected, and forest management activities are being implemented in these areas according to respective management objectives. Typical interventions include demarcation of village forest boundaries, village patrolling, forest rehabilitation, tree plantation, agroforestry and firebreak construction. As the villagers play key roles in forest management, they are fully incorporated from the planning to implementation stages. Near-real-time forest monitoring systems (the Provincial Deforestation Monitoring System (PDMS), and the Operational Logging and Degradation Monitoring (OLDM) are being extended stepwise in the target districts and villages.

3.1 Establishment of an enabling environment to implement and scale up sustainable forest management

The implementation of this sub component was initiated through a series of consultations and planning meetings to review issues and methods related to forest category classification, and selection of target areas. In addition to build capacity for MRV in national and sub-national institutions training was provided on carbon stock calculation and investment and training in deforestation monitoring tools.

3.2 Implementing and scaling up of village forestry

Village forest management has been implemented in the three national forest categories - production forest (albeit without any commercial harvesting potential in the short-term), protection and conservation forest, and unclassified forest. This implementation has followed a landscape approach (addressing SDG-15: Life on Land).

As of December 2022, 144 VFMPs (Village Forest Management Plans) have been implemented in the three Provinces (38 in Luang Prabang, 48 in Xayaboury, and 58 in Houaphan). More than 380,000 hectares of village forest are now managed under a signed Village Forest Management/Conservation Agreements in 129 new villages, covering a forest area of 315,000 ha. This area significantly exceeds the total target of 180,000 ha. Within this process, forest areas were identified for sustainable forest management, eventually leading to an increased forest cover.

Six workshops were organized to discuss coordination and Project implementation progress, including forest management and forest fire prevention. These workshops were attended by 239 participants from province, district forest staff and community members.

3.3 Implementing and scaling up forest landscape management and sustainable forest plantations

The ER Program initiated the collection and review of the existing management plans of the Production Forest Areas (PFAs) in Keng Chok-Nam Ngim and Houay Yang. The results of the review were presented at the two consultation workshops. At these events, potential management activities were identified. In this regard, the

management of PFAs will be supported as a part of the implementation of the VFMPs. As of December 2022, around 15,000 ha of PFAs are being managed through VFMPs.

In practice, National Protected Areas (NPA) management activities (e.g., inspection, patrolling) have been implemented, starting with 41 actions in Houaphan and 21 in Xayaboury, with the participation of 463 staff.

Forest officers and patrolling teams have built their capacities through three capacity-building events, and one stakeholder consultation with the province, district and village levels was held in Houaphan.

In addition, an exchange workshop on NPA management between the DoF, Nam-Et Phou Louey National Park, Nam Xam NPA and Nam Pouy NPA, was organized at the Nam-Et Phou Louey National Park.

Component 4: Program management and monitoring

The National Program Management Unit (NPMU) and Provincial Project Management Units (PPMUs) have been established at the REDD+ Division, DOF and at the Provincial Agriculture and Forestry Offices (PAFOs) of the six target provinces. The provincial management committees, provincial coordinators and provincial technical coordination committees are now all operational. Social and Environmental Safeguards Units (SESUs) have been created at the national and provincial levels. In addition, district-level SESUs have been set up in 17 districts (18 target districts for the first results-based payment). The organization of district SESUs in remaining target districts are ongoing (See Annex 1 for details).

The NPMU, PPMUs, and District PMUs (DPMUs) are mandated to coordinate between all stakeholders and are operating well. The National REDD+ Task Force, which functions as a Steering Committee updated all stakeholders about the progress of REDD+ implementation.

Training of District Agriculture and Forestry Office (DAFO) staff on the implementation of the Annual Operational Plans (AOPs) has been completed, and the training of beneficiaries on the implementation of the AOPs has been concluded in 56 villages. Finally, six workshops were organized to discuss coordination and the progress of implementation in forest management.

Training on Financial Management and Procurement was provided to 33 staff (including 16 women) from the Finance Unit under REDD+ Division, Planning and Cooperation Division under DoF, FPF Division and assigned finance staff from six PAFOs.

A consultation workshop on the selection criteria of target districts and villages was held with six PPMUs. These workshops generated a list and names of priority villages (14 villages per district), and reserve villages that will be upgraded to replace priority villages where any priority village is reluctant to participate in the Project after FPIC consultations.

Following the selection of target districts, and identification of priority villages, the training of trainers on FPIC was provided to provincial and district staff assigned to be responsible for FPIC. These staff include three technical staff from each Provincial Forestry Section of six PAFOs, and three district staff from each district of 18 districts (DAFO, Lao Women's Union (LWU), and the Lao Front for National Construction/Development (LFNC/D)).

FPIC 1 was conducted in 253 priority villages by 18 FPIC teams, composed of provincial and district staff members. Representatives from these villages were invited to FPIC 1, which included Village Headman/Deputy, LWU's President/Vice and LFNC/D's President/Vice.

Through FPIC 1, participants were briefed on: (1) GFLL Project Content – Goals, Objectives and four main components, and types of non-monetary and monetary benefits. The participants were also provided with the list of activities under components 2 and 3 focusing on climate-smart agriculture; and sustainable forest management.

The Lao National Safeguards Information system (LNSIS) has been developed, which specifies how safeguards will be managed. Each project contributing to the ER Program has its own safeguards policies and approaches, but these are harmonized with the World Bank and Government standards. Safeguards documents and a safeguards work plan were prepared and used for monitoring (for more details, see Annex 1). The Final Benefit Sharing Plan (BSP), finalized in September 2021, was also used for monitoring (see Annex 2).

b) Update on the strategy to mitigate and/or minimize potential displacement.

The ERPD assessed the overall risk of displacement of deforestation and forest degradation to be low (three drivers are assessed as low risk, and one driver assessed as medium risk). The ERPD risk mitigation strategy continues to be valid: it has been strengthened through the implementation of ER Program as well as gradual roll out of REDD+ at the national scale. Through the participatory land-use planning approach, which involves target villages and also neighboring villages, village boundaries are clarified, thereby decreasing the risk of displacement to adjoining areas.

Stepwise improvement of the NFMS facilitates the monitoring of drivers and interventions and helps to address displacement risks. The set of World Bank safeguards instruments i.e., Environmental and Social Assessment (SESA), Environmental and Social Management Framework (ESMF), Ethnic Group Policy Framework (EGPF), Process Framework (EF) and Resettlement Policy Framework (RPF)) have been completed and operationalized. The Lao National Safeguards Information System (LNSIS) also underpins monitoring and management of displacement. The effectiveness of such measures and lessons are briefly summarized in Section 1.2.

c) Effectiveness of the organizational arrangements and involvement of partner agencies

Apart from the project steering and management set-up already described, the National and Provincial REDD+ Task Forces provide strategic and policy guidance over REDD+ activities including the ER Program. The REDD+ Division within Department of Forestry and REDD+ Offices within Provincial Agriculture and Forestry Offices (PAFOs) coordinate the management of the REDD+ Program. Six multi-sector REDD+ Technical Working Groups (TWGs) are still operating, to cover issues of (1) Land Tenure and Land Use Planning, (2) Legal and Law Reinforcement, (3) Safeguards and Stakeholder Engagement, (4) Benefit Sharing, (5) National Forest Monitoring System (NFMS), and (6) REDD+ Strategy. The TWGs vary in their activeness, depending on the progress of each topic. Staff turnover and rotation have been seen as a common challenge, and continuous capacity building are needed to make the involved agencies aware of the latest REDD+ debates and requirements.

d) Updates on the assumptions in the financial plan and any changes in circumstances that positively or negatively affect the financial plan and the implementation of the ER Program.

The ER Program initially envisaged a budget of USD 136 million for its roll out for the six years of 2019-2024. This estimate covered the major projects comprising the ER Program. It included already committed finances from Government and international sources, anticipated finances including a project under formulation for submission to the Green Climate Fund, and reinvestments of part of the anticipated results-based payments from the Carbon Fund.

Since the ERPD formulation, the ER Program area has been attracting increasing level of co-financing that contributes to the achievement of the ER Program objectives. Table 1 below lists the projects active in the ER Program area during the reporting period, including two additional projects: the Partnerships for Irrigation and Commercialization of Smallholder Agriculture (PICSA) Project and the Sustainable Rural Infrastructure and Watershed Management Sector (SRIWSM) Project. The I-GFLL Project funding was split into two projects: support for the second project was only agreed on 16 March 2023, and became effective on 30 March 2023.

Table 1: Projects active in the ER Program area during the reporting period.

Project	Donor	Total budget USD (millions)	Total duration	Contribution to the ER Program
FCPF Readiness Grant	FCPF	8.2	2018 - 2022	Supported REDD+ readiness including Lao PDR to access the FCPF Carbon Fund. Targeted the six ER Program provinces and Champasack province.
GFLL	FCPF	3.0	2022 - 2025	Using the Carbon Fund's advance payment of USD 3 million for initial activities. Expecting to receive two results-based payments for emissions reductions, in 2023 and 2025. This future funding will be used to scale-up ER Program activities.
I-GFLL/CliPAD	GiZ, GCF Project 1 Project 2	 15.9 36.0	 2020 - 2024 2023 - 2026	Promoting implementation of ER Program activities (land use planning, sustainable forest management, and climate smart agriculture) in 240 villages in 3 provinces, Luang Prabang, Xayabouli, and Houaphan. Will expand activities to all 6 ER Program provinces. [1]
F-REDD, F-REDD 2	JICA	8.6	2015 - 2027	Supporting the NFMS including MMR and near-real time forest monitoring in the ER Program provinces. Small-scale village forest management activities in Luang Prabang and Oudomxay were also supported under F-REDD.
ICBF	KfW	18.3	2015 - 2023	Promoting integrated conservation of biodiversity and forests in two landscapes, one of which extends over parts of Luangnamtha and Bokeo provinces.
LLL	World Bank	57.4	2021 - 2027	In early stage of implementing its activities. Supporting 8 provinces in improved livelihoods and forest landscape management, including Houaphan and Luang Prabang.
LENS2	World Bank	37.0	2014 - 2022	Supporting the Lao Environmental Protection Fund. Part of the Fund is being used for protected area management in the ER Program area.
VFMP	KfW	7.3	2019 - 2026	Supporting village forest management in Xayabouli and Luang Prabang provinces.
PICSA	IFAD	21.0	2019 - 2025	Supporting improvement in irrigation infrastructure, catchment management, (irrigated) agriculture, and nutritional practices. The target areas Includes Houaphan, Luang Prabang and Xayabouli provinces.

[1] The I-GFLL project was initially designed to support the implementation of ER Program in the 6 provinces with a Green Climate Fund (GCF) grant of EURO (€) 65.2 million (total co-financing of €162.7 mil.) for 2020-2029. Due to the GCF's budget constraints, it was agreed to split the project into two projects. The first was reduced to €15.2 mil. (total co-financing of €62.6 mil.) with only 3 provinces targeted as Project 1 (2020-2024). The funding proposal for the Project 2 (2023-2026) with €32.8 4mil. covering the entire 6 ER Program provinces was submitted in early 2022. On 16 March 2023, the GCF Board approved a grant for Project 2 in the among of € 32.8 mil., or USD 36.0 mil. (with USD 45.3 mil. in co-financing). . This phasing of support has delayed the implementation of some ER Program activities in the 6 provinces, especially in the 3 provinces not covered in Project 1..

SRIWSM	ADB, EU and BMZ	74.2	2020 - 2027	Supporting upgrading of selected productive rural infrastructure schemes to be climate resilient, efficient, and sustainable; improving land use management, institutional arrangements and capacity for sustainable watershed management. Includes Houaphan and Luang Prabang provinces.

* NOTE: for each project the budget may include funding for activities not only inside, but also outside, of the ER Program area.

1.2 Update on major drivers and lessons learned

In 2018, the ERPD identified the following drivers of deforestation and forest degradation (Table 2). These four remain as the major drivers for deforestation and forest degradation in the ER Program area, however with some changes in their profile and degree. As explained above, and also in the ERPD (Section 10), the ER Program is fully aware of the importance of managing displacement risks and incorporating measures to reduce such risks. So far, there is no indication that the ER Program activities being implemented have resulted in any form of displacement.

The measures and lessons considered effective for mitigation of potential displacement are the participatory land use plans, which ensure that communities dependent on forest resources for fuel, fodder, NTFPs, herbs etc. are not deprived of access. In addition, appropriate alternative mitigation measures have been put into place through action plans approved by the community. For example, where communities are accessing and utilizing raw material and resources from forest areas for livelihoods, alternative measures to ensure supply of such raw material through enhanced production in non-forest areas, enhanced supply through external inputs, would be put into place. This would ensure displacement is avoided.

Another important measures and lessons considered effective is the forest monitoring. Together with improved community patrolling, the PDMS and OLDM are supporting enhanced law enforcement by the government authorities through early identification of displacement events and patterns. With the success of piloting in the ER Program areas, such forest monitoring actions are being expanded to other non-ERPD provinces, and the DOF plans to eventually extend them throughout the country.

Table 2: Update on major drivers.

	Description	Update
Key driver #1: Loss of forests to permanent agriculture (including agriculture and tree plantations)	Encroachment of upland ecosystems by smallholders through slash and burn practice for cash crops (e.g., including maize, rubber, banana, sugar cane, jobs tears), and conversion of forests into agricultural plantations, including tree crops (mainly rubber).	MAF annual (2021) agricultural statistics show that total harvest areas of major crops declined from 2016 - 2018, and have since stabilized in the ER Program area. Areas under maize and upland rice cultivation have decreased, while those under cultivation of cassava and jobs tear have increased. Major expansion of cassava into forests has been observed nationwide, including the ER Program area. Activity Data analysis shows more deforestation than in the Reference Period. Such loss is observed, however, much more in Regenerating Vegetation areas with low carbon stock, and much less in intact natural forests with high carbon stock. This change reflects the effectiveness of land use planning and law enforcement.
Key driver #2: Loss of forests/trees to shifting cultivation landscapes	Shifting cultivation is associated with subsistence, and most often with upland rice, but can also occur with other crops. The two forms of shifting cultivation, the "pioneering" form and "rotational" form, have different impacts. The use of slash-and-burn practices may lead to deforestation and degradation due to uncontrolled forest fires.	Rotational shifting cultivation is causing some loss of fallow forests (i.e., Regenerating Vegetation class). Pioneering shifting cultivation causing loss of primary forests is occurring on reduced scale compared to the Reference Period. This pattern also suggests improved conservation of intact natural forests with high carbon stock.
Key driver #3: Loss of forests/trees to infrastructure and other developments	Major infrastructure investments, such as roads, hydropower and mining, improve access to previously remote locations. As a results, this improved access often induces illegal timber harvesting and forest encroachment.	Given the socioeconomic development needs, infrastructure investments continue to be a driver of planned deforestation. Foreign investments from neighboring China, such as the high-speed railway, highways and hydropower dams, are on-going as nationally important projects. Some donors (e.g., the World Bank) also support road network maintenance.
Key driver #4: Unsustainable and illegal wood harvesting	Illegal logging of high-value timber species continues along the national borders with Vietnam. This border area has a thriving timber market. Lao PDR's increasingly stringent forest regulations have driven up prices for natural timber species.	Due to its illegal nature, it is difficult to get a clear idea of the volume of unauthorized timber trade. The UN COMTRADE data, however, shows a significant drop in the import of Lao wood products among the major import countries. It is assumed that the Lao PDR Government's strong commitment and measures for controlling commercial-based wood harvests are being effective. The stump survey conducted for the 1st reporting, however, shows an

	Description	Update
		approximate 12% increase in logging emissions compared to the reference period. Available evidence suggests that this logging is mostly for rural household consumption: during the COVID-19 pandemic, more people returned to these rural areas and relied more on forest-based livelihoods.

2 SYSTEM FOR MEASUREMENT, MONITORING AND REPORTING (MMR) EMISSIONS AND REMOVALS OCCURRING WITHIN THE MONITORING PERIOD

2.1 Forest Monitoring System

■ ***Organizational structure, responsibilities and competencies***

Table 3 (below), from the ERPD (Section 2.2), shows the entities involved in forest monitoring and their main responsibilities. The institutional arrangement of the measurement, monitoring, and reporting (MMR) system for the ER Program is consistent with that for the national level as elaborated in the NFMS Roadmap [2]. Most institutional arrangements build on existing arrangements and responsibilities of the respective entities and have been strengthened in a stepwise manner.

The Department of Forestry (DOF) approved the NFMS Roadmap in October 2020. Accordingly, the REL/MRV Technical Working Group (TWG) has been transformed into the NFMS TWG. It now has three sub-groups, Measurement, Reporting, and Verification (MRV), Forest Monitoring, and Data Management, which enables focused actions on each thematic area.

Within the DOF, the Forestry Inventory and Planning Division (FIPD) is responsible for generating the necessary data including the Activity Data (AD) and Emission/Removal Factors (E/R factors), conducting uncertainty assessment, and calculating the final ERs. This assessment includes the survey of tree stumps, used to estimate emissions from logging. They collaborate with the REDD+ Division who is responsible for coordinating the activities related to the ER Program.

[2] The NFMS Roadmap was developed as a shared vision for developing the NFMS for Lao PDR and to enhance coordinated actions among the stakeholders. It is made through a consultative process and provides orientation for developing and operationalizing the NFMS. It describe the current NFMS structure and areas for improvements. It presents the conceptual design of the NFMS, methodology for each component, institutional arrangement and expected actions.

Table 3: Framework of institutions involved in the forest monitoring.

	DOF	Department of Forest Inspection (DOFI)	Provincial Government	Private sector, local community	NFMS TWG	NRTF	MAF
MMR	Conduct the MMR. Within the DOF, the FIPD conducts collection and generation of data for AD, E/R factors, uncertainty assessment and ER calculation (including emissions from logging).	Technically review the MMR results as a member of the NFMS TWG.	Participate in National Forest Inventory (NFI)	Participate, serving as local guides, in National Forest Inventory (NFI)	Technically review the MMR results. Collaborate with other TWGs.	Endorse the MMR results. Facilitate collaboration with other concerned sectors	As the executing agency, responsible for the MMR.
Monitoring of drivers and interventions	Provide supporting data for enforcement actions. Compile the monitoring results.	Lead enforcement actions at the central-level and collaborate with provinces.	Lead enforcement actions at the provincial level and collaborate with district authorities.	Participate in forestry-related activities, e.g. protection, restoration, timber and NTFP supply-chain.	Technically review the monitoring results. Collaborate with other TWGs.	Facilitate collaboration with other concerned sectors following the monitoring results	As the executing agency, responsible for the monitoring.

- ***The selection and management of GHG related data and information***

The ER Program will account for Greenhouse Gas (GHG) related elements as summarized in the table below:

Table 4: Summary of GHG related elements accounted for the ER Program.

Forest Definition	"Current Forest": Diameter Breast Hight (DBH) >10cm, Crown cover >20%, Minimum area >0.5 ha; and "Potential Forest": forest land which are in temporarily un-stocked state (for details see next section.)
Sources and Sinks	Carbon emissions from deforestation; and Carbon emissions from forest degradation. Enhancement of carbon stocks through forest restoration; and Enhancement of forest carbon stock through reforestation.
Carbon pools	Above Ground Biomass (AGB). Below Ground Biomass (BGB).
Gases	CO2 emissions and removals.

To ensure robust management and enhance transparency of the data, Lao PDR developed the database system and web-based portal <https://nfms.maf.gov.la/>. The system unifies all the existing official data used for the estimation of emissions and removals at the national level and the ER Program into one single database. It also reduces costs by means of automating, and facilitating transparency, of the estimation methods and results. Moreover, overlaying such information with the administrative boundary data, forest category data, and other forestry-related data allows the data users to analyze forests according to their interests.

Table 5: Data presented in the NFMS web-portal.

Data related to Activity Data (AD)	Data type
Forest Type Map 2000, 2005, 2010, 2015, 2019, 2022 [3]	Raster data
Forest cover change map 2000-2005, 2005-2010, 2010-2015, 2015-2019, 2019-2021	Raster data (partly vector data) including ground-truthing points and photos
Satellite imagery used for the development of Forest Type Maps Landsat (2000), SPOT4, 5 MS(2005), RapidEye (2010, 2015) (both false color and true color), Sentinel 2(2019), Sentinel 2 (2022)	Raster data
Data related to Emission and Removal factors (E/R factors)	**Data type**
1st NFI data (1990s)	Tabular data.
2nd NFI data (2015-2017)	Tabular data including GIS points and ground-truthing photos.
3rd NFI data (2019)	Tabular data including GIS points and ground-truthing photos.
1st Regenerating Vegetation Survey (2017)	Tabular data including GIS points and ground-truthing photos.
2nd Regenerating Vegetation Survey (2019)	Tabular data including GIS points and ground-truthing photos.
Other data	**Data type**
Administrative area: national, province, district	Vector data
Forest category: Production Forest, Protection Forest, Conservation Forest	Vector data
Information on REDD+ projects	Project summary, project boundary and link to full information

Apart from the data and information disclosed in the NFMS web-portal, national documents and reports related to GHG are also transparently disclosed.

Table 6: National documents and reports related to GHG.

Document	Data storage
National FREL/FRL Report to the UNFCCC including annexes (2018)	http://dof.maf.gov.la/redd/en/frel-frl/ https://redd.unfccc.int/submissions.html?country=lao
1st National REDD+ Results to the UNFCCC including annexes (2020)	http://dof.maf.gov.la/redd/en/nfms/ https://redd.unfccc.int/submissions.html?country=lao

[3] The Forest Type Map 2022 is regarded as a map that represents the land and forest cover of 2022/01/01, and the Forest Type Map 2019 is regarded as the map that represents the land and forest cover of 2019/01/01. The ERs for the exact three years from January 1, 2019 - December 31, 2021 is reported in this 1st ER-MR by using these two maps.

1st National Communication to the UNFCCC (2000)	https://unfccc.int/documents/116663 https://unfccc.int/documents/116664
2nd National Communication to the UNFCCC (2013)	
1st Biennial Update Report to the UNFCCC (contains a Technical Annex on REDD+) (2020)	https://unfccc.int/documents/274307 https://redd.unfccc.int/submissions.html?country=lao

■ ***Processes for collecting, processing, consolidating and reporting GHG data and information***

Lao PDR has an established centralized process for collecting, processing, consolidating and reporting GHG data and information. The Standard Operating Procedures (SOPs) listed below have been prepared and can be found in the Lao REDD+ website <http://dof.maf.gov.la/redd/en/nfms/>:

Table 7: Manuals and Standard Operating Procedures (SOPs)

Document title	Summary
Standard Operation Procedures (SOP) for Forest Type Map development	The SOP provides guidance on the tasks and steps for developing the national forest type maps. It provides guidance on the preparation of the data required as well as the provision of the satellite imagery. The SOP describes how to conduct the visual interpretation and the steps for the QA/QC validation. Guidance for conducting ground truthing survey is also provided.
Standard Operating Procedures (SOP) for the Terrestrial Carbon Measurement	The SOP provides standard field measurement approaches to assist in quantifying the amount of carbon stored within the various organic pools found within a landscape. It also provides guidance on the plot distribution, plot establishment on the ground and navigation from/to the sub-plots.
Standard Operation Procedures (SOP) for the Lao PDR's REDD+ MRV - based on the methodologies applied for the 1st FREL/FRL and the 1st National REDD+ Results, and its Annex for calculation	The SOP provides guidance linked to calculation spreadsheet to conduct an estimation of the REDD+ results (or often interchangeably referred to as "MRV").
Standard Operation Procedures (SOP) for the National Forest Monitoring System Servers and Network	The SOP articulate the NFMS IT infrastructure hosted inside the FIPD's network, and provides guidance on the protocols for its administration.
National Forest Monitoring System User Manual	The manual provides guidance for the users of Laos National Forest Management System (NFMS) web-portal.
National Forest Monitoring System Data Installation Manual	The manual provides guidance for the NFMS IT administrators on the protocols for installing data into the National Forest Management System (NFMS) database.

Further details of the selection, generation, reporting, Quality Assurance/Quality Control (QA/QC) and management of Greenhouse gas (GHG) related data and information will be described in Section 2.2.

■ ***Systems and processes that ensure the accuracy of the data and information***

The following line diagram describes the overall flow of the MMR. In principle, the systems and processes have not changed since the ERPD to maintain full consistency with the Reference Level (RL) [4]. The full details of the estimation approach, data and information used for the MMR are explained in Section 2.2 and Section 3 respectively. The approach was considered as the best available approach for Lao PDR, through consultations with the international and national experts. Each of the data and information are produced following the respective standard operating procedures listed above. Lao PDR is proposing, however, a technical correction [5] to the RL (see Section 4.1) and to apply the same approach for the MMR.

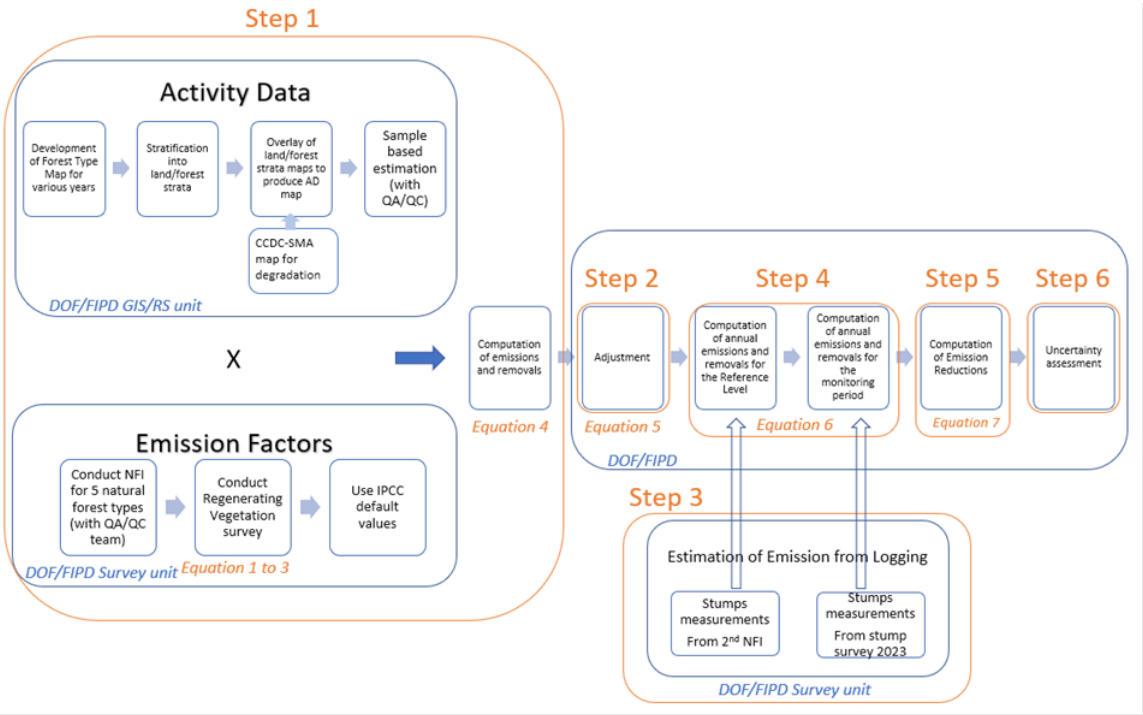


Figure 1: Line Diagram that outlines the overall approach for the MMR

SOPs have been developed for each of the components for ER calculation. These SOPs enable efficiency in the generation of quality output in a standardized manner. They make the NFMS more robust and transparent.

A framework for joint support of the MMR for the ER Program has been established with technical partners including the F-REDD 2 Project/JICA (technical support to the overall MMR process), the World Bank (advisory related to the MMR requirements), the SilvaCarbon Program (technical support related to the improvement of AD) and Boston University (provision of Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) map. See section 2.2.1 for detail). This collaboration has been providing an important Quality Assurance function to consider and implement best-available carbon accounting approach for Lao PDR including the technical correction of RL presented in Section 4.1.

Another technical collaboration also is in progress among the F-REDD 2 Project/JICA and forest inventory experts from the University of Göttingen in Germany and the US Forest Service, facilitated by the SilvaCarbon Program, for future improvements in the NFI. This work is expected to improve the accuracy and range of the NFI data to be

[4] The term RL and FREL/FRL are used interchangeably. RL is the term used in the FCPF, while FREL/FRL is the term used in the Lao's national REDD+ mechanism (following the UNFCCC terminology) but the two are literally the same. Same applies for the MMR (FCPF) and MRV (Lao's national REDD+ mechanism).

[5] A note that describes the methodological approach for the Technical Correction was discussed with the Facility Management Team (FMT) of the World Bank in 2022.

collected while maintaining the consistency in the estimation of emissions and removals. In 2021, FAO collaborated in the improvement of the R Script (an automatic calculation program) used for the NFI database.

- ***Design and maintenance of the Forest Monitoring System***

Recognizing the importance of a robust and transparent forest monitoring system, Lao PDR has developed its national Lao NFMS Roadmap. By consulting the FAO's Voluntary Guidelines on National Forest Monitoring and other good practices, the structure and content of the NFMS Roadmap were adapted for Lao PDR. This adaptation incorporated feedback from the capacity needs assessment of the Global Forest Observation Initiative REDD+ Compass, supported by the Forest Carbon Partnership Facility (FCPF) through 2018-2019, and feedback from the capacity needs assessment of the FAO Capacity-building Initiative for Transparency, conducted in 2020. The draft was finalized after two iterations of consultations with and comments from the NFMS TWG. It was approved by the DOF in October 2020. The draft was then finalized in the Lao and English languages and published on the UNFCCC REDD+ Web Platform.

The NFMS Roadmap provides a comprehensive overview and work plan for improvements, identified actions, institutional arrangements, and capacity building needs. The principle is to develop the NFMS in a step-wise fashion to support MRV, and monitoring of the drivers and interventions (Policies and Measures (PaMs). Safeguards Information System (SIS) and REDD+ Registry System are separate systems, however with some relation to the NFMS (a conceptual picture show in the Figure below). Several related initiatives are progressing in parallel: they are coordinated by the National REDD+ Task Force (NRTF) and the NFMS TWG to ensure that the NFMS will contribute to the overall performance monitoring of the forestry sector.

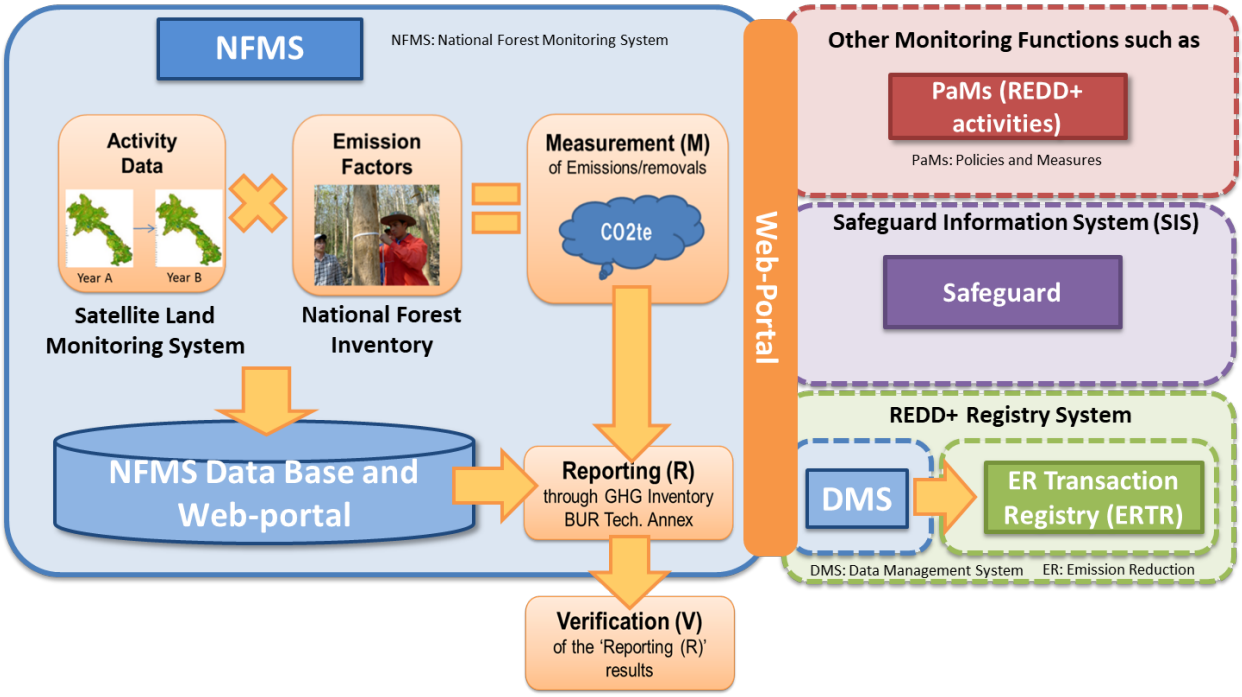


Figure 2: Conceptual diagram of Lao PDR's NFMS and its interactions with other REDD+ systems

- ***Systems and processes that support the Forest Monitoring System, including Standard Operating Procedures and QA/QC procedures***

As already explained, a robust institutional arrangement and a series of SOPs including quality assurance/quality control (QA/QC) procedures are integral elements of the estimation of emissions and removals process. The NFMS TWG and the technical partners provides technical review and advice to the process.

- ***Role of communities in the forest monitoring system***

Key stakeholders, including the private sector and local community, will be informed on an ongoing basis of the ER Program activities and results, to ensure transparency and accountability in its implementation. Some stakeholders, particularly the local communities, will continue to support the technical work, such as serving as local guides for the fieldwork for the National Forest Inventory. Moreover, information from their own activities will be used to support and improve the MRV, particularly for forest mapping. Such additional data includes, for example, plantation management information of the government (e.g., the Forest Plantation Registry System) and/or of the forest companies to improve classification of plantations. It will also include feedback from village-level forest monitoring activities, based on the land-use plans, to further understand stages of shifting-cultivation and forest regeneration.

Near-real time forest monitoring, which involves local communities, has made significant progress since the acceptance of the ERPD:

- The Provincial Deforestation Monitoring System (PDMS) is a system to support PAFO and DAFO to monitor deforestation caused by agricultural practices and to strengthen law enforcement. The PDMS is already being implemented in Xayabouli, Luang Prabang and Houaphan Provinces, and will be soon extended to Luang Namtha, Bokeo and Oudomxay Provinces through collaboration among the ER Program, I-GFLL, F-REDD 2 and the World Bank.
- The Operational Logging and Degradation Monitoring (OLDM) System provides a comprehensive and integrated set of tools that leads users from identification of potential disturbance and take corrective actions. With the support of the Protection and Sustainable Use of Forest Ecosystems and Biodiversity (ProFEB) Project and ICBF Project the OLDM System has been implemented in Luang Namtha, Bokeo, Khammouane, Sekong, Attapeu and Champasack Provinces.

- ***Use of and consistency with standard technical procedures in the country and the National Forest Monitoring System***.

Harmonization between the RL for the ER Program and the national FREL/FRL was seriously considered at the time of preparation of the ERPD. The national FREL/FRL applies methodologies that are largely consistent with those defined in the Carbon Fund Methodological Framework. The national FREL/FRL and the RL for the ER Program is based on the same dataset, prepared by the same DOF team using mostly the same methodologies, applying the same reference period, and assessed by the same group of stakeholders, thus, the ER Program RL was considered as a sub-set of the national FREL/FRL.

Following feedback from the Carbon Fund, Lao PDR now proposes a technical correction to the RL (see Section 4.1 for details).

The proposed approach would provide a higher level of accuracy for the forest degradation emissions, however with a quite large difference in the estimated volume. By applying this technical correction, however, the national-level and the ER Program estimates for forest degradation emissions will no longer be the same in their respective methodologies.

Consistency between the national-level and the ER Program accounting will be considered when Lao PDR updates the national-level FREL/FRL in the future, currently planned for 2025.

2.2 Measurement, monitoring and reporting approach

2.2.1 Line Diagram

The diagram shown as Figure **3**, outlines the steps followed to establish the Reference Level and estimate the Emission Reduction during the monitoring period. It consists of five main steps that are described below.

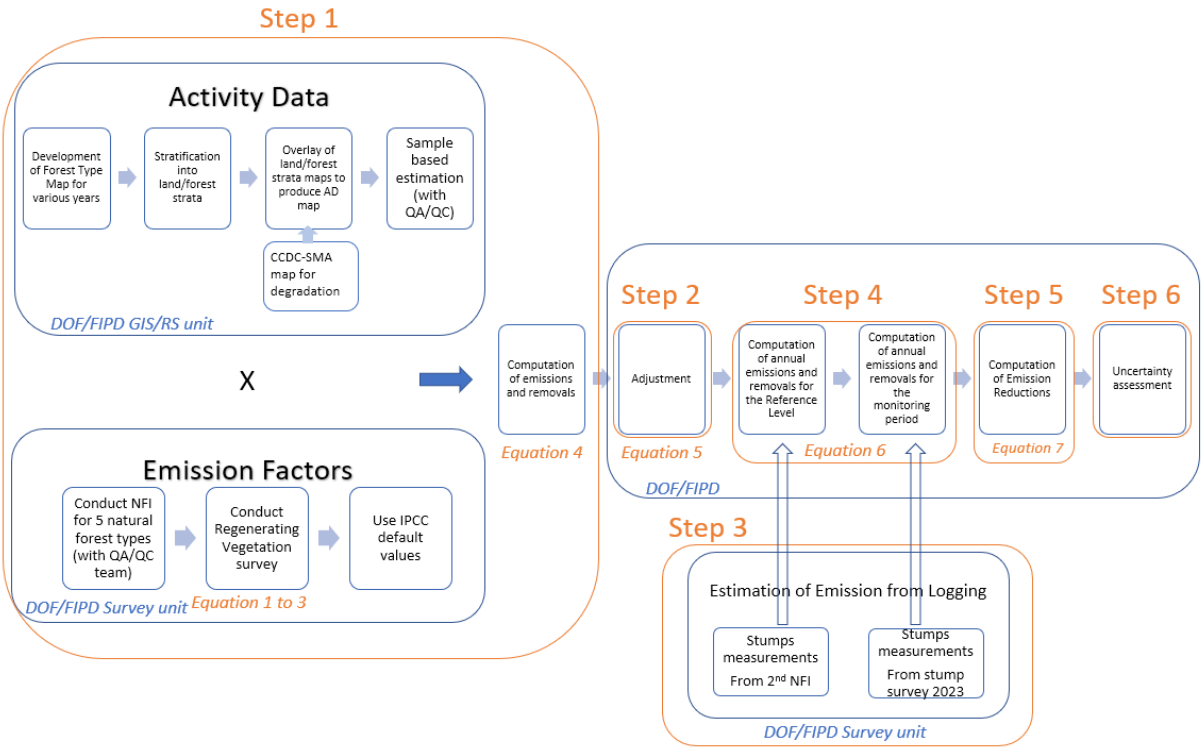


Figure 3: Line Diagram that outlines the overall approach for the MMR (identical to Figure 1)

【Step 1】

The first step is the estimation of the average annual historical emissions and removals based on the changes among REDD+ strata over the reference period (2005-2015) to establish the Reference Level, and the monitoring period (2019-2021) for assessing Emissions Reduction. This calculation uses the AD that are estimated through a sample-based approach on the REDD+ strata change maps. The emissions and removals are estimated separately for each source (emissions from deforestation and degradation) and sink (removals from restoration and reforestation).

Forest Type Maps are produced for years 2005, 2010, 2015, 2019 and 2022 following the level 2 of the Lao classification system as shown in the table below. Maps are then stratified according to the REDD+ strata, and overlaid.

Table 8: Land and forest stratification

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	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)	
Grassland	Other Vegetated Areas	Savannah (SA)	5
		Scrub (SR)	
		Grassland (G)	
Cropland	Cropland	Upland Agriculture (UC)	
		Rice Paddy (RP)	
		Other Agriculture (OA)	
		Agriculture Plantation (AP)	
Settlement	Settlements	Urban (U)	
Other Land	Other Land	Barren Land (BR)	
		Other (O)	
Wetland	Wetlands	Water (W)	
		Swamp/Wetland (SW)	

To enhance the estimation of emissions from degradation, a Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) [6] map has been developed by the Boston University to specifically detect forest degradation and used to supplement the AD map obtained from the Forest Type Maps. This procedure was applied as a Technical Correction to the Reference Level and integrated in the MMR.

Emissions and Removal (E/R) factors are developed based on national surveys and IPCC default values for each type of land/forest cover change, stratified into five REDD+ strata, and by taking the difference in carbon stock of each REDD+ stratum. For both the Reference Level and the Monitoring Period, the same E/R factors are used by using the outputs of the 3rd NFI which have lower uncertainty. This change constitutes one of the Technical Corrections proposed.

The implementation of the NFI follows a SOP [7] to ensure the quality and accuracy of the measurements conducted at the plot location. Another SOP [8] guides the production of the Forest Type Maps. For instance, the visual interpretation of the change is conducted with a three-step approach, wherein a first technician makes the initial interpretation that is reviewed by another technician and finally validated by a senior interpreter. The Sample-based assessment for computing the AD area estimates follows guidelines specified in a manual: it has a QA/QC approach that also uses three rounds of interpretation.

【Step 2】

As step 2, the value calculated by the adjustment below from average annual historical emissions and removals is subtracted from the value estimated in step 1. Two adjustments were made with an aim to make the Step 2 estimation as accurate as possible:

i) Adjustment of removals (regrowth rate and reversals)

Table 9. Adjustments for removals

Sinks	From	To	Adjustment of removals

[6] Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) algorithm. Chen, S., Woodcock, CE., Bullock E., Arevalo, P., Torchinava, P., Peng, S. and Olofsson P. (2021).

[7] Standard Operating Procedures (SOP) for the Terrestrial Carbon Measurement as listed in Table 7.

[8] Standard Operation Procedures (SOP) for Forest Type Map development as listed in Table 7.

Restoration	Stratum 4 (RV)	Stratum 1, 2 and 3	In forest ecosystems, forest biomass increases slowly over time to reach their full biomass (IPCC 2006) [9] In principle, 40-years [10] is assumed as the transition period from non-forest to Current Forest (i.e. Stratum 1, 2 and 3). From there, deduct 5 years as period for RV to reach its average biomass stock (See RV Survey Report), to arrive at 35 years for the transition period for biomass of Stratum 4 to reach Stratum 1, 2 and 3.
	Stratum 2 (MD, CF and MCB) Stratum 3 (DD)	Stratum with higher biomass	In principle, 20 years [11] is assumed as a transition period for forest with lower biomass to reach forest with higher biomass.
Reforestation	Stratum 5 (non-forest)	Stratum 4 (predominantly, RV)	In principle, the full removal factor is applied at the time change is observed, as RV reaches its average biomass stock after 5 years (See RV Survey Report) [12]. Adjustment based on 40-years default applied to the years following.
	Stratum 5 (non-forest)	Stratum 1, 2 or 3	No such change observed.

a. By considering the types of changes and rate of tree growth. This adjustment recognizes that in forest ecosystems, forest biomass increases slowly over time to reach their full biomass (IPCC 2006).

b. Reversals during the reference period (2005-2015) were identified through a time-series analysis of polygons, to avoid double-counting. Due to the estimation method of generating AD for two independent periods (i.e. 2005-2010 and 2010-2015), there is a chance that the emissions from reversal events that have occurred during the reference period are unreported (in other words, removals are over-estimated). Therefore, tracking is done of all the change patterns that are regarded as reversals (e.g., stratum 4 in 2005, changed to stratum 2 in 2010 and reverted to stratum 4 in 2015). The results were deducted as over-estimated removals.

ii) Adjustment of emissions (from deforestation and degradation)

The resulting estimation (above) presents the risk of overestimation of emissions from deforestation and degradation. The E/R factors are stratum-specific and do not reflect the actual accumulated biomass, which may be lower than the calculations. For example, a MD forest that is in its early regrowth stage (e.g., 10th year) should have lower biomass than the average biomass of entire MD class including all its age ranges. If, for example, a land parcel shifted from stratum 4, to stratum 3, and then back to stratum 4, the indication would be that the stratum 3 forests before the disturbance event would have reached at their maximum growth at about 10-11 years. Such change patterns are tracked through the time-series-analysis of forest maps. The resulting over-estimation of emissions

[9] IPCC (2006, Volume 4, Chapter 4.3: Land Converted to Forest Land) suggests default period of 20 years time interval for forest ecosystem to be established.

[10] The assumption is based on reference to the ERPD of neighboring Vietnam, which assumes 40 years for a non-forest to reach "Evergreen broadleaf forest – Medium". The Lao experts agreed on this assumption, as rather conservative. The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation of the Reference Level in the ERPD as well as the 3 years for the monitoring period.

[11] Again, following the case of Vietnam where 20 years is assumed as a period for forest with lower biomass shift to forest with higher biomass. However, such changes are actually rare: 71 ha for 2005-2010 and nil for 2010-2015. The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation for the Reference Level.

[12] The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation.

from deforestation and forest degradation are estimated and deducted, respectively. The same rationale was applied for the monitoring period, but considering the period 2015-2019 and 2019-2021.

【Step 3】

In Lao PDR, selective logging is considered as a major driver of forest degradation.
To improve the overall estimates of forest degradation, in addition to the approach described in Step 1, this Step 3 estimates the emissions from selective logging, both legal and illegal. These emissions from selective logging are estimated with a proxy-based approach that utilizes the stumps measurements collected in the field.
The Reference Level calculations use the stump measurements from the 2nd NFI and the first Monitoring Period uses data from a February 2023 stump survey. The biomass of the felled trees is estimated from the measured size of each tree stump and corresponding allometric equations, aggregated for each of the five forest classes (i.e., EG, MD, DD, CF, MCB) to estimate the average loss of carbon stock, and converted to tCO2e. Then, the results are multiplied with the area of each forest class calculated from the Forest Type Map 2015 and 2022 respectively for the Reference Level and the Monitoring Period, to estimate the assumed emissions from such logging events.

【Step 4】

In this step, the estimation of emissions and removals are finalized with the addition of the emissions from logging (Step 3), and the annual average is calculated for the Reference Level and the monitoring period, using their duration in years.

【Step 5】

The ERs are calculated by subtracting the annual emissions and removals of the monitoring period from the Reference Level.

【Step 6】

As final step, the uncertainty assessment using a Monte Carlo approach is conducted.

2.2.2 Calculation

In this section, the various steps for the carbon accounting as outlined in Figure 3 are described with more focus on the equations used for the calculation. Note that all data, formula, and calculations are explicitly documented in a reproducible manner in several spreadsheets submitted as part of the Laos 1st ER Monitoring Report. The examples below are only a subset of the calculations for illustrative purposes, refer to the respective spreadsheets for documentation of the complete set of calculations.

