# Forest Carbon Partnership Facility (FCPF)
# Carbon Fund

# ER Monitoring Report (ER-MR)

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| **ER Program Name and Country:** | Promoting REDD+ through Governance, Forest Landscapes & Livelihoods in Northern Lao PDR |
| **Reporting Period covered in this report:** | 01-01-2022 to 31-12-2024 |
| **Number of FCPF ERs:** | 1,837,467 tCO2e |
| **Quantity of ERs allocated to the Uncertainty Buffer:** | 381,480 tCO2e |
| **Quantity of ERs to allocated to the Pooled Reversal Buffer:** | 324,258 tCO2e |
| **Number of FCPF ERs from enhanced removals through afforestation/ reforestation** | n.a |
| **Number of FCPF ER from High Forest Low Deforestation (HFLD)** | n.a. |
| **Date of Submission:** | 15 December 2025 |
| **Version** | Version 1.0 |

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# List of Acronyms

| Acronym | Meaning |
|---|---|
| AD | Activity Data |
| AGB | Above Ground Biomass |
| BGB | Below Ground Biomass |
| CAP | Community Action Plan |
| 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 or ERMR | 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 |

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|---|---|
| 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 |
| MAE | Ministry of Agriculture and Environment |
| MAF | Ministry of Agriculture and Forestry |
| MILD | Monitoring of Illegal Logging and Deforestation |
| 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) |
| SU-I-GFLM | Scaling up the implementation of the Lao PDR Emission Reductions Programme through improved governance and sustainable forest landscape management Project |
| tCO2e | [Metric] tons 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 |

# 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 significant progress on implementation of its Emissions Reduction Program (ER Program) during the second reporting period, 2022-2024. The ER Program is currently being implemented through four 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. With the advance payment received in June 2022 and the first ER Payment received in July 2024, totaling USD 16 million.
- **Scaling up the implementation of the Lao PDR Emission Reductions Programme through improved governance and sustainable forest landscape management (SU-IGFLM) Project** 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 approved in 2019 and the second grant approved in 2023, totaling USD 51.9 million, has been supporting the ER Program provinces in coordination with the GFLL Project;
- **The Village Forest Management Project (VFMP)**, supported by KfW, working in two ER Program provinces, namely Luang Prabang and Xayabouri.
- **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.

The two projects below ended during the 1st ER monitoring period:

- **The Integrated Conservation of Biodiversity and Forests (ICBF) Project**, supported by the German development bank, KfW Entwicklungsbank (KfW), working in two ER Program provinces. It ended in 2022.
- **The Second Lao Environment and Social Project (LENS2)**, supported by the World Bank ended in 2021.

Additional supports are being provided to the ER Program by:

- **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). The project is focused on supporting measurement, monitoring, and reporting (MMR) for the ER Program, near-real time forest monitoring called PDMS, at both the national and provincial levels, including the ER Program area.
- **The 4th National Forestry Inventory (NFI 4) ,** funded jointly by the World Bank, the GiZ, the LLL Project, and F-REDD2. The NFI 4 is a national-level forest survey (ground survey) applying revised methodology to improve data accuracy and coverage, and align with international standards. The tree stump data corrected from the 6 northern provinces are used for estimating logging emissions for the 2nd ER monitoring.
- The World Bank support to the **Near-real time provincial deforestation monitoring system (PDMS)**, which conducted gap assessment and system upgrading, and provide technical training to the provincial and district forestry officers of Luang Namtha, Bokeo, and Oudomxay provinces (Houaphan, Luang Prabang and Xayabouly provinces already had PDMS in operation).

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.

**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 | 16.0 | 2022 - 2025 | The project received the Carbon Fund's advance payment of USD 3 million for initial activities. The first results-based payments for emissions reductions, in 2023, unlocked payment of additional USD 13 million. The project expects receiving payment for the second monitoring period in 2026. |
| I-GFLL/CliPAD<br>SU-I-GFLM | GiZ, GCF<br>Project 1<br>Project 2 | 15.9<br>36.0 | 2020 - 2024<br>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, Xayaboury, and Houaphan. With the new project, there are in total 572 villages covered throughout the 6 provinces . [1] |
| F-REDD,<br>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 | 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 Xayaboury 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 Xayaboury provinces. |
| 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.

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[1] The I-GFLL project was originally set to support the ER Program in six provinces with a Green Climate Fund (GCF) grant of €65.2 million (total co-financing: €162.7 million) for 2020-2029. Due to GCF budget constraints, the project was split into two. Project 1 (2020-2024) received a reduced grant of €15.2 million (total co-financing: €62.6 million) and covered only three provinces. A funding proposal for Project 2 (2023-2026), seeking €32.8 million to cover all six ER Program provinces, was submitted in early 2022. The GCF Board approved this Project 2 grant for €32.8 million (USD 36.0 million, with USD 45.3 million in co-financing) on March 16, 2023. This phased approach has caused delays in some ER Program activities across the six provinces, particularly in the three not covered by Project 1.

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

As of December 2024, the GFLL Project has disbursed 17.6% (US$ 2.82 million) out of the US$ 16 million received from the first ER Payment. These expenditures primarily financed and strengthened institutional arrangements for National, Provincial, and District Project Management Units (NPMU, PPMU, DPMU), capacity building, consulting services (59% of total spent), workshops/meetings (11.8%), goods (11.5%), and incremental operational costs. National-level agencies (NPMU/REDD+ Division) accounted for 14.2% of expenditures, followed by PPMU at 2.5% and DPMU at 0.9%[2].

Remarkable progress was observed in Component 1: Strengthening the enabling conditions for REDD+. The Government of Laos (GoL), in collaboration with and supported by various development partners, including the GFLL, has advanced efforts to update enabling conditions amidst a dynamic national and international policy environment. Significant efforts were also made to build a foundation for implementing Component 2: Climate Smart Agriculture (CSA) and sustainable livelihoods for forest-dependent people, and Component 3: Sustainable forest management. The project is now equipped with updated guidelines and manuals for conducting these two components. Technical training was provided to national, provincial, and district staff in areas such as community engagement, land-use planning, community action planning, safeguards, and gender. The same group also received training in project management.

**Component 1: Strengthening the enabling conditions for REDD+**
During the 2nd ER monitoring period (2022 - 2024) Lao PDR continued to make significant progress in strengthening the enabling conditions related to REDD+, as outlined below.

- ***Strengthening policies and legal framework***

  **Prime Minister Order 11**[3], issued on July 21, 2023, underscores the government's unwavering commitment to ensuring the effective implementation of its laws and regulations. This order explicitly prohibits a range of illegal activities that undermine forest integrity and sustainable land use, including illegal logging, unlawful timber trade, land encroachment, and unauthorized mining operations. The PMO 11 has been disseminated at the local level with regional workshops, and it was organized in Oudomxay in October 2023 for the northern region.

  Issuance or the **Decree on Protected Areas (June 2023)**, **Decree on Protection Forests (January 2024)**, and **Decree on Production Forests (January 2024)** improves the regulatory aspects and indicates the ambition of the GoL in strengthening the management of three forest categories.

  The **Lao Forest Strategy to 2035**, approved in May 2024, outlines an ambitious long-term vision for the sustainable management and development of the country's forest resources. Succeeding the national commitment of FS 2020, the key target is to allocate 70% of the country's land area as forestland and increase the forest cover to 70% by 2035. This aligns with the Lao Nationally Determined Contribution (NDC).

  The MAF **Instruction on Forest Carbon Management** (July 2024) stipulates the process for screening REDD+ projects by private sector. The Prime Minister **Decree on Carbon Credit** was newly approved in May 2025, paving the way also for the Lao forestry sector and the stakeholders to utilize carbon credits as innovative climate financing opportunities

  A recent Forest Governance Index study by the European Forest Institute (EFI) in 2024 compared the state of governance of 2022 against 2015. The assessment showed improvement in four areas, and no-change in one area,

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[2] Updated figure including 2025 is provided in Annex 2.

[3] The Prime Minister Order No. 11 on Strengthening Strictness on Managing, Protecting, Developing and Utilizing Forest and Forestland; Preventing and Controlling Forest Fires and Encroachment into Forest and Forestland, July 21, 2023.

with prominent progress in *Legislative and institutional clarity*, and good progress in *Compliance, promotion and enforcement in the forest sector*.