【Step 1】

Step 1 starts with the computation of the E/R factors.
Equation 1 (from 1a to 1e) outlines how the carbon stock of a forest type is calculated using the field measurements conducted during the National Forest Inventory. These calculations can be followed in the spreadsheet "NFI3 Cstock Calculation.xlsx" where Equation 1a is used in the tab "Trees". Equations 1b and 1c are used in the tab "Tree-plots". Equation 1d is used in the tab "Plots", and finally Equation 1e is used for carbon stock computation for the national level in the tab "National"

As indicated in the previous section, the E/R factors are based on the carbon stock of the various forest and land classes outlined in the Table 8. Carbon stocks for the five current natural forest classes are calculated using the field measurement data collected through the NFI. The carbon stock of the Regenerating Vegetation class comes from the field measurements collected during the Regenerating Vegetation survey. For the other classes, IPCC default values are used. For a specific forest type, the AGB is estimated from the specific forest type allometric equation using the tree measurements at the sub-plot level. Then the BGB is calculated using root-to-shoot ratio. The carbon stock at the sub-plot level being the estimated biomass AGB + BGB multiplied by the carbon fraction. The carbon-stock for a plot is the average of the carbon stock estimated in each sub-plot. Carbon stock for a forest type is the average of the carbon stock estimated in all plots of this forest type.

Equation 1a: AGB for a sub-plot

$$AGB_i = \sum_{j=1}^{n_i} \frac{AGB_{ij}}{A_{nest}}$$

Where:
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha) which is the sum of the biomass of all measured trees in the sub-plot, divided by the area of the sub-plot.
n_i = The number of measured trees (live and standing dead trees) in the sub-plot.
AGB_{ij}= The biomass of a tree, estimated with an allometric equation (in kg).
A_{nest}= The area of the nested sub-plot where the tree was measured (in ha)

Equation 1b: BGB for a sub-plot

$$BGB_i = AGB_i x\ RS$$

Where:
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha)
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
RS= Root to shoot ratio (2003 2006 IPCC default values) from Table 10 below.

The BGB is calculated at the sub-plot level using the root-shoot ratio that corresponds to the AGB threshold of the calculated sub-plot AGB and the forest type defined for the plot.

Table 10. RS ratio by forest types and AGB threshold [1 3]

Forest type (Level 2)	AGB threshold	Root-to-Shoot ratio (R/S ratios)	Source	Description
EG, DD, MD, and MCB	AGB < 125t/ha	0.20	IPCC GL 2006 for National Greenhouse Gas Inventories (Chapter 4: Forest land, Table 4.4)	These forest types are considered being in the Tropical domain and part of the Tropical moist deciduous forest ecological zone
	AGB > 125t/ha	0.24		
CF	AGB < 50t/ha	0.46	2003 IPCC Good Practice Guidance for LULUCF (Chapter 3: LULUCF Sector Good Practice Guidance, Table 3 A.1.8)	The values are for the Vegetation Type Coniferous forest and plantation in the table
	AGB = 50 - 150t/ha	0.32		
	AGB > 150t/ha	R/S = 0.23		
Plantation	AGB<50t/ha	0.46	2003 GPG(Anx_3A_1_Data_Tables3A.1.8)	The values are for the Vegetation Type Coniferous forest and plantation in the table
	AGB=50-150t/ha	0.32		
	AGB>150t/ha	0.23		
Bamboo		0.82	Junpei Toriyama http://www.ipcc-nggip.iges.or.jp/EFDB/main.php	Search by ID: 520906
RV	AGB<20t/ha	0.56	IPCC GL 2006 (V4_04_Ch4_Table4.4)	This forest type is considered being in the Tropical domain and part of the Tropical dry forest ecological zone
	AGB>20t/ha	0.28	IPCC GL 2006 (V4_04_Ch4_Table4.4)	

[1 3] LaoPDR_Modified REL (UNFCCC) Annex2 EF report, <https://redd.unfccc.int/files/2018_frel_submission_laopdr.pdf>

The RS ratio outlined in the table above were used in combination with the measurements made during the 3rd NFI for the five natural forest types, the measurements made during the 2nd RV survey for the RV, and IPCC default values for Bamboo and plantations.

Equation 1c: Total carbon stock for a sub-plot

$$C_i = (AGB_i + BGB_i)\ x\ CF$$

Where:
C_i= Carbon stock for the sub-plot i. (expressed in tC/ha) which is the sum of the biomass of all measured trees in the sub-plot.
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha) calculated with Equation 1b.
CF = Carbon Fraction, IPCC default value 0.47 (2006 IPCC GL Volume4, Chapter 4- Table 4.3 for the forest types in Laos).

Equation 1d: Total carbon stock for a plot

$$C_p = \frac{1}{n_{sp}} \sum_{i=1}^{n_{sp}} C_{isp}$$

Where:
C_p= Carbon stock for the plot p. (expressed in tC/ha)
n_{sp} = The number of surveyed sub-plots for the plot p.
C_{isp} = Carbon stock for the sub-plot i.

Equation 1e: Total carbon stock for a forest type

$$C_f = \frac{1}{n_p} \sum_{i=1}^{n_p} C_{ip}$$

Where:
C_f= Carbon stock for the forest type f. (expressed in tC/ha)
n_p = The number of surveyed plots for the forest type f.
C_{ip} = Carbon stock for the plot i.

Following the computation of the carbon stock with Equation 1, Equation 2 computes the carbon stocks for the five REDD+ stratum. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF".
For the carbon accounting, the Forest Type Maps are stratified into five REDD+ strata according to the amount of carbon stock for the various classes (see Table 8 above). The data comes from the NFI, the Regenerating Vegetation survey, or various IPCC default values. The carbon stock of each REDD+ stratum is calculated as follows:

Equation 2: Develop stratified carbon stocks for each of the five REDD+ stratum

Cstratum (tC/ha) = ($C1*A1$+$C2*A2$+....+Cn*An)/($A1$+$A2$+....+An)
Where:
Cstratum = average carbon stock (tC/ha) of the REDD+ stratum calculated from biomass and area of land/forest class;
Cn = carbon stock of land/forest class n (tC/ha);
An = area (ha) of land/forest class n.

For instance, for calculating the Cstratum of the strata 2 that combines three forest types, namely MD, CF and MCB, the carbon stock of each of these land/forest classes from the 3rd NFI as well as their respective areas in the Forest Type Map 2019 are used.

Then the Emissions/Removals factors for different combinations of land cover change are calculated using the equation 3 as shown below. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF". The results of this calculation are also presented in Section 3.1.

Equation 3. Calculation of E/R factors for changes among REDD+ strata

EFij $or\ RFij$ (tCO2e/ha) = $\left(Cstrata_i - Cstrata_j\right) \times \frac{44}{12}$

Where:

EFij or RFij: Emission Factor EF or Removal Factor when the change incurred from REDD+ stratum i to REDD+ stratum j;

$Cstrata_i\ and\ Cstrata_j$ are carbon stocks per ha of REDD+ stratum i and j corresponding to the changes;

If $Cstrata_i > Cstrata_j$, such change is considered emissions (change from a higher C/ha stratum to a lower C/ha stratum);

If $Cstrata_i < Cstrata_j$, such change is considered removal (change from a lower C/ha stratum to a higher C/ha stratum);

44/12 is the constant of CO2 mass to C mass for converting tC to tCO2e.

By using Equations 1, 2 and3, the E/R factors are calculated.

For the Activity Data, the area estimates and their related uncertainties are calculated from the error matrices following the sample-based estimation with the visual interpretation of plots. The calculation of the adjusted areas is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "AD_Uncertainty".

As displayed in the Figure 3, the result of Step 1 is the calculation of emissions and removals from the AD multiplied by the E/R factors.

Lao PDR applies an approach principally following the gain-loss method in calculating the average annual historical emissions and removals over the reference period, using AD generated from stratified sample-based assessment of satellite data and E/R factors derived from periodic national forest inventories.

Equation 4a is for the emissions and Equation 4b is for the removals respectively, are used in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total", where:.
In the tab "Total", Activity Data are displayed from row 1 to 54;
In the Tab "Total", E/R Factors are displayed from row 56 to 82; and
The calculation of AD x EF (equations 4a and 4b) are in cells E85:J115 displayed as matrices and aggregated by activities in the table M85:N98.

Equation 4a: Calculation of the emissions (over a time period)

$$Emissions = \sum_{j,i} EF_{ij} x\ A(j,i)_{RP}$$

Where:

Emissions = Emissions (tCO2e) from area changing from stratum I to stratum j over a time period.

$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the time period (ha).

EF_{ij} = Emission Factor when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

Equation 4b: Calculation of the removals (over a time period)

$$Removals = \sum_{j,i} RF_{ij} x\ A(j,i)_{RP}$$

Where:

Removals = Removals (tCO2e) from area changing from stratum I to stratum j over a time period.

$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the period (ha).

RF_{ij} : Removal Factor when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

For the Monitoring Period, the same equations 4a and 4b are used, considering the area converted during the Monitoring Period $A(j,i)_{MMR}$

【Step 2】

Once emissions and removals are calculated, adjustments are made as described in section 2.2.1, as step 2

- Removals are adjusted to account for the fact that forest recovery (change from lower biomass class to higher biomass class) does not happen instantly; per IPCC guidelines, this happens over a period of time, often set at 20 years. A similar adjustment is made to account for reversals (change from higher biomass class to lower biomass class) observed to occur on previously disturbed lands that had not yet achieved full recovery.
- Emissions are adjusted to account for the disturbances of land that had previously been disturbed and had recovered but had not yet achieved full recovery. A similar adjustment is made for potential double-counting of emissions for disturbed areas that are captured in the stump survey.

Adjustments are made for both Reference Level and the Monitoring Period.

Equation 5a: Adjustment on removals

$$Removals_{adj} = Removals\ x\ RegrowthRate - Reversal$$

Where:

$Removals_{adj}$= Adjusted removals in tCO2e.

$RegrowthRate$ = This adjustment takes into account the low regrowth of forest (40 years from non-forest to forest and 20 years from a lower biomass to a higher biomass forest) and the duration in year of the time period.

$Reversal$ = Amount of overestimated removals calculated from the historical Forest Type Maps where restoration or reforestation had occurred during the previous time period but saw a reversal event in the latest time period.

Equation 5b: Adjustment on emissions

$$Emissions_{adj} = Emissions - Reversal - Doublecounting(stumps)$$

Where:

$Emissions_{adj}$= Adjusted emissions in tCO2e.

$Reversal$ = Amount of overestimated emissions calculated from the historical Forest Type Maps where a restoration event had occurred during the previous time period before a disturbance in the latest time period.

$Doublecounting(stumps)$ = Degradation due to a downward shift in the three REDD+ strata (Stratum 1, 2 and 3), which may include the logging emissions. This amount is deducted to avoid potential double-counting with the logging emissions, as accounted using Equation 6a below.

The calculation of the adjusted emissions and removals is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total".

The $Reversal$ component is calculated in tab "TSA_Remove" and tab "TSA_Emission" for the adjustment of removals and emissions respectively for the RL. In the same spreadsheet, tab "TSA_Remove MMR" and tab "TSA_Emission MMR" calculate them for the monitoring period. As explained above, the historical Forest Type Maps are used for this calculation to conduct time-series analysis which is outlined in Section 3.1 and 3.2.

【Step 3】

Once the emissions are adjusted, the emissions from logging calculated from the stump measurements are added. The calculation of the emissions from logging is presented in the specific spreadsheet "Emissions from logging.xlsx". The calculation using Equation 6 below is presented in spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

Equation 6a: Calculation of the overall emissions with the addition of the emissions from logging, for the Reference Level and for the Monitoring Period.

$$Emissions_{all} = Emissions_{adj} + Emissions_{logging}$$

Where:

$Emissions_{all}$= Overall emissions in tCO2e.

$Emissions_{adj}$= Adjusted emissions in tCO2e.

$Emissions_{logging}$= Emissions from logging in tCO2e.

【Step 4】

To calculate the Reference Level as well as the annual average of emissions and removals during the Monitoring Period, the sum of respective emissions and removals are divided by the number of years of the considered period.

Equation 6b: Calculation of the Reference Level

$$RL_t = \frac{1}{t}(Emissions_{all} + Removals_{adj})$$

Where:

RL_t = Net emissions/year of the RL over the Reference Period; tCO2e/year.

$Emissions_{all}$= All adjusted emissions in tCO2e, including the logging emissions.

$Removals_{adj}$= Adjusted removals in tCO2e.

t = number of years of the Reference Period.

Equation 6c: Calculation of the net emission over the Monitoring Period

$$GHG_t = \frac{1}{t}(Emissions_{all} + Removals_{adj})$$

Where:

GHG_t = Monitored net emissions at year t; tCO2e/year

$Emissions_{all}$= All adjusted emissions in tCO2e, including the logging emissions.

$Removals_{adj}$= Adjusted removals in tCO2e.

t = Number of years of the Monitoring Period

For the Monitoring Period, emissions and removals would be calculated with the equations 4a and 4b, but using

$A(j,i)_{MP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the monitoring period (ha).

【Step 5】

Finally, the ERs will be calculated as Equation 7 below:

Equation 7: Calculation of the Emission Reductions (ERs)

$$ER_{RP} = RL_{RP} - GHG_{RP}$$

Where:

ER_{RP} = *Emission Reductions under the ER Program during the Reporting Period; tCO_2e;*

RL_{RP}	=	*Expected net emissions of the RL over the Reporting Period; tCO_2e;*
GHG_{RP}	=	*Monitored net emissions over the Reporting Period; tCO_2e;*

Steps 4 and 5 are presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

3 DATA AND PARAMETERS

3.1 Fixed Data and Parameters

Parameter:	EF_{ij} and RF_{ij} – Emission and Removal factor
Description:	Emission (and removal) factor are calculated using field measurements from the 3rd NFI for the five forest classes and from the 2nd RV survey for the Regenerating Vegetation class. For the other forest/land classes, IPCC default values are used. E/R factors are based on the aggregated carbon stock for the REDD+ Strata. Emission/Removal factor are calculated with equation 3 with the result (Carbon stock) from equation 1 and 2 and in the spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", the calculation is implemented in tab "EF".
Data unit:	tCO2e/ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Carbon stocks for each forest/land classes of the level 2 of the Lao classification are collected through various sources, as described below: **Natural forest** • Measurements of carbon stock of the five natural forest classes (Evergreen Forest (EG), Mixed Deciduous Forest (MD), Coniferous Forest (CF), Mixed Coniferous and Broadleaved Forest (MCB), and Dry Dipterocarp Forest (DD). • Measurements from the 3rd NFI conducted in 2019 are used to estimate the AGB. A total of 415 survey plots were distributed for these five forest classes through random-sampling. • Country-specific allometric equations [14] were developed and applied for the three major Level 2 forest classes (i.e. EG, MD and DD). For the other two forest classes (CF and MCB) the allometric equations developed in Vietnam [15] were used without applying correction factors.

Evergreen Forest (EG)	$0.3112*DBH^{2.2331}$
Dry Deciduous Forest (DD)	$0.2137*DBH^{2.2575}$
Mixed Deciduous Forest (MDF)	$0.523081*DBH^{2}$
Coniferous Forest (CF)	$0.1277*DBH^{2.3944}$
Mixed Coniferous and Broadleaf Forest (MCB)	$0.1277*DBH^{2.3944}$

[14] Morikawa Y., Daisuke Y., Therese T., and Walker S., *Development of country-specific allometric equations in Lao PDR*, 2017, <http://dof.maf.gov.la/redd/en/frel-frl/>.

[15] Hung, N.D., Bay, N.V., Binh, N.D. and Tung, N.C. (2012). Tree allometric equations in Evergreen broadleaf, Deciduous, and Bamboo forests in the South East region, Vietnam. In (Eds) Inoguchi, A., Henry, M., Birigazzi, L., Sola, G. Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD Programme, Hanoi, Viet Nam.

Regenerating Vegetation (RV)

The carbon stock is calculated from the 2nd RV survey conducted in 2019. As the RV occurs most prominently in Northern Lao PDR (including the ER Program area), survey sites were distributed in three provinces in the Northern region (Luang Namtha, Oudomxay and Houaphan). Other survey sites were located in one province in the Central region and three provinces in the Southern region. A total of 189 survey plots (63 survey clusters with three survey plots each) were distributed and the measurement of DBH for trees and biomass weight measurement for the understories were conducted.

Bamboo (B)

The value is derived from the average carbon stock values of the Northern Central Coast region of Vietnam for the cycles II to IV (2000, 2005, and 2010). (Vietnam modified REL report, submitted to UNFCCC 2016, P66 Table3.6)

In Table 3.6 copied below from the Vietnam modified REL report, Bamboo is the Forest type code 6.

Table 3.6: NCC average carbon stock (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	116 (1813)	169 ± 10%	220 (3654)	175 ± 7%	163 (2820)	162 ± 13%	78 (1225)	141 ± 9%	
2	139 (1463)	70 ± 2%	268 (3305)	70 ± 2%	260 (3447)	73 ± 2%	172 (2398)	70 ± 3%	
3	144 (1335)	32 ± 5%	265 (3018)	31 ± 4%	248 (2925)	33 ± 4%	185 (2481)	31 ± 4%	
4	62 (491)	29 ± 17%	120 (1233)	24 ± 16%	176 (1810)	21 ± 10%	155 (1663)	19 ± 18%	
5	174 (4887)	40 ± 14%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	National
6	110 (1320)	16 ± 23%	75 (1085)	13 ± 17%	215 (3418)	13 ± 11%	96 (1463)	15 ± 18%	
7	46 (523)	68 ± 22%	40 (482)	70 ± 23%	124 (1480)	42 ± 10%	91 (1131)	40 ± 11%	
8	31 (607)	87 ± 18%	73 (1707)	67 ± 13%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	National
9	29 (340)	85 ± 24%	49 (473)	73 ± 17%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	National
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	2 (27)	36 ± 76%	4 (6)	66 ± 22%	1 (4)	43	2 (11)	38 ± 287%	
12	6 (76)	22 ± 56%	6 (69)	28 ± 25%	24 (234)	20 ± 39%	42 (444)	22 ± 30%	

The calculation steps to obtain the value used for Lao PDR are as follow:

- Average the values for the cycle II, III and IV,
- Convert to AGB (using 0.47 for Carbon Fraction)
- Calculate the total biomass by using a Root to Shoot Ratio of 0.82 (as indicated in Table 10 in section 2.2.2
- Convert to carbon stock (using 0.46 for Carbon Fraction from table 4.3 IPCC Guidelines 2006 – value for wood, tree d<10cm in tropical and subtropical)

Plantations (P)

Carbon stocks were derived from default factors of the IPCC database.

(Good Practice Guidance for Land Use, Land-Use Change and Forestry, 2003 - Table 3A.1.3 Aboveground Biomass Stock in plantation forests by broad category – Asia (other species) moist with long dry season).

Other land classes

The value of carbon stocks of remaining land classes (non-forest classes) are mostly taken from IPCC GL 2006 and combined into a single area-weighted estimate for the non-forest class.

The detailed sources are listed below:

- Savannah, IPCC Emission Factor Database, ID=513130.
- Scrub, Table 4.7 from the IPCC 2006 Guideline V4. Tropical shrubland in Asia continental.
- Grassland, Table 3.4.2 from the GPG for LULUCF 2003. Peak AGB for Tropical, moist and wet climate zone.
- Upland Crop, Rice Paddy, Table 3.3.8 from the GPG for LULUCF 2003. Annual cropland.
- Other Agriculture, Table 3.3.8 from the GPG for LULUCF 2003. Perennial cropland in Tropical moist.
- Agriculture Plantation, IPCC Emission Factor Database, ID=511318

These E/R factors are calculated for the national level, though the use for the specific ER program area is valid as an analysis made after the 2nd NFI demonstrated that there was no tangible difference in carbon stock between the national results and t*hose of* the six provinces.

The 3rd NFI was conducted only for the national level.

Value applied:

Carbon stock tC/ha

		tC/ha	Area 2019 (ha)	REDD + strata
Forest Land	Evergreen Forest (EG)	205.8	2,594,961	1
	Mixed Deciduous Forest (MD)	87.9	9,036,767	2
	Coniferous Forest (CF)	77.1	124,009	
	Mixed Coniferous/Broadleaved Forest (MCB)	87.6	106,848	
	Dry Dipterocarp (DD)	50.8	1,171,873	3
	Forest Plantation (P)	37.2	213,585	4
	Bamboo (B)	24.4	84,561	
	Regenerating Vegetation (RV)	10.4	6,087,141	
Grassland	Savannah (SA)	16.4	69,918	5
	Scrub (SR)	38.6	26,391	
	Grassland (G)	7.4	250,603	
Cropland	Upland Crop (UC)	5.0	132,892	
	Rice Paddy and Other Agriculture (RP/OA)	3.8	2,378,434	
	Agriculture Plantation (AP)	38.8	83,072	

Settlements/Otherland/Wetlands	Urban (U)	0.0	100,994	
	Bare Land (BR)	0.0	185,954	
	Other (O)	0.0	22,319	
	Water (W)	0.0	377,863	
	Swamp (SW)	0.0	6,072	

Using the REDD+ strata and the equation 2 and 3 (Section 2.2.2), the following E/R factors were computed.

EF(tCO2/ha)

	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0	-432.8	-568.3	-712.4	-737.4
MD/CF/MCB	432.8	0.0	-135.5	-279.6	-304.7
DD	568.3	135.5	0.0	-144.1	-169.2
P/B/RV	712.4	279.6	144.1	0.0	-25.0
NF	737.4	304.7	169.2	25.0	0.0

QA/QC procedures applied

A SOP for the NFI has been developed and was used in the 3rd NFI campaign. Improvements were made for the distribution of plots where four to nine sub-plots were distributed into a cluster plot to enable more possibilities for the field teams. Additional training was emphasized, especially for the QA/QC team. 15% of all plots were checked by the QA/QC team. The Standard Operation Procedures (SOP) for the Terrestrial Carbon Measurement is available with this link ;

Uncertainty associated with this parameter:

For the ERPD, the uncertainty analysis used the propagation error approach. The following sources of uncertainty were assessed:

- Uncertainty of AGB originating from sampling error
- Uncertainty of AGB originating from biomass equation
- Uncertainty of Root-to-Shoot ratios due to the use of IPCC default values
- Uncertainty of Carbon Fraction factor due to the use of IPCC default values
- Uncertainty of AGB originating from measurement error

By using the propagation error approach, the uncertainty for the E/R factors are as in the table below.

E/R factors (Uncertainty %)

	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0%	12.0%	13.3%	15.3%	15.7%
MD/CF/MCB	12.0%	0.0%	10.5%	12.5%	13.3%
DD	13.3%	10.5%	0.0%	13.2%	14.4%
P/B/RV	15.3%	12.5%	13.2%	0.0%	15.1%
NF	15.7%	13.3%	14.4%	15.1%	0.0%

For the purpose of the ER Monitoring Report, the uncertainty analysis uses a Monte Carlo approach with 10,000 iterations of random estimates of the same uncertainty sources.

For the Monte Carlo simulation, the calculation of the below ground biomass (BGB) component of the EF differs from section 2.2.2 as it uses the R:S ratio associated with the REDD+ strata. This is necessary in order to simulate the uncertainty of the R:S parameter. The spreadsheet used for the Monte Carlo simulation is derived from a template prepared by the World Bank that proposed a similar approach.

	Value	Uncertainty (95%)	SE
Carbon Fraction	0.470	2.7	0.00647
R:S for stratum 3 and 4	0.200	11.5	0.01173
R:S for stratum 1 and 2	0.240	20.3	0.02486
AGB (Strata 1) kg/ha	353.1	10.9	19.636
AGB (Strata 2) kg/ha	150.6	6	4.610
AGB (Strata 3) kg/ha	90.1	9	4.136
AGB (Strata 4) kg/ha	20.4	19.6	2.038
AGB (Strata 5) kg/ha	8.3	20	0.844

The uncertainty for the AGB is computed using the uncertainty from the sampling error and the biomass equation, as shown below:

Class	Uncertainty from 3rd NFI Sampling	Uncertainty from allometric equation
EG	10.2	3.9
MDF	4.8	3.8
CF	11.1	18.0
MCB	14.1	18.0
DD	8.2	3.6
P	-	18.0
B	15.7	0.3
RV	22.2	-

Any comment: n.a.

Parameter:	$A(j,i)_{RP}$ - Activity Data for the Reference Level (AD) 2005-2015 (10 years)
Description:	The area of REDD+ strata change over the two periods of the Reference Level (2005-2010 and 2010-2015) was provided by the overlay of the stratified Forest Type Maps and adjusted by a sample-based estimation. Twenty-five possible changes describe four activities: Deforestation, Forest Degradation, Forest Restoration and Reforestation.

- Deforestation: loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum.
- Forest Degradation: downward shift of a forest stratum from a higher carbon stock stratum to another forest stratum with lower carbon stock. This shift will effectively include cases of transitional land use change events such as deforestation events not captured in the 5-year mapping interval (e.g. stages of rotational agriculture, from a recovered forest to a forest fallow, and/or a non-forest stage, or land conversion for forest plantations). Through the application of this method, fallow land from shifting cultivation sites are largely captured within the RV category and occur most prominently in MD and EG forests, accounting for the vast majority of the degradation events.
- Forest Restoration: upward shift of a forest land stratum with lower carbon stock to another forest/land stratum with higher carbon stock.
- Reforestation: gain of forest carbon stock due to conversion of non-forest land stratum to a forest land stratum

YearX	YearX+5: stratum 1	stratum 2	stratum 3	stratum 4	stratum 5
stratum 1	SF1	DG1	DG2	DG4	DF1
stratum 2	RS1	SF2	DG3	DG5	DF2
stratum 3	RS2	RS4	SF3	DG6	DF3
stratum 4	RS3	RS5	RS6	SF4	DF4
stratum 5	RF1	RF2	RF3	RF4	SNF

Deforestation (DF)
Degradation (DG)
Restoration (RS)
Reforestation (RF)
Stable Forest (SF)
Stable Non-Forest (SNF)

In spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", Activity Data and their related uncertainty are calculated in tab "AD_Uncertainty".

As part of the technical correction to the RL, the Forest Degradation is supplemented by a map produced with the CCDC-SMA script that directly captures forest degradation over a period of time (see Annex 4). The calculation of the AD and their uncertainty is in the spreadsheet "SBE_matrix_final_for_TC.xlsx" in the tabs "CCDC2005_2010" and "CCDC2010_2015" for the periods 2005-2010 and 2010-2015 respectively.

Data unit: Ha

Source of data or description of the method for developing the data including the spatial level of the data (local, regional,

Wall-to-wall national land/forest maps with the Level 2 classification for the years 2005, 2010 and 2015 developed by the Forestry Inventory and Planning Division (FIPD) of Department of Forestry (DoF), Ministry of Agriculture and Forestry (MAF).

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	Current Forest	Evergreen Forest (EG)	1
		Mixed Deciduous Forest (MD)	2
		Coniferous Forest (CF)	
		Mixed Coniferous/Broadleaved Forest (MCB)	
		Dry Dipterocarp (DD)	3

national, international):			Forest Plantation	**4**
		Potential Forest	Bamboo (B)	
			Regenerating Vegetation (RV)	
	Grassland	Other Vegetated Areas	Savannah (SA)	**5**
			Scrub (SR)	
			Grassland (G)	
	Cropland	Cropland	Upland Agriculture (UC)	
			Rice Paddy (RP)	
			Other Agriculture (OA)	
			Agriculture Plantation (AP)	
	Settlement	Settlements	Urban (U)	
	Other Land	Other Land	Barren Land (BR)	
			Other (O)	
	Wetland	Wetlands	Water (W)	
			Swamp/Wetland (SW)	

The 2010 map serves as the benchmark map, and the maps for the other years developed through applying a change detection method, to maintain consistency of classification and interpretation.

For the 2010 and 2015 maps, 5m resolution RapidEye imagery was used. For the 2005 map, SPOT 4&5 multi-spectral imagery was used.

The maps are stratified according to the five REDD+ strata and overlaid to produce the AD maps for the period 2005-2010 and 2010-2015. The AD map is used to distribute reference sample plots following a stratified random sampling approach specifically for the ER Program area. The visual interpretation of the plots is done with Collect Earth and the resulting reference sample is

used to calculate the AD estimates and their related uncertainty following the approach outlined by Olofsson [16] (2014).

The sample size was determined by using the formula by Cochran (1977), assuming that the sampling cost of each stratum is the same.

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

Where:

N = number of sample points for the stratum of interest

- = standard error of the estimated overall accuracy that we would like to achieve

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 values were set as the target for allocating statistically sound sampling size:

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 sample plots.

Value applied:

2005 \ 2010	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Stratum 1	473,906	355	0	482	154
Stratum 2	71	3,802,793	0	128,892	28,727
Stratum 3	0	0	17,056	66	65
Stratum 4	0	57,361	60	2,516,047	223,674
Stratum 5	0	0	0	182,805	690,635

2010 \ 2015	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Stratum 1	483,524	120	7	257	767
Stratum 2	0	3,770,430	161	101,607	42,539
Stratum 3	0	0	17,171	121	184
Stratum 4	0	45,796	49	2,712,747	99,489
Stratum 5	0	0	0	142,703	705,477

As indicated in the description, the calculation of the AD is conducted in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx". The AD displayed in the two matrices above, are in the tab "Total" cells M32:R46. These values are then used for the next calculation step for estimating the emissions and removals.

[16] Olofsson et al. (2014) Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment 148, 42-57.

However, with the technical correction, the area for forest degradation comes from the CCDC-SMA map and not from the change matrix above. The table below summarizes the AD as shown in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and tab "AD_Area" for deforestation (DF), restoration (RS) and reforestation (RF). For degradation (DF), the figure below comes from its AD estimated applying the technical correction and calculated in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", tab "Total", cells F135 and G135.

Area (ha)	2005-2010	2010-2015
DF	252,620	142,979
RS	57,492	45,845
RF	182,805	142,703
DG	219,069	133,888

QA/QC procedures applied

As mentioned in Section 2.1.2, QA/QC procedures were first applied for the production of the Forest Type Maps and more particularly in the interpretation of the areas that have changed during a time period. The procedures are described in the SOP for the production of the Forest Type Map as indicated in section 2.1. It consists of a three stages approach: a first team of technicians conducts the initial interpretation. A second team of experienced technicians reviews the interpretation and then a third-party reviewer with the support of the FIPD GIS/RS team leader validates the interpretation. Secondly QA/QC procedures were used for the sample-based estimation.

Uncertainty associated with this parameter:

Uncertainty is calculated through the sample-based estimation procedure.

Uncertainty (%)	2005-2010	2010-2015
DF	15.4	29.5
RS	50.4	70.5
RF	26.7	28.1
DG	26.0	28.0

Any comment:

n.a.

Parameter: :	$Regrowth\ Rate$, $Reversal$ and $Doublecounting(stumps)$ Adjustments to emissions and removals (Reference Level) to account for previous change in cover class.
Description:	Adjustments are subtracted to the emissions and removals calculated in step 1 to correct over-estimation by considering reversal events that occurred during the Reference Period, the biomass regrowth rate and the potential double-counting of the logging emissions.
Data unit:	tCO2eq

<table>
<tr><td>Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):</td><td>As described in section 2.2.1, adjustments were made by considering the types of changes and rate of tree growth. This modification recognizes that in forest ecosystems, forest biomass increases slowly over time to reach full biomass (IPCC 2006 [17]).
As such, the slow regrowth of the forest is taken into account to not over-estimate removals.
The same approach applies to the emissions, to not over-estimate the emissions from a land that would not have regrown completely to forest.
For the reference period, the number of years of each time period is used in the calculation.
Adjustment use a time-series analysis to identify the land cover change patterns that leads to over-estimation.
Forest Type Maps 2005, 2010 and 2015 were used for the time-series analysis.
As indicated in section 2.2.2, adjustments are implemented in equation5a and equation5b.
The time-series analysis as well as the calculation of the adjusted emissions and removals are in the spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", in tab “TSA_Remove”, “TSA_Emission” and “Total”.</td></tr>
<tr><td>Value applied:</td><td>Adjustment – Over estimation of removals
<table>
<tr><td></td><td>Stratum in 2005</td><td>Stratum in 2010</td><td>Stratum in 2015</td><td>Estimated area (ha)*</td><td>Emissions to be deducted from Removals (tCO_2e)</td></tr>
<tr><td rowspan="3">Change patterns from time series</td><td>4</td><td>2</td><td>4</td><td>2,299</td><td>73,475</td></tr>
<tr><td>4</td><td>2</td><td>5</td><td>1,684</td><td>53,833</td></tr>
<tr><td>4</td><td>3</td><td>5</td><td>1</td><td>17</td></tr>
</table>
In total, 127,325 tCO2e would be deducted from removals from restoration for the period 2010-2015.

Adjustment – Over estimation of emissions
<table>
<tr><td></td><td>Stratum in 2005</td><td>Stratum in 2010</td><td>Stratum in 2015</td><td>Estimated area (ha)*</td><td>Emissions to be deducted from Emissions (tCO_2e)</td></tr>
<tr><td rowspan="3">Change patterns from time series</td><td>4</td><td>2</td><td>4</td><td>1,492</td><td>-345,787</td></tr>
<tr><td>4</td><td>2</td><td>5</td><td>1,467</td><td>-370,226</td></tr>
<tr><td>4</td><td>3</td><td>5</td><td>1</td><td>-153</td></tr>
</table>
Over estimation of emissions from deforestation equals 370,379 tCO2e and 345,787 tCO2e from degradation.</td></tr>
<tr><td>QA/QC procedures applied</td><td>The calculation steps are reviewed by a second technician.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>The specific uncertainty of the adjustments is not included in the Monte Carlo simulation with the consideration that it is already covered by the uncertainty on the AD.</td></tr>
</table>

[17] IPCC (2006, Volume 4, Chapter 4.3: Land Converted to Forest Land) suggests default period of 20 year time interval for forest ecosystems to be established.

Any comment:	n.a.

Parameter:	$Emissions_{logging}$ Emissions from logging for the Reference Level
Description:	Emissions from logging estimated from the field measurements (stumps) from the 2nd NFI in the six northern provinces of the ER Program.
Data unit:	tCO2eq
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	The Lao NFI uses random nested plots. For the 2nd NFI, a total of 114 plots were surveyed in the ER Program area. Stumps located in the plots are measured and recorded as below: • Height (H) - below 1.3m • Smallest Diameter (D1) – the smallest diameter across the top of the stump • D2 – the diameter at a 90° angle to D1. • Instrument used for tree felling (e.g. machine, saw axe) With these measurements, the biomass loss is estimated as follows: 1. Calculate the 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 [18]: 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* 5. Estimate the AGB by using the allometric equation used in the 2nd NFI 6. Convert the AGB loss by using an area ratio (t/ha) 7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots) 8. Estimate the plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot) 9. Estimate the average AGB loss(t/ha) for each forest class by dividing the total number of plots of each forest class 10. Estimate the BGB loss by using default conversion factor found in the IPCC 2006 Guidelines 11. Convert biomass to CO2 with the same conversion factor for estimating the carbon stock 12. Estimate the total loss tCO2e by multiplying above value by the area of Forest Type Map 2015 for each forest class. The method above estimates the biomass loss but does not provide average emissions per year, as it is quite challenging to estimate when the trees were actually felled.

[18] Ito et al., 2010. Estimate Diameter at Breast Height from Measurements of Illegally Logged Stumps in Cambodian Lowland Dry Evergreen Forest. JARQ 44(4),440

	An equation, which was developed in an experimental study in Pasoh in the Malaysian Peninsula, [19] is used to estimate the years required for wood materials to decompose. According to the temperature and precipitation averages recorded for northern Lao PDR, it is reasonable to assume that the stumps observed and measured were felled within a 12-year period before the survey. The total biomass loss calculated above is then divided by 12 to obtain a yearly average for the Reference Level.
Value applied:	

	Average loss tCO2e/ha	**Area(ha) Forest type map 2015**	**tCO2e (12 years)**
EG: Evergreen Forest	3.7	481,380	1,802,956
MD: Mixed Deciduous Forest	2.1	3,771,453	7,873,894
DD: Dry Dipterocarp	6.1	17,351	105,519
CF: Conifer Forest	-	25,782	-
MCB: Mixed Conifer and Broadleaved forest	-	2,180	-
	Total		9,782,369
	Annual average (tCO2e) (Total divided by 12 years)		815,197
	Emissions for the Reference Level (10 years)		8,151,970

The detail of the calculation is available in the "emissions from logging.xlsx" spreadsheet, tab "StumpWork_2ndNFI FCPF CF". The figures for the table above is presented in the cells AS11:AV17 and the Annual Average value is in the cell AX17

QA/QC procedures applied	In the Lao NFI, a dedicated team conducts quality assurance/ quality control (QA/QC) by revisiting 10% of the measured plots. The measurements between the QA/QC team and the survey teams are compared to assess if they are statistically robust. For the 2nd NFI, no significant statistical difference was found in the measurements from QA/QC and the survey teams. The Standard Operation Procedures (SOP) for the Terrestrial Carbon Measurement is available with this link.
Uncertainty associated with this parameter:	This proxy-based approach has been identified through wide expert consultations as the best currently-available method to quantify the impacts of illegal logging in Lao PDR. The limitations around its design, however, are well-acknowledged. To compensate for this issue, the prescribed 15 % conservativeness factor is applied.

[19] 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

	For the uncertainty analysis which uses a Monte Carlo approach, the standard error used as the input parameter for the uncertainty for emissions from logging, comes from a previous analysis that was conducted for the national FREL in 2018. The calculation is in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and tab "logging_uncertainty". It uses a propagation of error approach. The uncertainty calculated for emissions from logging for the reference level is 21.68%
Any comment:	n.a.

3.2 Monitored Data and Parameters

Parameter:	$A(j,i)_{MMR}$ - Activity Data (AD) for the Reporting Period 2019-2021 (3 years)
Description:	Area of REDD+ strata change over the Reporting Period (2019-2021) is provided by the overlay of the stratified Forest Type Maps and adjusted by a sample-based estimation. Twenty-five possible changes describe four activities: Deforestation, Forest Degradation, Forest Restoration and Reforestation. • Deforestation: loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum. • Forest Degradation: downward shift of a forest stratum from a higher carbon stock stratum to another forest stratum with lower carbon stock. This change effectively includes cases of transitional land use change events such as deforestation events not captured in the 5-year mapping interval (e.g., stages of rotational agriculture from a recovered forest to a forest fallow, between which it would have gone through a non-forest stage, or, land conversion for forest plantations). Through the application of this method, fallow land from shifting cultivation sites are largely captured within the RV category and occur most prominently in MD and EG forests, accounting for the vast majority of the degradation events. • Forest Restoration: upward shift of a forest/land stratum with lower carbon stock to another forest/land stratum with higher carbon stock. • Reforestation: gain of forest carbon stock due to conversion of non-forest land stratum to a forest land stratum

YearX+5

YearX	stratum 1	stratum 2	stratum 3	stratum 4	stratum 5
stratum 1	SF1	DG1	DG2	DG4	DF1
stratum 2	RS1	SF2	DG3	DG5	DF2
stratum 3	RS2	RS4	SF3	DG6	DF3
stratum 4	RS3	RS5	RS6	SF4	DF4
stratum 5	RF1	RF2	RF3	RF4	SNF

Deforestation (DF)
Degradation (DG)
Restoration (RS)
Reforestation (RF)
Stable Forest (SF)
Stable Non-Forest (SNF)

In the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", AD and their related uncertainties are calculated in tab "AD_Uncertainty".

	The Forest Degradation is supplemented by a map produced with the CCDC-SMA script that directly captures forest degradation over a period of time (see Annex 4).
Data unit:	Ha
Value monitored during this Monitoring / Reporting Period:	The values displayed in the table below come from the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", tab "AD_Area" at the exception for degradation (DG), for which the value is calculated in tab "Total", cell H135.

Area (ha)	2019-2021
DF	214,999
RS	31,994
RF	155,577
DG	88,382

Source of data and description of measurement/calculation methods and procedures applied:	Wall-to-wall land/forest maps for the ER Program area with the Level 2 classification for the years 2019, and 2022 developed by the FIPD of DOF, MAF.

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	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)	
Grassland	Other Vegetated Areas	Savannah (SA)	**5**
		Scrub (SR)	
		Grassland (G)	
Cropland	Cropland	Upland Agriculture (UC)	
		Rice Paddy (RP)	
		Other Agriculture (OA)	
		Agriculture Plantation (AP)	
Settlement	Settlements	Urban (U)	
Other Land	Other Land	Barren Land (BR)	
		Other (O)	
Wetland	Wetlands	Water (W)	
		Swamp/Wetland (SW)	

	The maps are generated using 2010 as the benchmark map, and the maps for the other years developed through applying a change detection method in order to maintain consistency of classification and interpretation. For both 2019 and 2022 maps, Sentinel-2 imagery was used in combination with Planetscope imagery. The maps are stratified according to the five REDD+ strata and overlaid to produce the AD maps for the period 2019-2021. The AD map is used to distribute reference sample plots following a stratified random sampling approach. The visual interpretation of the plots is done with Collect Earth Online and the resulting reference sample is used to calculate the AD are estimates and their related uncertainty following the approach outlined by Olofsson (2014. The sample size was determined by using the formula by Cochran (1977), assuming that the sampling cost of each stratum is the same. $n = \frac{(\sum W_i\ S_i)^2}{[S(\widehat{O})]^2 + (1/N)\sum W_i\ S_i^{\ 2}} \approx \left(\frac{\sum W_i\ S_i}{S(\widehat{O})}\right)^2$ Where: N = number of sample points for the stratum of interest ● = standard error of the estimated overall accuracy that we would like to achieve 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 values were set as the target for allocating statistically sound sampling size: 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.
QA/QC procedures applied:	A SOP for the update of the Forest Type Map was followed. In a manner similar to that was conducted for the RL, a three-step approach was used to ensure the quality of the visual interpretation. For the sample-based estimation, two rounds of interpretation were conducted with different technicians. In any case where the two interpretations did not agree, a third round was conducted with teams of three technicians to reach consensus.
Uncertainty for this parameter:	The uncertainty is calculated through the sample-based estimation. Uncertainty (%) | 2019-2021

	DF	27.6
	RS	88.8
	RF	40.4
	DG	25.7
Any comment:	n.a.	

Parameter:	$RegrowthRate$, $Reversal$ and $Doublecounting(stumps)$ Adjustments to emissions and removals for the Reporting Period to account for previous change in cover class
Description:	Adjustments are subtracted to the emissions and removals calculated in step 1 to correct over-estimation by considering reversal events that occurred during the Reference Period, the biomass regrowth rate and the double-counting. Adjustments use a time-series analysis to identify the land cover change patterns that leads to over-estimation and adjusts the removals and emissions to reflect the actual time needed for forest recovery following a change in forest cover class. (IPCC 2006). As indicated in section 2.2.2, adjustments are implemented in equation5a and equation5b. The time-series analysis as well as the calculation of the adjusted emissions and removals are in the spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", in tab "TSA_Remove_MMR", "TSA_Emission_MMR" and "Total".
Data unit:	tCO2eq
Value monitored during this Monitoring / Reporting Period:	Adjustment – Over estimation of removals

	Stratum in 2015	Stratum in 2019	Stratum in 2022	Estimated area (ha)*	Emissions to be deducted from Removals? (tCO_2e)
Change patterns from time series	4	2	4	2,618	62,759
	4	2	5	299	7,157
	4	3	5	0	0

In total, 69,916 tCO2e would be deducted from removals from restoration for the period 2019-2021.

Adjustment – Over estimation of emissions

	Stratum in 2015	Stratum in 2019	Stratum in 2022	Estimated area (ha)*	Emissions to be deducted from Emissions (tCO_2e)
Change patterns from time series	4	2	4	2,226	-551,277
	4	2	5	1162	-313,505
	4	3	5	0	0
	4	5	4	11,1149	-247,250

	Over estimation of emissions from deforestation equals 560,755 tCo2e and 551,277 tCo2e from degradation respectively.
Source of data and description of measurement /calculation methods and procedures applied:	Forest Type Maps 2015, 2019 and 2022 are used for the time-series analysis.
QA/QC procedures applied:	An internal review of the calculation steps is conducted by an external expert.
Uncertainty for this parameter:	No specific uncertainty is considered for the adjustments.
Any comment:	n.a.

Parameter:	$Emissions_{logging}$ Emissions from logging for the Monitoring Period
Description:	Emissions from logging estimated from the February 2023 field stump survey in the six northern provinces of the ER Program.
Data unit:	tCO2eq
Value monitored during this Monitoring / Reporting Period:	

	Average loss tCO2e/ha	**Area (ha) Forest type map 2022**	**tCO2e (12 years)**
EG: Evergreen Forest	0.7	475,676	329,139
MD: Mixed Deciduous Forest	2.8	3,629,242	10,155,419
DD: Dry Dipterocarp	5.1	17,076	86,961
CF: Conifer Forest	11.1	25,224	280,179
MCB: Mixed Conifer and Broadleaved forest	-	2,133	-
	Total		10,851,698
	Annual average (tCO2e) (Total divided by 12 years)		904,308

		Emissions for the Monitoring Period (3 years)	2,712,924

The detail of the calculation is available in the "emissions from logging.xlsx" spreadsheet, tab "StumpSurvey2023".

Source of data and description of measurement /calculation methods and procedures applied:

The stump survey follows the exact same design as for the 2nd NFI. A total of 114 plots were surveyed in the ER Program area. Stumps located in the plots were measured and recorded as below:

- Height (H) - below 1.3m
- Smallest Diameter (D1) – the smallest diameter across the top of the stump
- D2 – the diameter at a 90o angle to D1.
- Instrument used for tree felling (e.g. machine, saw axe)

With these measurements, the biomass loss estimation is conducted as follow:

1. Calculate the 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 [20]:

   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
5. Estimate the AGB by using the allometric equation used in the 2nd NFI
6. Convert the AGB loss by using an area ratio (t/ha)
7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots)
8. Estimate the plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot)
9. Estimate the average AGB loss(t/ha) for each forest class by dividing the total number of plots of each forest class
10. Estimate the BGB loss by using default conversion factor found in the IPCC 2006 Guidelines
11. Convert biomass to CO2 with the same conversion factor for estimating the carbon stock
12. Estimate the total loss tCO2e by multiplying above value by the area of Forest Type Map 2022 for each forest class.

[20] Ito et al., 2010. Estimate Diameter at Breast Height from Measurements of Illegally Logged Stumps in Cambodian Lowland Dry Evergreen Forest. JARQ 44(4), 440.