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

  The targeted villages for receiving benefits under the first ER Payment are 247 villages. As part of the development of the Community Action plan (CAP), the GFLL Project, initiated Participatory Land-Use Planning (PLUP) or a review of existing PLUP. Up to March 2025, CAP have been completed in 18 villages. Furthermore, the project has completed 40 more CAPs from March 2025 to the time of reporting and for the year 2025, the total number of targeted CAPs will be 79 CAPs. All 247 CAPs are targeted to be completed before the end of Q1 2027 (end of the ERPA is set on 31 December 2025)

  In the background, efforts were made to streamline the CAP. The CAP template and content were recently revised and endorsed by the World Bank in April 2025. A decision letter by DoF on January 13, 2025, endorsed a streamlined process, allowing CAP development to proceed concurrently with PLUP development if existing PLUP data is valid, to accelerate the process.

  Capacity building has also seen progress, including trainings on Community Engagement Process (CEP), Participatory Land Use Planning (PLUP), CAP writing, and CAP implementation. The World Bank also provided an online training on streamlined and simplified CEP process and CAP preparation on May 2025, engaging 168 participants from sub-national levels.

- ***Improved forest law enforcement and monitoring***

  The **Provincial Deforestation Monitoring System (PDMS)** has been endorsed by the MAF (Decision 2761, 24 May 2024) as a national tool for monitoring forest cover and strengthening law enforcement. The PDMS is already rolled out in 16 out of 18 provinces across the country, including all 6 provinces of the ER Program. Since 2022, regular training sessions are provided to Provincial Agriculture and Forestry Offices (PAFOs) and District Agriculture and Forestry Offices (DAFOs), with support from the GFLL, I-GFLL, SU-I_GFLM, or F-REDD2 projects. In 2024, the GFLL supported the training of 18 staff members from Oudomxay province. In 2025, the SU-I_GFLM project organized three trainings: one for Houaphan province (27 staff), one for Bokeo, Luang Namtha, and Oudomxay provinces (49 staff), and one for Xayabouly and Luang Prabang provinces (39 staff). According to the PDMS Dashboard, 1,090 field visits have been conducted across the six provinces since January 2022.

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

  **The 2019 Land Law** marks a significantly positive shift, particularly for local communities, by laying the groundwork for greater land tenure security. This law, alongside subsequent **National Assembly Resolution No. 57 (September 2024)**, now enables residents, especially those in forest areas, to obtain formal land titles for their permanent agricultural and residential plots. This political commitment was further institutionalized through the **Prime Minister's Order No. 20** (November 2024), and has been operationalized in the **MAF Instructions 1821** (May 2025) which guides the implementation of the Prime Minister’s Order No. 20.

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

Progress have been made in laying the groundwork for CSA and REDD+ promotion. A "white list" of eligible CSA practices that contribute to rural livelihoods has been prepared, alongside a "black list" identifying activities not eligible under the GFLL project, to mitigate potential social and environmental risks.

Actual implementation of CSA activities is in its early stages to promote climates-smart agriculture and REDD+ (activity 2.1) as Emission Reduction funds were only recently released to the first batch of 18 approved Community Action Plans (CAPs). The Project is currently focusing on training VDCs on how to access and manage these funds and activities.

The first two and half years of the GFLL project (2022-2024), the transfer of the funds to village level was slow due to delay and slow progress of the preparation and facilitation of project implementation at field level especially for safeguards, FPIC, and community engagement processes, including capacity building for local government agencies (sub-national level). As of the end of 2024, the disbursement of monetary benefits to villages has not yet been conducted, and a small amount of non-monetary benefit has been shared to a limited number of villages. The main causes were delays in decision-making, such as fund management mechanism, village selection, agreeing on the guidelines and templates (e.g for FPIC, CAP), and turnover in advisors and technical staff.

**Component 3: Sustainable forest management**

Similar to Component 2 above, implementation of sustainable forest management activities are also in its early stages, with limited activities implemented for sustainable management of Production Forest Areas (Activity 3.3), and National Protected Area management (3.4).

**Component 4: Program management and monitoring**

Ensuring effective fund flow arrangements was one of the key program management action for the GFLL since the acceptance of advance payment and the initial results-based payment. The project developed two Financial Management Manuals: one for the National Project Management Unit (NPMU), Provincial Agriculture and Forestry Offices (PAFOs), and District Agriculture and Forestry Offices (DAFOs), and another for Village Development Committees (VDCs). In January 2025, capacity-building sessions on the VDC Financial Management Manual were conducted in Oudomxay and Luang Prabang, targeting PAFOs, DAFOs, and VDCs. This recent training was attended by 12 individuals from 6 PAFOs, 44 individuals from 18 districts, and 53 individuals from 18 villages, bringing the total number of participants to 109. Table 2 below summarizes the trainings organized by the GFLL Project, with full details provided in Annex: Information on the implementation of the benefit sharing plan.