	The method above estimates the biomass loss but does not provide an average per year, as it is quite challenging to estimate when the trees were actually felled. An equation, developed in an experimental study in Pasoh in the Malaysian Peninsula [21], estimates the number of years required for wood materials to decompose. Using this equation, the temperature and precipitation averages recorded for northern Lao PDR, it is reasonable to assume that the stumps observed and measured were felled within a 12 years period before the survey. The total biomass loss calculated above is then divided by 12 to obtain a yearly average for the Reference Level.
QA/QC procedures applied:	In Lao NFI, a dedicated team conducts QA/QC by revisiting 10% of the measured plots. The same approach was used for this specific stump survey. The measurements between the QA/QC team and the survey teams are compared to assess if they are statistically robust. For the 2nd NFI, no significant statistical difference was found in the measurements from QA/QC and the survey teams. The Standard Operation Procedures (SOP) for the Terrestrial Carbon Measurement_is available with this link.
Uncertainty for this parameter:	This proxy-based approach has been identified through wide expert consultations as the best currently-available method to quantify the impacts of illegal logging in Lao PDR. The limitations around its design, however, are well-acknowledged., To compensate for this issue, the prescribed 15 % conservativeness factor is applied. For the uncertainty analysis which uses a Monte Carlo approach, the standard error used as the input parameter for the uncertainty for emissions from logging, comes from a previous analysis that was conducted for the national MRV in 2019. The calculation is in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and tab "logging_uncertainty". It uses a propagation of error approach. The uncertainty calculated for emissions from logging for the monitoring period is 21.80% The most recent Forest Type Map 2022 is not yet completed for the whole country. Therefore, the accuracy assessment is not conducted yet which did not enable the team to estimate the logging uncertainty based on this map. The figure that was calculated for the MRV is considered as the best and most reliable data for this Monte Carlo analysis.
Any comment:	n.a.

[21] 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.

4 QUANTIFICATION OF EMISSION REDUCTIONS

4.1 ER Program Reference level for the Monitoring / Reporting Period covered in this report

The RL is separated for emissions and removals. The technical corrections as further described in Annex 4 and additionally explained in the technical note [22], applies using updated E/R factors and an improved approach for the estimation of emissions from forest degradation, in order to enhance the accuracy of the estimations.

Correction item 1 proposes to use the carbon stocks values derived from the 3rd National Forest Inventory and the 2nd Regenerating Vegetation survey to provide more accurate estimates. This correction changed the E/R factors and the resulting ER calculation, mostly because the carbon stock value for the Regenerating Vegetation was lower in the 2nd survey than the one estimated from the 1st RV survey (and used in the RL for the ERPD). As a consequence, the figures for deforestation and reforestation decreased. The figures for restoration increased because the E/R factors from Regenerating Vegetation to Mixed Deciduous Forest increased as well.
Correction item 2 proposes to use a specific map (the continuous change detection and classification spectral mixture analysis or CCDC-SMA script) that provides improved analysis of dynamics of shifting cultivation and therefore provides a better stratification of forest degradation for the sample-based estimation. This new approach enabled to map forest degradation more accurately over a time period and improved the uncertainty of the resulting Activity Data.
Correction item 3 proposes correction of a material error. An error was found in the calculation of logging emissions for the RL. There was one data from a province outside of the ER Program area included in the dataset. Complying with the technical correction item 3, this error was corrected by deleting such a data.

As a result of the technical corrections, the ER Program Reference Level was corrected as below.

A full calculation can be seen in the spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", tab Summary, Column B which reports the average annual emissions and removals over the three year reporting period 2019-2021.

Table 11: ER Program Reference Level before technical correction (ERPD 2018)

Year of Reporting period	Average annual historical emissions from deforestation over the Reference Period (tCO2e/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO2e/yr)	If applicable, average annual historical removals by sinks over the Reference Period (tCO2e/yr)	Adjust-ment, if applic-able (tCO2e/yr)	Reference level (tCO2e/yr)
2019	3,748,645	6,760,730	-1,964,406	n.a.	8,544,969
2020	3,748,645	6,760,730	-1,964,406	n.a.	8,544,969
2021	3,748,645	6,760,730	-1,964,406	n.a.	8,544,969
Total	**11,245,935**	**20,282,190**	**–5,893,218**	**n.a.**	**25,634,907**

[22] A note that describes the methodological approach for the Technical Correction was discussed with the Facility Management Team (FMT) of the World Bank in 2022.

Table 12: ER Program Reference Level after technical correction

Year of Reporting period	Average annual historical emissions from deforestation over the Reference Period (tCO2e/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO2e/yr)	If applicable, average annual historical removals by sinks over the Reference Period (tCO2e/yr)	Adjust-ment, if applic-able (tCO2e/yr)	Reference level (tCO2e/yr)
2019	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
2020	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
2021	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
Total	**9,046,917**	**31,883,281**	**–4,012,185**	**n.a.**	**36,918,012**

4.2 Estimation of emissions by sources and removals by sinks included in the ER Program's scope

The emissions and removals during the Reporting Period were calculated following the estimation approach fully described in Section 2.2, and using the data parameters described in Section 3. The paragraphs summarize the steps for calculation presented in Section 2.2.

Step 1 calculates the emissions and removals using the AD and the E/R Factors. For the AD, as shown below, the Forest Type Maps from various years are combined to produce map that reflects the changes in land and forest cover within the five REDD+ strata (as described in **Table 8**). This map is then supplemented by a CCDC-SMA map to identify forest degradation more accurately. The results of the sample-based estimation with the visual interpretation, are the error matrix that are in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "AD_Uncertainty".

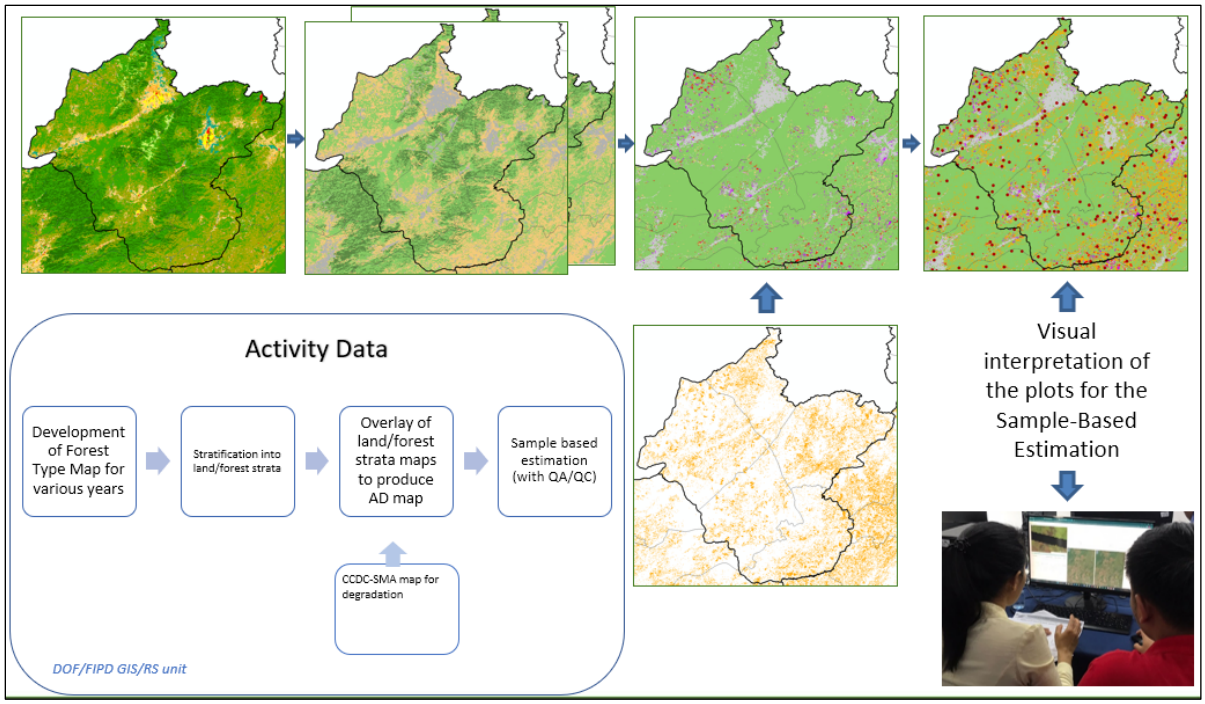


Figure 4: Overview of the computation of the Activity Data

For the E/R Factors, Section 3.1 provides the details of the source for each land and forest type, Section 2.2.2 outlines the calculation (equations 1 to 3) for the carbon stocks that use the results from the NFI.

- Equation 4 calculates the emissions/removals: MMR1_AD_ER_Calculation_20230413.xlsx Tab Total

Estimated area from reference sampling

ha

2010 \ 2015	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	483,524	120	7	257	767
MD/CF/MCB	0	3,770,430	161	101,607	42,539
DD	0	0	17,171	121	184
P/B/RV	0	45,796	49	2,712,747	99,489
NF	0	0	0	142,703	705,477

X

EF(tCO2/ha)

	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0	-432.8	-568.3	-712.4	-737.4
MD/CF/MCB	432.8	0.0	-135.5	-279.6	-304.7
DD	568.3	135.5	0.0	-144.1	-169.2
P/B/RV	712.4	279.6	144.1	0.0	-25.0
NF	737.4	304.7	169.2	25.0	0.0

=

2010-2015 MtCO2

	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0	-0.1	-0.0	-0.2	-0.6
MD/CF/MCB	0.0	0.0	-0.0	-28.4	-13.0
DD	0.0	0.0	0.0	-0.0	-0.0
P/B/RV	0.0	12.8	0.0	0.0	-2.5
NF	0.0	0.0	0.0	3.6	0.0

=J60*R33/1000000

Figure 5: Example of the calculation of emissions and removals

Emissions and Removals are calculated with the equation 4 as described in section 2.2.2 and shown in the figure above.

As an example, to supplement Figure 5 above, the Table 13 below shows the Activity Data for the period 2005-2010 (in blue color), with the E/R factors (in orange color), and the resulting emissions and removals (in red color) as presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx".

Table 13: Example of calculation for emissions and removals (2005-2010)

ha		2010				
		EG	MD/CF/MCB	DD	P/B/RV	NF
2005	EG	473,906	355	0	482	154
	MD/CF/MCB	71	3,802,793	0	128,892	28,727
	DD	0	0	17,056	66	65
	P/B/RV	0.00	57,361	60	2,516,047	223,674
	NF	0	0	0	182,805	690,635

EF(tCO2e/ha)					
	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0	-432.8	-568.3	-712.4	-737.4
MD/CF/MCB	432.8	0.0	-135.5	-279.6	-304.7
DD	568.3	135.5	0.0	-144.1	-169.2
P/B/RV	712.4	279.6	144.1	0.0	-25.0
NF	737.4	304.7	169.2	25.0	0.0

2005-2010	MtCO2e				
	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0	-0.2	0.0	-0.3	-0.1
MD/CF/MCB	0.0	0.0	0.0	-36.0	-8.8
DD	0.0	0.0	0.0	-0.0	-0.0
P/B/RV	0.0	16.0	0.0	0.0	-5.6
NF	0.0	0.0	0.0	4.6	0.0

Step 2 adjusts emissions and removal as described in section 2.2.1 and section 2.2.2. The values used for the adjustments are presented in section 3.1 and 3.2. These adjustments take into account the number of years for a forest to regrow and their changes over the RL and the monitoring period.

Step 3 calculates the emissions from logging as shown in the figure below. The detail of the calculation is available in the "emissions from logging.xlsx" spreadsheet.

Emissions from logging.xlsx Tab StumpSurvey2023

Average loss of biomass from logging AGB + BGB tCO2e/ha × Area (ha) per forest type 2022

FCPF CF 6 Provinces

	Number of Plot	Sum Ave (tB/ha)
EG	1	1.3
MDF	24	128.5
DD	5	29.6
CF	1	9.2
MCB	0	0.0
	31	

Plots with stumps

	Number of Plot	Biomass loss			
		AGB Ave tB/ha	AGB+BGB Ave tB/ha	AGB+BGB Ave tC/ha	AGB+BGB Ave tCO2/ha
EG	4	0.3	0.4	0.2	0.7
MDF	95	1.4	1.6	0.8	2.8
DD	12	2.5	3.0	1.4	5.1
CF	2	4.6	6.4	3.0	11.1
MCB	1	0.0	0.0	0.0	0.0
	114				

6 provinces

	Area(2022) (ha)	Loss tCO2	Loss MtCO2
EG	475,676	329,139	0.33
MDF	3,629,242	10,155,419	10.16
DD	17,076	86,961	0.09
CF	25,224	280,179	0.28
MCB	2,133	–	0.00
	4,149,351	10,851,698	10.85

Figure 6: Example of the calculation of emissions from logging for the monitoring period

Figure 6 refers to the emissions from logging for the monitoring period which the details of the parameter is described in Section 3.2. 〖Emissions〗_logging Emissions from logging for the Monitoring Period. The emission of 10,851,698 tCO2e is divided by 12 years using the assumed time for the wood materials to decompose, to obtain a yearly average of 904,308 tCO2e/year which is then used in Step 4 and in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" as seen in Table 15.

Step 4 calculates the annual emissions and removals for both the RL and the monitoring period. It considers the converted areas during the whole monitoring period (Equation 6a) combined with the emissions from logging that are calculated separately as shown on figure 6. Then the emissions and removals are divided by the number of years of the period (Equation 6b and 6c) to obtain a yearly average as displayed in Table 12 (for the RL) and Table 14 (for the monitoring period).

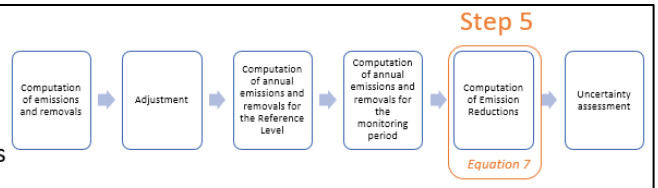
Table 14: Emissions by sources and removals by sinks

Year of Monitoring/Reporting Period	Emissions from deforestation (tCO2e/yr)	If applicable, emissions from forest degradation (tCO2e/yr)	If applicable, removals by sinks (tCO2e/yr)	Net emissions and removals (tCO2e/yr)
2019	3,718,168	8,951,203	-1,841,850	10,827,521
2020	3,718,168	8,951,203	-1,841,850	10,827,521
2021	3,718,168	8,951,203	-1,841,850	10,827,521
Total	**11,154,503**	**26,853,610**	**-5,525,551**	**32,482,562**

4.3 Calculation of emission reductions

The last step of the calculation uses Equation 7 as shown in the figure below. The results are presented in Table 15 below and also in the tab "summary" of the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx".

- ERs are calculated by subtracting the expected net emissions from the Reference Level over the Monitoring Period with the monitored net emissions over the Reporting Period



Equation 7: Calculation of the Emission Reductions (ERs)

$$ER_{RP} = RL_{RP} - GHG_{RP}$$

Where:

ER_{RP} = *Emission Reductions under the ER Program during the Reporting Period; tCO_2e;*

RL_{RP} = *Expected net emissions of the RL over the Reporting Period; tCO_2e;*

GHG_{RP} = *Monitored net emissions over the Reporting Period; tCO_2e;*

MMR1_AD_ER_Calculation_20230413.xlsx Tab Summary

Figure 7: Example of the calculation of ERs

Table 15: Summary table of the calculation after conducting Step 1 to 5

Unit: tCO2e

RL	Average/year	Total	MMR	Average/year	Total
Emissions	13,643,399	40,930,198	Emissions	12,669,371	38,008,113
DF	3,015,639	9,046,917	*DF*	3,718,168	11,154,503
DG	9,812,563	29,437,690	*DG*	8,046,895	24,140,686
Logging	815,197	2,445,591	*Logging*	904,308	2,712,924
DG all	10,627,760	31,883,281	*DG all*	8,945,276	26,835,827
Removals	-1,337,395	-4,012,185	Removals	-1,841,850	-5,525,551
Net	12,306,004	**36,918,012**	Net	10,827,521	**32,482,562**
ERs	**4,435,451**				

Table 16: Calculation of emission reductions

Total Reference Level emissions during the Reporting Period (tCO2e)	36,918,012
Net emissions and removals under the ER Program during the Reporting Period (tCO2e)	32,482,562
Emission Reductions during the Reporting Period (tCO2e)	4,435,451

5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

5.1 Identification, assessment and addressing sources of uncertainty

Table 17: Sources of uncertainty

Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High/Low)	Adressed through QA/QC	Residual uncertainty estimated ?
Activity Data						
Measurement	☑	☑	This source of uncertainty is linked with the visual interpretation of satellte imagery. Error in the interpretation may come from the quality of the imagery or misinterpretation from the technician. Lao PDR addresses this issue by procuring satellite imagery through the Google Earth Engine that ensures the quality of the imagery, and by use of comprehensive training, SOPs, and QA/QC procedures throughout the interpretation process. The SOP for Forest Type Map development presented in Table 7 particularly guides the production of the Forest Type Maps. Guidance on the interpretation of the satellite imagery is also provided in this SOP. Besides the SOP, the technicians always refer to the Lao National Classification System document which describes extensively each forest/land type, as well as an interpretation key. Technicians are trained to follow the interpretation procedures and a preliminary ground truthing survey is organized to make sure all technicians have a common undertanding of the various forest/land types and their interpretation. The QA/QC is conducted in the form of several iterations of interpretation as described in Section 3.1 and 3.2	High (bias/random)	YES	NO
Representativeness	☑	☒	This source of uncertainty is related to the representativeness of the estimate which is related to the sampling design. Forest Type Maps were produced for the area of interest, i.e., the entire ER Program areaThe CCDC-SMA (see Section 2.2.1) script was used to map forest degradation over the ER program area. The results served as the basis of stratification for the sample-based assesment. Sampling to generate AD estimates followed a stratified random sample	Low (bias)	YES	NO

			approach as outlined in Olofsson et al. 2014, and was also limited to the ER program area. All sample data were collected from times within the target period. Since all data used to generate AD were randomly collected within the ER program area, the sample is assumed representative and risk of bias is low. .			
Sampling	☒	☑	The uncertainty related to the interpretation of the sample plots, is the statistical variance of the estimate of area for the activity data. The sample design follows a stratified random sampling approach and the whole sample-based estimation approach follows the methods suggested by Olofsson et al (2014). The sample size was determined by using the formula by Cochran (1977) with more detailled provided in section 3.1..Sample points were allocated randomly across the entire ER program area of interest. The response design uses the Collect Earth Online interface and enables the technicians to conduct the interpretation of all REDD+ activitities related to the forest/land cover change. The Collect Earth Oline interface is specifically designed by the Forest Inventory and Planning Division and enables the use of high resolution imagery such as Planet or Sentinel-2.	High (random)	YES	YES
Extrapolation	☑	☒	The area estimates are calculated for each activity (deforestation, forest degradation, forest restoration, and reforestation) through the Sample-Based Estimation. Howerver, the “sub-activities” from the twenty various combinations given by the five REDD+ strata change matrix are inferred using the mapped areas. This is an extrapolation but it does not lead to an overestimation of the Emission Reductions for the reasons below: First the technical correction item 2 on the Reference Level enhanced the estimation for forest degradation and does not use the extrapolation outline above but uses only the reference data from the Sample-Based Estimation. Secondly, testing were conducted to assess the feasibility of a technical correction to calculate the AD for the sub-activities based on the reference data. Results of the testing were not considered positive as it would have increased the uncertainty as well as the Reference Level. Thus sticking to the approach based on mapped areas is judged consistent and conservative. Therefore this source of uncertainty is considered to be low.	Low (bias)	YES	NO

Approach 3	☑	☒	The AD are generated through Sample-Based Estimation for each time period. The Reference Period has two time periods 2005-2010 and 2010-2015, and the Monitoring period is 2019-2021. The sample plots are different for each period. However, the polygons of the Forest Type Maps have the whole historical trajectory described in the various attributes for the years 2005,2010,2015, 2019 and 2022 which enables to tracks the historical trajectory of land cover class and Activity Data status, identifying lands which are classified as transitioning more than one time between land cover classes. To avoid any over-estimation of emissions and reversals, or double-counting of change, a Time-Series Analysis was conducted under Step 2 of the measurement, monitoring and reporting approach as described in Section 2.2.. Due to the tracking and accounting, the degree of uncertainty is low	Low (bias)	YES	NO
Emission/Removal factors						
DBH measurement	☑	☑	The field measurements for the NFI are described in the SOP for the Terrestrial Carbon Measurement (presented in Table 7). Before each NFI campaign, field crew training is conducted. The data collection uses Open Data Kit (ODK) [2 3] forms that ensure limited entry errors. A specific QA/QC team revisit 15% of the surveyed plots to assess the quality of the measurements and also quantify any errors. The allometric equations of live trees use only diameter at breast height (DBH). Height measurement is done for the case of standing dead trees. The plot delineation is not prone to error as the NFI uses circular plots and distance are measured with an ultrasound measurer (DME).	High (bias) & Low (random)	YES	NO
H Measurement	☑	☑				
Plot delineation	☑	☑				
Wood density estimation	☑	☑	The allometric equations developed and used for Lao PDR do not use wood density classes.	NA	NA	NA
Biomass allometric model	☑	☑	Country-specific allometric equations were developped for the three main forest types in Lao PDR, namely EG, MD and DD forests, using random samples of trees measured with international support [2 4]. Compared to some data of Chave et al. (2005, 2015), which were	High (bias) & High (random)	NO	YES

[2 3] ODK is an open-source suite of tools that allows data collection using Android mobile devices and data submission to an online server, even without an Internet connection or mobile carrier service at the time of data collection.

[2 4] Morikawa Y., Daisuke Y., Therese T., and Walker S., *Development of country-specific allometric equations in Lao PDR*, 2017, <http://dof.maf.gov.la/redd/en/frel-frl/>.

			obtained in Southeast Asia, Lao national allometric equations estimate lower biomass. The two other forest types, namely CF and MCB forests use an equation used in Vietnam [15]. The most relevant predictor variable for AGB in the three forest types (EG, MD and DD) was DBH. According to comparative analysis with other data or equations, allometric equations developed were reasonable to be applied to the tree measurement data which are out of the surveyed DBH range, in terms of conservative estimation. The allometric model error was quantified for each model (see Section 3.1) and incorporated into the overall estimate of uncertainty for each EF.			
Sampling	☒	☑	The sampling error is the statistical variance of the estimate of aboveground biomass. The Lao NFI uses a two-stages random sampling. The uncertainty target for the Lao NFI is 20% with 90% of Confidence Interval. For the 3rd NFI, uncertainties for EG, MD and DD were below 10%, while CF and MCB were below 20%. Sample errors are estimated using Cochran's (1977) two stage random sampling formula, and are included in the Monte Carlo simulation assessment of uncertainty. The number of sample plots was generated using a spreadsheet developed by Winrock International (Winrock Sample Plot Calculator). The sampling error was quantified for each stratum (see Section 3.1) and incorporated into the overall estimate of uncertainty for each EF.	High (random)	YES	YES
Other parameters	☑	☑	Lao PDR uses a Root-to-Shoot ratio to derive Below Ground Biomass from the AGB. Carbon fraction is also used in the calculations. These parameters are not country-specific but sourced from the 2006 IPCC Guidelines. International and national experts were consulted when developing the RL including selection of the IPCC default values, and as the calculation uses the IPCC default values, the possibility of systematic errors is considered to be low. The Monte Carlo simulation and more specifically the Sensitivity Analysis showed very small effect of these parameters.	High (bias/random)	YES	YES
Representativeness	☑	☒	Following the SOP for the Terrestrial Carbon Measurement (presented in Table 7), the random sampling design of the Lao NFI considers all of	Low (bias)	YES	NO

			the five natural forest types across the ER Program area and reports the AGB of each forest type. The SOP is revisited and updated each time before each NFI campaign in order to ensure it is up-to-date and to incorporate improvements. As described earlier in this table, the QA/QC process is integrated in the NFI process and is applied to all lands in the ER Program Area. The results are used for generating the E/R factors which is expected to be representative because the sample data are randomly selected from the population of interest. Therefore this source of uncertainty is considered to be low.			
Integration						
Model	☑	☒	The entire estimation approach were developed in collaboration with international technical support (e.g. JICA, SilvaCarbon, World Bank). The approach is considered as a best-available approach under the Lao context. In addition to the series of SOPs for data collection, an SOP for the Lao PDR's REDD+ MRV (which shows the steps for the ERs calculation) was also developed (presented in Table 7). Therefore this source of uncertainty is considered to be low.	Low (bias)	YES	NO
Integration	☑	☒	Each AD has a corresponding E/R factors. AD are estimated through remote-sensing observations combined with sample-based estimation (Olofsson 2014) using the REDD+ strata that combine the land/forest classes from the Lao National Classification System. Corresponding E/R factors are estimated based on ground-based observations of the forest type which may be causing a low level of bias. The sample-based estimation process provides an independent QA check on the accuravy of forest classification and forest cover change. The final estimations were peer-reviewed to ensure correctness. Therefore this source of uncertainty is considered to be low.	Low (bias)	YES	NO

5.2 Uncertainty of the estimate of Emission Reductions

Parameters and assumptions used in the Monte Carlo method

The Monte Carlo Method was applied to assess uncertainties of emissions and removals estimates in reference level and the reporting period. In this analysis, all parameters associated with emissions and removals estimates are simulated with assumption of normal probability distribution. Four parameters analyzed are as follows:

- AGB of the five REDD+ strata
- AD for deforestation, forest degradation, forest restoration and reforestation for the two periods of the RL (2005-2010, 2005-2010), and the monitoring period (2019-2021)
- Root to shoot ratio (RS)
- Carbon fraction (all types of forest biomass)

The emissions from logging are included in the Monte Carlo simulation, however, a 15% conservativeness factor is applied both for the RL and MMR due to its proxy nature.

The details of description on parameters, parameters values, standard errors and probability distribution function can be provided in separate spreadsheet "LaoPDR_Uncertainty MC MMR1 20230413.xlsx".

Parameter included in the model	Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
Activity Data Deforestation (REDD+ strata 1 to 5) 2005-2010	154 ha (Standard Error (SE)=12 ha)	Sampling error	Normal	Above zero.
Activity Data Deforestation (REDD+ strata 2 to 5) 2005-2010	28,727 ha (SE= 2,263 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 3 to 5) 2005-2010	65 ha (SE=5 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 4 to 5) 2005-2010	223,674 ha (SE=17,621 ha)	Sampling error	Normal	Above zero
Activity Data Degradation (REDD+ strata 2 to 4) 2005-2010	641,565 ha (SE= 85,305 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 2 to 1) 2005-2010	71 ha (SE=18 ha)	Sampling error	Normal	Above zero
Activity Data	57,361 ha (SE=14,750 ha)	Sampling error	Normal	Above zero

Restoration (REDD+ strata 4 to 2) 2005-2010				
Activity Data Restoration (REDD+ strata 4 to 3) 2005-2010	60 ha (SE= 15 ha)	Sampling error	Normal	Above zero
Activity Data Reforestation (REDD+ strata 5 to 4) 2005-2010	182,805 ha (SE= 24,938 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 1 to 5) 2010-2015	767 ha (SE=115 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 2 to 5) 2010-2015	42,539 ha (SE= 6,404 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 3 to 5) 2010-2015	184 ha (SE=28 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 4 to 5) 2010-2015	99,489 ha (SE=14,979 ha)	Sampling error	Normal	Above zero
Activity Data Degradation (REDD+ strata 2 to 4) 2010-2015	636,048 ha (SE= 90,162 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 2) 2010-2015	45,796 ha (SE=16,472 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 3) 2010-2015	49 ha (SE= 18 ha)	Sampling error	Normal	Above zero
Activity Data Reforestation (REDD+ strata 5 to 4) 2010-2015	142,703 ha (SE= 20,470 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 1 to 5) 2019-2021	941 ha (SE=132 ha)	Sampling error	Normal	Above zero
Activity Data	20,067 ha (SE= 2,823 ha)	Sampling error	Normal	Above zero

Deforestation (REDD+ strata 2 to 5) 2019-2021				
Activity Data Deforestation (REDD+ strata 3 to 5) 2019-2021	343 ha (SE=48 ha)	Sampling error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 4 to 5) 2019-2021	193,647 ha (SE=27,246 ha)	Sampling error	Normal	Above zero
Activity Data Degradation (REDD+ strata 2 to 4) 2019-2021	346,733 ha (SE= 45,490 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 2 to 1) 2019-2021	83 ha (SE=36 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 1) 2019-2021	251 ha (SE=108 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 2) 2019-2021	31,656 ha (SE=19,699 ha)	Sampling error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 3) 2019-2021	5 ha (SE= 2 ha)	Sampling error	Normal	Above zero
Activity Data Reforestation (REDD+ strata 5 to 4) 2019-2021	155,577 ha (SE= 32,493 ha)	Sampling error	Normal	Above zero
Carbon Fraction	0.47 (SE=0.00647)	Model error	Normal	No assumption
Root to Shoot ratio (AGB<125 tC/ha)	0.2 (SE=0.012)	Model error	Normal	No assumption
Root to Shoot ratio (AGB<125 tC/ha)	0.24 (SE=0.025)	Model error	Normal	No assumption
Above Ground Biomass REDD+ strata 1	353.1 tC/ha (SE=19.636 tC/ha)	Sampling error	Normal	Above zero
Above Ground Biomass REDD+ strata 2	150.6 tC/ha (SE=4.61 tC/ha)	Sampling error	Normal	Above zero

Above Ground Biomass REDD+ strata 3	90.1 tC/ha (SE=4.136 tC/ha)	Sampling error	Normal	Above zero
Above Ground Biomass REDD+ strata 4	20.4 tC/ha (SE=2.038 tC/ha)	Sampling error	Normal	Above zero
Above Ground Biomass REDD+ strata 5	8.3 tC/ha (SE=0.844 tC/ha)	Sampling error	Normal	Above zero
Emissions from logging for the RL (annual average)	815,197 tCO2e (SE= 90,171 tCO2e)	Sampling error	Normal	Above zero
Emissions from logging for the MMR (Annual average)	904,308 tCO2e (SE=100,581 tCO2e)	Sampling error	Normal	Above zero

Quantification of the uncertainty of the estimate of Emission Reductions

As this is the first Reporting Period for Lao PDR, the Crediting Period to date is the same as the Reporting Period. Similarly, Forest Degradation is measured directly, not indirectly, and so is not broken out of the Total Emissions.

Table 18: Quantification of uncertainty

		Reporting Period	Crediting Period
		Total Emission Reductions*	**Total Emission Reductions***
A	**Median**	4,391,440	4,391,440
B	**Upper bound 90% CI** (Percentile 0.95)	(3,130,457)	(3,130,457)
C	**Lower bound 90% CI** (Percentile 0.05)	12,063,218	12,063,218
D	**Half Width Confidence Interval at 90% (B – C / 2)**	7,596,837	7,596,837
E	**Relative margin (D / A)**	173	173
F	**Uncertainty discount**	15%	15%

*Remove forest degradation from the estimate if forest degradation has been estimated with proxy data.

5.3 Sensitivity analysis and identification of areas of improvement of MRV system

The sensitivity analysis helps to identify how each parameter contribute to the overall uncertainty. Lao PDR used the Monte Carlo analysis spreadsheet provided under the Guidance note on estimating uncertainty of ERs using Monte Carlo simulation. To assess the impact of a specific parameter, the Monte Carlo analysis was conducted by turning "off" all other parameters, by defining their standard error as nearly 0 (0.00000001). The table below shows the results of the sensitivity analysis.

Table 19: Sensitivity analysis

Parameter	Uncertainty with one turned on (%)
All ON	173
R:S Uncertainty ON	7
CF Uncertainty ON	3
AGB Uncertainty ON	22
E/Removal factors Uncertainty ON (with RS, CF and AGB ON)	23
Activity Data ON	159

These results indicate that the uncertainty of the Emission Reductions comes mainly from the Activity Data as the uncertainty percentage is still very high, 159%, when only the uncertainty of AD is considered. It appears that another more prominent reason for the high overall uncertainty is the fact that the ERs are relatively low, only about 14% of the original RL emission total.

Additional analyses were conducted to further identify which specific AD causes the uncertainty. In the following table, individual AD for each time period were turned "ON". The uncertainty from the sample based estimation for the forest degradation seems to be the main source of the overall uncertainty, especially for the monitoring period. In the future, increasing the sampling intensity may help to reduce the resulting uncertainty.

Table 20: Analysis uncertainty per specific AD

Parameter	Uncertainty (%)
Activity Data ON	159
Deforestation RL 2005-2010 ON	8
Deforestation RL 2010-2015 ON	21
Deforestation MMR	38
Degradation RL 2005-2010 ON	85
Degradation RL 2010-2015 ON	57
Degradation MMR	111
Restoration RL 2005-2010 ON	17
Restoration RL 2010-2015 ON	15
Restoration MMR	11
Reforestation RL 2005-2010 ON	6
Reforestation RL 2010-2015 ON	4
Reforestation MMR	17

6 TRANSFER OF TITLE TO ERS

6.1 Ability to transfer title

The legislative framework of Lao PDR and specific regulations related to Lao REDD+ management, development, and implementation are unequivocal in granting full authority to the Ministry of Agriculture and Forestry (MAF) as the Program Entity, with full rights to transfer the ER title ownership. The legislative framework includes the Constitution of Lao PDR, its Land Law, and Forest Law. Specific articles vest responsibility with MAF: Annex 8.3 of the Final Benefit Sharing Plan for the Emission Reductions Programme of Lao PDR (September 2021) provides an overview of these laws and articles.

For reaching this conclusion, a detailed assessment of national legal systems was completed with regards to the right of the Program Entity's ability to transfer the ER title to the Carbon Fund. Consultations on this issue with land holders and provincial agencies (PAFOs and DAFOs) in the six ER Program provinces were also done. In addition, the Lao Bar Association (Attorney Association) reviewed the assessment note and concluded that the note is in line with current laws and regulations of Lao PDR (available upon request). It formalizes the conclusion of the assessment note that the MAF has full and complete rights to the transfer of ER titles that meets the legal requirements of the ERPA. The passage of the revised Forestry Law in 2019 further strengthens authorization of MAF in this aspect.

For private sector tree planters, sub-agreements with the private planters will be developed to specify carbon rights for planted trees. Implementation of GFLL in province areas will start only after the 1st results based payment has been received. No sub-agreements have been used for ERs reported under this first reporting period. There is only one company where ERs generated may come from activities on privately owned tree-plantations. However this company has formally agreed not to claim these ERs up to the timeline of the ERPA, 31 December 2024, and has provided this agreement in writing to GoL. Thus there are no ERs that involve any transfer of title. Please see Section 6.4 for additional information.

The sub-agreement contracts will ensure that only the Program Entity has the full power to transfer ownership of carbon rights for planted trees. The Benefit Sharing Plan has a provision for the involvement of private sector in ER Program under a pilot initiative scheme: its call for proposals will be announced six months prior to the delivery of first ER Payment. Sub-agreement contracts will be awarded to successful proponents, of private sector proposals that are successfully assessed and selected by Provincial Project Management Committees (PPMCs).

Currently, no titles to the ERs from the ER Program were contested during this 1st reporting period. The MAF does not foresee such risks for the 2nd reporting period.

- **Institutional and legal arrangement to avoid having multiple claims to an ER Title**

The risk of competing claims to the results proposed to the ER Program is controlled for the following reasons:

1. Most of the REDD+ results have been generated from reduction of emissions from deforestation and forest degradation of natural forests that belong to the national community and are managed by the state; and

2. Individuals or private companies may claim generation of REDD+ results from their privately-owned tree plantations. Several articles relate to forest carbon trade in the revised Forestry Law in this respect, such as in Article 5 State Policy on Forestry and Forestland, Article 65 Utilization of Forest, Timber and NTFPs for Business Purposes, Article 92 Types of Forestry Business, Article 103 Trade in Forest Carbon, Article 104 Operation of Forestry Businesses and Article 126 Usufruct Rights for Forest and Forestland)

The Lao Government encourages individuals, legal entities and organizations to conduct carbon trade under international mechanisms as a forest business: however, such businesses need to be registered in accordance with the Law on Investment Promotion or Law on Enterprises (Article 104). Taking all the articles presented above into

account, “Individuals, households, legal entities or organizations…” in Article 126 are interpreted as including forest carbon businesses that need to be registered under the relevant laws.

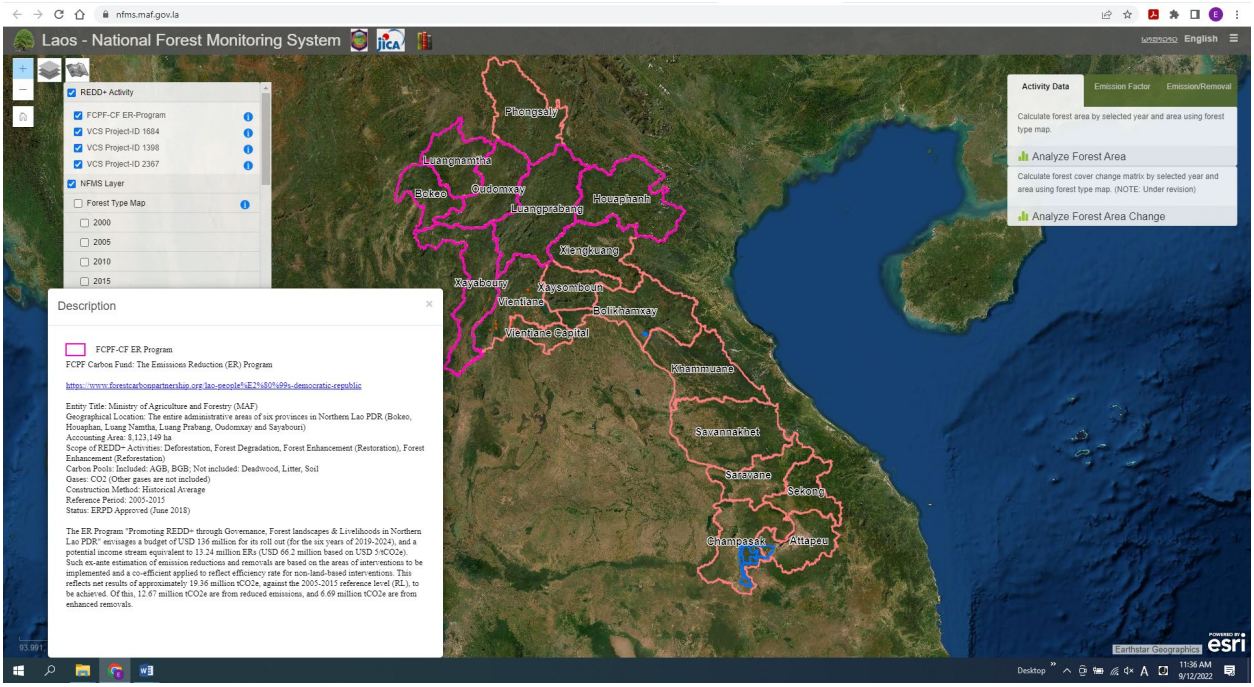
Despite the provisions and interpretation of the Articles of the Forestry Law (2019) presented above, if competing claims were to be presented by a third party, the Government would take full responsibility and take all necessary legal measures to resolve this issue.

One REDD+ project has emerged since the ERPD was prepared in 2018. The project has geographical overlap with the ER Program (See Section 6.4). To avoid the issue of double counting or claiming of the ERs, the Executing Entity and the project have already agreed that the project will not seek ER credits to be issued for the ERPA period (2019-2024).

6.2 Implementation and operation of Program and Projects Data Management System

■ Information on REDD+ projects published through the NFMS web-portal

Lao PDR has developed its NFMS web-portal <https://nfms.maf.gov.la/> to publish information on REDD+ projects, and to ensure transparent, accountable and coordinated implementation of REDD+ on different scales. The information includes project location and geo-spatial boundary, project entity, project description, etc. and provides link to full project information (e.g. scope of REDD+ activities, carbon pools and gasses). By accessing the NFMS web-portal, the viewers can know the forest carbon-related projects formally recognized by the Government of Laos. The DOF is responsible for keeping the information on REDD+ projects updated and transparent[25].



Lao PDR does not yet have a formalized administrative procedures that defines the operations of the REDD+ Programs and Projects Data Management System other than the legal arrangements explained in Section 6.1. The DOF is aware of the importance and currently in a process of preparing such formal procedures. The DOF, in fact, has initiated drafting a national legislation on management of carbon credits as well as a sectoral legislation on forest

[25] The REDD+ Division is tasked to supervise and coordinate REDD+ projects. The FIPD is trained to maintain and update the NFMS Web-portal including for the REDD+ projects following the technical procedures defined in the Standard Operation Procedures (SOP) for the National Forest Monitoring System Servers and Network; National Forest Monitoring System Data Installation Manual; and National Forest Monitoring System User Manual

carbon credits in consultation with concerned ministries (e.g Ministry of Natural Resources and Environment), private sector and development partners.

6.3 Implementation and operation of ER transaction registry

The institutional and legal arrangements explained in 6.1 and 6.2 will ensure that any ERs from REDD+ activities under the ER Program are not double-counted. They also guarantee that any ERs from REDD+ activities under the ER Program sold and transferred to the Carbon Fund are not used again by any entity for sale, public relations, compliance or any other purpose.

Lao PDR will use the World Bank Emission Reduction Transaction Registry (CATS – Carbon Assets Tracking System) to issue and transfer the ER units generated under the Lao PDR ER Program. There is no national registry in place yet.

6.4 ERs transferred to other entities or other schemes

To date, no ERs from the ER Program have been sold, assigned or used by any other entity. Lao PDR has no plan to sell ERs from the ER Program that would result in a percentage of units generated in the 1st reporting period not being issued as FCPF ERs. Thus, 100% of the monitored ERs during the 1st reporting period, which are subject to verification, will be offered to the Carbon Fund.

A Verified Carbon Standard (VCS) project [26] "Afforestation in Eucalyptus and Acacia Plantations for Burapha Agroforestry Co., Ltd.), is under "Registration and verification approval requested" status. Its proposed 1st crediting period term (31 May 2016 – 30 May 2036) and its project area in Xayabouli province overlaps with the ER Program. DOF and project proponent have agreed that the VCS project will not seek ER credits generated from its site in Xayabouli province to be issued for the ERPA period (2019-2024). This agreement (available upon request) has been made through receipt of a signed undertaking to this effect by Burapha Agroforestry Co Ltd dated 18 May 2023 wherein Burapha agrees to surrender all titles to ERs from the ER Program area and overlapping reporting period. Further DOF has transmitted this signed undertaking from Burapha Agroforestry Co Ltd to the FMT and the World Bank Task Team, Lao on 14 June 2023. In addition drafts of these letters were pre-approved by the World Bank legal team and are considered adequate assurance.

[26] Project ID 2367 <https://registry.verra.org/app/projectDetail/VCS/2367>. The project proponent have developed its tree plantation about 3,475 ha by 2020, and plans to scale up to 15,000 ha by 2021. The future goal is to manage 68,750ha of forests (plantation and protected areas) in total. Over a crediting period of 20 years the project expects to generate 408,682 tCO2e, 20,434 tCO2e/year (after discount of buffers). Note that the project site(s) in Xayabouli province is only a part of the entire project sites of the five provinces.

7 REVERSALS

7.1 Occurrence of major events or changes in ER Program circumstances that might have led to the Reversals during the Reporting Period compared to the previous Reporting Period(s)

Not applicable, thus intentionally left blank.

7.2 Quantification of Reversals during the Reporting Period

Not applicable, thus intentionally left blank.

7.3 Reversal risk assessment

Since the submission of the ERPD in 2018, Lao PDR has been making significant progresses in the implementation of the ER Program.

The ER Program is now adopted into the National REDD+ Strategy, being the first and so far the only sub-national scale REDD+ project in Lao PDR that has catalyzed implementation support to unlock ER payments. The ER Program is designed to function as the inception phase of REDD+ for the country, to feed experience into the rolling out of REDD+ at the national scale. In this regard, the key policies and measures designed for the ER Program will be continued well beyond the lifetime of the ER Program. The ER Program also is designed to sustain impact and avoid reversal events beyond the Program lifetime by institutionalizing capacity, policies and measures firmly within the Government as well as within the relevant stakeholders and their conduct.

Having the enabling conditions effective, and with the program interventions including donor support fully and/or newly operational (See Section 1.1), Lao PDR considers that the reversal [27] risk has significantly decreased. It expects to produce higher level of ERs in the 2nd monitoring period (2022 - 2024).

The following table re-assess the reversal risks:

Table 21: Reversal risk assessment

Risk Factor	Risk indicators	Default Reversal Risk Set-Aside Percentage	Discount	Resulting reversal risk set-aside percentage
Default risk	*N/A*	**10%**	*N/A*	*10%*
Lack of broad and sustained stakeholder support	The ER Program interventions are designed to assist and engage directly with village communities, and also with private businesses. Villagers have been consulted through the PRAP formulation processes (consultation record available in Lao language upon request). The results of consultations were summarized and	**10%**	10%	0%

[27] The COVID pandemic seemed to have brought negative impacts to Lao forests, with more people returning to villages, engaging in production activities (e.g., farming and logging) due to closure of domestic secondary and tertiary industries, as well as Lao workers returning from abroad. This situation should change in the post-COVID period. Lao PDR expects to see more ERs generated in the 2nd reporting period (2022-2024) compared to the 1st reporting period.

	reflected into the design of the ER Program (see Section 5 of the ER Program). Since the acceptance of ERPD in 2018, they have been further engaged through consultations during implementation of the ER Program and preparations of the Benefit Sharing Plan. Implementation of the ER Program is in progress. The FPIC team has been established for six provinces with the support of PAFOs, DAFOs, Lao Women Union (LWU), and Lao National Development Front (LNDF). Over 400 villages already have been implementing village-level activities applying climate-smart agriculture and forestry practices. More villages are preparing to be a part of this, including 253 villages under the FPIC process of the GFLL, and more under the I-GFLL Project 2 in GCF pipeline. Funding windows for partnership with private businesses have been established in some projects. With these progresses, the ER Program has been gaining much broader support in various levels compared to the assessment in the ERPD. As a result, the associated risk has significantly reduced.			
Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination	Along with the significant progress Lao PDR has made in REDD+ in the recent years, the ER Program has been gaining increasing support and understanding by the Government agencies and partners in the country. High levels of commitment, leading to effective participation and coordination, have been secured from central and provincial government leaders and staff involved in the ER Program. Various capacity building activities have been conducted, based on respective capacity building plans. This is apparent, for example, in the progress of the GFLL project. The institutional arrangements at National (NPMU), provinces (PPMU), and districts (DMPU) have been established and the activities have been implemented in accordance with the workplan. Safeguards instruments are in place, and national and provincial teams have been set up. Other projects in the ER Program area also share many of the objectives and operational mechanisms of the ER Program. Under the committed leadership of the Executing Entity, institutional capacities and coordination have been showing significant improvements. However, Lao PDR still recognizes that institutional capacities and coordination need to be further	**10%**	5%	5%

	enhanced. In collaboration with technical partners, such as the GFLL, I-GFLL, F-REDD 2, such effort will continue throughout and beyond the ER Program lifetime. Acknowledging such challenge, 5% of reversal risk is set aside.			
Lack of long term effectiveness in addressing underlying drivers	As explained in Section 1.1 and elsewhere, there has been significant progress in developing the enabling environment to generate ERs since the acceptance of the ER Program. The Government has renewed its commitment to the forestry sector and improving forest sector governance. This government commitment is evident from the issuance of the Prime Minister's Order No. 15, engagement in the Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement (VPA) negotiations, and the Nationally-Determined Contribution update in March 2021. The 2019 revisions of the Land Law and Forestry Law present opportunities for mainstreaming REDD+ into Government policies and sustaining its momentum. Work is ongoing on the Forestry Strategy 2035, and three Prime Ministerial Decrees on three forest categories (Conservation Forest, Protection Forest and Production Forest). These documents are in their final draft stage. The NRS has been a key document guiding the national roll-out of REDD+. The Benefit Sharing Plan for the GFLL plans for reinvestment of results-based payments to sustain and scale-up the interventions. The FPIC processes have been started for 253 villages in the ER Program provinces. Other projects, such as I-GFLL, also includes performance-based support that provides villagers longer incentives for forest conservation. Support to the ER Program Area has been synergized among the Green Climate Fund (GCF) and other donor funds. Time-series analysis of the forest type maps for the reference period shows that once degraded forests (i.e. Regenerating Vegetation: RV class) are restored to forests, in most cases these forests are then maintained as forests. These restored forests have not reverted back into regenerating vegetation (RV), i.e., these restored forests are not being slashed and burnt again. [28] These data indicate that the risks of reversal are small or negligible.	**5%**	5%	0%

[28] Less than 0.5% (or 20,000ha) of the forest cover reverted back to regenerating vegetation or deforestation.

	As a result, the associated risk has significantly reduced.			
Exposure and vulnerability to natural disturbances	The ER Program area is not prone to many natural disturbances (mostly natural disasters in the ER Program's context). The drivers analysis was conducted for the ERPD (Section 4.1.1) using three approaches: 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 iii) stakeholder consultations. None of the three approaches identified natural disasters as a major driver, and there are no information that indicate significant changes in this analysis. No catastrophic events have been reported that severely reversed or risked the implementation of the ER Program. Forest fires usually due to the slash-and-burn fires that spread elsewhere, are addressed by ER Program interventions.	**5%**	5%	0%
		Total reversal risk set-aside percentage		**15%**
		Total reversal risk set-aside percentage from ER-PD or previous monitoring report (whichever is more recent)		23%

8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

A.	**Emission Reductions during the Reporting period (tCO2e)**	*from section 4.3*	4,435,451
B.	**If applicable, number of Emission Reductions from reducing forest degradation that have been estimated using proxy-based estimation approaches (use zero if not applicable)**		(267,333)
C.	**Number of Emission Reductions estimated using measurement approaches (A-B)**		4,702,784
D.	**Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested**	*from section 6.1*	100%
E.	**ERs sold, assigned or otherwise used by any other entity for sale, public relations, compliance or any other purpose including ERs accounted separately under other GHG accounting schemes or ERs that have been set-aside to meet Reversal management requirements under other GHG accounting schemes**	*from section 6.4*	0
F.	**Total ERs (B+C)*D-E**		4,435,451
G.	**Conservativeness Factor to reflect the level of uncertainty from non-proxy based approaches associated with the estimation of ERs during the Crediting Period**	*from section 5.2*	15%
H.	**Quantity of ERs to be allocated to the Uncertainty Buffer (0.15*B/A*F)+(G*C/A*F)**		665,317
I.	**Total reversal risk set-aside percentage applied to the ER program**	*from section 7.3*	15%
J.	**Quantity of ERs to allocated to the Reversal Buffer (F-H)*(I-5%)**		377,014
K.	**Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*5%**		188,506
L.	**Number of FCPF ERs (F- H – J – K)**		3,204,614

ANNEX 1: INFORMATION ON THE IMPLEMENTATION OF THE SAFEGUARDS PLANS

- **Requirements of FCPF on Managing the Environmental and Social Aspects of ER Programs**

The requirement of this safeguard report aims to ensure that the people and the environment are protected from potential adverse impacts from the GFLL Program. The implementation of this program must be in line with policies that identify, avoid, and minimize harm to people and the environment. These policies require the government and implementing agencies of projects under the GFLL program to address certain environmental and social risks in order to achieve the goal and objectives of the Program.

The report summarizes an overall implementation of safeguard activities focusing on the application of the safeguard instruments, namely Strategic Environmental and Social Assessment (SESA), the Environment and Social Management Framework (ESMF), Ethnic Group Policy Framework (EGPF), Process Framework (PF), and Resettlement Policy Framework(RPF) by the GFLL/FCPF, Approved by the WB as part of the ERPA conditions of effectiveness. Readiness Project and other projects during the period 2019-2021. (Since GFLL had very few activities during the reporting period, the implementation of safeguards instruments mostly focusses on that of other projects, which are included in the Due Diligence Report i.e., CliPAD IV/I-GFLL, ICBF and VFMP plus the projects funded by the World Bank i.e., LENS2 and SUFORD SU.

The SESA, ESMF and safeguard work plan was prepared in line with WB safeguard standard and GoL policy as an annual work plan in 2019-2021, The safeguard report also provides information on the implementation of the safeguards plans of GFLL project and the other projects operating in six northern provinces of Lao PDR, namely Bokeo, Huaphan Luang Namtha, Luang Prabang, Oudomxay, and Sayaburi. The Provincial Department of Agriculture and Forestry and District Agriculture and Forestry Offices (PAFOs/DAFOs) are responsible for implementation of the safeguards plan of the projects at sub-national level, whereas DOF/REDD Division has overall responsibilities for technical support and management of the safeguard's issues at national level.

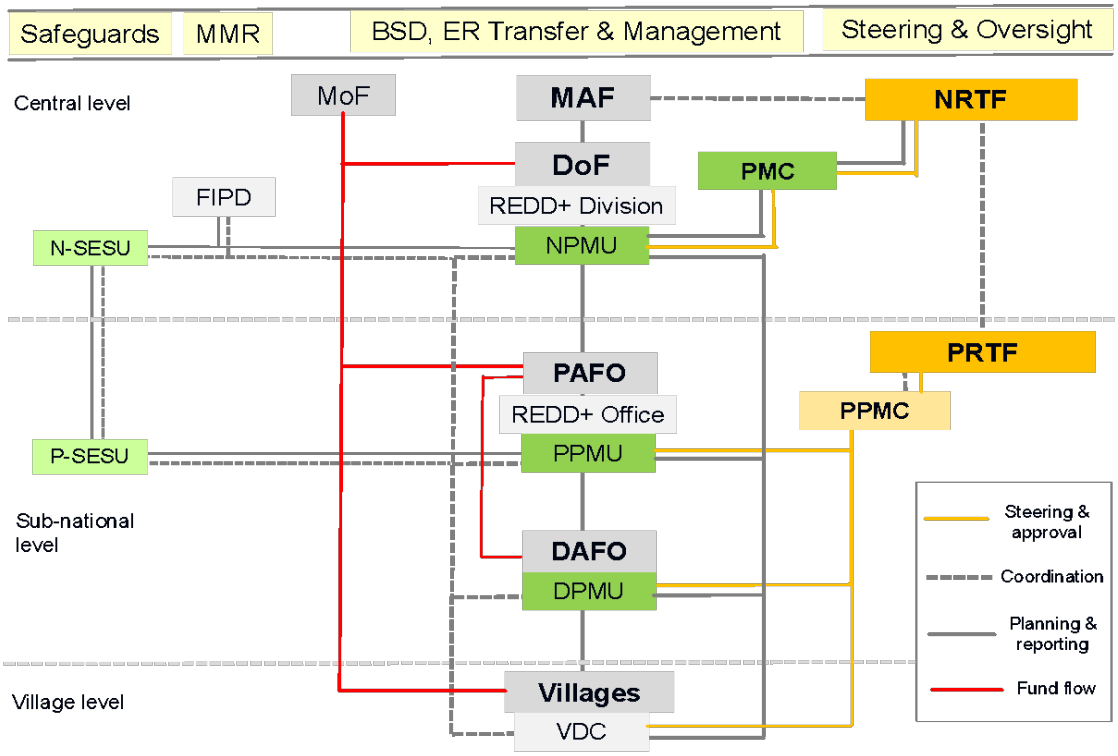
- **Monitoring and Reporting Requirements**

1. Entities that are responsible for implementing the Safeguards Plans are adequately resourced to carry out their assigned duties and responsibilities as defined in the Safeguards Plans.

1.1 Summarize the key institutional arrangements, such as decision procedures, institutional responsibilities, budgets, and monitoring arrangements that are required under the Safeguards Plans.

The GFLL is implemented at the sub-national level covering the six Northern Provinces of Bokeo, Huaphan, Luang Namtha, Luang Prabang, Oudomxay, and Sayabouri. The overall implementation will be undertaken by DoF and relevant divisions of DoF under the coordination of the REDD+ Division and REDD+ Offices and the day-to-day operations by local line agencies. The brief institutional framework for safeguards implementation and monitoring as well as their roles and responsibilities are given below:

Overall Responsibilities for Safeguards Management



The brief institutional framework for safeguards implementation and monitoring under GFLL project as well as their roles and responsibilities are given below:

Table 1. Responsibilities, Arrangements and Budgets for Safeguards Implementation

Agencies	Responsibilities	Monitoring arrangements	Expenditure (USD) All figures in LAK. Exchange Rate: 1 US$ = 9,100 LAK
Governance Forest Livelihood and Landscape -GFLL/FCPF= 52.175 USD			
Department of Forest (DoF)	Programme Implementing Entity and will be responsible for overseeing the Programme implementation including ESMF implementation and environmental performance of the Programme.	At least 2 times a year formal	
Project Management Unit (PMU) at DoF	PMU will be responsible for monitoring the overall Programme implementation, including environmental compliance of the Programme. PMU will have the final	Every quarter , and before, during and after project	10.320+1.846=12.176 USD Consultation on LNSIS Technical Document with safeguard technical and Stakeholders, and Consultation

Agencies	Responsibilities	Monitoring arrangements	Expenditure (USD) All figures in LAK. Exchange Rate: 1 US$ = 9,100 LAK
	responsibility for ESMF implementation and environmental performance of the Programme during the construction and operational phases.	activity implement	on SIS Manual with safeguard technical team working group.
Social and Environmental Safeguards Unit (SESU)	Social and Environment Safeguard Unit (SESU) will be responsible for monitoring the implementation of the World Bank's environmental safeguard policies in all stages and processes of the Programme.	Preparing safeguard document in the first stage, under implementation and operation phase, SESU will regularly coordinate with NSESU at central level, and Data collection of Safeguard is completed	31.451 USD (Code 3.1.3: Activity Consultation on SIS Technical Document with safeguard technical and Stakeholders)
PPMUs and PMU	PPMU/PMU is responsible for implementation of all the ESMP activities to be carried out under the Programme in coordination and cooperation with contractor, local authorities, and local communities		8.530 USD Activity Data collection through primary research and field visits; and consultations for EGDP (No 4.1.1.1) and Activity Data collection through primary research and field visits; and consultations for Gender action plan (GAP) (Code 4.1.2.1) and social impact assessment/screening for infrastructure or civil works sub-projects in six provinces based on annual work plan (4.1.4.1)
PAFO/DAFO, PoNRE/DoNRE	PAFO/DAFO and PoNRE/DoNRE are responsible to oversee the implementation of sub-projects under recommendations of DoNRE and PPMU/PMU to ensure compliance of		Not yet implemented. Budget needs to be allocated

Agencies	Responsibilities	Monitoring arrangements	Expenditure (USD) All figures in LAK. Exchange Rate: 1 US$ = 9,100 LAK
	policy and regulations as well as monitoring the compliance for environmental requirements.		
Independent Third-Party Monitoring (TPM)	The TPM will perform independent verification of self-reporting data provided by the DoF and annual audits of a sample of ER Programme activities including safeguards documentation, consultation processes, effectiveness of management measures specified in the Safeguards Plans, and disclosure of information, among other important aspects in a timely manner.		Not yet implemented. Budget need to be allocated
Communities	The community has the right and responsibility to routinely monitor environmental performance during construction to ensure that their rights and safety are adequately protected and that the mitigation measures are effectively implemented by the PMU/ PPMUs.		Not yet implemented. Budget need to be allocated
Social organizations, NGOs and civil society organizations	Provide in community mobilization, participation in the subprojects, providing training to communities and solving environmental and social problems.		Not yet implemented. Budget need to be allocated

1.2 Confirm whether the institutional arrangements summarized above have been put in place.

In Progress. The institutional arrangements for GFLL safeguards have been approved for set up through national and provincial policies (Table 2). The policies outline the roles and responsibilities for Social and Environmental Safeguards Units (SESU) that are appointed for National and Provincial Level covering six provinces, namely Bokeo, Huaphan, Luang Namtha, Luang Prabang, Oudomxay, and Sayabouri. The LNSIS (Lao National Safeguards Information System) that has been established and approved in September 2020 will have staff appointed in all provinces, 2 staff per province and 2 staff appointed at National level. So, totally LNSIS will have 14 staff, of which 12 staff are assigned for safeguards (SESU) and 2 staff assigned for national SESU. All 12 SESU staff from provinces have been appointed among which 2 women are included. The LNSIS will initially be made operational in GFLL provinces and will incrementally be expanded at the national level. Staff levels are considered adequate and will be reviewed and expanded as required.

Table 2. Established institutional arrangements for LNSIS

Institutional Implemented	Established/ Authorized by	Main Responsibilities
National Social and Environmental Safeguards Units (SESU)	The agreement No 1882/DOF, Date 21 Sep 2020, Deputy Ministry of MAF.	**Central level** 1. Responsibility to manage information, coordinate with the technician or the person in charge at the district level in the implementation of the plan and tools for social and environmental protection. 2. Responsibility to monitor the activities of the technical or social and environmental protection teams at the provincial and district levels. 3. Provide technical support and capacity building for provincial and district liaison officers. 4. Coordinate with social organizations to strengthen and collaborate on local communities. 5. Monitor and evaluate the implementation of the social and environmental Safeguard plan 6. To have the duty to compile, report and provide information on social and environmental protection to the relevant parties at the central and international levels.
Provincial Social and Environmental Safeguards Units (SESU), District Social and Environmental Safeguards Units (SESU)	1. Agreement No 1010/, Date 16 Jan 2020 (LPB) 2. Agreement No 2309/PAFO, Date 10 Nov 2020 (UDX) 3. Agreement No 4344/PAFO, Date 12 Nov2020 (XYBL) 4. No 0446/PFS, date 09 Nov 2020(BK) 5. No 2518/PFS, date 06 Nov 2020 (HP) 6. No 536/PAFO, date 17 Nov 2020 (LNT) 7. No 4344/PAFO, date 12 Nov 2020 Authorized by PAFO	**District and provincial levels** 1. Responsible for information management, coordinating with the relevant departments at the provincial level and the relevant offices at the district level in the implementation of social and environmental protection plans and tools. 2. Responsible for the implementation of the social and environmental protection plans at the provincial and district levels. 3. Provide technical support and capacity building for technical staff or responsible teams at the district level. 4. Compile and provide social and environmental protection information to the relevant departments or parties at the provincial and district levels as required. 5. Coordinate with social organizations in building the capacity and cooperation of local communities. 6. Monitor and evaluate the implementation of social and environmental protection plans at the provincial and district levels and to report to the provincial, district and central levels for implementation.

1.3 Confirm that the implementing entities and stakeholders understand their respective roles; have the technical capacity to execute their responsibilities; and have adequate human and financial resources.

Capacity building for SESU staff was conducted in 2021 through a 3-day workshop with 15 participants from six provinces and representatives from DoE, DEQP, NUOL/FOE, LNFC, LWU, UDOFI, and REDD+ Division. The workshop aimed to introduce social and environment safeguards of ER programs in six northern provinces of Laos. The training was funded by the FCPF Readiness grant. The appointment of staff to National SESU is in progress and expected to be completed during the third quarter of 2022 .
There is ongoing capacity building and additional training planned for third quarter of 2022 facilitated by the REDD Division targeting SESU staff and other stakeholders focusing on the overall safeguards framework and roles and responsibilities of SESU for safeguard implementation.

Table 3. Capacity Building for SESU

No	Capacity building priorities	Date carried out	Number of Participants	Duration (Days)
1	Training workshop on Social and Environment safeguard	23-27/8/2021	15 Participants,DoF and Representative from DoE, DEQP, NUOL/FOE, LNFC, LWU, UDOFI, REDD+ Office.	3 days of workshop, and only theory

2. ER Program activities are implemented in accordance with management and mitigation measures specified in the Safeguards Plans.

2.1 Confirm that environmental and social documents prepared during Program implementation are based on the Safeguards Plans. Provide information on their scope, main mitigation measures specified in the plans, whether the plans are prepared in a timely manner, and whether disclosure and consultation on the plans are carried out in accordance with agreed measures.

In Progress. There are currently six major donor projects on REDD+ in six provinces (Bokeo, Huaphanh, Luang Namtha, Luang Prabang, Oudomxay and Xayaburi), namely GFLL/FCPF Carbon Fund, LLL, CliPAD IV/I-GFLL, Supported by Green Climate Fund (GCF), ICBF, LENS2, and VFMP support by KfW. For the last four projects they have developed and implemented their safeguards policies and instruments (LLL is still at an inception phase as of 2021), including monitoring systems and gender inclusion. The environmental and social documents prepared during project implementation is based on the Safeguards Plans listed in table 4 below.

Table 4. Safeguards Policies and Instruments developed and implemented in six provinces of northern Lao PDR

Project Name	Compliance key Safeguard document	Key Safeguard implemented Progress
GFLL/FCPF	The key safeguard document of GFLL/FCPF Project comprised SESA, ESMF, RPF, PF, EGPF	Safeguard implementation progress to date : The progressing of implementation Safeguards: ● The package of safeguards documents was completed and received clearance and disclosed on the DoF website. These include SESA, ESMF, EGPF, RPF and PF. ● Safeguards Information System: A first draft of the SIS has been prepared including a work plan

Project Name	Compliance key Safeguard document	Key Safeguard implemented Progress
		• Safeguards Due Diligence for potential retroactive ER was completed and approved by the WB as part of the ERPA conditions of effectiveness. • National and provincial public awareness events on REDD+ with outreach to approximately 4,000 persons and 7,500 communication products distributed Environmental and Social Management Framework (ESMF) • Completed Sub-project checklist, 'Pesticide management plan 'Chance find procedure 'Feedback and GRM forms, Technical specification and contracts, IEE format, Safeguard report format, UXO site and safety brief, UXO visitor's indemnity form B. Resettlement Policy Framework (RPF) • Gender action/ monitoring plan', 'Social screening form', 'Resettlement action plan (RAP)', 'Process land donation', 'Voluntary land donation form' C. Capacity Building activities. • Training for 12 SESU staffs from 6 provinces in August 2021, and focusing topic such as: A brief introduction to REDD+, the GFLL program included results and Beneficiaries, Implementation approached and institution arrangement, Policies, laws, regulations, World Bank Policies and International Conventions on safeguard, GFLL project safeguard documents and mitigation measures, Duties and responsibilities of safeguard work, Grievance Redress Mechanism, Benefit-sharing plan and management structure, Social and environmental impact assessment process for sub-projects, Information Protection System (SIS), and Forms, tools for safeguard work.
VFMP	The key safeguard document of VFMP Project comprises ESMS, ESMF, FPIC guidelines, which constitute the main elements of a Community Engagement and Planning Framework (CEPF).	• Elaboration of ESMF, FPIC Guidelines and Inception Report; training of PIA staff and mass organization members; • FPIC 1 (Orientation, Review and Revision of Forest and Forest Land Categories Within the Village Jurisdictional Area, decision about participation in VFMP activities) done in all 70 villages; • FPIC 2 (Original PLUP reviewed, Village administration and villagers participate in data collection on the status of forest and forest land use in the village. The village administration and the people agree with the sketch map and maps showing a boundary for each forest category) carried out in all 70 villages • FPIC 3 (PLUP updated, the village administration and the people agree on where to set the signboards and Boundary posts for each forest category) done in all 70 villages; • FPIC 4 (Key issues discussed, Potential negative impacts by the project that may affect people have been identified, i.e., lose their use rights of tenures) done in 34 villages (Phonxay 20; Phieng 14); • FPIC 5: A Master plan for Forestry Development with required key activities prepared and Villages consented to the plan in 34 villages (Phonxay 20; Phieng 14); Plan endorsed by GoL and first agreements signed with villagers in 24 villages (Phonxay 10,

Project Name	Compliance key Safeguard document	Key Safeguard implemented Progress
		Phieng 14) - Collection of environmental and social baseline data in all 70 villages;
CLiPAD/ I-GFLL	In the CliPAD program, GIZ's approach to FPIC was taken into account showing compliance with the donor's safeguards. And GCF's safeguards policy, and takes into account the IFC's Performance Standards, World Bank's Safeguards Policy and Lao PDR's policies, laws and regulations. The I-GFLL has safeguards protocols in place and is in the process of setting up the NPMU and PPMU, including mechanisms for compliance with safeguards. It should be noted that I-GFLL developed an Environmental and Social Impact Assessment, an Environmental and Social Management Plan, a Gender Action Plan, and a Gender Assessment. In addition the GFLL and I-GFLL have an agreement to use a common ESMF.	Achievements/implemented activities (January–December 2021) GIZ team has been jointly collaborating with GoL counterparts and other concerned agencies implementing national and sub-national level activities under close guidance of DOF (MAF) and the main outputs and results of the Technical Cooperation Module include: Output 1: Enabling environment for REDD+ ● The project completed the training on FPIC 1 and FPIC 2&3 to three Provincial Lao Front for National Developments, and Provincial Lao Women Unions. ● FPIC1 completed 170 villages in three provinces, but one village in Phonthong district rejected the project but the DPMU reselected a new village to replace it two villages in Hongsa have been merged into one village and so added a new village. FPIC2&3 completed in 3 villages (HP: 2 and LPB: 1) ● Houaphan provincial Lao Front for National Development and Lao Women Union organized FPIC2&3 training for 5 districts Lao Front for Development (LFND) and Lao Women Union (LWU) as FPIC Teams. ● Completed FPIC2&3 or village forest management contracts signed in four villages (3 in Houaphan and 1 in Luang Prabang). ● Village Forest and Agriculture Grant (VFAG) guidelines, VFAG Bylaw, VFAG establishment and VFAG financial management formats were developed. ● Organized Village Forest and Agriculture Grant (VFAG) Training of Trainer to 13 new districts VFAG Teams in three provinces. ● Established 155 villages' VFAG Committees and Bylaws in three provinces (HP: 66, LPB: 43, SAY: 46). ● Trained VFAG financial management (fund request, fund management and fund reporting) in 96 VFAG committees and opened VFAG bank accounts of 94 villages. ● Completed VFAG training to two existing districts (Houameung and Samneua) and currently 70 villages in these two districts completed revision of VFAG committees, Bylaws, bank accounts and VFAGCs were trained on financial management. ●

Project Name	Compliance key Safeguard document	Key Safeguard implemented Progress
ICBF:	The ICBF project design and activities are aligned with the KfW's Sustainability Guideline and environmental and social principles, and underlying environmental and social safeguard policies.	This project comprised 3 main components: Component 1/ Protected Area Planning and Management, Component 2/ Law Enforcement, Component 3/Forest/ Land Management and Livelihood. The ICBF also implemented safeguard activities such as: Community consultation, and conducted FPIC before PLUP, but no information is mentioned in an annual report in 2019,2020 and 2021.
LENS2 Lao Social and Environment project (Phase2)	The key safeguard document of LENS2 Project comprised WB social safeguard standard ESMF, CEF and GoI Policy, Project POM	Beneficiaries. Available data suggested that the 10 PA related subprojects cover for 7 provinces 31 districts, and 191 target villages with total budget about 25,128 million kip or US$ 2.5 million and benefit about 22,572 households (HHs), comprising 130,348 beneficiaries of which 62,305 are women (48% of total beneficiaries), and 11,108 ethnic groups that meet the definition of indigenous peoples per the WB safeguard policy (mainly Mone-Khmer, and Hmong-Mien). Detail below: ● Completed the preparation of the Community Engagement Framework (CEF) operation manual. ● Completed 3 general training on the application of ESMF and CEF, and a total of 162 participants from center and provincial and district staff of which 42 are women or 29% of total participants. ● Completed Social Management Plan (ESMP) in the form of subproject ESMF Including training workshops on sharing the CEF implementation experience following the CEF manual with the TA teams of NNT-NPA and NEPL-NPA as well as with NUOL-FEB team and 3 north province HP, LPB and XK ● Completed extensive training and capacity building on the CEF and ESMF implementation processes of the 7 PAFO sub-projects, including the preparation of CEF supporting documents (FPIC, SER, PAR, CAP, AP, PLUP, CCA) for 191 villages, all of which were completed by mid-December 2021. ● The total budget of about US$11 million was allocated to support the planning and implementation of the 10 sub projects including about 479 sub-activities for livelihood development and conservation activities, which were identified under the preference list of the CEF Manual. ● The CEF Monitoring Matrix which includes 3 mains of information such as checklist of CEF Completed stages, capacity building information (Number of governments, and villager involved capacity activities), and number beneficiary this matrix has been

Project Name	Compliance key Safeguard document	Key Safeguard implemented Progress
		developed and updated and shared with WB, EPFO, DOF, and the 10 PAFO subprojects every quarterly.
LLL Lao Landscapes and Livelihoods Project	The project investments are expected to result in positive environmental and social impacts, and livelihood development outcomes from better managed forest landscapes. However, potential risks and negative impacts associated with project activities in relation to the World Bank ESF exist, ESMF is prepared to manage and mitigate the potential environmental and social risks and impacts, CEF based on the successful model adopted in SUFORD SU and LENS2 projects is prepared for LLL.	The following activities were implemented or initiated so far: ● 2 initial ESF trainings for central/ provincial level ES FPs & staff conducted (Feb./ Mar) ● 1 initial training course for district ES FPs & staff in Bolikhamxay province conducted (7 districts) ● ESF implementation plan developed, inputs into AWP 22/23 and reporting provided ● Formulation of 'model documents' for 3 villages (Bolikan district) including CAP, CCA, SS-ESMP initiated ● Guideline/ training materials & agendas developed for 'FPIC, Community Resource Profiling/ Baseline Setting' (CEE2), set of related posters in work ● Exchange/ coordination with technical teams (e.g., livelihood, infrastructure) initiated Planning & ESF Integration Component 1 (sub-component 1.1 and 1.2) ● All steps of community engagement, ES assessment & SS-ESMP integrated as activities/ sub-activities into sub-components 1.1 and 1.2; integration of technical & ES teams Component 3 (sub-component 3.3) ● Support to policy framework for SESA/ ESIA (3.3.1) & assessment of impacts by private sector activities (3.3.2); DoE in charge in cooperation with relevant stakeholders Component 4 (sub-component 4.1) ● Implementation of Environmental and Social Framework (4.1.2); under responsibility of DoF, PAFO, DAFO (ES focal points) ● Initial FPIC consent, subsequent CAP & SS-ESMP are required prior to activities/ investments in target villages; examples of CAP & SS-ESMP need to be approved by WB ● Refine/ re-submit CEE 2 guidebook to WB VTE; complete posters ● Conduct CEE 2 trainings in all provinces, subsequent implementation & scaling up ● Establish pre-conditions for CAP/ SS-ESMP: agree on PLUP approach, develop 'positive list' (livelihood, village infrastructure), establish technical teams/ recruit village facilitators ● Complete/ submit 'model documents' in selected villages (CAP, SS-ESMP) to WB, after approval conduct training and subsequent implementation/ scaling up

2.2 Confirm if entities responsible for implementing the Safeguards Plans maintain consistent and comprehensive records of ER Program activities such as records of administrative approvals, licenses, permits, documentation of public consultation, documentation of agreements reached with communities, records of screening process, due diligence assessments, and records of handling complaints and feedbacks under the Feedback and Grievance Redress Mechanism (FGRM).

The Grievance Redress Mechanism for GFLL/FCPF for the project is based on existing policies, strategies, and regulations on grievances as defined by GoL. However, specific components have and will be adapted to the needs of the GFLL program including additional training. The immediate components where further development is planned includes the setting up of more robust systems and tools for recording, and documentation of grievances, resolutions and agreements specific to GFLL. For instance, cloud-based systems are under consideration and specifications will be completed by the end of July 2022.

In the interim, during 2021, training has been provided for the SESU on the overall FGRM obligations and reporting requirements. The other similar projects (LENS2, CliPAD IV/I-GFLL, ICBF, PRF, and VFMP/KfW) have implemented the mechanism as presented in Table 5.

Table 5. Summary complaints or grievances from similar project implemented in six provinces

Project name	Complaints or grievances Mechanism Process	Record of grievance system (National, Province, District and Community)
FCPF/GFLL	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (FGRM)	The FGRM process has been set-up and in line with existing policies, strategies, and regulations on grievances as defined by GoL, which require project owners/developers to set up grievance mechanisms starting from the village level, and also follow recent legislation under Decision No. 08/MOJ, dated 22 February 2005 that seeks to strengthen conflict resolution at the grassroots level, by establishing Village Mediation Committee (VMC). This project will be applied to learn from other projects LENS2, PRF to bridge the gaps for further implementation such as recording system/or Grievance's logbook, the recording system also mentioned in all levels of GFRM (Central, Provincial, District and Village level). During preparation, the GFLL project team (N-PMU) received some grievances from the SESU team and requested more technical training related to safeguarding.
LENS2	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (GRM)	The LENS2 Project has a recording system; there were 254 grievances received from the total 191 target villages. These grievances are mainly centered around suggestions and requests for further technical training and extension support from the subproject owners (SDAs), PAFOs and DAFOs to strengthen and sustain their livelihood activities funded through the village development funds and/or other funds that have been established at the village level. All complaints are responded to and recorded by the SDAs, PAFOs, and/or DAFOs. However, given limited knowledge and capacity of PAFO/DAFO and other related departments at provincial and district levels as well as the lack of

Project name	Complaints or grievances Mechanism Process	Record of grievance system (National, Province, District and Community)
		knowledge and capacity at village levels, it is important to provide support on GRM operations as part of all new investment and capacity building of PA related activities
VFMP	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (GRM)	No grievance record system mentioned in the progress report. So far major issues to activate grievance management have not been found. One topic mentioned by the mass organizations is only that more villages in the two districts would like to participate in the VFMP project. It is obvious that funds are limited and not all villages or districts in Lao PDR can form part of the initiative. There was a transparent selection process in the inception phase of the project, agreed between all stakeholders, to identify the present 70 target villages of VFMP. Nevertheless, the implementing agency will check the available and needed funds to attend the currently selected villages. If funds allow, the PEA will discuss with KfW if it is possible to increase numbers of villages within the same budget frame. The Government of Laos is open to supporting every village to implement Article 39 of the F orest L aw 2019. Villages which show their interest to join the project will then be welcome and a transparent procedure will be established.
I-GFLL/CliPAD	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (GRM)	There is a recording system, but no number of concerns or compliance mentioned in the report.
ICBF	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (GRM)	There is a recording system but not functioning, Grievance or Compliance mentioned in the report. villages and district level, no record system mentioned in the report.
PRF Poverty Reduction fund	There is Feedback and Grievance Redress Mechanism system prepared according to the safeguard plan. (GRM) Since project	PRF works in 12 provinces including northern provinces such as: XK, HP, PSL, LNT, ODX LPB. GRM implemented by the PRF have set-up a GRM system for all target villages (The Grievance redress Mechanism Received Boxes), target district as well as provincial level.

2.3 Summarize the extent to which environmental and social management measures set out in the Safeguards Plans and any subsequent plans prepared during Program implementation are implemented in practice, the quality of stakeholder engagement, as well as whether field monitoring and supervision arrangements are in place.

Progressing all safeguard documents and standards have been included into the safeguard work plan, Approach, Mechanism, steps, consultation, and capacity strengthening also included.

2.4 Confirm that the FGRM is functional, supported with evidence that the FGRM tracks and documents grievances, and is responsive to concerns, complaints or grievances.

Progressing.

The Grievance Redress Mechanism for GFLL/FCPF for the project is based on existing policies, strategies, and regulations on grievances as defined by GoL. As noted in Section 2.2 above, some components such as documentation, recording and access or disclosure need to be adapted to the needs of the GFLL program. However, the other similar projects (LENS2, CliPAD IV/I-GFLL, ICBF, and VFMP/KfW) have implemented the grievance mechanism. Please see Table 5, section 2.2 for the implementation of Grievance mechanisms in the six northern provinces.

3. The objectives and expected outcomes in the Safeguards Plans have been achieved.

3.1 Assess the overall effectiveness of the management and mitigation measures set out in the Safeguards Plans.

Progressing the self-assessments were conducted to understand the effectiveness of the management and mitigation measures in the Safeguards Plans and are summarized in table

Table 6. Summary of self-assessment

Main Activities under Safeguard Plan	Progresses Update	Sell-Assessments
1. Safeguard due diligence.	There are 5 Sub-activities under Safeguard due diligence and the overall implementation are fully completed, DDR report approved by the WB and information has been disclosed by DOF website.	Fully Completed and ready to share 100%
2. Safeguard Information system (SIS) 2.1 SIS Technical Document 2.2. SIS Operational Manual	There are 7 Sub-activities under SIS and the overall implementation is fully completed, approved by the DOF and WB. The technical document has applied to the safeguard training	Fully Completed and ready to share 100%
3. Safeguard and SESU Capacity Building	3.1 Safeguards capacity building. This activity includes developing capacity building approach, Safeguard Technical Guidebook and Plan, design capacity building workshop and training material/presentations and conduct capacity building workshops. That document has been completed and endorse by DOF and WB (GFLL Safeguard progress update 18 Jan 2022, WB Mission)	Fully Completed and ready to share 100%
	3.2 SESU capacity building. Informal safeguard theory training has been organized in August 2021; 6 Provinces have been participants. However, to make sure that SESU has capability to apply, approach, step, tools, material in the field NPMU/NSESU should give consideration to providing more specific training, coaching, and on the job training during implementation of safeguard	Partially completed about 20%

4. Safeguard Operation. 4.1 Social safeguard 4.2 Environment	Since the second round of COVID19 pandemic in 2021-2022, the activity planned for safeguards training has been delayed. Capacity building is now being prioritised with the addition of an international environmental safeguards consultant in December 2022 and an international social safeguard consultant in February 2023. These two consultants are supported by two national consultants. However, The REDD+ Division and consultants have collected some data for preparing Ethnic Group Development (EGDP) Plans, Gender Action Plans (GAP) for six provinces.	Work in progress estimated 10% completed
5. FGRM Recording system	The FCPF project was launched nationally in HP province, and SG training for 6 provinces was completed including FGRM season.	The recording system will be recording and regularly report as annual report

3.2 Are the arrangements for quality assurance, monitoring, and supervision effective at identifying and correcting shortcomings in cases when ER Program activities are not implemented in accordance with the Safeguards Plans?

This section is intentionally left blank since the GFLL activities have not been started yet.

The overall institutions and staff's responsibility for implementing the project has been established at the national, provincial and district level under agreement of MAF, DOF, and PAFO (See table 7), and SESU unit (See section 1.2), The progress report and implementation plan has been prepared, and WB also assigned a technical supervision advisor to support implementation of the project see table below:

Table 7. Established institutional arrangements for GFLL

Institution	No of Agreement and the date of endorse	Number of staffs	Authorized by
Established project coordinator and financial responsibility for FCPF	No 0997/MAF, Date 09May2018	04	Minister, Ministry of Agriculture and forestry
Established project steering committee, project coordinator and financial responsibility for GFLL	No 1365/MAF, Date 29 Oct 2021	18	Minister, Ministry of Agriculture and forestry

Established project Coordinator, Huaphan province	No 159/PAFO, Date 24 Jan 2022	03	PAFO
Established project steering committee, project coordinator for GFLL, Oudomxay province	No 604/PAFO, Date 20 April 2022	06	PAFO
Established project steering committee, project coordinator for GFLL, REDD Oudomxay province	No 783/PG, Date 14 March 2017	17	Provincial Governor (PG)
Established project steering committee, project coordinator for GFLL, Luangprabang province	No 298/PAFO, Date 15 Feb 2022	05	PAFO
Established project steering committee, project coordinator for GFLL, REDD Luangprabang	No 308/PG, Date 02 Sep 2021	34	Provincial Governor
Established project coordinator for GFLL Luangprabang province	No 381/PAFO, Date 01 March 2021	01	PAFO
Established project steering committee, project coordinator for GFLL, Bokeo province	No 475/PAFO, Date 11 April 2022	09	PAFO
Established project steering committee, project coordinator for GFLL, Bokeo province	No 192/PG, Date 03 April 2017	15	Provincial Governor (PG)
Established project steering committee, project coordinator for GFLL, Sayboury province	No 693/PG, Date 14 Feb 2017	07	Provincial Governor (PG)

3.3 Describe the supervision and oversight arrangements to ensure that the Safeguards Plans and, if any, subsequent environmental and social documents prepared during Program implementation are implemented. Are these supervision and oversight arrangements effective (e.g., provide meaningful feedback mechanism to implementing entities to allow for corrective actions)?

This section is intentionally left blank since the GFLL activities have not been started yet. However, GFLL has a Monitoring and reporting system including a feedback grievance mechanism (FGRM) described in detail in the section 4 of project implementation manual (POM), GCF supervision, and World Bank mission to supervision project.

4 Program activities present emerging environmental and social risks and impacts not identified or anticipated in the Safeguard Plans prepared prior to ERPA signature.

4.1 Is the scope of potential risks and impacts identified during the SESA process continue to be relevant to ER Program activities?

The scope of potential risks and impacts found in the SESA document will be effectively measured once the GFLL activities start.

4.2 During implementation, has any ER Program activities led to risks or impacts that were not previously identified in those Safeguard Plans prepared prior to ERPA signature? If so, what are the proposed actions to manage such risks and impacts that were not anticipated previously?

This section is intentionally left blank since the GFLL activities have not been started yet.

5. Corrective actions and improvements needed to enhance the effectiveness of the Safeguards Plans.

5.1 Provide a self-assessment of the overall implementation of the Safeguards Plans

Confirmed. See Table 6 above.

5.2 List any corrective actions and areas for improvements. Take care to distinguish between: (i) corrective actions to ensure compliance with the Safeguards Plans; and (ii) improvements needed in response to unanticipated risks and impacts

The Implementation of safeguard Action Plan (CAP)table 8 below shows the progress of Implementation safeguard work plan:

Table 8. Implementation Action Plan on Safeguards Plans

SN	Activities	Deliverable	Action for improvement
1	**SAFEGUARDS DUE DILIGENCE**		
1,1	Preparation of draft report and submission to WB	Draft report	Completed
1,2	Share final report with DPs for endorsement	Final report	Completed
1,3	Submission of final report to the World Bank	Final report	Completed
1,4	Due Diligence Clearance by the World Bank	Final report	Completed
1.5	Disclosure of report by DoF/MAF and WB	Disclosed report	Completed
2	**SAFEGUARDS INFORMATION SYSTEM**		
2,1	SIS Technical Document		
2.1.1	Prepare draft SIS Technical Document	Draft English	Completed
2.1.2	Translate English SIS document into Lao	Draft Lao	Completed, need to be finalize and endorse

2.1.3	Consultation on SIS document with Safeguards TWG	Consultation report	Completed
2.1.4	Prepare final SIS Technical Document and obtain endorsement from DoF	Final SIS Document	Completed
2,2	SIS Operational Manual		
2.2.1	Development of SIS Manual	Draft Manual	Completed
2.2.2	Consultation on SIS Manual with Safeguards TWG	Consultation report	Completed
2.2.3	Prepare final SIS Manual and obtain endorsement from DoF	Final Manual	Completed
3	**SAFEGUARDS AND SESU CAPACITY BUILDING**		
3,1	Safeguard's capacity building	Training report	
3.1.1	Develop capacity building approach / Safeguard Technical Guidebook and plan	Safeguards Training Guidebook	Fully completed and approved by WB, but need to be provide more specific training, provided on the job training
3.1.2	Design capacity building workshop and training material/presentations	Workshop design and material	Fully completed, and IEC Material need to be produced (e.g communication tools, Poster, Video, Pamphlet)
3.1.3	Conduct capacity building workshops	Workshop report	Planned for July 2023
3,2	SESU capacity building	Workshop report	Planned for July 2023
3.2.1	Utilize SIS manual to design workshop/material	Workshop design material	Fully completed, SIS manual has been approved
3.2.2	Consultation to receive feedback on workshop design and material	Plan for database	Conduct after draft of training material has been prepare
3.2.3	Conduct capacity building workshop	Workshop report	After finalize tools and training material
3.2.4	Post training follow up and report	Workshop report	
4	**SAFEGUARDS OPERATIONS**		
4,1	**SOCIAL SAFEGUARDS**		
4.1.1	EGDP - Ethnic Group Development Plans	Training report	Provided specific training, on the job training
4.1.1.1	Data collection through primary research and field visits; and consultations	Consultation report	Prepared concept notes for the whole assessment, Tools, questionnaire form, Methodology, analysis, and outline for SMP including EGDP
4.1.1.2	Prepare EGDPs for six provinces	Draft 6 EGDP	Outline of EGDP/Draft, Consultation workshop with stakeholder, feedback, and NOL
4.1.2	GAP - Gender Action Plans	Draft GAP	Outline of EGDP/Draft, Consultation workshop with stakeholder, feedback, and NOL
4.1.2.1	Data collection through primary research and field visits; and consultations	Consultation report	Prepared concept notes for the whole assessment, Tools, questionnaire form, Methodology, analysis, and outline for SMP including GAP

4.1.2.2	Prepare Gender Action Plans for six provinces	6 Draft GAP	Outline of EGDP/Draft, Consultation workshop with stakeholder, feedback, and NOL
4.1.3	RPF - Resettlement Policy Framework	Draft RAP	Prepared concept notes for the whole assessment, Tools, questionnaire form, Methodology, analysis, and outline for SMP including RAP
4.1.3.1	Identification and category of civil work sub-projects (new irrigation or maintenance of existing irrigation systems and establishment of additional paddy fields) for RPF disclosure (extraction of vital clauses)	Draft ESMP	Sub-Project screening and checklist, EIA, IEE, ECOP, and prepare ESMP, PSC plan
4.1.3.2	Prepare text of vital clauses for RPF	**TBD**	
4.1.3.3	Conduct the first consultation and disclose the RPF, announcement of Cut off-Dates in the infrastructure sub-project areas, produce Minutes of consultation, list of participants and keep filing	List completed of checklist safeguard supporting document	Prepare tools, Set of document packages and Database system
4.1.4	Assessment and Screening for Civil Works	Screening checklist for Civil Works	DDR (SMR/EMR) monitoring report need to be provided
4.1.4.1	Social impact assessment/screening for infrastructure or civil works sub-projects in six provinces based annual work plan	Draft DDR Report and Completed screening form	Prepared concept notes for the whole assessment, Tools, questionnaire form, Methodology, analysis, and outline mitigate measure
4.1.4.2	Local authority prepares cut off-dates for infrastructure or civil works sub-project areas	Minute consultation,	Prepare supporting document
4,2	**ENVIRONMENTAL SAFEGUARDS**		
4.2.1	Environmental Impact Assessment and Screening	Draft DDR Report and Completed screening form	Prepared concept notes for the whole assessment, Tools, questionnaire form, Methodology, analysis, and outline mitigate measure
4.2.2.1	Environmental impact assessment and screening for infrastructure and civil works sub-projects in six provinces	RRD Report	EIA, IEE, COPE assessment and prepare management plan.
4.2.2.2	Training on environmental impact assessment and monitoring	Training report	Provide training, coaching, on the job training, and supervision,
4.2.2	EMP - Environmental Management Plans	Draft EMP	
4.2.2.1	Prepare EMPs for six provinces	EMP Report	Outline of EGDP/Draft, Consultation workshop with stakeholder, feedback, and NOL
4.2.2.1	EMP monitoring and management framework	Draft EMP	Conduct TWG consultation for Draft Guidelines
4.2.3	Pest Management Guidelines		
4.2.3.1	Prepare pest management guidelines	Draft guideline	
5.	**FGRM, what needs to be done.**		

5.1	Establish GRM Committee, role and responsibility	Agreement and report	GFLL Project management Unit requested to line agency/or update existing responsibility
5.1.1	Provide TOT Training for FGRM/Conflict Management solution	FGRM Monitoring report	Preparing GRM Recording system and provide training for P-SESU, D-SESU Team, Implementation FGRM and re
5.1.2	Conduct training/on the job training GRM/Conflict Management solution for VMU.	Training report	The training session or field supervision should be included this topic
5.1.2	Monitoring and supervised FGRM	Monitoring report	A Feedback Grievance Redress Mechanism has been prepared by FCPF to manage complaints and address issues related to the development of the GFLL project, which includes the principles and process of how to file a complaint. The government of Lao also has a system to resolve complaints, issues and conflicts from the village level up the national, involving courts and the National Assembly. Additionally, a detailed Feedback Grievance Redress Mechanism has been included in Safeguards Training Guidebook and therefore the project will consult during stakeholder consultation at community level, when and if there is a complaint or concern raised by the stakeholders and villagers.

5.3 Describe the timeline to carry out the corrective actions and improves identified above.

This section is intentionally left blank since the GFLL activities have not been started yet. The corrective actions will be carried out once GFLL activities are implemented.

ANNEX 2: INFORMATION ON THE IMPLEMENTATION OF THE BENEFIT-SHARING PLAN

I. Requirements of FCPF on Benefit Sharing Plans

The Final BSP for the ER Program was approved by the Carbon Fund in September 2021. The conditions of effectiveness for the ERPA transfer and payment provisions were met. Under the ERPA, three disbursed will be made by the Carbon fund – an Upfront Advance Payment received in July 2022 to fund program operational costs, and two results-based payments in 2023 and 2025 for verified ERs.

II. Monitoring and Reporting Requirements

1. Benefit Sharing Plan Readiness

1.1 Confirm that the BSP has been completed and endorsed by all relevant parties. Are there any aspects of the BSP which remain unclear or require further review of endorsement by beneficiaries or other stakeholders? Has the BSP been made publicly available?

Confirmed. The BSP document has been approved and endorsed by the Government of Lao. The document is available for the public (http://dof.maf.gov.la/en/gfll-governance-forest-landscapes-and-livelihoods-northern-laos-benefit-sharing-plan-final/ and on the World Bank website).

Documents that are most relevant to the implementation of BSP are the Project Operational Manual[29] (POM), Financial Management Manual[30], and Procurement Manual[31]. The POM and Procurement Manual are already approved by the World Bank. The Financial Management Manual (FMM) is completed and is being reviewed by the World Bank.

Modality for Financial Management

The FCPF Readiness Grant financial management arrangements will be used as the default modality for receiving and disbursing the upfront advance and ER payments. The advance payment was transferred from the World Bank/Carbon Fund to the designated account at the Bank of Lao PDR/BoL (MoF) on 30 June 2022. The Department of Forestry (DOF), through the REDD+ Division, will subsequently request a transfer of the funds from the BoL through custodian banks to beneficiaries based on approved workplans and budget requests. The payment process from the BoL to beneficiaries will take up to two weeks – based on FCPF's Readiness experience disbursing the funds to PAFOs (see Figure 1). To date, USD 250,000 has been transferred to DOF for operational expenses.