**Table 2. Summary of training implemented by the GFLL Project**

| Key action | In charge | Date | Target Participants | Remarks |
|---|---|---|---|---|
| **Safeguards, PLUP, Monitoring and Evaluation (M&E), and CAP** | | | | |
| TOT on FPIC | NPMU/TA | October 2022 | All six provinces<br>LNFC, LWU and DAFO of targeted districts | |
| Training on Safeguards for SESUs, P-SESUs and District SESU staff | NPMU/TA | Sept 2023 | National SESU, Provincial SESUs, District SESU staff, and members of the Community Engagement Teams of both provincial and district levels including staff from PONRE | |
| CEP 1, CEP2, CEP 3 trainings for PAFOs/DAFOs | NPMU/TA | December 2023 – Oct 2024 | 6 PAFOs and 18 DAFOs including LWU and NDLF | |
| PLUP training | NPMU/TA | June – Aug 2024 | 6 PAFOs and 18 DAFOs including LWU and NDLF, including implementation supporting consultants (junior consultants) | |
| **Finance Management** | | | | |
| Training workshop on Procurement, Financial Management, Accounting (including the accounting software), Financial management for VDCs, | FM/TA | September 2022 – January 2025 | Depending on the type of training:<br>Finance Unit/REDD+ Division and FPF Division<br>6 provinces facilitators under DoF.<br>6 provinces PAFOs and 18 DAFOs<br>Administration/Finance Unit under 6 provinces PAFOs and 18 DAFOs | |
| **Monitoring Reporting and Verification (MRV)** | | | | |
| Training on MRV | FIPD/TA | October 2022 | 24 staff (including 4 women) from FIPD, REDD Division, Forestry | |

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|---|---|---|---|
| (Monitoring, Reporting and Verification) | | | Training Center, F-REDD2 Project, and the World Bank Team |
| Training on PDMS (Near-real time Provincial Deforestation Monitoring System) | NPMU/TA | Nov-Dec 2022 | FIPD, REDD+ Division and DOFI; 6 provincial technical staff from Forestry Section and Forest Inspection Section (one from each section) and 48 district technical staff from Forestry Unit and Forest Inspection Unit in16 districts |

Safeguards and Feedback and Grievance Redress Mechanism (FGRM); the project has operational instruments and institutions for managing safeguards in compliance with the requirements. The FGRM has been developed and operational prior to the August 2024 deadline, with hard copy forms available in all provinces, districts, and visited villages. However, to date, no grievances have been lodged. During the mission to Luang Prabang province in October 2025, three villagers who are using land in forest area for their livelihood raised concern over their forestland use. The team of safeguard focal persons and consultants of PMU revisited them and clarified that they can continue using the land without expansion until the legal and institutional frameworks for recognition and registration of forestland use rights are operational. These cases have been resolved and recorded in the FGRM. Challenges identified include literacy barriers for some ethnic groups and limited facilities in certain villages preventing access to online systems. Project information, including the FGRM system, is being converted into four languages (Hmong, Akha, Khmu, and Lao) to address these issues. See Annex 1: Information on the implementation of the safeguards plans for further details.

Financial management: Financial Management Manuals have been developed for VDCs, and capacity building on their use was conducted in January 2025 for 109 participants from PAFOs, DAFOs, and VDCs. The Computerized Accounting System (K-PACC) has been installed and used by the project since October 2023 at NPMU, 6 PAFOs, and 18 DAFOs. See Annex 2: Information on the implementation of the benefit sharing plan.

### 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). Similar to the 1st ER monitoring period, 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. This common approach is extensively applied across several initiatives. This includes GCF Project 1 (Funding Proposal 117), which covers 212 villages (170 original plus 42 from an extension), GCF Project 2 (Funding Proposal 200), with 290 villages, and the KfW-funded Village Forest Management Project, with 70 villages. Advancements of these activities have significant importance in mitigating and minimizing the potential of displacement from the ER Program area. The GFLL is targeting villages within the same provinces, focusing on different villages (see Annex 2 for the latest list).

Stepwise improvement of the NFMS facilitates the monitoring of drivers and interventions and helps to address displacement risks. The national rollout of the PDMS has been providing far advanced opportunities to monitor the land and forest near real-time. As noted under Component 1, the PDMS has been successfully rolled out across all six ER Program provinces, significantly increasing its effectiveness and supporting monitoring of the agreed land-use plans. The next step is to incorporate a forest fire monitoring function, with prototype testing planned to begin in the 2025 - 2026 dry season.

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 effectiveness of such measures and lessons are briefly summarized in Section 1.2, and more in details in Annex 1.

### 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 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 Enforcement, (3) Safeguards and Stakeholder Engagement, (4) Benefit Sharing, (5) National Forest Monitoring System (NFMS), and (6) REDD+ Strategy.

The technical working groups (TWGs) have adopted different operational approaches. The **NFMS** TWG is the most structured, holding biannual meetings to focus on MRV, Forest Monitoring, and Data Management. This group has been reviewing the technical approaches, timelines, and overall progress of the 2nd MMR to ensure a clear and coordinated effort. While other TWGs have not held dedicated meetings, significant work has progressed in their thematic areas. The **Safeguards and Stakeholder Engagement** and **Benefit Sharing** topics, in particular, have been intensively worked out under the ER Program. Additionally, progress in **Land Tenure** and **Legal and Law Enforcement** has been driven by high-level dialogues and cross-sectoral implementation (as detailed in Component 1 and Annex 5). The MAF directed the DOF in April to renew the National **REDD+ Strategy**. The DOF is now preparing a workplan and will establish a committee to draft the new strategy with support from key technical partners, including the World Bank LLL Project, UN-REDD, and JICA F-REDD 2.

As above, 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. 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. The new addition in the 2nd ER monitoring period is the launching of the SU-I-GFLM in 2023 as explained at the beginning of the Section 1.1.

The limited distribution of the 1st ER Payment of USD 16 million is due to institutional and procedural bottlenecks, with only 25.7% (USD 4.1million) spent by June 2025. Below are the summary of the two key implementation challenges with the detailes explained in Annex 2,

- Management Instability: Changes in senior management and project consultants slowed decision-making and project activity acceleration.
- Slow Progress on CAPs: The mechanism for benefit transfer requires the completion of Community Action Plans (CAPs). Only 40 CAP documents were completed and cleared by June 2025, significantly lagging the overall target.

The delay restricts the implementation of core ER activities such as participatory land-use planning, forest management and alternative livelihoods support activities outlined in the CAPs, which have only recently started in GFLL funded villages. However, as noted previously in item b) above, other collaborating projects have been implementing their activities ahead of the GFLL, contributing to the shared objectives to sustainably manage the forests and furthering emission reductions. Displacement risk mitigation relies on the thorough implementation of the CAPs and the safeguards framework by GFLL and othe projects in the area.

## 1.2 Update on major drivers and lessons learned

In 2018, the ERPD identified four drivers of deforestation and forest degradation (Table 3 below). As it was the case for the 1st ER motoring period, these four largely remain as the major drivers for deforestation and forest degradation in the ER Program are for the 2nd monitoring period. 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. Along with the PM Order No.11 [4]and the endorsement of the PDMS by the MAF, the government authorities are conducting more regular field visit for law enforcement through early identification of potential displacement events and patterns. The PDMS is currently deployed in 16 out of 18 provinces in the country, including the six ER Program provinces, and four other provinces sharing their borders, i.e. Phongsali, Xaysomboune, Xiengkwang and Vientiane..

**Table 3: Update on major drivers.**

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[4] No. 11/PM (21st July 2023): Order On Strengthening Strictness on Managing, Protecting, Developing and Utilizing Forest and Forestland; Preventing and Controlling Forest Fires and Encroachment into Forest and Forestland.