[29] https://docs.google.com/document/d/15JJ1r1rfeZQCrI5EFJ7b18x3u06LRPZq/edit?usp=sharing&ouid=101725422399758171423&rtpof=true&sd=true

[30] https://docs.google.com/document/d/1fvEUdL_D6gabZM9gYjFAHc9IJmJ1LlNu/edit?usp=sharing&ouid=101725422399758171423&rtpof=true&sd=true

[31] https://drive.google.com/drive/folders/1ITG-3BpGTml2CbvrozDDggCy9H5v5oWQ?usp=sharing

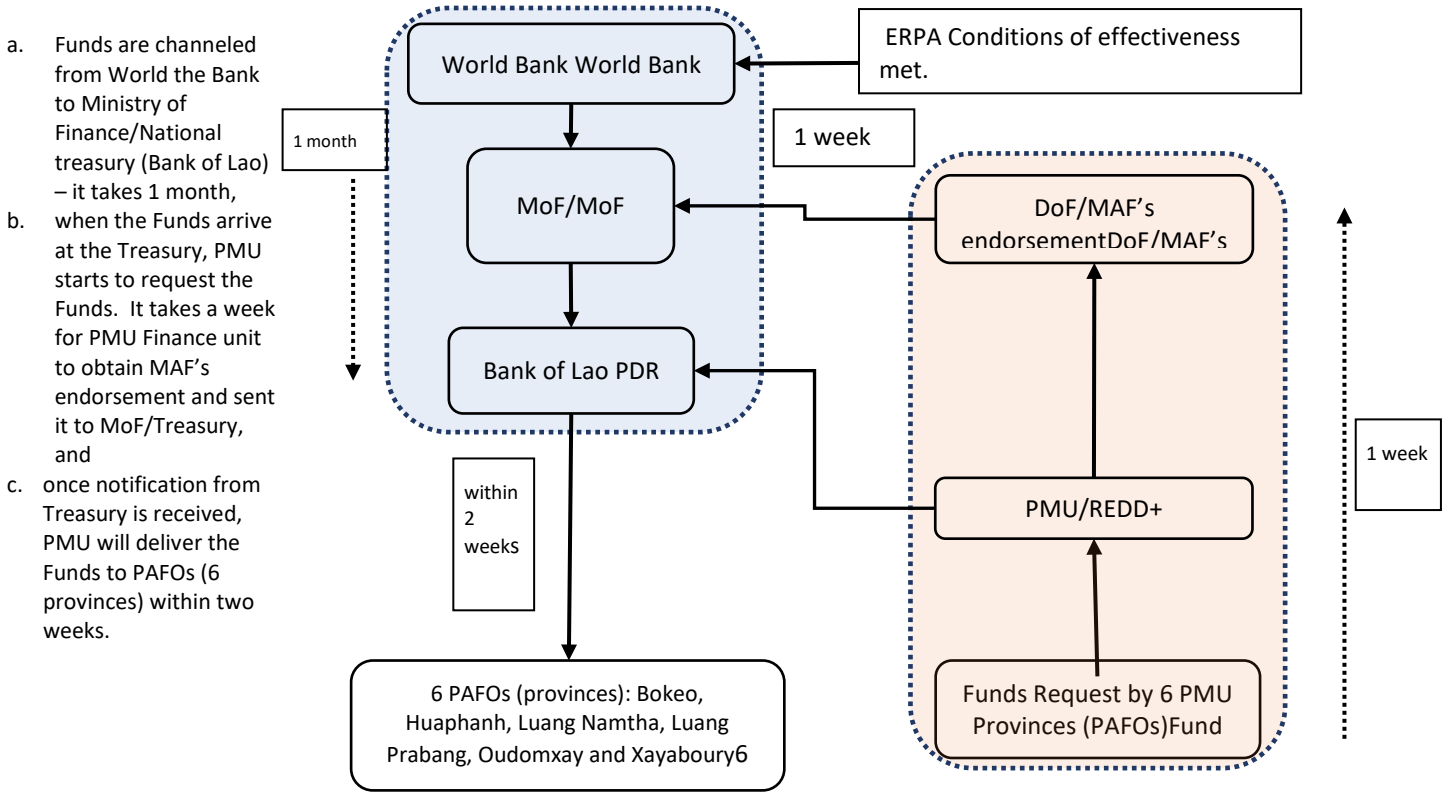


Figure 8. Arrangement for Management of Advance Payment for Operational Costs

Communities as the main recipient of ERPA: 90% of net performance-based payments

As mentioned in BSP document, 90% of net performance-based payments from the Carbon Fund is allocated for communities, whereas 5% is allocated for sub-national government agencies as incentives, and the other 5% is allocated for pilot initiatives. See Figure 2.

Participants in pilot initiatives includes private companies, Civil Society Organizations (CSOs) or known as Non-profit Association (NpA), and Education/Research Institutions to enable their direct participation in ER activities. The selection of the participants will be based on the submission of proposals that meet the agreed set of assessment criterion[32]. There will be a call for proposals for pilot initiatives three months after the first ER payment is received.

The criteria for the prioritization and selection of villages to receive benefits under the BSP for the GFLL has been consulted and finalized. The criteria for village selection for

[32] https://drive.google.com/file/d/1Q3UPRLRjj84UGQ8ReiBYytYvEnI4_JjF/view?usp=sharing

consultations with Provincial/District Agriculture and Forest Offices (P/DAFOs), Development Partners (DPs), Civil Social Organizations (CSOs) have been agreed by the selection criteria on August 27, 2022; followed by consultation and agreement on the determination of districts and village prioritization what was done on September 27, 2022.

PAFOs and DAFOs from the targeted 6 provinces and 18 districts for GFLL ER Program have proposed prioritization of 309 villages of which 253 villages have been prioritized based on the village selection criteria. The other 56 villages are kept under the backup reserve list. If during the FPIC process any of the 253 prioritized villages opt not to participate in the GFLL activities, new villages will be incorporated from the backup reserve list. Confirmation for those villages to participate in the program will be done through the Free Prior Inform Consent (FPIC) process. The FPIC process was been started since November onwards. Training of Trainers for FPIC Facilitators was conducted on 12-21 October 2022. The final list of villages to participation in the GFLL Program will be completed in October/November 2023 after completion of FPIC-2 processes in all of the prioritized villages.

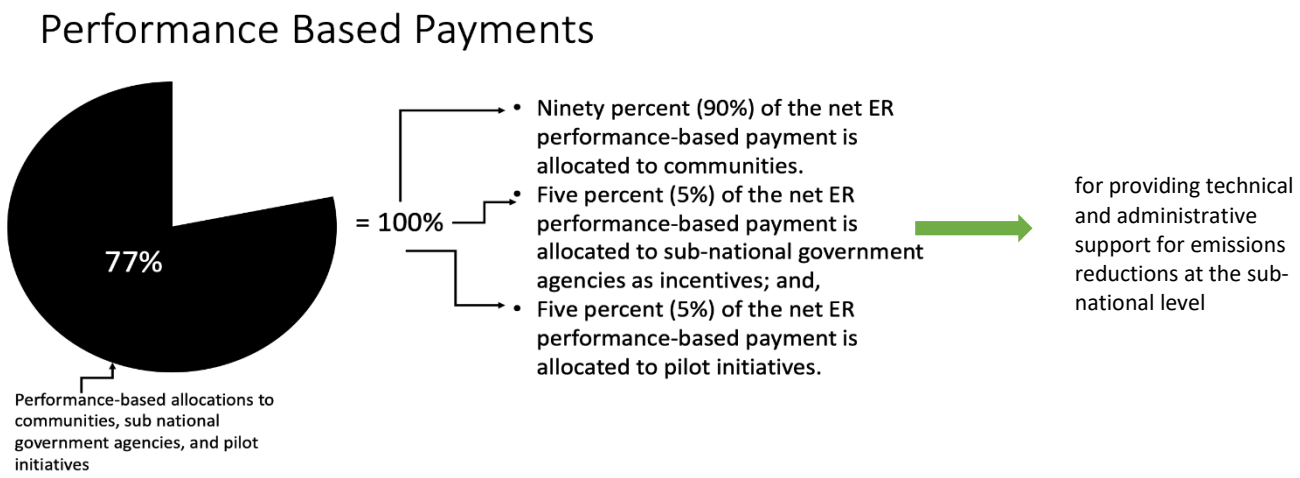


Figure 9. Allocation of Performance Based Payments

The total benefits received by communities will depend on the result of total GFLL's ER performance (preliminary estimation is 3.4 MCO2e ERs for the period 2019-2021). At sub-national level, Provincial Project Management Unit (PPMU) is supported by the PAFOs to facilitate and guide the implementation of ER program. However, it is not possible for benefits to be distributed to all villages or for one PAFO to engage with all villages in the province. PAFOs will prioritize villages that will be considered as recipients from the ER program. The criteria are built on inputs or lessons learned from other projects and relevant stakeholders such as PAFOs/DAFOs, DoF, I-GFLL/CliPAD and VFMP/KfW project. The criteria of priority villages are in line with the approach set out in the Final BSP [33] (by providing benefits to villages based on ER activities and also incentivizing

[33] http://dof.maf.gov.la/en/gfll-governance-forest-landscapes-and-livelihoods-northern-laos-benefit-sharing-plan-final/

communities to participate in activities that will lead to additional or sustained ERs in the future), [3 4], and inputs from the recent World Bank mission in Luang Prabang in July 2022.

The GFLL, on the other hand, will cover around 500 villages in about 30 districts, if the ER payment is as large as defined in ERPA. The GFLL might have the same districts with other existing projects. For the villages under Project 1 of I-GFLL, LENS 2, or LLL project, which require continued support to sustain results, the GFLL may also support those villages depending on the payment amount available and prioritization. The village selection criteria may need to be revised for the second ER payment, to accommodate lessons learned and program implementation, as needed. For example, to incentivize other sectors, actors (such as those in remote areas) to participate in ERs or reforestation activities to ensure the sustainability of program interventions across the landscape.

As noted, the process of village acceptance to participate to GFLL project is determined FPIC. The FPIC process is conducted after the selection criteria for priority villages is completed and consulted with the PAFOs/DAFOs and the list of potential villages to be part of the GFLL projects is produced. The criteria for village selection was approved by REDD+ Division and the selection was conducted in October 2022. The first FPIC process was conducted between November and December 2022 in order to consult with eligible villages on the scope and requirements for receiving benefits under the BSP. The FPIC process will continue in October 2023 (Figure 3) and expected to conclude in December 2023. However, it may be necessary to adjust these timelines once there is clarity of timelines regarding the verification of the first ERMR and subsequent payment.

The advance payment was delivered on 30 June 2022. The funds are used to finance operational costs of national and sub-national government agencies, include VDCs. The funds for VDCs' operational costs will be delivered after the FPIC processes are completed. The training on workplan preparation and budget request at all levels and agencies will be conducted from October to December 2023. The workplans and proposed budgets for 2024/2025 from beneficiaries will be submitted from April to September 2024. Then, the delivery of benefits to beneficiaries from the first ER Payment will be done from September to December 2024 (See Figure 4).

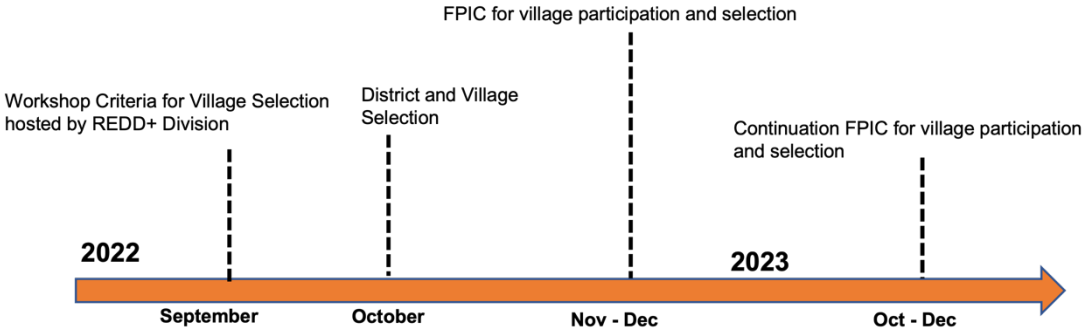


Figure 10. Timeline for Village Selection and FPIC (2022)

[3 4] https://docs.google.com/document/d/1ObfBHGgvRNYpPj1Z7-arWnRT4sBPvbp-/edit?usp=sharing&ouid=101725422399758171423&rtpof=true&sd=true

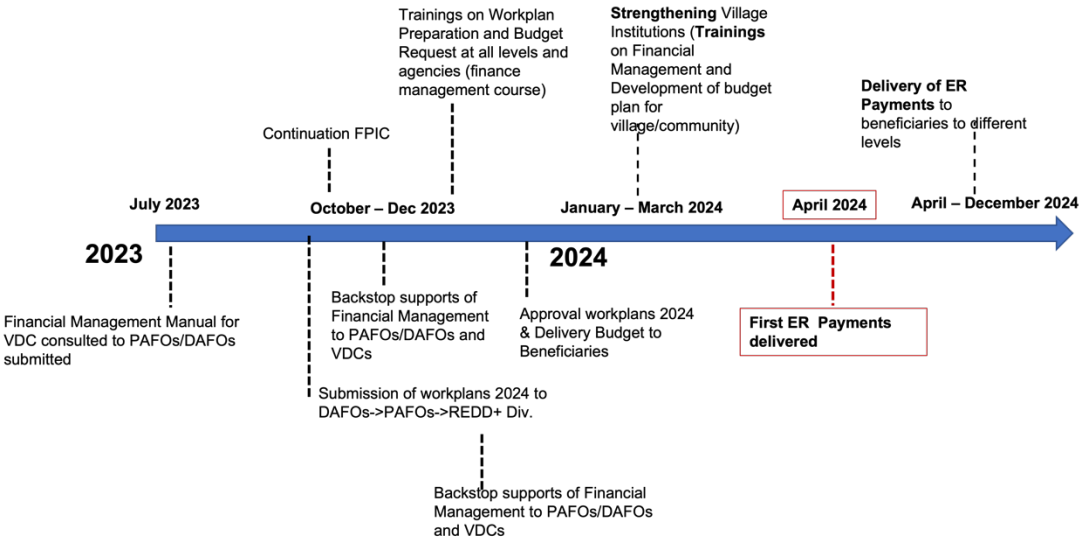


Figure 11. Timeline BSP and Capacity Building on Finance Management (2023)

Data for village profile will be collected through secondary means including collection for Safeguards and Monitoring and Evaluation data during the community engagement processes started in early October 2023. Once data collection including social, economy, and environmental data of the villages is conducted, the district team (DAFO/PAFO, LWU, and LNFD) will start to facilitate the development of community action plans (CAPs) scheduled in the fourth quarter of 2023. Mapping or review of village institutions will be conducted in November/December 2023 as well. The CAP is expected to finalize by end of December 2023. The safeguards plans based on CAP will be determined by end of December 2023 (Figure 5).

In order to strengthen village institutions in financial management for the implementation of CAP, training on financial management and development of budget plans for community/village will be conducted in January – March 2024. The REDD+ Division is expected to receive full proposals from VDCs or DAFOs in April - September 2024 (see Figure 5).

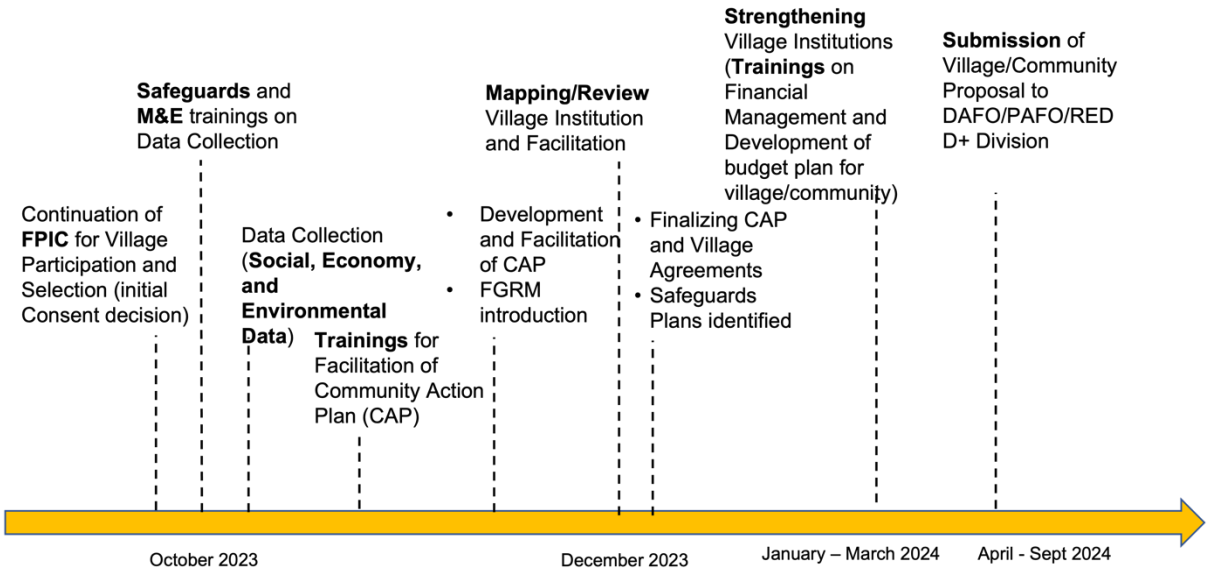


Figure 12. Community Engagement Plan for BSP

1.2 In cases where capacity building initiatives have been included as part of the BSP, confirm whether the Program Entity has completed required capacity building measures to ensure system effectiveness. What other measures are still outstanding?

The GoL has began conducting capacity building related to the BSP on financial management and procurement. Training was provided to financial and procurement staff from PAFOs and FPF in June 2022 and November 2022. This training is continuous through on the job training to increase the capacity to meet the World Bank fiduciary standards. Current FM staffing arrangements, including consultant support, will be maintained throughout implementation period. The second advanced finance management training and procurement was conducted in January 2023. The agenda and items for continued capacity building as described in the POM are presented as follows (Table 1):

Table 22. Capacity Building Plan

Thematic Area	Capacity building priorities	Target group	Timeline
Project management	▪ Planning process, developing work plans and budgets ▪ Progress monitoring, use of reporting formats ▪ Develop and consolidate progress reports ▪ Use of computerized M&E system (if necessary)	▪ Members of PMUs all levels	Feb – May 2023 (project work plans and budgets completed)
Benefit sharing and distribution/ financial management	▪ Internal organization and procedures ▪ Benefit sharing, payment scenarios/ calculation	▪ FPF; REDD Division and PMU/ finance staff all levels	The first batch of training on financial management and procurement has been done in June 2022.

Thematic Area	Capacity building priorities	Target group	Timeline
	▪ Fund flow and disbursement set-up ▪ Accounting policies and procedures ▪ Use of FMIS, accounting software and Excel ▪ Budgeting, budget requests and replenishment ▪ Reconciliation and financial reporting ▪ Asset management, filing and data security ▪ Internal control, external audit preparation		The second batch was done in January 2023. PAFOs/DAFOs have received their operational costs to implement FPIC processes. Procurement process of FMIS software has been purchased in June 2023. The project database is being developed and expected to complete in September 2023. Backstop supports will be provided by REDD+ Division every three months to ensure the implementation of financial management.
Procurement	▪ Procurement plan development ▪ Categories and documents ▪ Processes - bidding, evaluation, contracting, contract monitoring ▪ Documentation, monitoring and filing	▪ REDD Division/ procurement staff and PMU sub-national/ procurement staff	The first batch of training on financial management and procurement was done in June 2022. The second batch was done in January 2023.
Village level activities	▪ Consultation, feedback, grievance redress (FGRM) ▪ Participatory land use planning (PLUP) ▪ Community action planning (CAP) ▪ Village forest management planning (VFMP) ▪ Village forest management implementation (patrolling, fire control, forest rehabilitation, nursery techniques) ▪ Good agricultural practices/ livelihood (improved livestock, agroforestry, improved systems/ conservation agriculture, NTFPs) ▪ Village fund mechanism (account set up, by-laws, grant management/ disbursement, reporting) ▪ Monitoring and reporting	▪ SESU/DAFO/ DoNRE staff, organizations (LNFD, LWU), VDC/ unit members, villagers, user groups	July – December 2023 Backstop support will be provided by REDD+ Division every three months to ensure the implementation of financial management.

1.3 Where relevant, confirm whether any agreed changes to the benefit sharing arrangement identified during the previous reporting period have been completed.

As this is the first Reporting Period ER Monitoring Report, and payments are pending completion of validation and verification, this section has been left intentionally blank. Information will be included in the ER Monitoring Report for the subsequent Reporting Period.

2. Institutional Arrangements

2.1 Confirm that the agreed institutional arrangements under the BSP are in place and that implementing entities are appropriately resourced to carry out their respective responsibilities.

Confirmed. The readiness grant (to June 2022) and Advance Payment (from July 2022) provided adequate resources to implementing entities to carry out their respective responsibilities.

Department of Forestry (DoF) plays a key role in ensuring coordination and communication between and within key relevant institutions takes place. REDD+ Division as National PMU has regularly updated the REDD+ Task Force and other technical working groups (decision making bodies) on the progress of GFLL[35]. REDD+ Division as fund manager has a key role in ensuring funds are disbursed to beneficiaries for supporting their operational costs, including the reporting of financial expenses and technical issues to the Division. The REDD+ Division has provided guidance and support to PAFOs including DAFOs on the use of the finance management manual and procurement manual through training on 8-9 June 2022 in Vientiane Province. In addition, the REDD+ Division has committed to provide backstop support to the implementation of financial management and procurement to PAFOs/DAFOs and village institutions every three months.

For the advance payment, the fund is being managed by the REDD+ Division. The capacity building related to financial management and procurement is part of fiduciary requirements as started and will continue until 2023, including capacity building for VDCs. See point 1.1 and 1.2 above.

2.2 Confirm that any regulatory or administrative approvals required for implementing the BSP have been obtained.

Confirmed. For advance payment, any regulatory approval is based on existing government policies and regulations. This includes administrative approval (such as appointment of staff responsible for fund disbursement).

Once emission reductions are verified and the ER monitoring report is accepted, the ER payments from the Carbon Fund will be channelled through to the Bank of Lao (BoL) through the Ministry of Finance (MoF).

[35] The latest National REDD+ Task Force was done on 22 December 2021. The presentation for NRT is here

Since Department of Forestry (DoF) has experienced as fund manager under FCPF Readiness grant, then the disbursement of ER payments to different levels will be under the responsibility of DoF´s REDD+ Division. The DoF will subsequently request a transfer of the funds from the BoL through custodian banks to beneficiaries based on approved workplans and budget requests. The workplans and budgets will have to be approved by the MAF.

2.3 Assess whether all BSP stakeholders (beneficiaries and administrators) clearly understand their obligations, roles and responsibilities associated with the BSP. This assessment could be based on, for example, findings and feedback received during field implementation support missions, during interviews with beneficiaries, issues raised through public consultation meetings, beneficiary monitoring or grievance mechanisms.

Roles and responsibilities associated with the BSP have been introduced and discussed in the trainings for the appointed staff from REDD+ Division, PAFOs, FPF, and VDCs during interim and inception phase. The latest training on financial management and procurement was done on 8-9 June 2022 and January 2023. The report of training can be found here. The prioritization and selection of villages to receive benefits under BSP for the GFLL has been completed. The consultations and agreement were based on the determination of districts and village prioritization (September 2022), followed by FPIC processes in prioritized villages in November - December 2022 and to be continued in October 2023. During FPIC processes in 2022, ER program activities were introduced including types of benefits for villages if they agreed to participate the Program. During the next phase of the FPIC process, more comprehensive consultation, and dissemination of information about GFLL activities, possible negative and positive impact will be determined in each of the 253 prioritized village and decision of communities to participate the Program will be confirmed after the next phase of FPIC.

2.4 Confirm that a system is in place for recording the distribution of benefits and associated obligations to eligible beneficiaries. For example, are payment information systems, payment tracking and monitoring systems, bank accounts, accounting and financial control mechanisms, and payment modalities in place and functional?

Confirmed. At the national level, the current system for fund disbursement is based on the existing finance management of the REDD+ Division that has experience in disbursing funds to PAFOs. FM procedures and funds flow mechanism used at DOF for the FCPF Readiness grant are adequate to handle the advance payment. The financial management manual for GFLL implementation was developed based on the FCPF readiness grant approach the it is adequate has been reviewed by the WB.

The Procurement Manual [36] has been approved by the World Bank and endorsed by the GoL, whereas the Financial Management Manual [37] is completed and has been cleared by the World Bank. The trainings for both manuals were conducted on 8 – 9 June 2022 and January

[36] https://drive.google.com/drive/folders/1ITG-3BpGTml2CbvrozDDggCy9H5v5oWQ?usp=sharing

[37] https://docs.google.com/document/d/1fvEUdL_D6gabZM9gYjFAHc9IJmJ1LlNu/edit?usp=sharing&ouid=101725422399758171423&rtpof=true&sd=true

2023 in Vientiane Province. It is expected that by end of 2023 those management systems are in place and functional, specifically on accounting, budgeting, reporting, documenting, filling, and monitoring system.

Systems at the province/district/village level will be established as part of the program of work in 2023, following village selection.

Based on the WB mission 20-24 Feb 2023, the finance management of REDD+ Division is adequate enough to receive and manage the first ER Payment.

2.5 Confirm that agreed accountability mechanisms are in place and functional (e.g., stakeholder participation arrangements; agreed public information disclosure procedures; independent third party monitoring and or performance audit mechanisms; dispute resolution and grievance redress mechanisms)

Confirmed. The accountability mechanism for BSP will be based on the existing government policies and regulations. As fund manager, the REDD+ Division will be audited annually by the State Audit Organization or an independent auditor. In the event that an offense is found, the relevant laws of the Lao PDR (Article 17, Government Decree. No.567/Gov) will apply.

Engagement of stakeholders to participate the Program is ensured through stakeholder consultations with PAFOs/DAFOs/Villages from the six provinces based on approved safeguards processes that include a well-defined FPIC framework. Feedback and input from stakeholders are taken into account as consideration for policy decision making by DoF/REDD+ Division. The agreed policy is then published into DoF's website (dof.maf.gov.la) as a part of public information disclosure procedures.

2.6 Confirm that the Feedback and Grievance Redress Mechanisms (FGRM) is functional to record and address feedback and grievances related to the implementation of the BSP. Confirm the number and types of grievance received and submitted to the FGRM and how and whether they were addressed.

Progressing. The Feedback and Grievance Redress Mechanism (FGRM) framework for GFLL has been established. The FRGM is described in the environmental and social management framework (ESMF) of the GFLL and based on the existing system and legislation in Laos. One staff from REDD+ Division has been appointed to oversee the FGRM. The person is equipped with a mobile phone connected to WhatsApp number (+856 20 9966 2977) for FGRM and a dedicated email fgrm.gfll@gmail.com to receive public grievances. The draft manual for the FGRM on reporting, recording, and tracking grievance has been prepared. The manual has been sent to the World Bank. The comments from the World Bank to the manual are being addressed. The final manual will be ready by May 2023. One dedicated focal point staff at central level and 1 dedicated staff in each of the 6 target provinces has been assigned to handle the FGRM. Since the result-based payment has not been delivered, no grievances have been received related to the distribution of benefits. However, the other similar projects (LENS2, CliPAD IV/I-GFLL, ICBF, and VFMP/KfW) have grievance mechanisms in place. Please see Annex 1 on Safeguards (Table 5, section 2.2) for the implementation of grievance mechanisms in the six northern provinces.

2.7 Confirm that adequate human and financial resources have been allocated or maintained for implementing the BSP.

A full team of national stuff and national and international specialist consultants has been recruited to support all the thematic areas of the program (BSP, MRV, Safeguards, Monitoring and Evaluation, Financial Management and reporting. The consulting team is supported by technical specialists provided by development partners for the duration of the program (end of 2025). Adequate financial resources have been made available for BSP implementation as outlined in Table 2 below. The current allocation and progress of advance payment to BSP implementation is as follows:

Table 23. Allocated Funds for BSP Implementation and Progress as of 2022

PROJECT COMPONENTS	Progress 2022*	Total (USD)
PROJECT MANAGEMENT		**1.815.700**
PMU National		**954.330**
Management and Support Staff	*Partly recruited*	*493.630*
Capital expenses	*In process*	*190.000*
Recurring costs	*In process*	*270.700*
PMU Province		**861.370**
Management and Support Staff	*Recruited*	*144.000*
Capital expenses	*In process*	*450.000*
Recurring costs	*In process*	*267.370*
TECHNICAL SUPPORT		**1.184.300**
Natural Resource Management	*In process*	**244.800**
Safeguards Management	*Recruited*	**168.000**
Measurement, Reporting and Verification/GIS Specialist	*Recruited*	**189.500**
Capacity Building	*In process*	**270.000**
Forest Protection Fund Strengthening	*In process*	**312.000**
Total (USD)		***3.000.000***

Note: * as of December 2022.

3. Status of Benefit Distribution

3.1 Summarize the distribution of all monetary and non-monetary benefits during the reporting period.

During the first reporting period, no ER payments were received.

The upfront advance payment is being used to cover government agencies' operating costs at the national, provincial and district levels. As already indicated, the criteria for village selection have been completed and consulted with PAFOs/DAFOs.. The advance payment for operational costs such as for FPIC Processes have been disbursed to PAFOs/DAFOs since end of October 2022. The REDD+ Division disburses funds to PAFOs/DAFOs based on preparation of proposals for FPIC processes and in line with existing government standards' policies. The disbursement of funds for VDC operational costs will be conducted once the Community Action Plans (CAP) are completed. The operational costs here are considered as monetary benefits. The CAPs are scheduled to be started in October - December 2023 as illustrated in Figure 5.

3.2 Indicate in a table format the number and type of beneficiaries who received benefits during the reporting period (examples of tables to be used and expanded upon below). The tables should include information on:

- *the type of benefits distributed, including monetary or non-monetary benefits*
- *the criteria for distributing the benefits*
- *the processes and timeline for distributing the benefits (e.g., whether the benefits are distributed one-time or continuous/periodic)*
- *who the beneficiaries are, including a break-down of the beneficiaries by gender, civil society organizations (CSOs), Indigenous Peoples, and local communities.*
- *any specific agreements signed with the beneficiaries for them to receive the benefits, and the key terms of such agreements*

During the first reporting report, no ER payments were received. The allocated benefits to intended beneficiaries under the advance payment is as follows:

Table 24. Allocated Benefits of Advance Payment for intended Beneficiaries

No	Beneficiaries	Benefits	Criteria	Process and Timeline
1	National Government Agencies	**Monetary benefits** for covering operational costs, defined as expenditures related to the technical support (e.g., MRV, safeguards) and administrative and financial management of the ER Program, and coordination across sectors between and within line ministries and agencies. **Non-monetary benefits** in capacity building in financial management systems for the ER Program, strengthening institution for ER project management.	As defined in BSP document (Table 4)	30 June 2022 USD 250,000 has been transferred to DoF.

No	Beneficiaries	Benefits	Criteria	Process and Timeline
2	Sub-National Agencies (Six Provinces, number of districts will be determined after the land use change analysis come out)	**Monetary benefits** for covering operational costs in relation to implementation of ER activities at field levels. This includes facilitation of VDCs on financial management, development of workplan, and budget. **Non-monetary benefits** in capacity building in financial management systems for the ER Program at sub-national level (PAFOs/DAFOs), strengthening institutions for ER project management.	As defined in BSP document (Table 4)	December 2022 – January 2023 USD 20,000 per province has been transferred in October 2022.
3	Community Level Organizations (Number of villages will be updated after the criteria of village selection is done)	**Monetary Benefits** for covering Operational costs for the Village Development Committee**.** **Non-monetary benefits** for covering trainings in managing funding for community, developing annual workplan, and budgeting, including other activities supporting to ER program such as forest land use planning, patrolling, land titling, and transfer knowledge and information sharing.	As defined in BSP document (Table 5)	December 2022 – January 2023
4	Private Sector	As defined in BPS document (Table 7)	As defined in BSP document (Table 6)	Not Applicable for Advance Payment
5	NpAS/CSOs			Not Applicable for Advance Payment
6	Research Institutions			Not Applicable for Advance Payment

3.3 Do beneficiaries receive adequate implementation support to assist in the management and use of benefits distributed to them?

During the first reporting report, no ER payments were received.

For the advance payment, PAFOs obtained implementation support from the REDD+ Division on Financial Management and Procurement (training in June 2022, in Vientiane Province). The additional training for workplan preparation and budget request from beneficiaries (PAFOs/DAFOs/VDCs) will be conducted from July to December 2023 (See Figure 5).

3.4 Describe and assess the effectiveness of the mechanisms for ensuring transparency and accountability during the implementation of the BSP, such as participatory monitoring by beneficiaries.

As mentioned at para 1.3, this is the first Monitoring Period report, and payments are pending completion of validation and verification. The program will create a participatory monitoring

system and strong FGRM to ensure transparency and accountability during the implementation of the BSP. The information will be included in the ER Monitoring Report for the subsequent Reporting Period.
To avoid mismanagement or inefficient use of the advance payment, backstopping support will be provided to PAFOs/DAFOs and VDCs on finance management and procurement every quarter (see Figure 4). The backstopping support includes monitoring and evaluation of the financial management operated by PAFOs/DAFOs and VDCs. The backstopping support will be provided by the finance unit under the REDD+ Division.

3.5 Assess whether Benefit Sharing distributions continue to be relevant to core objectives and legitimacy of the ER Program objectives (e.g., benefit sharing is considered equitable and effective; seeks active participation of recipients; is respectful of customary land rights; enjoys broad community support of Indigenous People; benefit distributions incentivize adoption of emission reduction measures, among others).

As mentioned at para 1.3, this is the first Monitoring report, and payments are pending completion of validation and verification. The Project will ensure effective sharing of benefits in line with the BSP. Active participation of recipients will be guaranteed through effective FPIC processes, respect for customary land rights of the community through the PLUP processes. A pipeline project called Enhancing Access to Benefits while Reducing Emissions (EnABLE) is expected to further support the implementation of the BSP focusing on selection of ethnic communities that will require support to effectively participate in the ER program. This complements the ER Program focus to target Indigenous Ethnic People and gender participation in benefit distributions and to incentivize adoption of emission reduction measures. The information will be included in the ERMR for the subsequent Reporting Period.

3.6 Describe the mechanisms that are in place to verify how benefits are used and whether those payments provide sufficient incentive or compensation to participate in program activities to change land use or reduce carbon emissions. To what extent are distribution mechanisms viewed as credible and trusted by beneficiaries?

This section is intentionally left blank since the First ER Payments have not been received yet.

3.7 Do beneficiaries understand their continued obligations once benefit distribution has taken place? Is there any evidence that there is a mismatch of expectations among beneficiaries regarding the nature and value of benefits accruing to them? What mechanisms are in place to manage such risks?

During the FPIC process, GFLL delivers information about the project interventions including role of community; nature, magnitude, and scope of any proposed project or activity; purpose of the GFLL; likely economic, social, cultural and environmental impact, including potential risks and fair and equitable benefit sharing in a context that respects the precautionary principle; personnel likely to be involved in the execution of the proposed project (including indigenous peoples, private sector staff, research institutions, government employees, and others) and procedures that the project may entail. Village Development Plans which include the scope for the livelihood improvement, PLUP, VFMP will be prepared in consultation with the community and with their agreement at each step. During the implementation, if there are mismatches of expectations among beneficiaries regarding the nature and value of benefits accruing to them, reconciliation can be achieved through the FGRM.

4. Implementation of the Environmental and Social Management Measures for the BSP

4.1 Assess to what extent the measures for managing the environmental and social aspects of BSP activities have been implemented. Refer to applicable sections in the Safeguards Plans where relevant.

Since no ER Payment have been received yet, managing environmental and social aspects of BSP activities financed by ER Payments has been limited to ensuring institutional arrangements are in place and safeguards plans are ready for roll out. However, other projects such as i-GFLL, LLL (Lao Landscape and Livelihoods), ICBF, and VFMP have conducted ER activities by using their allocated funds. Please see Annex 1 (Section 2) on the Safeguards Implementation.

5. Recommendations for BSP Improvement or Modifications.

5.1 Based on experience during the current reporting period as well as feedback from recipients, identify any specific recommendations for modifying the procedural or substantive content of the BSP, if necessary. Substantive changes may include modifications to eligible beneficiaries; rationale or justification for benefits sharing; form or modality of benefit distribution; structure of dedicated funds established to distribute benefits; obligations of recipient among others.

BSP is a live document and can be updated/modified, if necessary, based on lesson learnt during the implementation of the ER programme, feedback from recipients.

5.2 Are there procedural or administrative obstacles to timely distribution of benefits (e.g., adequacy of financial channels, ability to use funds)? Are benefits distributed in a timely manner?

Since the first ER Payment has not been made or distributed yet, obstacles to the timely distribution of benefits cannot be assessed at this time.

5.3 Is there evidence of other emerging risks that may affect the sustainability or effectiveness of the BSP?

Since the First ER Payments have not been received yet, benefit sharing has not been tested so there are no additional emerging risks identified. Thus, obstacles to the timely distribution of benefits cannot be assessed at this time.

However, some lessons learned from BSP design and benefit distribution under other projects (LENS2, VFMP/KfW project) are as follows:

- There is limited knowledge of PAFO/DAFO staff on the projects hence many questions related to project background and management from villages were not well addressed. The limited knowledge of PAFO/DAFO was evident in questions raised during various meetings, including a World Bank mission in July 2022.
- Due to delay recruitment of International Safeguards Consultant, it has an impact to the FPIC process in the field. As a result, community action plans including village agreements have to be postponed to June 2023.

- The delay of ER monitoring report will also affect the schedule of ER payment delivered to the beneficiaries. The verification and validation (VV) process will take at least 22 to 40 weeks or six to ten months accordingly. If the VV starts in April, then the quickest ER payment will be in October. If there are some revisions to the VV report that might take one or two months, then the ER payment might happen in March 2024. It is therefore that it is important to shorten the VV process and provide quickly the revisions of the ER monitoring report to the VV body (auditors). So that the ER payment could be delivered to the beneficiaries as soon as possible.
- Prioritization of the villages has been completed based on the village selection criteria. As stated above, final selection of the villages was completed in by second quarter 2023. There may be some risk of delays in readiness and benefit distribution to villages. However, project is trying to complete the village selection following international FPIC standards. Benefit will be shared with the community as per the agreed BSP.
- Coordination between development partners have been problematic particularly were there is project overlap.. This is resolved through regular meetings to exchange data, information, and progress to avoid misunderstanding in approaches.
- Some communities may not have the necessary capacity and setting to receive and manage funds for implementing community action plans. As funds will be transferred directly from the Bank of Lao PDR (BOL) to the community accounts based on community action plan, it will be necessary to provide proper fund management systems and training on fund management and reporting including adequate extension support.

Based on these lessons, the Program Entity will focus on ensuring ER payment investments are sustainable and build the capacity of PAFO/DAFO staff in order to increase the knowledge of the GFLL program and mainstreaming program interventions beyond 2025.

5.4 Provide a suggested timeline and an outline of administrative arrangements to introduce any recommended changes.

This section is intentionally left blank since the First ER Payments have not been received yet.

ANNEX 3: INFORMATION ON THE GENERATION AND/OR ENHANCEMENT OF PRIORITY NON-CARBON BENFITS

ER programs should review potential Non-Carbon Benefits, identifying a set of priority Non-Carbon Benefits and report on the generation or enhancement of such priority Non-Carbon Benefits. The priority Non-Carbon Benefits should culturally appropriate, and gender and inter-generationally inclusive, as relevant.

*Refer to **criterion 34 and 35** of the Methodological Framework*

Priority Non-Carbon benefits

Priority Non-Carbon Benefits (PNCB) and Approaches are from the ERPD and some of them are bundled because activities cover not only one but several PNCBs. Activities are compiled from the annual reports, presentations or documents from I-GFLL, VFMP, ICBF, SUFORD SU projects and the reports of 3 LENS2 sub-projects inside the GFLL area. The reports and documents are available at Reports from other projects.[38] Out of these projects, only I-GFLL is a REDD+ specifically ERPD implementation project and it ESMF identifies the set of priority non-carbon benefits as described below. Others are for village forest management, biodiversity conservation, Production Forest management and so on, therefore the term non-carbon benefits is not used. However, most the priority non-carbon benefits are important components or activities of these projects.

1. List the **identified set of priority Non-Carbon benefits** and provide necessary details on activities for generation and enhancement of these Non-Carbon benefits. (See questions in sections 2 and 3 below for examples of details on potential specific non-carbon benefits identified)

Priority Non-Carbon Benefit	• **Details on activities for generation and enhancement** ○ **Approach (as defined in ERPD including relevant indicators);**
- Reduced poverty incidence - Enhanced food security - Increased participation (particularly of women and ethnic groups) in sustainable forest management, land use planning, and village development activities - Improved land tenure security	**<u>Approach</u>** The ER Program design focus is pro-poor as well as long-term sustainability of proposed interventions. Village consultations during the time of preparation of PRAP of six provinces held in all 50 districts, and in 50 kumbans with representatives from 339 villages, highlighted the lack of alternative livelihoods. Safeguards measures and plans including the Ethnic Group Policy Framework, (EGPF), FPIC, and other instruments ensure participation of ethnic groups and other marginalized groups by ensuring broad participation throughout the program's interventions. Marginalized and vulnerable groups are pro-actively engaged in program measures to improve and sustain their livelihood options. The development of forestry value chains and agroforestry through the Promotion of Sustainable and Deforestation-free Agricultural Practices and Value Chains project (PSAP) developed under the CliPAD which can be replicated under the GFLL, will enable local communities to produce and market improved products. The ER Program recognizes the role of communities and importance of broader participation through participatory land use planning with enhanced support from extension services to raise standards, village

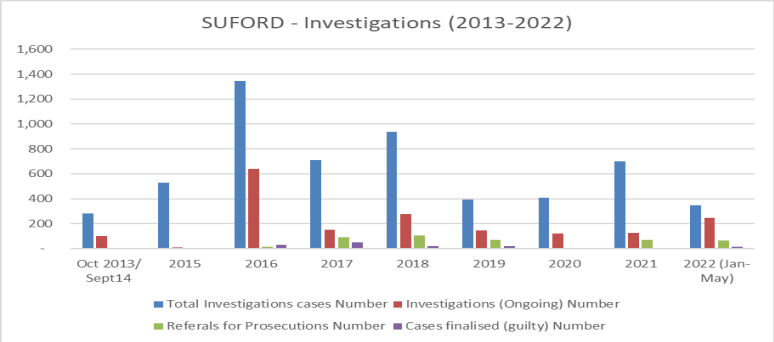
[38] https://drive.google.com/drive/folders/1y27ZMz75fO7--rFohNdheCM1TcQXVwm_

	forest management as well as improved land tenure security. Additional support is anticipated through the World Bank funded Enhancing Access to Benefits while Lowering Emissions (EnABLE) program which aims to increase participation of marginalized and vulnerable groups. This is important and should lead to enhanced recognition and rights of the village communities in planning, managing, protecting, using and benefiting from village forest resources including village forests inside the national forestlands including the improving land tenure security is through participatory land use planning (PLUP) and village forest management plans (VFMP). <u>Activities (I-GFLL)</u> Improvement of land tenure is a significant part of the ER Program. In 2021, PLUP 2.0 was conducted in 48 villages (Houaphan 25, Sayabury 18, Luang Prabang 5). In the target Districts of Paklay in Sayabury and Xone in Huaphan Province, the GIZ/Land Program led the PLUP 2.0 implementation in 14 villages. This cooperation reduces the pressure on human resources and improves staff-availability in the shared target Districts. However, the unpredictable COVID-19 lockdown situation caused disruptions of the overall progress of PLUP 2.0 implementation. District PLUP Teams were not able to conduct fieldwork amid concern over the disease transmission to local communities. While Huaphan and Sayaboury were moderately affected, Luang Prabang underwent a lengthy lockdown of approximately two months (from September to October 2021). More than 14,000 villagers engaged in the consultation process of PLUP with 46% of total participants female. In about 80% of the completed villages, existing village land use plans were reviewed, updated or redone during PLUP 2.0 process. Most of previous land use planning activities in the target villages were supported by international development projects, NGOs and took place between 1996 and 2018. The total village land area of approximately 220,000 ha is demarcated and under village land use plans, all the 48 village regulations are established and agreed by the villagers. 64% of the total land areas are designated as village forestland. 25.1% of total village area is zoned as fixed agriculture areas, while shifting cultivation and fallow land make up about 10%. In 2021, the project initiated the implementation of the previously developed guidelines for the “Promotion of Sustainable and Deforestation-free Agricultural Practices and Value Chains” (PSAP) approach in 32 villages. PSAP is based on the results of Participatory Land Use Planning (PLUP) conducted in each target village. PSAP is guided by a so-called “White List”, a comprehensive list of 32 sustainable agricultural practices and crops to be promoted. PSAP implementation has reached 34 villages, and 984 households have registered for participation and have dedicated more than 1000 ha to the implementation of PSAP activities. Community-managed financial schemes offer considerable potential for outreach and financial inclusion. Each of the project target villages will, upon request, be supported in starting and operating a Village Forest and Agriculture Grant (VFAG). Currently, 170 villages have been selected in 13 Districts in which villagers are eligible for three types of VFAG funds: (1) cash for work (average EUR 2,000 per year), (2) up-front payments (investment payment, EUR 10,800), and (3) performance-based funds (Bonus payments, up to EUR 10,000). Increasing overall participation is a key part of the program implementation

	and is continuously emphasized. Women and men have opportunities to participate in all Project activities in line with the Gender Action Plan. Monitoring information shows that there is strong participation of women in all village meetings and in all key areas of intervention (e.g., FPIC 54%, PLUP 46%, PSAP 47%, VFAG 47%). Furthermore, female-led households and young households are given priority in the selection of PSAP participants. Monitoring data shows, that there are approximately 10 female participants in PSAP per village (27% of participants). 7% of PSAP beneficiary households are led by women, which is approximately double the ratio of female-led households in rural Laos. This proves that the prioritization has been implemented in practice. In 80% of villages women are represented in VFAG Committees, thereby attaining financial management capacities and promoting women's inclusion in economic activities promoted by the Project. The consideration of gender aspects is also included as a component within the ESMP Checklist. Implementing partners and project staff have been provided with instruction materials and are required to consider gender aspects in the project's activities. <u>Activities (ICBF)</u> Village land use plans were updated in all 106 eligible target villages until end of 2019. The implementation of village specific Village Biodiversity Conservation Agreement (VBCA) has commenced after initial funds for VBCA were transferred, and is currently ongoing in 99 target villages within the conservation landscape (Nam Ha and Nam Kan National Protected Areas (NPA) and their corridors). Various livelihood related vocational education courses were implemented by the Technical Vocational Education Schools (TVETS) in Bokeo province and attended by 32 persons from ICBF target villages, for which the project provided scholarships and support. <u>Activities (SUFORD SU)</u> After new or updated PLUPs were agreed with villages, village development grants ($8000/village) have been distributed to 329 villages in and around the Production Forest Areas in Luang Namtha, Bokeo, Sayaburi and Oudomxay Provinces and villagers have started various livelihood activities with the grant. <u>Activities (VFMP)</u> By the end of December 2021 all target villages completed FPIC steps 1 to 3 (information, orientation, consent; PLUP review and PLUP update), meaning that 70 villages had an updated land use plan. 34 villages have a completed VFM Masterplan (20 Phonxay, 14 Phieng) and the first VFMP contracts were signed in 24 villages (10 Phonxay, 14 in Phieng). <u>Activities (LENS2; Luang Prabang)</u> LENS2 in Luang Prabang Province had a Sub-project for Capacity Building for Participatory Management of Phou Pheung- Phu Pha Thoun-Tad Kuang Xee National Protection Forest (PPTKX NPF). This sub-project conducted participatory rural assessment, produced a community engagement framework and established PLUP in 12 target villages inside the NPF. Based on these, about $ 10,300/village on average were provided to support their livelihood activities including small

	livestock raising, fruit trees and so on. <u>Activities (LENS2; Huaphan)</u> LENS2 in Huaphan Province had a Sub-project for Capacity Building for Participatory Management of Nam Sam NPA. The Sub-Project conducted PLUP in 10 villages adjacent to the NPA boundary. After PLUP, around $10,000/village was provided for livelihood improvement activities such as livestock raising, expansion of paddy, small irrigation for paddy and so on. <u>Activities (LENS2; Nam ET Phou Loey National Park (NEPL NP) Sub-Project contracted to WCS)</u> The sub-project achieved its objective firstly, through the declaration of the NPA as one of the first NPs officially declared in Laos. Secondly, the development and approval of a 10-year strategic management plan and a 5-year implementation plan had provided a framework to the NEPL NP Management Unit for future management actions. The sub-project established a strong community engagement framework with the development and approvals of 43 PLUP's, Community Activity Plans (CAP) and Community Conservation Agreements (CCA) ensuring a strong cooperative management model within key guardian villages inside and adjacent to the park. Communities were further empowered through an outreach and awareness campaign conducted in 50 villages that saw a 29% increase in knowledge and awareness of key hunting related issues. 1,052 visitors visited the eco-tourism products (night safari and trekking) providing financial support to 165 service providers, 26 villages, NEPL MU and the local Industry, Commerce and Tourism departments. A partnership with private sector has been in discussion. Key communities received direct benefits linked to the terms of the CCA's totaling 3,368,406,500 KIP ($353,842) for selected livelihood improvement activities, contributing to increased compliance to NEPL NP regulations and laws. A total of 80 participating households signed household coffee grower and conservation agreements and planted out a total of 129,634 coffee seedlings in 53.35 ha of village forestry land. 1,928 kg of cherries had been harvested, processed, and sold through this project. A private coffee company has been providing technical advice and market through a Partnership document. 25 households (5 from each of the 5 villages) signed agreements and became participants of the Honey production livelihood trial project. They received equipment and training to construct a total of 75 hives and are now ready to harvest the first crop of honey.
Increased watershed protection, protection of streams and water sources	<u>Approach</u> The proposed ER Program area contains five NPAs (conservation forest areas), as well as numerous Production Forest Areas and Protection

Increased conservation of natural habitat for wild species and biodiversity and increased forest restoration/ rehabilitation, listed as a priority benefit in the ERPD	Forest Areas. Within this region, work is ongoing to re-establish biodiversity conservation corridors. <u>Activities(I-GFLL)</u> ADB is providing co-financing of EUR 12.3 million to implement Activity 2.3 (in conjunction with the Sustainable Rural Infrastructure and Watershed Management Sector project, SRIWSM), which is implemented in 4 Provinces. The co-financing contribution is based on the implementation overlap of Project 1 and Sustainable Rural Infrastructure and Watershed Management Sector Project (SRIWSM) in seven Districts in three of the Provinces (Huaphan, Sayaboury and Luang Prabang), where the project and SRIWSM will work together. The project implementation has started, however is delayed due to the impact of COVID. <u>Activities(I-GFLL)</u> The first step was to review the management plans for the NPAs and get the plans formally approved by the government. The management plans of Nam Xam NPA, Nam Pouy NPA and Nam Et-Phou Louey NP were finally endorsed by the Department of Forestry in December 2020, and January 2021, respectively. The implementation of the activities specified in the management plans started with exchange and coordination meetings on forest law enforcement between NPA staff, POFI, police, military, and prosecution authorities. After the review of implementation approaches of conservation agreements from other programs, like KfW ICBF and World Bank LENS2, specific annual operational plans and conservation agreements for guardian villages, i.e. villages in or adjacent to the NPA, were developed. In Nam Et-Phou Louey NP, 9 guardian villages completed their annual operational planning. Awareness raising on forest conservation was carried out in 10 villages: 5 in Nam Et-Phou Louey and 5 in Nam Xam NPA. Furthermore, the negotiations of village forest conservation agreements (VilFoCA) have started, and until the end of 2021 has been fully carried out in one village of Nam Et-Phou Louey NP. <u>Activities (ICBF)</u> The northern conservation landscape includes 2 (NPAs; Nam Ha and Nam Kan) and 2 corridors stretching across Luang Namtha and Bokeo provinces. The project has completed the update of management plans for both supported protected areas (Nam Ha and Nam Kan). Final NPA management plan updates for 2 ICBF supported NPAs were submitted to PAFO's and after to DoF, and approved end of 2020. NPA management units have improved work organization and internal processes, co-management was ensured by consultations and participation of villages and private sector, as well as technical activities such as boundary demarcation, ranger patrolling, establishment of biodiversity baseline (identification of indicator species), and outreach and linking conservation with eco-tourism. A biodiversity endline survey was conducted in 2022 in order to observe the conservation status and a report on this will be published in early 2023. <u>Activities (LENS2; Luang Prabang)</u> The 5 Year Management Plan (2021-25) of Phu Pha Thoun-Tad Kuang Xee National Protection Forest (PPTKX NPF) was formulated by PAFO

	in collaboration with experts from DOF, CHES-Lao, F-REDD, representatives from concerned DAFO and villages. After Approval by the Province Vice Governor, DOF endorsed the Management Plan in March 2021. <u>Activities (LENS2; Huaphan)</u> The 5 Year Management Plan (2021-25) of Nam Sam NPA was approved by the PAFO and concerned Districts in June 2020 and endorsed by DOF accordingly. Activities (LENS2; NEPL NP) A set of biodiversity baselines were established through a camera trap presence absence survey during which 3X180km^2 blocks were monitored for 50 days using 160 cameras. A gibbon survey at 80 survey points were monitored for 4 days at each site. Any endline survey has not been conducted or planned.
Increased participation in forest management	(Already covered above)
Improved capacity for law enforcement, monitoring and reporting	<u>Approach</u> This is also reflected in national level green growth priorities supported by a strong focus on policy reforms including strengthening regulatory enforcement, addressing gaps in policies, laws and regulations and improving monitoring of implementation. Feedback from stakeholders aligns with the widely held view that improvements in forest management can only be achieved through reforms and strengthening of forest governance systems. Component 1 on enabling conditions for REDD+ will address forest governance related issues, including alignment with and support to the FLEGT process, capacity building in Government and non-Government actors, transparent and strengthened data management in land management and carbon accounting; and strengthening capacity in applying rule of law and enforcement of regulations. <u>Activities (SUFORD-SU for the all of 18 Provinces)</u> With SUFORD-SU support, DOFI conducted forest crime investigations. The number of investigations peaked in 2016 which coincided with the issuance of the PMO15. After this DOFI, as well as other law enforcement agencies, intensified their activities. As a result, illegal logging was reduced by about 75 % in one year. There was a dip in the number of investigations in 2019 and 2020 due to a break in financing and the Covid-19 pandemic.  <u>Activities(I-GFLL)</u> The Provincial Deforestation Monitoring System (PDMS) has become operational in February 2021 in Huaphan (Districts Sam Neua and

	Houameuang) and was extended to the other two Provinces in the course of 2021. In cooperation with F-REDD I project (JICA), the SOPs on PDMS for provincial and District staff have been revised and a total of four trainings have been carried out at national level and in the three Provinces for appointed technical staff at national, provincial and District levels. The Terms of References (ToRs) for appointed technical staff were developed and agreed. Under SOPs and ToRs, the coordination, exchange and reporting channels were elaborated and clarified. Furthermore, necessary equipment for PDMS Teams were procured and distributed. Dissemination of regulations and guidelines regarding forest utilization is still ongoing. Now, the PDMS is applied in the three Provinces and the trained staff is able to carry out the monitoring, however, the support and supervision from national staff continues to be needed to ensure the quality and consistency of applying the PDMS and strengthen the subsequent law enforcement. In the first 9 month of operation, the PDMS helped to detect forest encroachments in Houaphan in 14 villages of Samneua District and 10 villages of Houameuang District. The use of remote sensing data showed the changes in the forest cover, which was confirmed by DAFO Teams on the ground. Overall, the area affected was small with about 46 ha and the cases have been addressed according to the established processes. <u>Activities (ICBF)</u> Final statistics from 2019 and from 2020 indicate positive impacts of ICBF supported law enforcement activities in both conservation landscapes. There is a tendency of an increased number of detected violations, submissions of cases to the prosecutor's office, as well as prosecutions compared to the baseline data (DoFI report 2016). According to the official law enforcement statistics for 2021, PoFI Luang Namtha confiscated 200,5 cubic meter of timber, 85,0 kg of wildlife meat and animal parts, 6 life animals (bear, dole, mina birds), 1 guns, 1 chainsaws and stopped illegal forest clearing in the Nam Ha NPA on 222 ha. A total of 6 cases including 86 offenders were reported and processed. Five cases were resolved by warnings, mediation and educational measures. One case including 45 offenders were handed over to the Prosecutors Office (forest conversion in Nam Ha NPA). According to the preliminary law enforcement statistics for 2021, PoFI Bokeo confiscated 63,8 cubic meter of timber, 20 kg of wildlife meat/ animal parts, 3 guns, 4 chainsaws and 67 ha illegal forest clearing in the Nam Kan NPA. A total of 8 cases were reported and processed including a total of 66 offenders. Seven cases including 52 offenders were resolved by warnings, mediation and educational measures. One case including 14 offenders were handed over to the Prosecutors Office (sale of forest land in Nam Kan NPA). <u>Activities (LENS2)</u> Key achievements in 2021 included completion of Lao-WEN operational framework (Lao-Wildlife and Forest Law Enforcement Network Operation Manual). DOF has completed in term of the website structure and functionality. The website now has a host with an MTS server under the domain name www.npalao.org which is the public can access to the website.

	Activities (LENS2; Luang Prabang) Forest patrol was conducted by a team of Province, District and Village on average twice per month. In total 78 cases were found and out of these 50 cases of illegal harvest and processing, 24 cases of illegal forest destruction and 17 cases of forest clearing for planting forage grass. All these cases were sent to the investigation agency. Activities (LENS2; Huaphan) Forest patrol consisting of POFI, DOFI, villagers and so on was conducted 69 times covering most of the NPA area. 2 sets of SMART equipment expedite the estimate of destructed or logged forest area. Most of the illegal activities found through patrols were of minor degree and education or warning on site was enough to stop them. There were following cases; - Harvesting along the NPA boundary; 24 cases - Hunting and hunting camp; 153 cases - NTFP collection (orchid, vine and so on); 12 cases - Slash and burn outside of permitted area; 11cases Activities (LENS2; NEPL NP) Law enforcement teams were increased from a total of 5 up to 12 during the peak period of the project. They received training and equipment necessary for the patrolling of key areas within the TPZ and CUZ of NEPL NP, conducting 3,900 patrol days during which they uncovered 1,742 threats to biodiversity. 1,069 people were arrested of which 304 received sanctions. Deforestation mapping for 2019 and 2020 as well as a host of observation date obtained through SMART ranger patrols and ecotourism tours.

Other Non-Carbon benefits and additional information as linked to Monitoring and Evaluation Framework

The following indicators are to meet the monitoring requirements within the revised M&E Framework as endorsed at PC25 to be measured through the ER-Monitoring template.

*Refer to **Annex 4** of the FCPF Monitoring and Evaluation Framework March 2018*

2. If applicable linked to **any other (non-priority identified) Non-Carbon benefits**, or if not already covered above linked to Priority Non-Carbon benefits, provide the following additional details:

Livelihood enhancement and sustainability

2.1. Is your CF program testing ways to sustain and enhance livelihoods (e.g. one of your program objective/s is explicitly targeted at livelihoods; your approach to non-carbon benefits explicitly incorporates livelihoods)?

Yes, see information included in section 1 above.

Biodiversity

2.2. Is your CF program testing ways to conserve biodiversity (e.g. one of your program objective/s is

explicitly targeted at biodiversity conservation; your approach to non-carbon benefits explicitly incorporates biodiversity conservation)?

Yes, see information included in section 1 above.

Protected/conserved areas

2.3. What amount (in ha) of protected or conserved areas are included in your CF program area? Has this amount increased or decreased in the last year? If so, by how much?

There are 1 National Park and 4 National Protected Areas (NPA) in the GFLL area. Their names and areas are as follows;
Nam Et Phou Loey National Park: 401,720 ha
Nam Ha NPA: 220,755ha
Nam Kan NPA: 145,440ha
Nam Sam NPA: 68,092 ha
Nam Phouy NPA: 177,515 ha
Total Area: 1,013,522 ha

In Feb 2019, Nam Et Phou Loey NPA was designated the first National Park by PM Decree No 35.
There was no area change in 2021.

Re/afforestation and restoration

2.4. Total forest area re/afforested or restored through program

ICBF
The implementation of Village Biodiversity Conservation Activities (VBCA) is ongoing in 106 target villages and assisted natural regeneration and forest and fallow restoration were implemented as follows;

Assisted natural regeneration: 313 ha
Forest and fallow rehabilitation/ restoration: 328 ha.

SUFORD SU
Forest restoration grant ($2000/village) has been distributed to 329 villages in and around the Production Forest Areas in Luangnamtha, Bokeo, Sayaburi and Oudomxay Provinces and villagers started improving conditions of degraded forest through thinning, cleaning and so on. Restored area not known (nk).

Finance and Private Sector partnerships

2.5. Update on CF program budget (as originally presented in ERPD), with updated detail on secured (i.e. fully committed) finance, in US$

2.5.1. Detail the amount of finance received (including ER payments) in support of development and delivery of your CF program. Figures should only include secured finance (i.e. fully committed): ex ante (unconfirmed) finance or in-kind contributions should not be included:

Amount (US$)	**Source** (e.g. FCPF, FIP, name of gov't department)	**Date committed** (MM/YY)	**Public or private finance?** (Delete as appropriate)	**ERP, grant, loan, equity or other?** (Delete as appropriate)
$ 17.7 million	GCF/GIZ (I-GFLL)	Nov 2019 (GCF Board approval)-Jun 2024	Public	Grant
$ 6.9 million	GIZ/BMZ (I-GFLL)	Apr 2020-Jun 2024	Public	Grant
$ 7.7 million	KfW/BMZ (VFMP)	Jun 2019-May 2026	Public	Grant

$ 1.3 million	JICA (F-REDD 1&2)	Nov 2015 – Jan 2027	Public	Grant
$ 9.8 million	KfW/BMZ (ICBF)	Sep 2016-Dec 2022	Public	Grant
$ 1.4 million	FCPF (REDD+ Readiness 2nd phase)	Jul 2018-Jun 2022	Public	Grant
$ 3.3 million	SUFORD SU	Nov 2013-Dec 2021	Public	Grant
$ 3.7 million	EPF/World Bank (LENS 2)	Mar 2018-Dec 2021	Public	Grant
Sub-total	**$ 51.8 M (62% of the necessary international finance ($ 83.5 M) assessed in the ERPD)**			
$ 13.5 million	ADB (SRIWSM)*	Oct 2019	Public	Loan
$ 8.5 million	IFAD (PICSA)*	Sep 2019	Public	Loan

*ADB and IFAD projects have con-financing arrangements with GCF/GiZ (I-GFLL)

2.5.2. Not including ER payments from the FCPF Carbon Fund, what is the value of REDD+ ER payments that your CF projects have received, and that your country has received overall?

Description	Total REDD+ ER payments received to date ($US)
Carbon Fund project/s (i.e. ER payments from sources other than the Carbon Fund)	$ None
All other national REDD+ projects	$ None

2.5.3. How many formal partnerships have been established between your CF program and private sector entities? Formal partnerships are defined as:

- The partnership is based on a written MoU (or equivalent), and/or
- The partnership involves tangible financial exchange/s, and/or
- The partnership involves tangible non-financial exchange/s (e.g. in-kind contributions)

I-GFLL

The Agriculture Teams have carried out an analysis of private sector companies operating in the respective Districts. Additionally, selected companies from provincial and national level have been included. Information on 164 private or state companies involved in marketing agricultural products from the Districts was collected. This initial private sector review showed that 14 agricultural commodities matched with the Whitelist.

LENS2 (NEPL NP; WCS)

A coffee company (SAFFRON) and WCS has a partnership document "Understanding of mutual benefits concerning partnership between WCS and Saffron Coffee" for development coffee in the villages in and around NEPL National Park.

Description	Established in the last year (Jul-Jun)	Total to date
Number of private sector partnerships involving financial exchange	None	None
Number of private sector partnerships involving non-financial exchange	None	one

3. Other Non-Carbon benefits and additional information

Any other activities that generate or enhance non-carbon benefits in addition to those listed as earlier priority or those that are required for the Monitoring and Evaluation Framework

Policy development

3.1. Is your CF program involved in the development, reform and/or implementation of policies to help institutions/people/systems/sectors? Please provide information on the approach and any other relevant or related indicators/results.

- Forestry Law revision in 2019

The FCPF Readiness Project supported the technical team established for the revision of Forestry Law in organizing their meetings, drafting and consultations with stakeholders in 2019. The revised Forestry Law was approved by the national Assembly in June 2019. The 2019 Forestry law provides detailed rules on timber harvesting and transportation including legality assurance system, strict rules on conversion of forestland to other land categories, simplified process for harvesting and transportation of planted forest after registration, promotion of REDD+ and forest carbon trade and provisions on village forest management plans.

- Finalization of the National REDD+ Strategy

The NRS was approved by MAF Minister in April 2021 and submitted to UNFCCC. It is available at https://redd.unfccc.int/submissions.html?country=lao

- Forestry Strategy 2035 Vision to 2050 (final draft)

The Forestry Strategy 2035 with Vision to 2050 has been finalized and planned to be submitted to the Government meeting in May 2022. REDD+ is one of focused activities in line with the NRS and the 2nd Nationally Determined Contribution (NDC).

Capacity building

1.1. Is your CF program involved in training, education or provision of capacity building opportunities to increase the capacity of institutions/people/systems? Please provide information on the approach and any other relevant or related indicators/results.

By GFLL/FCPF Project

- Capacity building of the Forest Protection Fund to receive and manage carbon revenue including Program ER Payments (to be continued; see Annex 2 for details)
- Social and environmental safeguards implementation capacity building for SESU (see Annex 1 for details)
- 6 Provinces (PAFO and Provincial REDD+ Office) on the GFLL including BSP in March 2021
- Capacity building for Financial Management (FM) and procurement for PAFO/DAFOs which started in June 2022 see table-1 of annex-1 for details)
-

Capacity building for provincial deforestation monitoring

By other projects

Numerous trainings and capacity buildings pertaining to the GFLL program have been conducted by the projects in the following areas (trainings on project specific areas such as project management mechanism, institutional arrangements, financial management and so on are not listed) ;

- FPIC
- PLUP

- ESMP and other safeguards instruments
- Use of equipment for law enforcement including SMART and PDMS
- Biodiversity survey
- Nature-based tourism
- Others

Other

3.2. Is your CF program involved in generation or enhancement of any non-carbon benefits not already covered in this annex? Please provide information on the approach and any other relevant or related indicators/results.

All non-carbon benefits are covered in 1 above.

ANNEX 4: CARBON ACCOUNTING – Technical Correction to the ERPD

Table of Contents

List of tables and figures

Technical corrections

Lao PDR proposes to conduct technical corrections to the methods and data used to establish the Reference Level [39]. Three correction items were in the positive list presented in paragraph 3 of Guidelines on the Application of the Methodological Framework Number 2: On technical corrections to greenhouse gas (GHG) emissions and removals reported in the reference period (Version 2, November 2020).

Correction item 1

Complying with the technical correction item 1.a, Lao PDR proposes to use the carbon stocks values for the five natural forest classes derived from the 3rd National Forest Inventory (NFI) conducted in 2019 and the carbon stock value for the Regenerating Vegetation (RV) forest/land type from the 2nd Regenerating Vegetation (RV) survey conducted in 2019, to improve the emissions factors. For the Reference Level in the original ERPD, emissions factors were calculated using the carbon stocks value from the 2nd NFI and the 1st Regenerating Vegetation survey. The results from the 3rd NFI and the 2nd RV survey have a smaller uncertainty compared to the results from the 2nd NFI and the 1st RV survey. Between the 2nd and 3rd NFI, the SOP was updated with the lessons learned from the 2nd NFI. The same team from the Forest Inventory and Planning Division (FIPD), was re-trained accordingly and thoroughly followed the updated SOP. For instance, the number of sample plots for each forest types was adjusted so that there would be enough number of plots for each types, and the identification of the forest types by the field crews was more consistent as specific training was conducted for this topic. As a result, the 3rd NFI benefited from the experience gained with the 2nd NFI and was conducted in a more effective manner. The carbon stock values from the 3rd NFI and the 2nd RV survey are used to update the emissions factors for both the reference period and the monitoring periods.

Correction item 2

During the ERPD assessment, the Technical Advisory Panel (TAP) observed that the frequency of the time-series of Activity Data (AD), used for the Reference Level (RL) (5 years), could not fully track the true changes of carbon stock caused by shifting cultivation, which are represented in the changes between forest strata (stratum 1, 2 and 3) and Regenerating Vegetation (RV, stratum 4). The RV includes fallow land, previously forested but cleared by shifting cultivation practice, for which the cultivation cycle may vary from four to nine years. As a result of the TAP, conservativeness factor of 15% was applied to the emissions from forest degradation associated with the RV lands.

Another issue was that the uncertainty of the AD estimates, especially for degradation, are quite high for the reference period: 40% for the period 2005-2010 and 32% for 2010-2015 respectively. The FMT considered these estimates as relatively high, and strongly encouraged Lao PDR to improve the estimation approach.

Lao PDR proposes a technical correction that would fall into the positive list concerning item 2.a. Improvements to the statistical design for estimation of activity data, and item 2.b Corrections to activity data resulting from the use of reference data of higher accuracy and/or precision. This technical correction improves the forest degradation AD estimates. It uses a new map produced by the continuous change detection and classification spectral mixture analysis (CCDC-SMA) script that identifies the area where the forest is disturbed, in combination with the Collect Earth Online interface. For each period of the Reference Period, 2005-2010 and 2010-2015, a CCDC-SMA map was produced for the six provinces of the ER Program. Plots were distributed following a simple random sampling approach and were visually interpreted by the FIPD team. The interpreters identified the change that occurred during the time period. For degradation, they identified the drivers of changes, such as shifting cultivation, logging, fire, or other various causes. The adjusted AD for the degradation caused by shifting cultivation occurring in natural forest replaced the AD used in the ERPD for the RL.

Correction item 3

[39] See an official letter and technical note for the proposed technical corrections.

Correction item 3 proposes correction of a material error. An error was found in the calculation of logging emissions for the RL. There was one data from a province outside of the ER Program area included in the dataset. Complying with the technical correction item 3, this error was corrected by deleting such a data.

Comparison between the previous Reference Level and the technical correction

Table 1 below is a replication of Table 8.3.n in the Emission Reduction Program Document. It displays the emissions and removals by source and sink, including emissions from logging.

Table 25. Average annual emissions and removals over the reference period (ERPD 2018)

	Emissions(+)/ Removals(-)		
Source/Sink	2005-2010 (tCO2)	2010-2015 (tCO2)	Annual average 2005-2015 (tCO2/year)
Deforestation	19,561,481	17,924,974	3,748,645
Forest Degradation	38,286,544	29,201,727	6,748,827
Changes among REDD+ strata	33,466,780	25,988,551	5,945,533
Logging	4,819,764	3,213,176	803,294
Reforestation	-8,731,889	-5,453,126	-1,418,501
Restoration	-2,537,961	-2,921,082	-545,904
Total Emission	57,848,024	47,126,701	10,497,473
Total Removals	-11,269,849	-8,374,208	-1,964,406

The net emission annual average is 8,533,067 tCO2e/year (aggregation of Total Emission 10,497,473 tCO2e/year and Total Removals -1,964,406 tCO2e/year).

With the technical correction, the annual average emissions and removals are revised as in Table 2 below.

Table 26. Average annual emissions and removals over the reference period (Technical Correction)

	Emissions(+)/ Removals(-)		
Source/Sink activity	2005-2010 (tCO_2e)	2010-2015 (tCO_2e)	Average annual 2005-2015 (tCO_2e/year)
Deforestation	14,478,006	15,678,383	3,015,639
Forest Degradation	65,998,947	40,278,661	10,627,760
Degradation (CCDC-SMA)	61,107,763	37,017,871	9,812,563
Logging	4,891,184	3,260,790	815,197
Reforestation	-4,577,325	-2,858,572	-743,590
Restoration	-2,760,571	-3,177,484	-593,805
Total Emission	80,476,953	55,957,044	13,643,399
Total Removals	-7,337,896	-6,036,055	-1,337,395

The technical corrected net emission annual average is 12,306,004 tCO2e/year (aggregation of Total Emission 13,643,399 tCO2e/year and Total Removals -1,337,395 tCO2e/year).

The technical correction item 1 impacted the Emission/Removal factors (E/R factors) quite significantly, mostly because the carbon stock value for the Regenerating Vegetation is lower in the 2nd survey than the one estimated from the 1st RV survey. As a consequence, the figures for deforestation and reforestation decreased. The figures for restoration increased because the emission factor from Regenerating Vegetation to Mixed Deciduous Forest increased as well.

The technical correction item 2 focused on forest degradation. The revised approach helped to better identified the dynamic of the shifting cultivation and thus adjust the amount of forest degradation. It also improved the uncertainty of the resulting Activity Data.

Application of Monte Carlo analysis
In the original RL, the overall uncertainty was estimated using error-propagation. In line with the Guideline on the Application of the Methodological Framework Number 3 – Uncertainty Analysis, the overall uncertainty has been re-calculated using the Monte Carlo method with a confidence interval (CI) of 90%.

Start Date of the Crediting Period

The Crediting Period for the Lao PDR's ER Program is defined as January 1, 2019 - December 31, 2024 (6 years) according to the ERPA (Emission Reductions Payment Agreement) signed between the Lao PDR and the FCPF on December 30, 2020. This comply with the conditions of the Crediting Period Start Date defined in the FCPF Carbon Fund's Glossary of Terms (Version 2.2, May 2022).

1. **It is not earlier than the date the first ER Program Measure(s) (including any Sub-Project(s)) begins generating ERs, i.e. first implementation**

The start date is not earlier than the date the first ER Program Measure(s) began generating ERs (see below).

2. **It is justified with objective evidence by the ER Program Entity and it is independently assessed by a Validation Verification Body during Validation**

The following projects provide support in the ER Program areas and have been contributing to generating ERs through implementation of activities as a part of, or in complementarity with, the ER Program measure(s). Details of the project implementation status can be obtained from each project.

Project	Duration	Donor
FCPF Readiness Grant	2018 - 2022	FCPF
GFLL	2022 -	FCPF
ICBF	2015 - 2023	KfW
I-GFLL	2020 - 2024	GiZ, GCF
LLL	2021 - 2027	World Bank
LENS2	2014 - 2022	World Bank
VFMP	2019 - 2026	KfW
PICSA	2019 - 2025	IFAD
SRIWSM	2020 - 2027	ADB, EU and BMZ

3. **It is not earlier than January 1st 2016**

The start date is not earlier than 1 January 2016.

4. **It does not fall within the Reference period.**

The Reference Period starts on January 1, 2005 and ends on December 31, 2014.

5. It is demonstrated that the ER Program complies with requirements since the start date on safeguards carbon accounting and double-counting as specified in the MF

The ER program has been in compliance with all requirements since its start date. This compliance includes the safeguards (see Annex I of this report), carbon accounting practices (Section 4 of the ER Monitoring Report), and double counting (Section 6 of the ER Monitoring Report).

7. CARBON POOLS, SOURCES AND SINKS

7.1 Description of Sources and Sinks selected

Table 27: Sources and Sinks accounted for in the ER Program

Sources/Sinks	Included?	Justification/Explanation
Emissions from deforestation	Yes	A deforestation event is a change from a forest REDD+ stratum to the non-forest REDD+ stratum. This change can be caused by activities such as conversion of forests to agricultural land, infrastructure, urbanization etc.
Emissions from forest degradation	Yes	A degradation event is a change within forest REDD+ strata from a higher carbon stock stratum to lower carbon stock stratum, and also through measurement of tree stumps as a proxy indicator for estimating emissions from selective logging activities. The short-term changes between certain stages of rotational agriculture may also be recorded as a degradation event (see Section 8). In the context of the ER Program area, such degradation events occur most often in classes of Evergreen forest: EG (Strata 1) and Mixed Deciduous forest: MD (Strata 2) being degraded into the Regenerating Vegetation: RV class (Strata 4)
Removals from forest Restoration	Yes	A restoration event is a change within forest strata from a lower carbon stock stratum to a higher carbon stock stratum (in IPCC terms, "forest land remaining forest land"). This change often is due to regrowth of the RV class (Stratum 4), resulting in a transition to other natural forest classes.
Removals from reforestation	Yes	A reforestation event is a change of non-forest land categories (Stratum 5) to forest land categories (Strata 1-4). This change often results from a non-forest land (Stratum 5) being converted into the Plantation class, or regenerating into the RV class (both Stratum 4).

7.2 Description of carbon pools and greenhouse gases selected

Table 28: Carbon pools accounted for under the ER Program

Carbon Pools	Selected?	Justification/Explanation
Above Ground Biomass (AGB)	Yes	AGB comprises most of the forest biomass of the ER Program area, and thus is considered as a significant carbon pool.
Below Ground Biomass (BGB)	Yes	On average, BGB equals 37.6% of the AGB per ha. Thus, BGB is considered as a significant carbon pool. Due to the lack of country-specific data, the IPCC default values were used for the estimation.
Dead Wood (DW)	No	The 2nd NFI included measurement of DW. Historical results showed that emissions from DW through deforestation accounts only 1.7% of the sum of the AGB, BGB, and DW, and therefore is considered insignificant. Lao PDR currently lacks complete data sets to account for DW in the RL, but may include DW in the measurement of the next NFI. Nonetheless, consistency between the RL and MMR will be maintained. Exclusion of DW is considered to be conservative on the assumption that the proposed ER Program interventions will be successful.

Litter	No	As carbon stock of litter was assumed to be small under a moist tropical climate, such as in Lao PDR (2.1 tC/ha for Lao PDR according to the IPCC 2006 Guideline Volume 4, Chapter 2, Table 2.2), the discussions leading up to the 2nd NFI agreed not to measure litter in the 2nd NFI. The emissions from litter can be assumed to be smaller than that of the DW. Inclusion of litter in the measurement will be considered in the future step-wise improvement. Exclusion of litter is considered to be conservative on the assumption that the proposed ER Program interventions will be successful.
Soil Organic Carbon (SOC)	No	No reliable country specific data exists for soil organic carbon. Inclusion of soil organic carbon in the measurement will be considered in the future step-wise improvements. Exclusion of soil organic carbon is considered to be conservative on the assumption that the proposed ER Program interventions will be successful.

Table 29: Gases accounted for under the ER Program

GHG	Selected?	Justification/Explanation
CO2	Yes	The ER Program shall always account for CO_2 emissions and removals
Non – CO2 (CH4, N2O)	No	Shifting cultivation is an important disturbance event in the ER Program area, where nearly 100,000ha/year of forest lands are assumed to be affected by slash and burn practices. CH4 and N2O are the gasses emitted from biomass burning. There is no country-specific biomass combustion factor which can be applied for slash and burn activities. Forest fires, which are mostly uncontrolled spreading of fire from slash and burn activities, are another source of emissions of CH4 and N2O. Lao PDR currently does not have a national system to accurately monitor forest fires and its affected areas; it is also a challenge to distinguish whether the fires are anthropogenic or naturally caused. For these reasons, non-CO2 gasses (CH4 and N2O) are excluded from the RL. Exclusion of CH4 and N2O is considered to be conservative.

8 REFERENCE LEVEL

8.1 Reference Period

The reference period of the RL for the ER Program is 10 years, with January 1, 2005 as the start-date and December 31, 2014 as the end-date.

8.2 Forest definition used in the construction of the Reference Level

Forest and forest resources in Lao PDR occur in lands that are designated by the Government as forest lands, and in areas outside forest lands, and includes both stocked and temporarily un-stocked forests.

The land and forest classification system of the country applies two levels of classification, namely, Level 1 consisting of seven classes including "Current Forests" and "Potential Forests" among others, and Level 2 which further classifies the "Current Forest" class under Level 1 into five natural forest and one plantation forest classes.

The carbon accounting approach applied in the RL for the ER Program uses both "Current Forest" and "Potential Forest" classes as corresponding to the IPCC forestland category.

In Lao PDR, current forest is defined as **area of minimum 0.5 ha, with a minimum crown cover of 20% with trees with minimum DBH of 10 cm**.

Potential forests are 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. This definition is in line with the IPCC's definition of forest land that includes "...a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category." (IPCC, 2006).

For the REDD+ MRV including the MMR for the ER Program, the national land and forest classes are condensed into five strata (referred to as the 5 REDD+ strata). Such simplified stratification is intended to reduce uncertainty of emissions and removals while balancing the accuracy of sampling, and the costs and efforts required. The forest stratification used for the construction of the ER Program RL includes the following five types of forestland and non-forest land. One of the applied technical corrections is to update the Emission/Removal factors (E/F factors) by using the data from the 3rd NFI and the 2nd RV survey, which both have higher accuracy compared to the previous data. A summary of stratification is presented below:

- Evergreen Forest (EG) has distinctly high carbon stocks (205.8 tC/ha), and thus is separated as an independent stratum – **Stratum 1**.
- Mix Deciduous Forest (MD), Conifer Forest (CF) and Mixed Coniferous and Broadleaved Forest (MCB) form one stratum on the basis of similarity in carbon stocks (87.9 tC/ha, 77.1 tC/ha, 87.6 tC/ha) – **Stratum 2**.
- Dry Dipterocarp Forest (DF) forms one stratum due to the difference in carbon stock from other forest classes (50.8 tC/ha) – **Stratum 3**.
- Plantation (P), Bamboo (B) and Regenerating Vegetation (RV) forms one stratum on the basis of similarity in average carbon stock (37.2 tC/ha, 24.4 tC/ha, 17.4 tC/ha) – **Stratum 4**.
- The remaining 12 non-forest classes forms one stratum – **Stratum 5**.

Table 30: National level land and forest classification system of Lao PDR with IPCC definition on land use categories "Land/forest classes"

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	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)	
Grassland	Other Vegetated Areas	Savannah (SA)	5
		Scrub (SR)	
		Grassland (G)	
Cropland	Cropland	Upland Agriculture (UC)	
		Rice Paddy (RP)	
		Other Agriculture (OA)	
		Agriculture Plantation (AP)	
Settlement	Settlements	Urban (U)	
Other Land	Other Land	Barren Land (BR)	
		Other (O)	
Wetland	Wetlands	Water (W)	
		Swamp/Wetland (SW)	

8.3 Average annual historical emissions over the Reference Period

8.3.1 Description of method used for calculating the average annual historical emissions over the Reference Period

Reflecting the dynamic nature of land-use changes in the ER Program area, and also to adequately monitor the future impacts of the ER Program, Lao PDR considers it more appropriate to present historical emissions and removals separately for each source and sink activity. Accordingly, the four sources and sinks are estimated by calculating the changes in biomass caused by the shift from one REDD+ stratum to another. Considering the available nationally derived data, Lao PDR applies an approach principally following the gain-loss method in calculating the average annual historical emissions and removals over the reference period, using AD and E/R factors. Both emissions and removals occurring in forests remaining in the same category, however, are not accounted for, except in the case of emissions from selective logging estimated through measurement of tree stumps as a proxy indicator.
As described in the section 2.2.2 of the ER Monitoring Report, the Emission/Removal factors are calculated from the carbon stock of the forest/land classes stratified for the five REDD+ strata.

Equation 1 (from 1a to 1e) outlines how the carbon stock of a forest type is calculated using the field measurements conducted during the National Forest Inventory. These calculations can be followed in the spreadsheet "NFI3 Cstock Calculation.xlsx" where Equation 1a is used in the tab "Trees". Equations 1b and 1c are used in the tab "Tree-plots". Equation 1d is used in the tab "Plots", and finally Equation 1e is used for carbon stock computation for the national level in the tab "National"

Equation 1a: AGB for a sub-plot

$$AGB_i = \sum_{j=1}^{n_i} \frac{AGB_{ij}}{A_{nest}}$$

Where:
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha) which is the sum of the biomass of all measured trees in the sub-plot, divided by the area of the sub-plot.
n_i = The number of measured trees (live and standing dead trees) in the sub-plot.
AGB_{ij}= The biomass of a tree, estimated with an allometric equation (in kg).
A_{nest}= The area of the nested sub-plot where the tree was measured (in ha)

Equation 1b: BGB for a sub-plot

$$BGB_i = AGB_i x\ RS$$

Where:
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha)
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
RS= Root to shoot ratio (2003 2006 IPCC default values) from Table 5 below.

The BGB is calculated at the sub-plot level using the root-shoot ratio that corresponds to the AGB threshold of the calculated sub-plot AGB and the forest type defined for the plot.

Table 31. RS ratio by forest types and AGB threshold [40]

Forest type	AGB threshold	Root-to-Shoot ratio (R/S ratios)	Source	Description
EG, DD, MD, and MCB	AGB < 125t/ha	0.20	IPCC GL 2006 for National Greenhouse Gas Inventories (Chapter 4: Forest land, Table 4.4)	These forest types are considered being in the Tropical domain and part of the Tropical moist deciduous forest ecological zone
	AGB > 125t/ha	0.24		
CF	AGB < 50t/ha	0.46	2003 IPCC Good Practice Guidance for LULUCF (Chapter 3: LULUCF Sector Good Practice Guidance, Table 3 A.1.8)	In the table the values are for the Vegetation Type Coniferous forest and plantation
	AGB = 50 - 150t/ha	0.32		
	AGB > 150t/ha	R/S = 0.23		
Plantation	AGB<50t/ha	0.46	2003 GPG(Anx_3A_1_Data_Tables3A.1.8)	In the table the values are for the Vegetation Type Coniferous forest and plantation
	AGB=50-150t/ha	0.32		
	AGB>150t/ha	0.23		
Bamboo		0.82	Junpei Toriyama (http://www.ipcc-nggip.iges.or.jp/EFDB/main.php)	Search by ID: 520906
RV	AGB<20t/ha	0.56	IPCC GL 2006 (V4_04_Ch4_Table4.4)	This forest type is considered being in the Tropical domain and part of the Tropical dry forest ecological zone
	AGB>20t/ha	0.28	IPCC GL 2006 (V4_04_Ch4_Table4.4)	

[40] LaoPDR_ModifiedREL(UNFCCC) Annex2 EF report https://redd.unfccc.int/files/2018_frel_submission_laopdr.pdf

The RS ratio outlined in the table above were used in combination with the measurements made during the 3rd NFI for the five natural forest types, the measurements made during the 2nd RV survey for the RV, and IPCC default values for Bamboo and plantations.

Equation 1c: Total carbon stock for a sub-plot

$$C_i = (AGB_i + BGB_i)\ x\ CF$$

Where:
C_i= Carbon stock for the sub-plot i. (expressed in tC/ha) which is the sum of the biomass of all measured trees in the sub-plot.
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha) calculated with equation 1b.
CF = Carbon Fraction, IPCC default value 0.47 (2006 IPCC GL Volume4, Chapter 4- Table 4.3 for the forest types in Laos).

Equation 1d: Total carbon stock for a plot

$$C_p = \frac{1}{n_{sp}} \sum_{i=1}^{n_{sp}} C_{isp}$$

Where:
C_p= Carbon stock for the plot p. (expressed in tC/ha)
n_{sp} = The number of surveyed sub-plots for the plot p.
C_{isp} = Carbon stock for the sub-plot i.

Equation 1e: Total carbon stock for a forest type

$$C_f = \frac{1}{n_p} \sum_{i=1}^{n_p} C_{ip}$$

Where

C_f= Carbon stock for the forest type f. (expressed in tC/ha)
n_p = The number of surveyed plots for the forest type f.
C_{ip} = Carbon stock for the plot i.

Following the computation of the carbon stock with Equation 1, Equation 2 computes the carbon stocks for the five REDD+ stratum. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF".

For the carbon accounting, the Forest Type Maps are stratified into five REDD+ strata according to the amount of carbon stock for the various classes (see Table 4 above). The data comes from the NFI, the Regenerating Vegetation survey, or various IPCC default values. The carbon stock of each REDD+ stratum is calculated as follows:

Equation 2: Develop stratified carbon stocks for each of the five REDD+ stratum

$$C\text{stratum}\ (tC/ha) = (C1*A1+C2*A2+....+Cn*An)/(A1+A2+....+An)$$

Where:
Cstratum = average carbon stock (tC/ha) of the REDD+ stratum calculated from biomass and area of land/forest class;
Cn = carbon stock of land/forest class n (tC/ha);
An = area (ha) of land/forest class n.

For instance, for calculating the C stratum of the strata 2 that combines three forest types, namely MD, CF and MCB, the carbon stock of each of these land/forest classes from the 3rd NFI as well as their respective areas in the Forest Type Map 2019 are used.

Then the Emissions/Removals factors for different combinations of land cover change are calculated using the equation 3 as shown below. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF". The results of this calculation are presented in section 3.1 of the Emission Reductions Monitoring Report.

Equation 3. Calculation of E/R factors for changes among REDD+ strata

$$EF\text{ij } or\ RFij \text{ (tCO2e/ha)} = \left(Cstrata_i - Cstrata_j\right) \times \frac{44}{12}$$

Where:
EFij or RFij: Emission Factor EF or Removal Factor when the change incurred from REDD+ stratum i to REDD+ stratum j;
$Cstrata_i$ and $Cstrata_j$ are carbon stocks per ha of REDD+ stratum i and j corresponding to the changes;
If $Cstrata_i > Cstrata_j$, such change is considered emissions (change from a higher C/ha stratum to a lower C/ha stratum);
If $Cstrata_i < Cstrata_j$, such change is considered removal (change from a lower C/ha stratum to a higher C/ha stratum);
44/12 is the constant of CO2 mass to C mass for converting tC to tCO2e.

By using Equations 1, 2 and 3, the E/R factors are calculated. For the Activity Data, the area estimates and their related uncertainties are calculated from the error matrices following the sample-based estimation with the visual interpretation of plots. The calculation of the adjusted areas is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "AD_Uncertainty".
Lao PDR applies an approach principally following the gain-loss method in calculating the average annual historical emissions and removals over the reference period, using AD generated from stratified sample-based assessment of satellite data and E/R factors derived from periodic national forest inventories.

Equation 4a is for the emissions and Equation 4b is for the removals respectively, are used in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total".
In the tab "Total", Activity Data are displayed from row 1 to 54
In the Tab "Total", E/R Factors are displayed from row 56 to 82
The calculation of AD x EF (equations 4a and 4b) are in cells E85:J115 displayed as matrices and aggregated by activities in the table M85:N98.

Equation 4a: Calculation of the emissions (over a time period)

$$Emissions = \sum_{j,i} EF_{ij} x\ A(j,i)_{RP}$$

Where:
Emissions = Emissions (tCO2e) from area changing from stratum I to stratum j over a time period.
$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the time period (ha).
EF_{ij} = Emission Factor when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

Equation 4b: Calculation of the removals (over a time period)

$$Removals = \sum_{j,i} RF_{ij} x\ A(j,i)_{RP}$$

Where:
Removals = Removals (tCO2e) from area changing from stratum I to stratum j over a time period.
$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the period (ha).
RF_{ij} : Removal Factor when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

For the Monitoring Period, the same equations 4a and 4b are used, considering the area converted during the Monitoring Period $A(j,i)_{MMR}$

Once emissions and removals are calculated, adjustments are made as described in Section 2.2.1 of the ER Monitoring Report, as step 2

- Removals are adjusted to account for the fact that forest recovery (change from lower biomass class to higher biomass class) does not happen instantly; per IPCC guidelines, this happens over a period of time, often set at 20 years. A similar adjustment is made to account for reversals (change from higher biomass class to lower biomass class) which are observed to occur on previously disturbed lands which had not yet achieved full recovery.
- Emissions are adjusted to account for the disturbances of land which had previously been disturbed and had recovered but had not yet achieved full recovery. A similar adjustment is made for potential double-counting of emissions for disturbed areas which are captured in the stump survey.

Adjustments are made for both Reference Level and the Monitoring Period.

Equation 5a: Adjustment on removals

$$Removals_{adj} = Removals\ x\ RegrowthRate - Reversal$$

Where:
$Removals_{adj}$= Adjusted removals in tCO2e.
$RegrowthRate$ = This adjustment takes into account the low regrowth of forest (40 years from non-forest to forest and 20 years from a lower biomass to a higher biomass forest) and the duration in year of the time period.
$Reversal$ = Amount of overestimated removals calculated from the historical FTMs where restoration or reforestation had occurred during the previous time period but saw a reversal event in the latest time period.

Equation 5b: Adjustment on emissions

$$Emissions_{adj} = Emissions - Reversal - Doublecounting(stumps)$$

Where:
$Emissions_{adj}$= Adjusted emissions in tCO2e.
$Reversal$ = Amount of overestimated emissions calculated from the historical Forest Type Maps where a restoration event had occurred during the previous time period before a disturbance in the latest time period.
$Doublecounting(stumps)$ = Degradation due to a downward shift in the three REDD+ strata (Stratum 1, 2 and 3), which may include the logging emissions. This amount is deducted to avoid potential double-counting with the logging emissions, as accounted using Equation 6a below.

The calculation of the adjusted emissions and removals is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total".
The $Reversal$ component is calculated in tab "TSA_Remove" and tab "TSA_Emission" for the adjustment of removals and emissions respectively for the RL. In the same spreadsheet, tab "TSA_Remove MMR" and tab "TSA_Emission MMR" calculate them for the monitoring period. As explained above, the historical Forest Type Maps are used for this calculation to conduct time-series analysis which is outlined in Section 3.1 and 3.2 of the ER Monitoring Report.

Once the emissions are adjusted, the logging emissions calculated from the stump measurements are added.
The calculation of the emissions from logging is presented in the specific spreadsheet "Emissions from logging.xlsx".

The calculation using Equation 6 below is presented in spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

Equation 6a: Calculation of the overall emissions with the addition of the emissions from logging, for the Reference Level and for the Monitoring Period.

$$Emissions_{all} = Emissions_{adj} + Emissions_{logging}$$

Where:
$Emissions_{all}$= Overall emissions in tCO2e.
$Emissions_{adj}$= Adjusted emissions in tCO2e.
$Emissions_{logging}$= Emissions from logging in tCO2e.

To calculate the Reference Level as well as the annual average of emissions and removals during the Monitoring Period, the sum of respective emissions and removals are divided by the number of years of the considered period. The Reference Level is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

Equation 6b: Calculation of the reference level

$$RL_t = \frac{1}{t}(Emissions_{all} + Removals_{adj})$$

Where:
RL_t = Net emissions/year of the RL over the Reference Period; tCO2e/year.
$Emissions_{all}$= All adjusted emissions in tCO2e, including the logging emissions.
$Removals_{adj}$= Adjusted removals in tCO2e.
t = number of years of the reference period.

To enhance the estimation of emissions from forest degradation, a technical correction was applied to the Reference Level. This approach that uses a specific map and sample-based estimation is described in the following section. The adjusted area from the Sample-Based Estimation is used as AD for forest degradation: $\mathrm{A_{DG}(j,i)_{RP}}$

8.3.2 Activity data and emission factors used for calculating the average annual historical emissions over the Reference Period

Activity data

Parameter:	$\mathrm{A(j,i)_{RP}}$ Activity Data for the Reference Level (AD) 2005-2015 (10 years)
Description:	Area of REDD+ strata change over the two periods of the Reference Level (2005-2010 and 2010-2015) provided by the overlay of the stratified Forest Type Maps and adjusted by a sample-based estimation. Twenty-five possible changes cover four activities: Deforestation, Forest Degradation, Forest Restoration and Reforestation. • Deforestation: loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum. • Forest Degradation: downward shift of a forest stratum from a higher carbon stock strata to another forest stratum with lower carbon stock. This shift will effectively include cases of transitional land use change events such as deforestation events not captured in the 5- year mapping interval (e.g. stages of rotational agriculture, from a recovered forest to a forest fallow, or a non-forest stage, or, land conversion for forest plantations). Through the application of this method, fallow land from shifting

cultivation sites are largely captured within the RV category and occur most prominently in MD and EG forests, accounting for the vast majority of the degradation events.

- Forest Restoration: upward shift of a forest land stratum with lower carbon stock to another forest land stratum with higher carbon stock.
- Reforestation: gain of forest carbon stock due to conversion of non-forest land stratum to a forest land stratum

YearX	YearX+5: stratum 1	stratum 2	stratum 3	stratum 4	stratum 5
stratum 1	SF1	DG1	DG2	DG4	DF1
stratum 2	RS1	SF2	DG3	DG5	DF2
stratum 3	RS2	RS4	SF3	DG6	DF3
stratum 4	RS3	RS5	RS6	SF4	DF4
stratum 5	RF1	RF2	RF3	RF4	SNF

Deforestation (DF)
Degradation (DG)
Restoration (RS)
Reforestation (RF)
Stable Forest (SF)
Stable Non-Forest (SNF)

In spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", Activity Data and their related uncertainty are calculated in tab “AD_Uncertainty”.

As part of the technical correction to the RL, the Forest Degradation is supplemented by a map produced with the CCDC-SMA script that directly captures forest degradation over a period of time (see below).

The calculation of the Activity Data and the uncertainty is presented in the spreadsheet “SBE_matrix_final_for_TC.xlsx” in the tabs “CCDC2005_2010” and “CCDC2010_2015” for the periods 2005-2010 and 2010-2015 respectively.

Data unit: Ha

Source of data and description of measurement /calculation methods and procedures applied:

Wall-to-wall national land/forest maps with the Level 2 classification for the years 2005, 2010 and 2015 developed by the FIPD of DOF, MAF.

The 2010 map serves as the benchmark map. Maps for the other years were developed through applying a change detection method to maintain consistency of classification and interpretation.

For the 2010 and 2015 maps, 5m resolution RapidEye imagery was used. For the 2005 map, SPOT 4&5 multi-spectral imagery was used.

The maps are stratified according to the five REDD+ strata and overlaid to produce the AD maps for the period 2005-2010 and 2010-2015. The AD map is used to distribute reference sample plots following a stratified random sampling approach. The visual interpretation of the plots is done with Collect Earth and the resulting reference sample is used to calculate

the AD are estimates and their related uncertainty following the approach outlined by Olofsson (2014)[41].

The sample size was determined by using the formula by Cochran (1977), assuming that the sampling cost of each stratum is the same.

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

Where:

N = number of sample points for the stratum of interest

- = standard error of the estimated overall accuracy that we would like to achieve

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 values were set as the target for allocating statistically sound sampling size:

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 sample plots.

Value applied

2005 \ 2010	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Stratum 1	473,906	355	0	482	154
Stratum 2	71	3,802,793	0	128,892	28,727
Stratum 3	0	0	17,056	66	65
Stratum 4	0	57,361	60	2,516,047	223,674
Stratum 5	0	0	0	182,805	690,635

2010 \ 2015	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
Stratum 1	483,524	120	7	257	767
Stratum 2	0	3,770,430	161	101,607	42,539
Stratum 3	0	0	17,171	121	184
Stratum 4	0	45,796	49	2,712,747	99,489
Stratum 5	0	0	0	142,703	705,477

[41] Olofsson et al. (2014) Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment 148, 42-57.

	As indicated in the description, the calculation of the Activity Data is conducted in the spreadsheet “MMR1_AD_ER_Calculation_20230413.xlsx". The adjusted values, displayed in the two matrices above, are in the tab “Total” cells M32:R46. These values are then used for the next calculation step for estimating the emissions and removals. However, with the technical correction, the area for forest degradation comes from the CCDC-SMA map and not from the change matrix above. The table below summarizes the AD as shown in the spreadsheet “MMR1_AD_ER_Calculation_20230413.xlsx" and tab “AD_Area” for deforestation (DF), restoration (RS) and reforestation (RF). For degradation (DF), the figure below comes from the Activity Data area estimated with the technical correction and calculated in the spreadsheet “MMR1_AD_ER_Calculation_20230413.xlsx", tab “Total”, cells F135 and G135. Area (ha) / 2005-2010 / 2010-2015 DF / 252,620 / 142,979 RS / 57,492 / 45,845 RF / 182,805 / 142,703 DG / 219,069 / 133,888
QA/QC procedures applied:	A mentioned in Chapter 2.1.2 of the ER Monitoring Report, quality assurance/quality control (QA/QC) procedures were first applied for the production of the FTMs and more particularly in the interpretation of the areas that have changed during a time period and, secondly for the sample-based estimation. It consists of a three stages approach: a first team of technicians conducts the initial interpretation. A second team of experienced technicians reviews the interpretation and then a third-party reviewer with the support of the FIPD GIS/RS team leader validates the interpretation. Secondly QA/QC procedures were used for the sample-based estimation.
Uncertainty associated with this parameter:	Uncertainty is calculated through the sample-based estimation procedure. Uncertainty (%) / 2005-2010 / 2010-2015 DF / 15.4 / 29.5 RS / 50.4 / 70.5 RF / 26.7 / 28.1 DG / 26 / 28
Any comment:	n.a.

Parameter:	$A_{DG}(j,i)_{RP}$ AD for the Reference Level (AD) 2005-2015 (10 years) – Technical correction to the estimate of emissions from forest degradation
Description:	**Technical correction to the RL** During the ERPD assessment, the Technical Advisory Panel (TAP) observed that the 5-year frequency of the time-series of AD used for the RL would not fully track the true carbon stock

	balance of the Regenerating Vegetation (stratum 4). This stratum includes fallow land, previously forested but cleared by shifting cultivation, as cultivation cycles may vary from four to nine years. A conservativeness factor of 15% was therefore applied to the emissions from forest degradation associated with the RV lands. Another issue was that the uncertainty of the AD estimates, especially for the degradation are quite high for the reference period: 40% for the period 2005-2010 and 32% for 2010-2015 respectively. The FMT considered these as relatively high, and strongly encouraged Lao PDR to improve the estimation approach. To address the points above, Lao PDR proposed to apply a revised approach for the estimation of emissions from forest degradation and more particularly from shifting cultivation. The area of forest degradation is given by a map produced with the CCDC-SMA script – one map for each period 2005-2010 and 2010-2015. A sample-based estimation provides the adjusted area estimates.
Data unit:	Ha
Source of data and description of measurement /calculation methods and procedures applied:	The Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) script [42] has been developed by the Boston University to specifically detect forest degradation. One map was produced for each time period. The CCDC-map was combined with the existing Forest Type Map to supplement the forest degradation area. Sample-based estimation was conducted for each period using a random sample of 500 plots. The visual interpretation of the plots uses Collect Earth Online (CEO) projects to enable the technicians to assess various drivers of forest degradation. Therefore, the adjusted area is the one for which the reference plots were identified as shifting cultivation plots (setting aside the ones that were identified as forest degradation resulting from other drivers). The E/R factors used for this technical correction are the E/R factors corresponding to the DG4, DG5, or DG6 sub-activities depending on the forest stratum identified for at the start of the time period. This activity corresponds to pioneering shifting cultivation. As no related E/R factors can be associated with rotating shifting cultivation, any related emissions could not be calculated. The Technical Correction to enhance the estimation of emissions from forest degradation focused only on the ER Program area.
Value applied	

AD	Shifting cultivation (ha)	Form of shifting cultivation	
		Pioneering (%)	Rotating (%)
2005-2010	641,565	34	66
2010-2015	636,048	21	79

The calculation of the Activity Data and the uncertainty is in the spreadsheet "SBE_matrix_final_for_TC.xlsx" in the tabs "CCDC2005_2010" and "CCDC2010_2015" for the periods 2005-2010 and 2010-2015 respectively.
These figures are then used in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", tab "Total", cells F135 and G135 for the calculation of emissions and removals.

[42] https://code.earthengine.google.com/?accept_repo=users/shijuanchen32/forest_degradation_georgia

QA/QC procedures applied:	A specific manual was produced to guide technicians in the use of the Collect Earth Online interface. For the visual interpretation, two rounds of interpretation were conducted by different technicians. A third one was conducted for the plots with non-matching interpretations. The third round was overseen by a senior technician.
Uncertainty associated with this parameter:	Uncertainty is calculated through the sample-based estimation procedure. Uncertainty from sampling: 2005-2010 26%; 2010-2015 28%
Any comment:	n.a.

Parameter:	$RegrowthRate$, $Reversal$ and $Doublecounting(stumps)$, Adjustments to emissions and removals (Reference Level)
Description:	Considering that forest biomass increases slowly over time to reach their biomass and the land cover change over time, adjustments are made to not over-estimate emissions or removals
Data unit:	tCO2eq
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Adjustments were made by considering the types of changes and rate of tree growth. This recognizes that in forest ecosystems, forest biomass increases slowly over time to reach full biomass (IPCC 2006) [43]. As such, the slow regrowth of the forest is taken into account to not over-estimate removals. The same approach applies to the emissions, to not over-estimate the emissions from a land that would not have regrown completely to forest. For the reference period, the number of years of each time period is used in the calculation. Adjustment uses a time-series analysis to identify the land cover change patterns that leads to over-estimation and adjusts the Emissions/Removals to reflect the actual time needed for forest recovery (IPCC 2006) as mentioned above. Forest Type Maps 2005, 2010 and 2015 were used for the time-series analysis. As indicated in section 2.2.2 of the ER Monitoring Report, adjustments are implemented in equation5a and equation5b.

[43] IPCC (2006, Volume 4, Chapter 4.3: Land Converted to Forest Land) suggests default period of 20 year time interval for forest ecosystems to be established.

	The time-series analysis as well as the calculation of the adjusted emissions and removals are in the spreadsheet '"MMR1_AD_ER_Calculation_20230413.xlsx", in tab "TSA_Remove", "TSA_Emission" and "Total".
Value applied:	Adjustment – Over estimation of removals

	Stratum in 2005	Stratum in 2010	Stratum in 2015	Estimated area (ha)*	Emissions to be deducted from Reversals (tCO_2e)
Change patterns from time series	4	2	4	2,299	73,475
	4	2	5	1,684	53,833
	4	3	5	1	17

In total, 127,325 tCO2e would be deducted from removals from restoration for the period 2010-2015.

Adjustment – Overestimation of emissions

	Stratum in 2005	Stratum in 2010	Stratum in 2015	Estimated area (ha)*	Emissions to be deducted from Emissions (tCO_2e)
Change patterns from time series	4	2	4	1,492	-345,787
	4	2	5	1,467	-370,226
	4	3	5	1	-153

Overestimation of emissions from deforestation equals 370,379 tCo2e and 345,787 tCo2e from degradation.

QA/QC procedures applied	The calculation steps and the spreadsheet used for calculating the adjustments are reviewed by an external expert.
Uncertainty associated with this parameter:	The uncertainty of the adjustments is not used in the Monte Carlo simulation as it is considered being covered by the uncertainty of the Activity Data.
Any comment:	n.a.

Parameter:	$Emissions_{logging}$ Emissions from logging for the Reference Level
Description:	Emissions from logging estimated from the field measurements (stumps) from the 2nd NFI in the six northern provinces of the ER Program.
Data unit:	tCO2eq
Source of data or description of the method for developing	The Lao NFI uses random nested plots. For the 2nd NFI, a total of 114 plots were surveyed in the ER Program area. Stumps located in the plots are measured and recorded as below: • Height (H) - below 1.3m • Smallest Diameter (D1) – the smallest diameter across the top of the stump • D2 – the diameter at a 90° angle to D1.

the data including the spatial level of the data (local, regional, national, international):	• Instrument used for tree felling (e.g. machine, saw axe) With these measurements, the biomass loss is estimated as follows: 1. Calculate the 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 [44]: 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* 5. Estimate the AGB by using the allometric equation used in the 2nd NFI 6. Convert the AGB loss by using an area ratio (t/ha) 7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots) 8. Estimate the plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot) 9. Estimate the average AGB loss(t/ha) for each forest class by dividing the total number of plots of each forest class 10. Estimate the BGB loss by using default conversion factor found in the IPCC 2006 Guidelines 11. Convert biomass to CO2 with the same conversion factor for estimating the carbon stock 12. Estimate the total loss tCO2e by multiplying above value by the area of Forest Type Map 2015 for each forest class. The method above estimates the biomass loss but does not provide average emissions per year, as it is quite challenging to estimate when the trees were actually felled. An equation, which was developed in an experimental study in Pasoh in the Malaysian Peninsula, [45] is used to estimate the years required for wood materials to decompose. According to the temperature and precipitation averages recorded for northern Lao PDR, it is reasonable to assume that the stumps observed and measured were felled within a 12-year period before the survey. The total biomass loss calculated above is then divided by 12 to obtain a yearly average for the Reference Level.

[44] Ito et al., 2010. Estimate Diameter at Breast Height from Measurements of Illegally Logged Stumps in Cambodian Lowland Dry Evergreen Forest. JARQ 44(4),440

[45] 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

Value applied:

	Average loss tCO2e/ha	Area(ha) Forest type map 2015	tCO2e (12 years)
EG: Evergreen Forest	3.7	481,380	1,802,956
MD: Mixed Deciduous Forest	2.1	3,771,453	7,873,894
DD: Dry Dipterocarp	6.1	17,351	105,519
CF: Conifer Forest	-	25,782	-
MCB: Mixed Conifer and Broadleaved forest	-	2,180	-
	Total		9,782,369
	Annual average (tCO2e) (Total divided by 12 years)		815,197
	Emissions for the Reference Level (10 years)		8,151,970

The detail of the calculation is available in the "emissions from logging.xlsx" spreadsheet, tab "StumpWork_2ndNFI FCPF CF". The table above is in cells AS11:AV17 and the annual average value is in cell AX17.

QA/QC procedures applied

In the Lao NFI, a dedicated team conducts quality assurance/ quality control (QA/QC) by revisiting 10% of the measured plots. The measurements between the QA/QC team and the survey teams are compared to assess if they are statistically robust. For the 2nd NFI, no significant statistical difference was found in the measurements from QA/QC and the survey teams.

The Standard Operation Procedures (SOP) for the Terrestrial Carbon Measurement is available with this link.

Uncertainty associated with this parameter:

This proxy-based approach has been identified through wide expert consultations as the best currently-available method to quantify the impacts of illegal logging in Lao PDR. The limitations around its design, however, are well-acknowledged. To compensate for this issue, the prescribed 15 % conservativeness factor is applied.

For the uncertainty analysis which uses a Monte Carlo approach, the standard error used as the input parameter for the uncertainty for emissions from logging, comes from a previous analysis that was conducted for the national FREL in 2018. The calculation is in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and tab "logging_uncertainty". It uses a propagation of error approach. The uncertainty calculated for emissions from logging for the reference level is 21.68%

Any comment:

n.a.

Emission/Removal factors

Parameter:	EFij Emission/Removal factors (E/R factors)
Description:	E/R factors are developed for each type of REDD+ strata change (i.e., 20 possible change combinations) and by taking the difference in carbon stock of each of the 5 REDD+ strata. AGB and BGB are the carbon pools selected.
Data unit:	tCO2eq/ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international) :	Carbon stocks for each forest land classes of the level 2 of the Lao classification, are collected through various sources as described below: • Measurements of carbon stock of the five natural forest classes (Evergreen Forest (EG), Mixed Deciduous Forest (MD), Coniferous Forest (CF), Mixed Coniferous and Broadleaved Forest (MCB), and Dry Dipterocarp Forest (DD). • Measurements from the 3rd NFI conducted in 2019 are used to estimate the AGB. A total of 415 survey plots were distributed for these five forest classes through random-sampling. • Country-specific allometric equations [46] were developed and applied for the three major Level 2 forest classes (i.e. EG, MD and DD). (Morikawa Y., Daisuke Y., Therese T., and Walker S., Development of country-specific allometric equations in Lao PDR, 2017) • For the other two forest classes (CF and MCB) the allometric equations developed in Vietnam [47] were used without applying correction factors.

Evergreen Forest (EG)	$0.3112*DBH^{2.2331}$
Dry Deciduous Forest (DD)	$0.2137*DBH^{2.2575}$
Mixed Deciduous Forest (MDF)	$0.523081*DBH^{2}$
Coniferous Forest (CF)	$0.1277*DBH^{2.3944}$
Mixed Coniferous and Broadleaf Forest (MCB)	$0.1277*DBH^{2.3944}$

Regenerating Vegetation (RV)

The carbon stock is calculated from the 2nd RV survey conducted in 2019. As the RV occurs most prominently in Northern Lao PDR (including the ER Program area), survey sites were distributed in three provinces in the Northern region (Luang Namtha, Oudomxay and Houaphan). Other survey sites were located in one province in the Central region and three provinces in the Southern region. A total of 189 survey plots (63 survey clusters with three survey plots each) were distributed and the measurement of DBH for trees and biomass weight measurement for the understories were conducted.

[46] Morikawa Y., Daisuke Y., Therese T., and Walker S., *Development of country-specific allometric equations in Lao PDR*, 2017

[47] Hung, N.D., Bay, N.V., Binh, N.D. and Tung, N.C. (2012). Tree allometric equations in Evergreen broadleaf, Deciduous, and Bamboo forests in the South East region, Vietnam. In (Eds) Inoguchi, A., Henry, M., Birigazzi, L., Sola, G.
Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD Programme, Hanoi, Viet Nam.

Bamboo (B)

The value is derived from the average carbon stock values of the Northern Central Coast region of Vietnam for the cycles II to IV (2000, 2005, and 2010). (Vietnam modified REL report, submitted to UNFCCC 2016, P66 Table3.6)

In this table 3.6 copied below from the Vietnam modified REL report, Bamboo is the Forest type code 6.

Table 3.6: NCC average carbon stock (tC/ha) per forest type

Forest type code	Cycle I		Cycle II		Cycle III		Cycle IV		Remark
	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	PSP (SSP)	Carbon stock	
1	116 (1813)	169 ± 10%	220 (3654)	175 ± 7%	163 (2820)	162 ± 13%	78 (1225)	141 ± 9%	
2	139 (1463)	70 ± 2%	268 (3305)	70 ± 2%	260 (3447)	73 ± 2%	172 (2398)	70 ± 3%	
3	144 (1335)	32 ± 5%	265 (3018)	31 ± 4%	248 (2925)	33 ± 4%	185 (2481)	31 ± 4%	
4	62 (491)	29 ± 17%	120 (1233)	24 ± 16%	176 (1810)	21 ± 10%	155 (1663)	19 ± 18%	
5	174 (4887)	40 ± 14%	321 (8822)	43 ± 5%	264 (7600)	32 ± 5%	165 (4401)	31 ± 8%	National
6	110 (1320)	16 ± 23%	75 (1085)	13 ± 17%	215 (3418)	13 ± 11%	96 (1463)	15 ± 18%	
7	46 (523)	68 ± 22%	40 (482)	70 ± 23%	124 (1480)	42 ± 10%	91 (1131)	40 ± 11%	
8	31 (607)	87 ± 18%	73 (1707)	67 ± 13%	57 (1341)	83 ± 13%	36 (645)	95 ± 11%	National
9	29 (340)	85 ± 24%	49 (473)	73 ± 17%	25 (293)	84 ± 25%	19 (227)	67 ± 45%	National
10	NA	35	NA	35	NA	35	NA	35	VAFS
11	2 (27)	36 ± 76%	4 (6)	66 ± 22%	1 (4)	43	2 (11)	38 ± 287%	
12	6 (76)	22 ± 56%	6 (69)	28 ± 25%	24 (234)	20 ± 39%	42 (444)	22 ± 30%	

The calculation steps to obtain the value used for Lao PDR are as follow:

- Average the values for the cycle II, III and IV,
- Convert to AGB (using 0.47 for Carbon Fraction)
- Calculate the total biomass by using a Root to Shoot Ratio of 0.82 (as indicated *in* Table 7 *in Section 8.3.1*
- Convert to carbon stock (using 0.46 for Carbon Fraction from table 4.3 IPCC Guidelines 2006 – value for wood, tree d<10cm in tropical and subtropical)

Plantations (P)

Carbon stocks were derived from default factors of the IPCC database.

(Good Practice Guidance for Land Use, Land-Use Change and Forestry, 2003 - Table 3A.1.3 Aboveground Biomass Stock in plantation forests by broad category – Asia (other species) moist with long dry season).

Other land classes

The value of carbon stocks of remaining land classes (non-forest classes) are mostly taken from IPCC GL 2006 and combined into a single area-weighted estimate for the non-forest class.

The detailed sources are listed below:

- Savannah, IPCC Emission Factor Database, ID=513130.
- Scrub, Table 4.7 from the IPCC 2006 Guideline V4. Tropical shrubland in Asia continental.
- Grassland, Table 3.4.2 from the GPG for LULUCF 2003. Peak AGB for Tropical, moist and wet climate zone.
- Upland Crop, Rice Paddy, Table 3.3.8 from the GPG for LULUCF 2003. Annual cropland.

- Other Agriculture, Table 3.3.8 from the GPG for LULUCF 2003. Perennial cropland in Tropical moist.
- Agriculture Plantation, IPCC Emission Factor Database, ID=511318

These E/R factors are calculated for the national level, though the use for the specific ER program area is valid as an analysis made after the 2nd NFI demonstrated that there was no tangible difference in carbon stock between the national results and t*hose of* the six provinces.
The 3rd NFI was conducted only for the national level.

Value applied:

Emission Factors (tCO2e/ha))

	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	-169.2
Stratum 4 (P/B/RV)	712.4	279.6	144.1	0.0	-25.0
Stratum 5 (NF)	737.4	304.7	169.2	25.0	0.0

QA/QC procedures applied

Standard Operating Procedures (SOP) for the NFI have been developed and was used in the 3rd NFI campaign. Improvements were made for the distribution of plots whereby four to nine sub-plots were distributed into a cluster plot to enable more possibilities for the field teams to find sub-pots for measurement. An emphasis was given to training, especially for the QA/QC team. 15% of all plots were checked by the QA/QC team.

Uncertainty associated with this parameter:

The ERPD uncertainty analysis used the propagation error approach. The following sources of uncertainty were assessed:

- Uncertainty of AGB originating from sampling error;
- Uncertainty of AGB originating from biomass equation;
- Uncertainty of Root-to-Shoot ratios due to the use of IPCC default values;
- Uncertainty of Carbon Fraction factor due to the use of IPCC default values; and
- Uncertainty of AGB originating from measurement error.

By using the propagation error approach, the uncertainty for the E/R factors are as in the table below.

E/R factors (Uncertainty %)

	EG	MD/CF/MCB	DD	P/B/RV	NF
EG	0.0%	12.0%	13.3%	15.3%	15.7%
MD/CF/MCB	12.0%	0.0%	10.5%	12.5%	13.3%

DD	13.3%	10.5%	0.0%	13.2%	14.4%
P/B/RV	15.3%	12.5%	13.2%	0.0%	15.1%
NF	15.7%	13.3%	14.4%	15.1%	0.0%

For the ER Monitoring Report, the uncertainty analysis uses a Monte Carlo approach with 10,000 iterations.

For the Monte Carlo simulation, the calculation of the EF differs from section 2.2.2 of the ER Monitoring Report as it uses the RS ratio in combination with the REDD+ strata. This is necessary in order to simulate the uncertainty of the R:S parameter. The spreadsheet used for the Monte Carlo simulation is derived from a template prepared by the World Bank that proposed a similar approach.

	Value	**Uncertainty (95%)**	**SE**
Carbon Fraction	0.470	2.7	0.00647
R:S for stratum 3 and 4	0.200	11.5	0.01173
R:S for stratum 1 and 2	0.240	20.3	0.02486
AGB (Strata 1) kg/ha	353.1	10.9	19.636
AGB (Strata 2) kg/ha	150.6	6	4.610
AGB (Strata 3) kg/ha	90.1	9	4.136
AGB (Strata 4) kg/ha	20.4	19.6	2.038
AGB (Strata 5) kg/ha	8.3	20	0.844

The uncertainty for the AGB is computed using the uncertainty from the sampling error and the biomass equation, as shown below:

Class	Uncertainty from 3rd NFI Sampling	Uncertainty from allometric equation
EG	10.2	3.9
MDF	4.8	3.8
CF	11.1	18.0
MCB	14.1	18.0
DD	8.2	3.6
P	-	18.0
B	15.7	0.3
RV	22.2	-

Any comment:	n.a.

8.4 Estimated Reference Level

ER Program Reference level

The RL is separated for emissions and removals. The technical corrections, as described already, apply using updated E/R factors and an improved approach for the estimation of emissions from forest degradation, to enhance the accuracy of the estimations.

As a result of the technical corrections, the ER Program Reference Level was corrected as below.

A full calculation can be seen in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx".

Table 32: ER Program Reference level after technical correction

Crediting Period Year	Average annual historical emissions from deforestation over the Reference Period (tCO2e/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO2e/yr)	If applicable, average annual historical removals by sinks over the Reference Period (tCO2e/yr)	Adjust-ment, if applicable (tCO2e/yr)	Reference level (tCO2e/yr)
2019	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
2020	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
2021	3,015,639	10,627,760	-1,337,395	n.a.	12,306,004
Total	**9,046,917**	**31,883,281**	**–4,012,185**	**n.a.**	**36,918,012**

8.5 Upward or downward adjustments to the average annual historical emissions over the Reference Period (if applicable)

No adjustments have been made to the RL.

8.6 Relation between the Reference Level, the development of a FREL/FRL for the UNFCCC and the country's existing or emerging greenhouse gas inventory

As part of its National Forest Monitoring System (NFMS), the approach used for constructing the initial RL was designed initially to establish the national FREL/FRL that was submitted to the UNFCCC in January 2018. The Emission Reduction Program was considered as a sub-national project for which the RL is a sub-set of the national FREL/FRL. The initial RL presented in the ERPD used the exact same methodological approach as the national FREL/FRL and is based on the same dataset.

The table below outlines the similarity between the national FREL/FRL and the initial RL as established for the ERPD and, compares them with the updated RL through the technical correction.

Table 33: Comparison table for national FREL/FRL with the ER Program RL

	National	ER Program	
	National FREL/FRL	ERPD initial RL	Technically corrected RL
Methodologies			
AD	Sample-based area estimation of AD for the national level.	Sample-based area estimation of AD for the 6 provinces (based on Forest Type Maps for the ER Program area derived from the national-scale Forest Type Maps for year 2005, 2010, and 2015)	Sample-based area estimation of AD for the 6 provinces (based on Forest Type Maps for the ER Program area derived from the national-scale Forest Type Map for year 2005, 2010, and 2015) Forest degradation used supplemental map produced with CCDC-SMA.
E/R factors	2nd NFI, 1st RV survey. Combination of country-specific allometric equation and IPCC default values.	2nd NFI, 1st RV survey. Combination of country-specific allometric equation and IPCC default values.	3rd NFI, 2nd RV survey Combination of country-specific allometric equation and IPCC default values
Reference Period	2005-2015	2005-2015	2005-2015
Carbon pools	AGB, BGB	AGB, BGB	AGB, BGB
Non-CO2 gasses	no	no	no
Scope of activities	Deforestation, forest degradation, forest enhancement (restoration) forest enhancement (reforestation)	Deforestation, forest degradation, forest enhancement (restoration) forest enhancement (reforestation)	Deforestation, forest degradation, forest enhancement (restoration) forest enhancement (reforestation)
Model applied	Historical average	Historical average	Historical average
Adjustment	n.a.	n.a.	n.a.
Uncertainty assessment	n.a.	Propagation of error approach	Monte Carlo analysis
Technical team			
Government team	Department of Forestry	Department of Forestry	Department of Forestry
Supporting partners	F-REDD/JICA, FCPF Readiness Project	F-REDD/JICA, FCPF Readiness Project	F-REDD 2/JICA, World Bank Task Team, Silva Carbon
Assessment process			

Technical endorsement	REL/MRV Technical Working Group, National REDD+ Task Force, Ministry of Agriculture and Forestry	REL/MRV Technical Working Group, National REDD+ Task Force, Ministry of Agriculture and Forestry	NFMS Technical Working Group National REDD+ Task Force, Ministry of Agriculture and Forestry
Political endorsement	Ministry of Natural Resources and Environment, as the UNFCCC focal point	Ministry of Agriculture and Forestry, as the implementing Agency of ER Program	Ministry of Agriculture and Forestry, as the implementing Agency of ER Program

9 APPROACH FOR MEASUREMENT, MONITORING AND REPORTING

9.1 Measurement, monitoring and reporting approach for estimating emissions occurring under the ER Program within the Accounting Area

The diagram shown as Figure 1, outlines the steps followed to establish the Reference Level and estimate the Emission Reduction during the monitoring period. It consists of five main steps that are described below.

【Step 1】

The first step is the estimation of the average annual historical emissions and removals based on the changes among REDD+ strata over the reference period (2005-2015) to establish the Reference Level, and the monitoring period (2019-2021) for assessing Emissions Reduction. This calculation uses the AD that are estimated through a sample-based approach on the REDD+ strata change maps. The emissions and removals are estimated separately for each source (emissions from deforestation and degradation) and sink (removals from restoration and reforestation).

The Forest Type Maps are produced for years 2005, 2010, 2015, 2019 and 2022 following the level 2 of the Lao classification system as shown in the table below. Maps are then stratified according to the REDD+ strata, and overlaid.

Table 34: Land and forest stratification

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	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)	
Grassland	Other Vegetated Areas	Savannah (SA)	5
		Scrub (SR)	
		Grassland (G)	
Cropland	Cropland	Upland Agriculture (UC)	
		Rice Paddy (RP)	
		Other Agriculture (OA)	
		Agriculture Plantation (AP)	
Settlement	Settlements	Urban (U)	
Other Land	Other Land	Barren Land (BR)	
		Other (O)	
Wetland	Wetlands	Water (W)	
		Swamp/Wetland (SW)	

To enhance the estimation of emissions from degradation, a CCDC-SMA[48] map is used to supplement the AD map obtained from the Forest Type Maps. This procedure was applied as a Technical Correction to the Reference Level and integrated in the MMR.

E/R factors are developed based on national surveys and IPCC default values for each type of land/forest cover change, stratified into five REDD+ strata, and by taking the difference in carbon stock of each REDD+ stratum. For both the Reference Level and the Monitoring Period, the same E/R factors are used by using the outputs of the 3rd NFI which have lower uncertainty. This change constitutes one of the Technical Corrections proposed.

The implementation of the NFI follows a SOP[49] to ensure the quality and accuracy of the measurements conducted at the plot location. Another SOP[50] guides the production of the Forest Type Maps. For instance, the visual interpretation of the change is conducted with a three-step approach, wherein a first technician makes the initial interpretation that is reviewed by another technician and finally validated by a senior interpreter. The sample-based assessment for computing the AD area estimates follows guidelines specified in the FCPF's templates for SOPs for sample-based area estimation: it has a QA/QC approach that also uses three rounds of interpretation.

【Step 2】

As step 2, the value calculated by the adjustment below from average annual historical emissions and removals is subtracted from the value estimated in step 1. Two adjustments were made with an aim to make the Step 2 estimation as accurate as possible:

iii) Adjustment of removals (regrowth rate and reversals)

Table 35. Adjustments to removals

Sinks	From	To	Adjustment of removals
Restoration	Stratum 4 (RV)	Stratum 1, 2 and 3	In forest ecosystems, forest biomass increases slowly over time to reach their full biomass (IPCC 2006)[51] In principle, 40-years[52] is assumed as the transition period from non-forest to Current Forest (i.e., Stratum 1, 2 and 3). From there, deduct 5 years as the period for RV to reach its average biomass stock (See RV Survey Report), to arrive at 35 years for the transition period for biomass of Stratum 4 to reach Stratum 1, 2 and 3.
	Stratum 2 (MD, CF and	Stratum with higher biomass	In principle, 20 years[53] is assumed as a transition period for forest with lower biomass to reach forest with higher biomass.

[48] Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) algorithm. Chen, S., Woodcock, CE., Bullock E., Arevalo, P., Torchinava, P., Peng, S. and Olofsson P. (2021).

[49] Standard Operating Procedures (SOP) for the Terrestrial Carbon Measurement as listed in Table 18.

[50] Standard Operation Procedures (SOP) for Forest Type Map development as listed in Table 18.

[51] IPCC (2006, Volume 4, Chapter 4.3: Land Converted to Forest Land) suggests default period of 20 years time interval for forest ecosystem to be established.

[52] The assumption is based on reference to the ERPD of neighboring Vietnam, which assumes 40 years for a non-forest to reach "Evergreen broadleaf forest – Medium". The Lao experts agreed on this assumption, as rather conservative. The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation (See footnote 32 in Section 4.1).

[53] Again, following the case of Vietnam where 20 years is assumed as a period for forest with lower biomass shift to forest with higher biomass. However, such changes are actually rare: 71 ha for 2005-2010 and nil for 2010-2015. The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation.

	MCB) Stratum 3 (DD)		
Reforestation	Stratum 5 (non-forest)	Stratum 4 (predominantly, RV)	In principle, the full removal factor is applied at the time change is observed, as RV reaches its average biomass stock after 5 years (See RV Survey Report) [54]. Adjustment based on 40-years default applied to the years following.
	Stratum 5 (non-forest)	Stratum 1, 2 or 3	No such change observed.

c. Adjustments due to considering the types of changes and rate of tree growth. This adjustment recognizes that in forest ecosystems, forest biomass increases slowly over time to reach full biomass (IPCC 2006).

d. Reversals during the reference period (2005-2015) were identified through a time-series analysis of polygons, to avoid double-counting. Due to the estimation method of generating AD for two independent periods (i.e., 2005-2010 and 2010-2015), there is a chance that the emissions from reversal events that have occurred during the reference period are unreported (in other words, removals are over-estimated). Therefore, tracking is done of all the change patterns that are regarded as reversals (e.g., stratum 4 in 2005, changed to stratum 2 in 2010 and reverted to stratum 4 in 2015). The results were deducted as over-estimated removals.

iv) Adjustment of emissions (from deforestation and degradation)

The resulting estimation (above) presents the risk of overestimation of emissions from deforestation and degradation. The E/R factors are stratum-specific and do not reflect the actual accumulated biomass, which may be lower than the calculations. For example, a MD forest that is in its early regrowth stage (e.g., 10th year) should have lower biomass than the average biomass of entire MD class including all its age ranges. If, for example, a land parcel shifted from stratum 4, to stratum 3, and then back to stratum 4, the indication would be that the stratum 3 forests before the disturbance event would have reached at their maximum growth at about 10-11 years. Such change patterns are tracked through the time-series-analysis of forest maps. The resulting overestimation of emissions from deforestation and forest degradation are estimated and deducted, respectively. The same rationale that was applied for the monitoring period was also considered for the periods 2015-2019 and 2019-2021.

【Step 3】

In Lao PDR, selective logging is considered as a major driver of forest degradation.

To improve the overall estimates of forest degradation, in addition to the approach described in Step 1, this Step 3 estimates the emissions from selective logging, both legal and illegal. These emissions from selective logging are estimated with a proxy-based approach that utilizes the stumps measurements collected in the field.

The Reference Level calculations use the stump measurements from the 2nd NFI and the first Monitoring Period uses data from a February 2023 stump survey. The biomass of the felled trees is estimated from the measured size of each tree stump and corresponding allometric equations, aggregated for each of the five forest classes (i.e., EG, MD, DD, CF, MCB) to estimate the average loss of carbon stock, and converted to tCO2e. Then, the results are multiplied with the area of each forest class calculated from the Forest Type Map 2015 and 2022 respectively for the Reference Level and the Monitoring Period, to estimate the assumed emissions from such logging events.

【Step 4】

In this step, the estimation of emissions and removals are finalized with the addition of the emissions from logging (Step 3), and the annual average is calculated for the Reference Level and the monitoring period, using their duration in years.

[54] The actual mapping cycle of 6 years and 4 years are also reflected in the actual calculation.

【Step 5】
The ERs are calculated by subtracting the annual emissions and removals of the monitoring period from the Reference Level.

【Step 6】
As final step, the uncertainty assessment using a Monte Carlo approach is conducted.

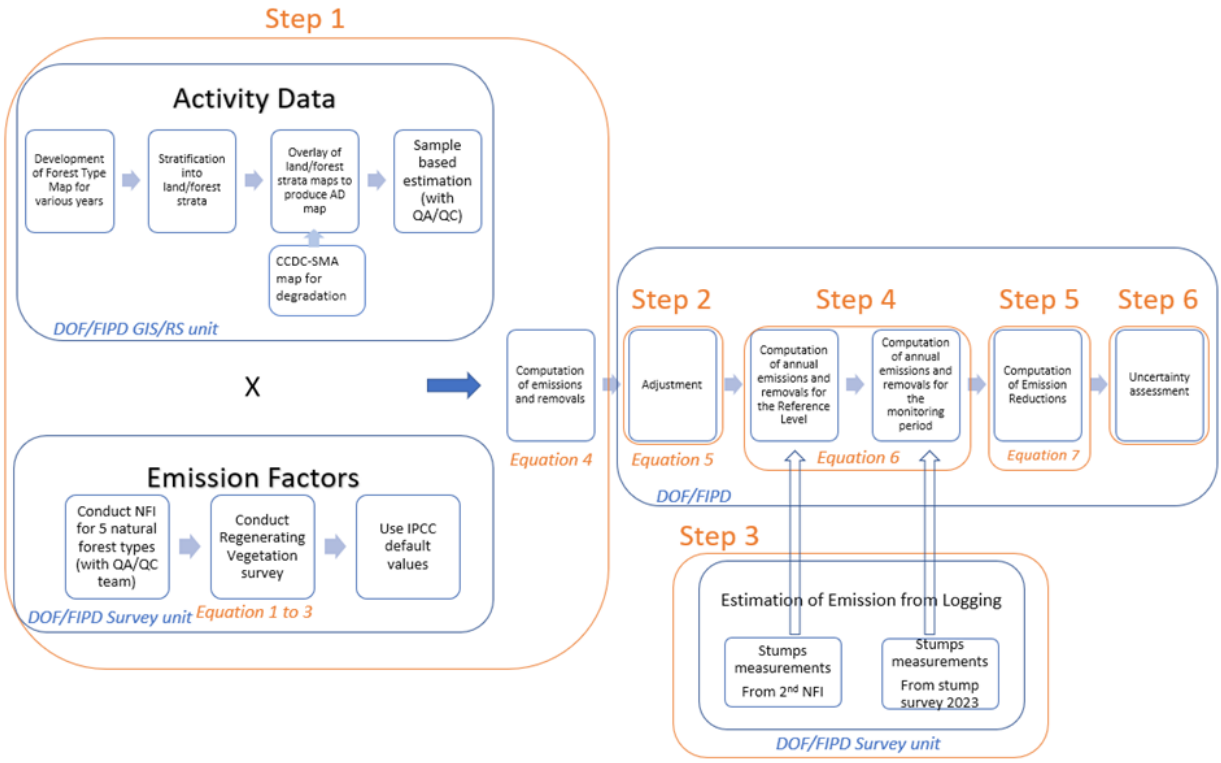


Figure 13: Line Diagram that outlines the overall approach for the MMR.

9.1.1 Calculation

In this section, the various steps for the carbon accounting as outlined by the Figure 1, are described with more focus on the equations used for the calculation. Note that all data, formula, and calculations are explicitly documented in a reproducible manner in several spreadsheets submitted as part of the Lao first Emission Reduction Monitoring Report. The examples below are only a subset of the calculations for illustrative purposes, refer to the respective spreadsheets for documentation of the complete set of calculations.

【Step 1】
The step 1 starts with the computation of the E/R factors.
The equation 1 (from 1a to 1e) outlines how the carbon stock of a forest type is calculated from the field measurements conducted during the National Forest Inventory. These calculations can be followed in the spreadsheet "NFI3 Cstock Calculation.xlsx" where Equation 1a is used in tab "Trees". Equations 1b and 1c are used in the tab "Tree-plots". Equation 1d is used in the tab "Plots", and finally Equation 1e is used for carbon stock computation for the national level in the tab "National".

As indicated in the previous section, the E/R factors are based on the carbon stock of the various forest and land classes outlined in the Table 10. Carbon stocks for the five current natural forest classes are calculated using the field measurement data collected through the NFI. The carbon stock of the Regenerating Vegetation class comes from the field measurements collected during the Regenerating Vegetation survey. For the other classes, IPCC default values are used. For a specific forest type, the AGB is estimated from the specific forest type allometric equation using the tree measurements at the sub-plot level. Then the BGB is calculated using root-to-shoot ratio. the carbon stock at the sub-plot level being the estimated biomass AGB + BGB multiplied by the carbon fraction. The carbon-stock for a plot is the average of the carbon stock estimated in each sub-plot.
Carbon stock for a forest type is the average of the carbon stock estimated in all plots of this forest type.

Equation 1a: AGB for a sub-plot

$$AGB_i = \sum_{j=1}^{n_i} \frac{AGB_{ij}}{A_{nest}}$$

Where:
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha) which is the sum of the biomass of all measured trees in the sub-plot, divided by the area of the sub-plot.
n_i = The number of measured trees (live and standing dead trees) in the sub-plot.
AGB_{ij}= The biomass of a tree, estimated with an allometric equation (in kg).
A_{nest}= The area of the nested sub-plot where the tree was measured (in ha)

Equation 1b: BGB for a sub-plot

$$BGB_i = AGB_i x\ RS$$

Where:
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha)
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
RS= Root to shoot ratio (2003 2006 IPCC default values) from Table 12 below.

The BGB is calculated at the sub-plot level using the root-shoot ratio that corresponds to the AGB threshold of the sub-plot AGB and the forest type defined for the plot.

Table 36. RS ratio by forest types and AGB threshold [5] [5]

Forest type	AGB threshold	Root-to-Shoot ratio (R/S ratios)	Source	Description
EG, DD, MD, and MCB	AGB < 125t/ha	0.20	IPCC GL 2006 for National Greenhouse Gas Inventories (Chapter 4: Forest land, Table 4.4)	These forest types are considered being in the Tropical domain and part of the Tropical moist deciduous forest ecological zone
	AGB > 125t/ha	0.24		
CF	AGB < 50t/ha	0.46	2003 IPCC Good Practice Guidance for LULUCF (Chapter 3: LULUCF Sector Good Practice Guidance, Table 3 A.1.8)	In the table the values are for the Vegetation Type Coniferous forest and plantation
	AGB = 50 - 150t/ha	0.32		
	AGB > 150t/ha	R/S = 0.23		
Plantation	AGB<50t/ha	0.46	2003 GPG(Anx_3A_1_Data_Tables3A.1.8)	In the table the values are for the Vegetation
	AGB=50-150t/ha	0.32		

[5] [5] LaoPDR_ModifiedREL(UNFCCC) Annex2 EF report https://redd.unfccc.int/files/2018_frel_submission_laopdr.pdf

	AGB>150t/ha	0.23		Type Coniferous forest and plantation
Bamboo		0.82	Junpei Toriyama (http://www.ipcc-nggip.iges.or.jp/EFDB/main.php)	Search by ID: 520906
RV	AGB<20t/ha	0.56	IPCC GL 2006 (V4_04_Ch4_Table4.4)	This forest type is considered being in the Tropical domain and part of the Tropical dry forest ecological zone
	AGB>20t/ha	0.28	IPCC GL 2006 (V4_04_Ch4_Table4.4)	

The RS ratio outlined in the table above were used in combination with the measurements made during the 3rd NFI for the five natural forest types, the measurements made during the 2nd RV survey for the RV, and IPCC default values for Bamboo and plantations.

Equation 1c: Total carbon stock for a sub-plot

$$C_i = (AGB_i + BGB_i)\ x\ CF$$

Where:
C_i= Carbon stock for the sub-plot i. (expressed in tC/ha) which is the sum of the biomass of all measured trees in the sub-plot.
AGB_i= Above Ground Biomass for the sub-plot i. (expressed in kg/ha)
BGB_i= Below Ground Biomass for the sub-plot i. (expressed in kg/ha) calculated with equation 1b.
CF = Carbon Fraction, IPCC default value 0.47 (2006 IPCC GL Volume4, Chapter 4- Table 4.3 for the forest types in Laos).

Equation 1d: Total carbon stock for a plot

$$C_p = \frac{1}{n_{sp}} \sum_{i=1}^{n_{sp}} C_{isp}$$

Where:
C_p= Carbon stock for the plot p. (expressed in tC/ha)
n_{sp} = The number of surveyed sub-plots for the plot p.
C_{isp} = Carbon stock for the sub-plot i.

Equation 1e: Total carbon stock for a forest type

$$C_f = \frac{1}{n_p} \sum_{i=1}^{n_p} C_{ip}$$

Where:
C_f= Carbon stock for the forest type f. (expressed in tC/ha)
n_p = The number of surveyed plots for the forest type f.
C_{ip} = Carbon stock for the plot i.

Following the computation of the carbon stock with the Equation 1, the Equation 2 computes the carbon stocks for the five REDD+ stratum. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF".

For the carbon accounting, the Forest Type Maps are stratified into five REDD+ strata according to the amount of carbon stock for the various classes (see Table 4 above). The data comes from the NFI, the Regenerating Vegetation survey, or various IPCC default values. The carbon stock of each REDD+ stratum is calculated as follows:

Equation 2: Develop stratified carbon stocks for each of the five REDD+ stratum

$$C\text{stratum } (tC/ha) = (C1*A1+C2*A2+....+Cn*An)/(A1+A2+....+An)$$

Where:

Cstratum = average carbon stock (tC/ha) of the REDD+ stratum calculated from biomass and area of land/forest class;

Cn = carbon stock of land/forest class n (tC/ha);

An = area (ha) of land/forest class n.

For instance, for calculating the Cstratum of the strata 2 that combines three forest types, namely MD, CF and MCB, the carbon stock of each of these land/forest classes from the 3rd NFI as well as their respective areas in the Forest Type Map 2019 are used.

Then the Emissions/Removals factors for different combinations of land cover change are calculated using the equation 3 as shown below. This calculation is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "EF". The results of this calculation are also presented in section 3.1of the ER Monitoring Report

Equation 3. Calculation of E/R factors for changes among REDD+ strata

EFij $or\ RFij$ (tCO2e/ha) = $\left(Cstrata_i - Cstrata_j\right) \times \frac{44}{12}$

Where:

EFij or RFij: Emission Factor EF or Removal Factor when the change incurred from REDD+ stratum i to REDD+ stratum j;

Cstrata_i and Cstrata_j are carbon stocks per ha of REDD+ stratum i and j corresponding to the changes;

If $\text{Cstrata}_\text{i} > \text{Cstrata}_\text{j}$, such change is considered emissions (change from a higher C/ha stratum to a lower C/ha stratum);

If $\text{Cstrata}_\text{i} < \text{Cstrata}_\text{j}$, such change is considered removal (change from a lower C/ha stratum to a higher C/ha stratum);

44/12 is the constant of CO2 mass to C mass for converting tC to tCO2e.

By using equations 1, 2 and 3, the E/R factors are calculated.

For the Activity Data, the area estimates and their related uncertainties are calculated from the error matrices following the sample-based estimation with the visual interpretation of plots. The calculation of the adjusted areas is in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "AD_Uncertainty".

As displayed in the Figure 1, the result of the step 1 is the calculation of emissions and removals from the Activity Data multiplied by the E/R factors.

Lao PDR applies an approach principally following the gain-loss method in calculating the average annual historical emissions and removals over the reference period, using AD generated from stratified sample-based assessment of satellite imagery plus E/R factors derived from periodic National Inventories.

Equation 4a is for the emissions and Equation 4b is for the removals respectively, are used in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total, where:.

In the tab "Total", Activity Data are displayed from row 1 to 54;

In the Tab "Total", E/R Factors are displayed from row 56 to 82; and

The calculation of AD x EF (equations 4a and 4b) are in cells E85:J115 displayed as matrices and aggregated by activities in the table M85:N98.

Equation 4a: Calculation of the emissions (over a time period)

$$Emissions = \sum_{j,i} EF_{ij} x\ A(j,i)_{RP}$$

Where:
Emissions = Emissions (tCO2e).
$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the period (ha).
$\mathrm{EF_{ij}}$ = Emission Factor EF when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

Equation 4b: Calculation of the removals (over a time period)

$$Removals = \sum_{j,i} RF_{ij} x\ A(j,i)_{RP}$$

Where:
Removals = Removals (tCO2e).
$A(j,i)_{RP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the period (ha).
$\mathrm{RF_{ij}}$: Removal Factor EF when the change incurred from REDD+ stratum i to REDD+ stratum j (tCO2e/ha).

For the Monitoring Period, the same equations 4a and 4b are used, considering the area converted during the Monitoring Period $A(j,i)_{MMR}$

【Step 2】

Once emissions and removals are calculated, adjustments are made as described in Section 2.2.1 of the ER Monitoring Report, as step 2

- Removals are adjusted to account for the fact that forest recovery (change from lower biomass class to higher biomass class) does not happen instantly; per IPCC guidelines, this happens over a period of time, often set at 20 years. A similar adjustment is made to account for reversals (change from higher biomass class to lower biomass class) which are observed to occur on previously disturbed lands which had not yet achieved full recovery.
- Emissions are adjusted to account for the disturbances of land which had previously been disturbed and had recovered but had not yet achieved full recovery. A similar adjustment is made for potential double-counting of emissions for disturbed areas which are captured in the stump survey.

Adjustments are made for both Reference Level and the Monitoring Period.

Equation 5a: Adjustment on removals

$$Removals_{adj} = Removals\ x\ RegrowthRate - Reversal$$

Where:
$Removals_{adj}$= Adjusted removals in tCO2e.
$RegrowthRate$ = This adjustment takes into account the low regrowth of forest (40 years from non-forest to forest and 20 years from a lower biomass to a higher biomass forest) and the duration in year of the time period.
$Reversal$ = Amount of overestimated removals calculated from the historical Forest Type Maps where restoration or reforestation had occurred during the previous time period but saw a reversal event in the latest time period.

Equation 5b: Adjustment on emissions

$$Emissions_{adj} = Emissions - Reversal - Doublecounting(stumps)$$

Where:
$Emissions_{adj}$= Adjusted emissions in tCO2e.

$Reversal$ = Amount of overestimated emissions calculated from the historical Forest Type Maps where a restoration event had occurred during the previous time period before a disturbance in the latest time period.
$Doublecounting(stumps)$ = Degradation due to a downward shift in the three REDD+ strata (Stratum 1, 2 and 3), which may include the logging emissions. This amount is deducted to avoid potential double-counting with the logging emissions, as accounted using Equation 6a below.

The calculation of the adjusted emissions and removals is presented in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Total".
The $Reversal$ component is calculated in tab "TSA_Remove" and tab "TSA_Emission" for the adjustment of removals and emissions respectively for the reference level. In the same spreadsheet, tab "TSA_Remove MMR" and tab "TSA_Emission MMR"are used for the monitoring period. As explained above, the historical FTMs are used for this calculation, as a Time-Serie Analysis (TSA) which is outlined in Section 8.3.2.

【Step 3】

Once the emissions are adjusted, the emissions from logging calculated from the stump measurements are added. The calculation of the emissions from logging is presented in a specific spreadsheet "Emissions from logging.xlsx". The calculation using equation 6 below in spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

Equation 6a: Calculation of the overall emissions with the addition of the emissions from logging, for the Reference Level and for the Monitoring Period.

$$Emissions_{all} = Emissions_{adj} + Emissions_{logging}$$

Where:
$Emissions_{all}$= Overall emissions in tCO2e.
$Emissions_{adj}$= Adjusted emissions in tCO2e.
$Emissions_{logging}$= Emissions from logging in tCO2e.

【Step 4】

To calculate the Reference Level as well as the annual average of emissions and removals during the Monitoring Period, the sum of respective emissions and removals are divided by the number of years of the considered period.

Equation 6b: Calculation of the reference level

$$RL_t = \frac{1}{t}(Emissions_{all} + Removals_{adj})$$

Where:
RL_t = Net emissions/year of the RL over the Reference Period; tCO2e/year.
$Emissions_{all}$= All adjusted emissions in tCO2e, including the logging emissions.
$Removals_{adj}$= Adjusted removals in tCO2e.
t = number of years of the Reference Period.

Equation 6c: Calculation of the net emission over the monitoring period

$$GHG_t = \frac{1}{t}(Emissions_{all} + Removals_{adj})$$

Where:
GHG_t = Monitored net emissions at year t; tCO2e/year
$Emissions_{all}$= Overall emissions in tCO2e.

$Removals_{adj}$= Adjusted removals in tCO2e.
t = Number of years of the Monitoring Period

For the Monitoring Period, emissions and removals would be calculated with the equations 4a and 4b, but using
$A(j,i)_{MP}$ = Area converted/transited from REDD+ stratum j to another REDD+ stratum i during the Monitoring Period (ha)

【Step 5 】

Finally, the ERs will be calculated as below equation 7:

Equation 7: Calculation of the Emission Reductions (ERs)

$$ER_{RP} = RL_{RP} - GHG_{RP}$$

Where:

ER_{RP}	=	*Emission Reductions under the ER Program during the Reporting Period; tCO_2e;*
RL_{RP}	=	*Expected net emissions of the RL over the Reporting Period; tCO_2e;*
GHG_{RP}	=	*Monitored net emissions over the Reporting Period; tCO_2e;*

Steps 4 and 5 are calculated in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and the tab "Summary".

9.1.2 Parameters to be monitored

Parameter:	$A(j,i)_{MP}$ Activity Data for the crediting period 2019-2021 (3 years)
Description:	Area of REDD+ strata change over the crediting period (2019-2021) is provided by the overlay of the stratified Forest Type Maps and adjusted by a sample-based estimation. Twenty-five possible changes describe four activities: Deforestation, Forest Degradation, Forest Restoration and Reforestation. • Deforestation: loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum. • Forest Degradation: downward shift of a forest stratum from a higher carbon stock stratum to another forest stratum with lower carbon stock. This change effectively includes cases of transitional land use change events such as deforestation events not captured in the 5-year mapping interval (e.g., stages of rotational agriculture from a recovered forest to a forest fallow, during which it would have gone through a non-forest stage, or, land conversion for forest plantations). Through the application of this method, fallow land from shifting cultivation sites are largely captured within the RV category and occur most prominently in MD and EG forests, accounting for the vast majority of the degradation events. • Forest Restoration: upward shift of a forest land stratum with lower carbon stock to another forest land stratum with higher carbon stock.

- Reforestation: gain of forest carbon stock due to conversion of non-forest land stratum to a forest land stratum.

YearX	YearX+5 stratum 1	stratum 2	stratum 3	stratum 4	stratum 5
stratum 1	SF1	DG1	DG2	DG4	DF1
stratum 2	RS1	SF2	DG3	DG5	DF2
stratum 3	RS2	RS4	SF3	DG6	DF3
stratum 4	RS3	RS5	RS6	SF4	DF4
stratum 5	RF1	RF2	RF3	RF4	SNF

Deforestation (DF)
Degradation (DG)
Restoration (RS)
Reforestation (RF)
Stable Forest (SF)
Stable Non-Forest (SNF)

In the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", Activity Data and their related uncertainty are calculated in tab "AD_Uncertainty".
Through the technical correction, Forest Degradation is supplemented by a map produced with the CCDC-SMA script that directly captures forest degradation over a period of time.

Data unit: Ha

Value monitored during this Monitoring / Reporting Period:

The values displayed in the table below come from the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx", tab "AD_Area" at the exception for degradation (DG), for which the value is calculated in tab "Total", cell H135.

Area (ha)	2019-2021
DF	214,999
RS	31,994
RF	155,577
DG	88,382

Source of data and description of measurement /calculation methods and procedures applied:

Wall-to-wall land/forest maps for the ER Program area with the Level 2 classification for the years 2019, and 2022 developed by the FIPD of DOF, MAF.

IPCC Definition	Level 1	Level 2	REDD+ Strata
Forest Land	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)	
Grassland	Other Vegetated Areas	Savannah (SA)	5
		Scrub (SR)	
		Grassland (G)	
Cropland	Cropland	Upland Agriculture (UC)	

		Rice Paddy (RP)	
		Other Agriculture (OA)	
		Agriculture Plantation (AP)	
Settlement	Settlements	Urban (U)	
Other Land	Other Land	Barren Land (BR)	
		Other (O)	
Wetland	Wetlands	Water (W)	
		Swamp/Wetland (SW)	

The maps are generated using 2010 as the benchmark map, and the maps for the other years developed through applying a change detection method in order to maintain consistency of classification and interpretation.

For both 2019 and 2022 maps, Sentinel-2 imagery was used in combination with Planetscope imagery.

The maps are stratified according to the five REDD+ strata and overlaid to produce the AD maps for the period 2019-2021. The AD map is used to distribute sample plots following a stratified random sampling approach. The visual interpretation of the plots is done with Collect Earth Online to calculate the AD are estimates and their related uncertainty.

The sample size was determined by using the formula by Cochran (1977), assuming that the sampling cost of each stratum is the same.

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

Where:

N = number of sample points for the stratum of interest

- = standard error of the estimated overall accuracy that we would like to achieve

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 values were set as the target for allocating statistically sound sampling size:

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.

QA/QC procedures applied:	A SOP for the update of the Forest Type Map was followed. In a manner similar to that was conducted for the RL, a three-step approach was used to ensure the quality of the visual interpretation.

	For the sample-based estimation, two rounds of interpretation were conducted with different technicians. In any case where the two interpretations did not agree, a third round was conducted with teams of three technicians to reach consensus.
Uncertainty for this parameter:	The uncertainty is calculated through the sample-based estimation.

Uncertainty (%)	2019-2021
DF	27.6
RS	88.8
RF	40.4
DG	25.7

Any comment:	n.a.

Parameter:	$Emissions_{logging}$ Emissions from logging for the Monitoring Period
Description:	Emissions from logging estimated from the February 2023 field stump survey in the six northern provinces of the ER Program.
Data unit:	tCO2eq
Value monitored during this Monitoring / Reporting Period:	

	Average loss tCO2e/ha	**Area (ha) Forest type map 2022**	**tCO2e (12 years)**
EG: Evergreen Forest	0.7	475,676	329,139
MD: Mixed Deciduous Forest	2.8	3,629,242	10,155,419
DD: Dry Dipterocarp	5.1	17,076	86,961
CF: Conifer Forest	11.1	25,224	280,179
MCB: Mixed Conifer and Broadleaved forest	-	2,133	-
	Total		10,851,698
	Annual average (tCO2e) (Total divided by 12 years)		904,308
	Emissions for the Monitoring Period (3 years)		2,712,924

The detail of the calculation is available in the “emissions from logging.xlsx” spreadsheet, tab “StumpSurvey2023”.

Source of data and description of measurement /calculation methods and procedures applied:	The stump survey follows the exact same design as for the 2nd NFI. A total of 114 plots were surveyed in the ER Program area. Stumps located in the plots were measured and recorded as below: • Height (H) - below 1.3m • Smallest Diameter (D1) – the smallest diameter across the top of the stump • D2 – the diameter at a 90o angle to D1. • Instrument used for tree felling (e.g. machine, saw axe) With these measurements, the biomass loss estimation is conducted as follow: 1. Calculate the 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 [56]: 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* 5. Estimate the AGB by using the allometric equation used in the 2nd NFI 6. Convert the AGB loss by using an area ratio (t/ha) 7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots) 8. Estimate the plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot) 9. Estimate the average AGB loss(t/ha) for each forest class by dividing the total number of plots of each forest class 10. Estimate the BGB loss by using default conversion factor found in the IPCC 2006 Guidelines 11. Convert biomass to CO2 with the same conversion factor for estimating the carbon stock 12. Estimate the total loss tCO2e by multiplying above value by the area of Forest Type Map 2022 for each forest class. The method above estimates the biomass loss but does not provide an average per year, as it is quite challenging to estimate when the trees were actually felled. An equation, developed in an experimental study in Pasoh in the Malaysian Peninsula [57], estimates the number of years required for wood materials to decompose. Using this equation, the temperature and precipitation averages recorded for northern Lao PDR, it is reasonable to assume that the stumps observed and measured were felled within a 12 year period before the survey.

[56] Ito et al., 2010. Estimate Diameter at Breast Height from Measurements of Illegally Logged Stumps in Cambodian Lowland Dry Evergreen Forest. JARQ 44(4), 440.

[57] 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.

	The total biomass loss calculated above is then divided by 12 to obtain a yearly average for the Reference Level.
QA/QC procedures applied:	In Lao NFI, a dedicated team conducts QA/QC by revisiting 10% of the measured plots. The same approach was used for this specific stump survey. The measurements between the QA/QC team and the survey teams are compared to assess if they are statistically robust. For the 2nd NFI, no significant statistical difference was found in the measurements from QA/QC and the survey teams. The Standard Operation Procedures (SOP) for the Terrestrial Carbon Measurement_is available with this link.
Uncertainty for this parameter:	This proxy-based approach has been identified through wide expert consultations as the best currently-available method to quantify the impacts of illegal logging in Lao PDR. The limitations around its design, however, are well-acknowledged., To compensate for this issue, the prescribed 15 % conservativeness factor is applied. For the uncertainty analysis which uses a Monte Carlo approach, the standard error used as the input parameter for the uncertainty for emissions from logging, comes from a previous analysis that was conducted for the national MRV in 2019. The calculation is in the spreadsheet "MMR1_AD_ER_Calculation_20230413.xlsx" and tab "logging_uncertainty". It uses a propagation of error approach. The uncertainty calculated for emissions from logging for the monitoring period is 21.80% The most recent Forest Type Map 2022 is not yet completed for the whole country. Therefore, the accuracy assessment is not conducted yet which did not enable the team to estimate the logging uncertainty based on this map. The figure that was calculated for the MRV is considered as the best and most reliable data for this Monte Carlo analysis.
Any comment:	n.a.

9.2 Organizational structure for measurement, monitoring and reporting

■ ***Organizational structure, responsibilities and competencies***

The table below, from the ERPD Chapter 2.2, shows the preliminary framework of the entities to be involved and their main responsibilities. In principle, the institutional arrangement of the measurement, monitoring, and reporting (MMR) system for the ER Program is consistent between that of the ER Program and that for the National REDD+ Program. Most institutional arrangements build on existing arrangements and responsibilities of the respective entities and have been strengthened in a step-wise manner.

The DOF approved the 'National Forest Monitoring System Roadmap,' which is a detailed multi-year National Forest Monitoring System (NFMS) plan, in October 2020. Accordingly, the REL/MRV TWG was transformed into the NFMS TWG with three sub-groups: MRV; Forest monitoring; and Data management, enabling focused actions on each thematic area.

Within the DOF, the Forestry Inventory and Planning Division (FIPD) is responsible for generating the necessary data including the Activity Data (AD) and Emission/Removal Factors (E/R factors), conducting uncertainty assessment, and calculating the final ERs. This assessment includes the survey of tree stumps, used to estimate emissions from logging. They collaborate with the REDD+ Division who is responsible for coordinating the activities related to the ER Program.

Table 37: Framework of institutions involved in the forest monitoring

	DOF	DOFI	Provincial Govern-ment	Private sector, local community	NFMS TWG	NRTF	MAF
MMR	Conduct the MMR. Within the DOF, FIPD conducts collection and generation of data for AD, E/R factors, uncertainty assessment and ER calculation (including emissions from logging).	Technically review the MMR results as a member of the NFMS TWG.	Participate in National Forest Inventory (NFI)	Participate in NFI as local guides	Technically review the MMR results. Collaborate with other TWGs.	Endorse the MMR results. Facilitate collabora-tion with other concerned sectors	As the executing agency, responsible for the MMR.
Monitoring of drivers and interven-tions	Provide supporting data for enforce-ment. Compile the monitoring results.	Lead enforcement actions at the central-level and collaborate with provinces.	Lead enforcement actions at the provincial level and collaborate with district authorities.	Participate in forestry-related activities, e.g. protection, restoration, timber and NTFP supply-chain.	Technically review the monitoring results. Collaborate with other TWGs.	Facilitate collaboration with other concerned sectors following the monitoring results	As the executing agency, responsible for the monitoring.

■ ***The selection and management of GHG related data and information***

The ER Program will account for GHG related elements as summarized in the table below:

Table 38: Summary of GHG related elements accounted for the ER Program

Forest Definition	"Current Forest": DBH >10cm, Crown cover >20%, Minimum area >0.5 ha; and "Potential Forest": forest land which are in temporarily un-stocked state (for details see next section.)
Sources and Sinks	Carbon emissions from deforestation; and Carbon emissions from forest degradation. Enhancement of carbon stocks through forest restoration; and Enhancement of forest carbon stock through reforestation.
Carbon pools	Above Ground Biomass (AGB). Below Ground Biomass (BGB).
Gases	CO2 emissions and removals.

To ensure robust management and enhance transparency of the data, Lao PDR developed the database system and web-based portal <https://nfms.maf.gov.la/>. The system unifies all the existing official data used for the estimation of emissions and removals at the national level and the ER Program into one single database. It also reduces costs by means of automating, and facilitating transparency, of the estimation methods and results. Moreover, overlaying such information with the administrative boundary data, forest category data, and other forestry-related data will allow the data users to analyze forests according to their interests.

Table 39: Data presented in the NFMS web-portal

Data related to AD	Data type
Forest Type Maps 2000, 2005, 2010, 2015, 2019, 2022 [58]	Raster data
Forest cover change maps 2000-2005, 2005-2010, 2010-2015, 2015-2019, 2019-2021	Raster data (partly vector data) including ground-truthing points
Satellite imagery used for the development of Forest Type Maps Landsat (2000), SPOT4, 5 MS(2005), RapidEye (2010, 2015) (both false color and true color), Sentinel 2(2019), Sentinel 2 (2022)	Raster data
Data related to E/R factors	**Data type**
1st NFI data (1990s)	Tabular data.
2nd NFI data (2015-2017)	Tabular data including GIS points and ground-truthing photos.
3rd NFI data (2019)	Ditto
1st Regenerating Survey (2017)	Tabular data including GIS points and ground-truthing photos.
2nd Regenerating Survey (2019)	Ditto
Other data	**Data type**
Administrative area: national, province, district	Vector data
Forest category: Production Forest, Protection Forest, Conservation Forest	Ditto

Apart from the data and information disclosed in the NFMS web-portal, national documents and reports related to GHG are also transparently disclosed.

Table 40: National documents and reports related to GHG

Document	Data storage
National FREL/FRL Report to the UNFCCC including annexes (2018)	http://dof.maf.gov.la/redd/en/frel-frl/ https://redd.unfccc.int/submissions.html?country=lao
1st National REDD+ Results to the UNFCCC including annexes (2020)	http://dof.maf.gov.la/redd/en/nfms/ https://redd.unfccc.int/submissions.html?country=lao
1st National Communication to the UNFCCC (2000)	https://unfccc.int/documents/116663 https://unfccc.int/documents/116664
2nd National Communication to the UNFCCC (2013)	
1st Biennial Update Report to the UNFCCC (contains a Technical Annex on REDD+) (2020)	https://unfccc.int/documents/274307 https://redd.unfccc.int/submissions.html?country=lao

[58] The Forest Type Map 2022 is regarded as a map that represents the land and forest cover of 2022/01/01, and the Forest Type Map 2019 is regarded as the map that represents the land and forest cover of 2019/01/01. The ERs for the exact three years from January 1, 2019 - December 31, 2021 is reported in this 1st ER-MR by using these two maps.

■ ***Processes for collecting, processing, consolidating and reporting GHG data and information***

Lao PDR has an established centralized process for collecting, processing, consolidating and reporting GHG data and information. The Standard Operating Procedures (SOPs) listed below have been prepared and can be found in the Lao REDD+ website <http://dof.maf.gov.la/redd/en/nfms/>:

Table 41: Manuals and Standard Operating Procedures (SOPs)

Document title	Summary
Standard Operation Procedures (SOP) for Forest Type Map development	The SOP provides guidance on the tasks and steps for developing the national forest type maps. It provides guidance on the preparation of the data required as well as the provision of the satellite imagery. The SOP describes how to conduct the visual interpretation and the steps for the QA/QC validation. Guidance for conducting ground truthing survey is also provided.
Standard Operating Procedures (SOP) for the Terrestrial Carbon Measurement	The SOP provides standard field measurement approaches to assist in quantifying the amount of carbon stored within the various organic pools found within a landscape. It also provides guidance on the plot distribution, plot establishment on the ground and navigation from/to the sub-plots.
Standard Operation Procedures (SOP) for the Lao PDR's REDD+ MRV - based on the methodologies applied for the 1st FREL/FRL and the 1st National REDD+ Results, and its Annex for calculation	The SOP provides guidance linked to calculation spreadsheet to conduct an estimation of the REDD+ results (or often interchangeably referred to as "MRV").
Standard Operation Procedures (SOP) for the National Forest Monitoring System Servers and Network	The SOP articulate the NFMS IT infrastructure hosted inside the FIPD's network, and provides guidance on the protocols for its administration.
National Forest Monitoring System User Manual	The manual provides guidance for the users of Laos National Forest Management System (NFMS) web-portal.
National Forest Monitoring System Data Installation Manual	The manual provides guidance for the NFMS IT administrators on the protocols for installing data into the National Forest Management System (NFMS) database.

Further details of the selection, generation, reporting, Quality Assurance/Quality Control (QA/QC) and management of Greenhouse gas (GHG) related data and information will be described in the ER Monitoring Report (Section 2.2).

■ ***Systems and processes that ensure the accuracy of the data and information***

In principle, the system described in the ERPD Chapter 9.1 is followed for implementing the MMR to maintain full consistency with the RL. Lao PDR is proposing, however, a technical correction to the RL (as already described in this Annex 4) and applying the same approach for the MMR.

SOPs have been developed for each of the components for ER calculation. These SOPs enable efficiency in the generation of quality output in a standardized manner. They make the NFMS more robust and transparent.

A framework for joint support of the MMR for the ER Program has been established with technical partners including

the F-REDD 2 Project/JICA, the World Bank, the SilvaCarbon Program and Boston University. This collaboration has been providing an important Quality Assurance function to consider and implement best-available carbon accounting approach for Lao PDR including the technical correction of RL.

Another technical collaboration also is in progress among the F-REDD 2 Project/JICA and forest inventory experts from the University of Goettingen in Germany and the US Forest Service (USFS), facilitated by the SilvaCarbon Program, for future improvements in the NFI. This work is expected to improve the accuracy and range of the NFI data to be collected while maintaining the consistency in the estimation of emissions and removals. In 2021, FAO collaborated in the improvement of the R Script (an automatic calculation program) used for the NFI database.

- ***Design and maintenance of the Forest Monitoring System***

Recognizing the importance of a robust and transparent forest monitoring system, Lao PDR has developed its national Lao NFMS Roadmap. By consulting the FAO's Voluntary Guidelines on National Forest Monitoring and other good practices, the structure and content of the NFMS Roadmap were adapted for Lao PDR. This adaptation incorporated feedback from the capacity needs assessment of the Global Forest Observation Initiative REDD+ Compass, supported by the Forest Carbon Partnership Facility (FCPF) through 2018-2019, and feedback from the capacity needs assessment of the FAO Capacity-building Initiative for Transparency, conducted in 2020. The draft was finalized after two iterations of consultations with and comments from the NFMS TWG. It was approved by the DOF in October 2020. The draft was then finalized in the Lao and English languages and published on the UNFCCC REDD+ Web Platform.

The NFMS Roadmap provides a comprehensive overview and work plan for improvements, identified actions, institutional arrangements, and capacity building needs. The principle is to develop the NFMS in a step-wise fashion to support monitoring of the drivers and interventions (a conceptual picture show in the Figure below). Several related initiatives are progressing in parallel: they are coordinated by the National REDD+ Task Force (NRTF) and the NFMS TWG to ensure that the NFMS will contribute to the overall performance monitoring of the forestry sector.

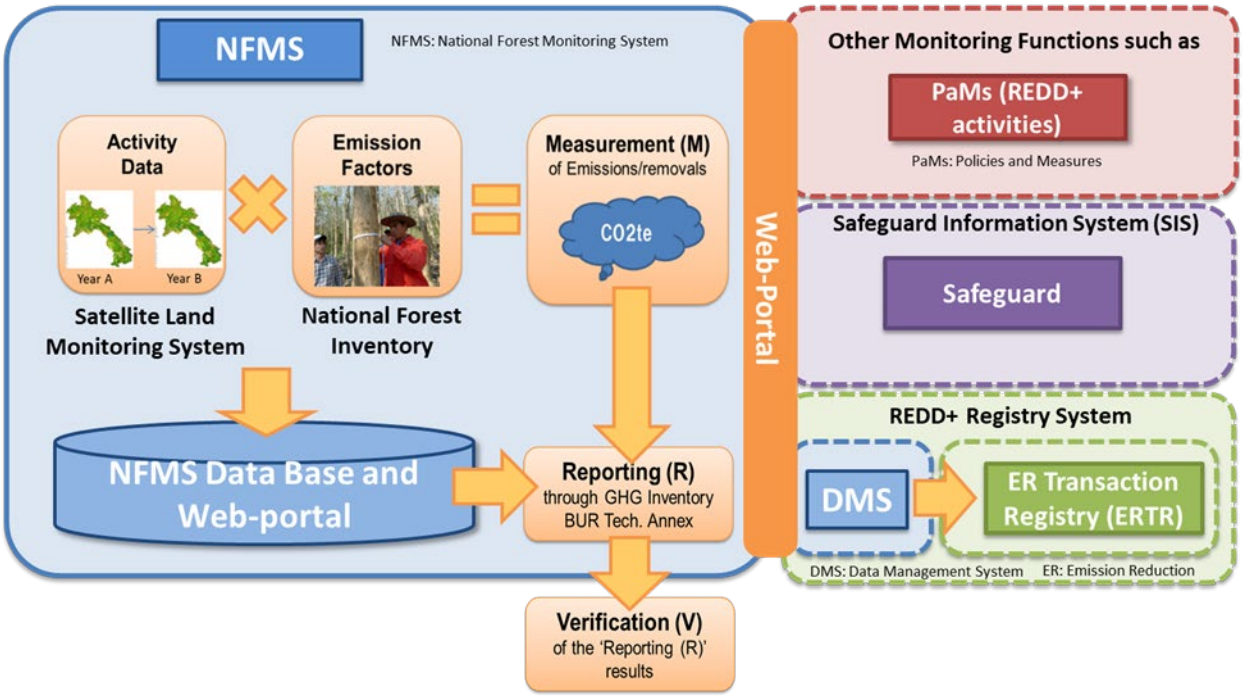


Figure 14: Conceptual diagram of Lao PDR's NFMS and its interactions with other REDD+ systems

- ***Systems and processes that support the Forest Monitoring System, including Standard Operating Procedures and QA/QC procedures***

As already explained, a robust institutional arrangement and a series of SOPs including QA/QC procedures are integral elements of the estimation of emissions and removals process. The NFMS TWG and the technical partners provides technical review and advice to the process.

- ***Role of communities in the forest monitoring system***

Key stakeholders, including the private sector and local community, will be informed on an ongoing basis of the ER Program activities and results, to ensure transparency and accountability in its implementation. Some stakeholders, particularly the local communities, will continue to support the technical work, such as serving as local guides for the fieldwork for the NFI. Moreover, information from their own activities will be used to support and improve the MRV, particularly for forest mapping. Such additional data includes, for example, plantation management information of the government (e.g., the Forest Plantation Registry System) and/or of the forest companies to improve classification of plantations. It will also include feedback from village-level forest monitoring activities, based on the land-use plans, to further understand stages of shifting-cultivation and forest regeneration.

Near-real time forest monitoring, which involves local communities, has made significant progress since the acceptance of the ERPD:

- The Provincial Deforestation Monitoring System (PDMS) is a system to support PAFO and DAFO to monitor deforestation caused by agricultural practices and to strengthen law enforcement. The PDMS is already being implemented in Xayabouli, Luang Prabang and Houaphan Provinces, and will be soon extended to Luang Namtha, Bokeo and Oudomxay Provinces through collaboration among the ER Program, I-GFLL, F-REDD 2/JICA and the World Bank.
- The Operational Logging and Degradation Monitoring (OLDM) System provides a comprehensive and integrated set of tools that leads users from identification of potential disturbance and take corrective actions. With the support of ProFEB Project/GIZ and ICBF Project/KfW the OLDM System has been implemented in Luang Namtha, Bokeo, Khammouane, Sekong, Attapeu and Champasack Provinces.

9.3 Relation and consistency with the National Forest Monitoring System

- ***Use of and consistency with standard technical procedures in the country and the National Forest Monitoring System.***

Harmonization between the RL for the ER Program and the national FREL/FRL was seriously considered at the time of preparation of the ERPD. The national FREL/FRL applies methodologies that are largely consistent with those defined in the Carbon Fund Methodological Framework. The national FREL/FRL and the RL for the ER Program is based on the same dataset, prepared by the same DOF team using mostly the same methodologies, applying the same reference period, and assessed by the same group of stakeholders. Thus, the ER Program RL is considered to be a sub-set of the national FREL/FRL.

Following feedback from the Carbon Fund, Lao PDR now proposes a technical correction to the RL. The proposed approach would provide a higher level of accuracy for the forest degradation emissions, however with a quite large difference in the estimated volume. By applying this technical correction, however, the national-level and the ER Program estimates for forest degradation emissions will no longer be the same in their respective methodologies.

Consistency between the national-level and the ER Program accountings will be considered when Lao PDR updates the national-level FREL/FRL in the future, currently planned for 2025.

12 UNCERTAINTIES OF THE CALCULATION OF EMISSION REDUCTIONS

12.1 Identification and assessment of sources of uncertainty

Sources of uncertainty	Analysis of contribution to overall uncertainty
Activity Data	
Measurement	This source of uncertainty is linked with the visual interpretation of satellte imagery. Error in the interpretation may come from the quality of the imagery or misinterpretation from the technician. Lao PDR addresses this issue by procuring satellite imagery through Google Earth Engine that ensures the quality of the imagery and by use of comprehensive training, SOPs, and QA/QC procedures throughout the interpretation process. The SOP for Forest Type Map development presented in Table 18 particularly guides the production of the Forest Type Maps. Guidance on the interpretation of the satellite imagery is also provided in this SOP. Besides the SOP, the technicians always refer to the Lao National Classification System document which describes extensively each forest/land type, as well as an interpretation key. Technicians are trained to follow the interpretation procedures and a preliminary ground truthing survey is organized to make sure all technicians have a common undertanding of the various forest/land types and their interpretation. The QA/QC is conducted in the form of several iterations of interpretation as decribed in Section 8.3.2.
Representativeness	This source of uncertainty is related to the representativeness of the estimate that is related to the sampling design. Forest Type Maps were produced for the area of interest, i.e., the entire ER Program area. The CCDC-SMA (see Section 8.3.2) script was used to map forest degradation over the ER program area. The results served as the basis of stratification for the sample-based assesment. Sampling to generate AD estimates followed a stratified random sample approach as outlined in Olofsson et al 2014, and was also limited to the ER program area. All sample data were collected from times within the target period. Since all data used to generate AD were randomly collected within the ER program area, the sample is assumed representative and risk of bias is low.
Sampling	The uncertainty related to the interpretation of the sample plots, is the statistical variance of the estimate of area for the Activity Data. The sample design follows a stratified random sampling approach and the whole sample-based estimation methods suggested by Olofsson et al (2014). The sample size was determined by using the formula by Cochran (1977) with more detailled provided in section 3.1 of the ER Monitoring Report. Sample points were allocated randomly across the entire ER program area of interest. The response design uses the Collect Earth Online interface and enables the technicians to conduct the interpretation of all REDD+ activitities related to the forest/land cover change. The Collect Earth Oline interface is specifically designed by the Forest Inventory and Planning Division and enables the use of high resolution imagery such as Planet or Sentinel-2.
Extrapolation	The area estimates are calculated for each activity (deforestation, forest degradation, forest restoration, and reforestation) through the Sample-Based Estimation. However, the “sub-activities” from the twenty various

Sources of uncertainty	Analysis of contribution to overall uncertainty
	combinations given by the five REDD+ strata change matrix are inferred using the mapped areas. This is an extrapolation but it does not lead to an overestimation of the Emission Reductions for the reasons below: First the technical correction item 2 on the Reference Level enhanced the estimation for forest degradation and does not use the extrapolation outline above but uses only the reference data from the Sample-Based Estimation. Secondly, testing were conducted to assess the feasibility of a technical correction to calculate the AD for the sub-activities based on the reference data. Results of the testing were not considered positive as it would have increased the uncertainty as well as the Reference Level. Thus sticking to the approach based on mapped areas is judged consistent and conservative. Therefore this source of uncertainty is considered to be low.
Approach 3	The AD are generated through Sample-Based Estimation for each time period. The Reference Period has two time periods 2005-2010 and 2010-2015, and the Monitoring period is 2019-2021.The sample plots are different for each period. However, the polygons of the Forest Type Map (FTM) have the whole historical trajectory described in the various attributes for the years 2005,2010,2015, 2019 and 2022 which enables to tracks the historical trajectory of land cover class and Activity Data status, identifying lands which are classified as transitioning more than once time between land cover classes. To avoid any over-estimation of emissions and reversals, or double-counting of change, a Time-Series Analysis was conducted under Step 2 of the measurement, monitoring and reporting approach as described in Section 3.1 and 3.2 of the ER Monitoring Report. Due to the tracking and accounting, the degree of uncertainty is low
Emission factor	
DBH measurement	The field measurements for the National Forest Inventory are specified in the SOP for the Terrestrial Carbon Measurement. Before each NFI campaign, training is conducted. The data collection uses Open Data Kit (ODK) [59] forms that ensure limited entry errors. A specific QA/QC team revisit 15% of the surveyed plots to assess the quality of the measurements and also quantify any errors. The allometric equations of live trees use only DHB. H measurements is done for the case of standing dead trees. The plot delineation is not prone to error as the NFI uses circular plots and distance are measured with DME.
H measurement	
Plot delineation	
Wood density estimation	The allometric equations developed and used for Lao PDR do not use wood density classes.
Biomass allometric model	Country-specific allometric equations were developped for the three main forest types in Lao PDR, namely EG, MD and DD forests, using random samples of trees measured with international support [60]. Compared to some data of Chave et al. (2005, 2015), which were obtained in Southeast Asia, Lao national allometric equations estimate lower biomass.The two other forest types, namely CF and MCB forests use an equation used in Vietnam. The most relevant predictor variable for AGB in the three forest types (EG, MD and DD) was DBH. According to comparative analysis with other data or equations, allometric equations developed were reasonable to be

[59] ODK is an open-source suite of tools that allows data collection using Android mobile devices and data submission to an online server, even without an Internet connection or mobile carrier service at the time of data collection.

[60] Morikawa Y., Daisuke Y., Therese T., and Walker S., *Development of country-specific allometric equations in Lao PDR*, 2017.

Sources of uncertainty	Analysis of contribution to overall uncertainty
	applied to the tree measurement data which are out of the surveyed DBH range, in terms of conservative estimation. The allometric model error was quantified for each model (see Section 8.3.2) and incorporated into the overall estimate of uncertainty for each EF.
Sampling	The sampling error is the statistical variance of the estimate of aboveground biomass. The Lao NFI uses a two-stages random sampling. The uncertainty target for the Lao NFI is 20% with 90% of Confidence Interval. For the 3rd NFI, uncertainties for EG, MD and DD were below 10%, while CF and MCB were below 20%. Sample errors are estimated using Cochran's (1977) two stage random sampling formula, and are included in the Monte Carlo simulation assessment of uncertainty. The number of sample plots was generated using a spreadsheet developed by Winrock International (Winrock Sample Plot Calculator). The sampling error was quantified for each stratum (see Section 3.1 of the ER Monitoring Report) and incorporated into the overall estimate of uncertainty for each EF
Other parameters (e.g., Carbon Fraction, root-to-shoot ratios)	Lao PDR uses a Root-to-Shoot ratio to derive Below Ground Biomass from the AGB. Carbon fraction is also used in the calculations. These parameters are not country-specific but sourced from the 2006 IPCC Guidelines. International and national experts were consulted when developing the RL including selection of the IPCC default values, and as the calculation uses the IPCC default values, the possibility of systematic errors is considered to be lowThe Monte Carlo simulation and more specifically the Sensitivity Analysis showed very small effect of these parameters.
Representativeness	Following the SOP for the Terrestrial Carbon Measurement, the random sampling design of the Lao NFI considers all of the five natural forest types across the ER Program area and reports the AGB of each forest type. The SOP is revisited and updated each time before each NFI campaign in order to ensure it is up-to-date and to incorporate improvements. As described earlier in this table, the QA/QC process is integrated in the NFI process and is applied to all lands in the ER Program Area. The results are used for generating the E/R factors which is expected to be representative because the sample data are randomly selected from the population of interest. Therefore this source of uncertainty is considered to be low.
Integration	
Model	The entire estimation approach were developed in collaboration with international technical support (e.g. JICA, SilvaCarbon, World Bank). The approach is considered as a best-available approach under the Lao context. In addition to the series of SOPs for data collection, an SOP for the Lao PDR's REDD+ MRV (which shows the steps for the ERs calculation) was also developped.). Therefore this source of uncertainty is considered to be low.
Integration	Each AD has a corresponding E/R factors. AD are estimated through remote-sensing observations combined with sample-based estimation (Olofsson 2012) using the REDD+ strata that combine the land/forest classes from the Lao National Classification System. Corresponding E/R factors are estimated based on ground-based observations of the forest type which may be causing a low level of bias. The sample-based estimation process provides an independent QA check on the accuravy of forest classification and forest cover change. The final estimations were peer-reviewed to

Sources of uncertainty	Analysis of contribution to overall uncertainty
	ensure correctness. Therefore this source of uncertainty is considered to be low.

12.2 Quantification of uncertainty in Reference Level Setting

Parameters and assumptions used in the Monte Carlo method

The Monte Carlo Method was applied to assess uncertainties of emissions and removals estimates in reference level and the reporting period. In this analysis, all parameters associated with emissions and removals estimates are simulated with assumption of normal probability distribution. Four parameters analyzed are as follows:

- AGB of the five REDD+ strata;
- AD for deforestation, forest degradation, forest restoration and reforestation for the two periods of the RL (2005-2010, 2005-2010), and the monitoring period (2019-2021);
- Root-to-shoot ratio (RS); and
- Carbon fraction (all types of forest biomass).

The emissions from logging are included in the Monte Carlo simulation, however, a 15% conservativeness factor is applied both for the RL and MMR due to its proxy nature.

The details of description on parameters, parameters values, standard errors and probability distribution function can be provided separate spreadsheet "LaoPDR_Uncertainty MC MMR1 20230413.xlsx".

Parameter included in the model	Parameter values	Range or standard deviations		Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
		Lower	Upper			
Activity Data Deforestation (REDD+ strata 1 to 5) 2005-2010	154 ha (standard error (SE)=12 ha)	142	166	Sampling Error	Normal	Above zero.
Activity Data Deforestation (REDD+ strata 2 to 5) 2005-2010	28,727 ha (SE= 2,263 ha)	26,464	30,990	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 3 to 5) 2005-2010	65 ha (SE=5 ha)	60	70	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata	223,674 ha (SE=17,621 ha)	206,052	241,295	Sampling Error	Normal	Above zero

4 to 5) 2005-2010						
Activity Data Degradation (REDD+ strata 2 to 4) 2005-2010	641,565 ha (SE= 85,305 ha)	556,260	726,870	Sampling Error	Normal	Above zero
Activity Data Restoration (REDD+ strata 2 to 1) 2005-2010	71 ha (SE=18 ha)	53	90	Sampling Error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 2) 2005-2010	57,361 ha (SE=14,750 ha)	42,611	72,112	Sampling Error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 3) 2005-2010	60 ha (SE= 15 ha)	44	75	Sampling Error	Normal	Above zero
Activity Data Reforestation (REDD+ strata 5 to 4) 2005-2010	182,805 ha (SE= 24,938 ha)	157,866	207,743	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 1 to 5) 2010-2015	767 ha (SE=115 ha)	651	882	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 2 to 5) 2010-2015	42,539 ha (SE= 6,404 ha)	36,134	48,943	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 3 to 5) 2010-2015	184 ha (SE=28 ha)	157	212	Sampling Error	Normal	Above zero
Activity Data Deforestation (REDD+ strata 4 to 5) 2010-2015	99,489 ha (SE=14,979 ha)	84,510	114,467	Sampling Error	Normal	Above zero
Activity Data Degradation (REDD+ strata	636,048 ha (SE= 90,162 ha)	545,886	726,210	Sampling Error	Normal	Above zero

2 to 4) 2010-2015						
Activity Data Restoration (REDD+ strata 4 to 2) 2010-2015	45,796 ha (SE=16,472 ha)	29,324	62,268	Sampling Error	Normal	Above zero
Activity Data Restoration (REDD+ strata 4 to 3) 2010-2015	49 ha (SE= 18 ha)	32	67	Sampling Error	Normal	Above zero
Activity Data Reforestation (REDD+ strata 5 to 4) 2010-2015	142,703 ha (SE= 20,470 ha)	122,233	163,174	Sampling Error	Normal	Above zero
Carbon Fraction	0.47 (SE=0.00647)	0.46	0.48	Model error	Normal	No assumption
Root to Shoot ratio (AGB<125 tC/ha)	0.2 (SE=0.012)	0.19	0.21	Model error	Normal	No assumption
Root to Shoot ratio (AGB<125 tC/ha)	0.24 (SE=0.025)	0.22	0.26	Model error	Normal	No assumption
Above Ground Biomass REDD+ strata 1	353.1 tC/ha (SE=19.636 tC/ha)	333.46	372.73	Sampling Error	Normal	Above zero
Above Ground Biomass REDD+ strata 2	150.6 tC/ha (SE=4.61 tC/ha)	145.97	155.19	Sampling Error	Normal	Above zero
Above Ground Biomass REDD+ strata 3	90.1 tC/ha (SE=4.136 tC/ha)	85.93	94.20	Sampling Error	Normal	Above zero
Above Ground Biomass REDD+ strata 4	20.4 tC/ha (SE=2.038 tC/ha)	18.34	22.41	Sampling Error	Normal	Above zero
Above Ground Biomass REDD+ strata 5	8.3 tC/ha (SE=0.844 tC/ha)	7.42	9.11	Sampling Error	Normal	Above zero

Emissions from logging for the RL (annual average)	815,197 tCO2e (SE= 90,171 tCO2e)	741,817	864,771	Sampling error	Normal	Above zero
Emissions from logging for the MMR (Annual average)	904,308 tCO2e (SE= 100,581 tCO2e)	835,101	973,515	Sampling error	Normal	Above zero

Quantification of the uncertainty of the estimate of the Reference level (tCO2e/year)

		Deforestation	Forest degradation	Enhancement of carbon stocks
A	**Median**	3,010,531	10,595,218	-1,334,151
B	**Upper bound 90% CI** (Percentile 0.95)	2,560,848	8,850,488	-1,680,896
C	**Lower bound 90% CI** (Percentile 0.05)	3,491,153	12,430,191	-1,006,096
D	**Half Width Confidence Interval at 90% (B – C / 2)**	465,152	1,789,851	337,400
E	**Relative margin (D / A)**	15%	17%	25%
F	**Uncertainty discount**	0%	4%	4%

Monte Carlo analysis was applied to assess the uncertainties of emissions and removals estimates for the RL (and the reporting period). The analysis is presented in the spreadsheet "LaoPDR_Uncertainty MC MMR1 20230413.xlsx". The results of uncertainty analysis for the RL are in the tab "Emission Reductions", row29 to 33 and columns AY, BB, BE for deforestation, forest degradation and enhancement of carbon stocks respectively.

Sensitivity analysis and identification of areas of improvement of MRV system

Lao PDR used the Monte Carlo analysis spreadsheet provided under the Guidance note on estimating uncertainty of ERs using Monte Carlo simulation. The table below shows the results of the sensitivity analysis which demonstrates that the main source of uncertainty comes from the Activity Data.

Table 42: Sensitivity analysis

Parameter	Uncertainty of the Reference Level (%)
All ON	16
RS Uncertainty ON	4
Carbon Fraction Uncertainty ON	2
AGB Uncertainty ON	6
Emission/Removal factors Uncertainty ON	8
Activity Data ON	15