| | 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 agricultural statistics (2022) show that total harvest areas of major crops declined from 2016 - 2018, and have since stabilized in the ER Program area [5]. Areas under maize, upland rice and job's tear cultivation have decreased, while those under cultivation of cassava have increased. Major expansion of cassava into forests has been continuously observed nationwide, including the ER Program area [6].<br>29% of the deforestation during the 2nd ER monitoring period occurred in current forest with higher carbon stock (strata 1, 2 and 3), compared to 10% in the 1st ER monitoring period. The rest of deforestation occurred in degraded forestland (potential forest strata with lower carbon stock, stratum 4), which was 71% for the 2nd ER monitoring period compared to 90% for the 1st ER monitoring period, which has led to increased emissions.<br>According to the PDMS dashboard, the field check confirmed more lands being converted into permanent agriculture and cattle grazing than before, totaling 15% of the entire drivers [7], presenting challenges in enforcing land use planning and compliance. |
| 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), but in smaller scale compared to the Reference Level and the 1st ER monitoring period. While the detailed reasons require further analysis, this trend could represent a trade-off with Key Driver #1: farmers increasingly favoring permanent agriculture over shifting cultivation.<br>The satellite-based interpretation using Collect Earth Online conducted as a part of the NFI 4 suggests shifting cultivation (classified as Upland Crop) as a major driver of deforestation driver and forest degradation, followed by permanent type of agriculture for cash crop and cattle grazing (classified as Other Agriculture). The PDMS analysis agrees with this result, showing upland cropping as the largest driver throughout the entire ER monitoring period [8]. . |

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[5] According to the Agricultural Statistics Data available up to 2022. For 2023 and 2024, the change in the statistical method made the tracking difficult for some crops.

[6] Both harvested area and production of cassava have shown obvious growth, starting gradually in 2018 and accelerating notably from 2021. This trend aligns with the observations of government and forestry experts, who note that the "cassava boom" began in southern Laos before moving northward to the central and northern regions

| | | |
|---|---|---|
| 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 result, 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. Increasing pressure comes from illegal mining activities in Houaphan province[9]. |
| 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. However, it is commonly acknowledged that the Lao PDR Government's commitment and measures for controlling commercial-based wood harvests are being effective.<br>The stump survey conducted for the 1st reporting, however, showed an approximate 11% increase in logging emissions compared to the reference period, while the data from the 4th NFI, which is used for the 2nd reporting period, shows that logging has significantly decreased, 80% compared to the reference level. The observations from the survey teams suggest that most of the logging seem to be for subsistence, thus small in their scale.<br>Several reasons can be considered for this positive trend: strengthened law enforcement through policy measures, such as Prime Minister Order 11[10], has been effective; more regular forest monitoring activities using the PDMS have been implemented; and the full implementation of large-scale projects—such as GFLL, SU-IGFLM, LLL, and VFMP—has been crucial in raising awareness among those involved in illegal logging. Furthermore, global efforts to address the illegal timber supply chain (e.g., the EU Deforestation Regulation), along with a continued ban on unprocessed timber and the closure of unlicensed timber processing mills, could also be contributing to this positive trend." |

### 1.3 Methodological deviations

There are no methodological deviations to be reported.

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[7] Still the majority is shifting cultivation. However, note that this field check only represent a small part of the land and forest areas of the ER program. Also, the system records the state of land-use at the time of check, which could be different from the direct cause of deforestation.

[8] Note that distuingishing upland cropping and perament type of agriculture is still challenging, as it requires time-series analysis of multiple years.

[9] For example, there is a media coverage concerning the mining in Houaphan province <https://www.mekongeye.com/2024/10/07/laos-rare-earth-leak>.

[10] PMO 11, July 2023, Order On Strengthening Strictness on Managing, Protecting, Developing and Utilizing Forest and Forestland; Preventing and Controlling Forest Fires and Encroachment into Forest and Forestland.

# 2 SYSTEM FOR MEASUREMENT, MONITORING AND REPORTING EMISSIONS AND REMOVALS OCCURRING WITHIN THE MONITORING PERIOD

## 2.1 Forest Monitoring System

- ***Organizational structure, responsibilities and competencies***

Table 4 (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 [11]. 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. The FIPD leads the implementation of the National Forest Inventory and stumps survey from which the stump measurements are 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 4.Framework of institutions involved in the forest monitoring.**

| Institutions | MMR | Monitoring of drivers and interventions |
|---|---|---|
| **DOF** | Conduct the MMR.<br>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). | Provide supporting data for enforcement actions.<br>Compile the monitoring results. |
| **Department of Forest Inspection (DOFI)** | Technically review the MMR results as a member of the NFMS TWG. | Lead enforcement actions at the central-level and collaborate with provinces. |
| **Provincial Government** | Participate in National Forest Inventory (NFI) | Lead enforcement actions at the provincial level and collaborate with district authorities. |
| **Private Sector, local community** | Participate, serving as local guides, in National Forest Inventory (NFI) | Participate in forestry-related activities, e.g. protection, restoration, timber and NTFP supply-chain. |

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[11] 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 describes 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. DOF is planning to update the NFMS Roadmap in 2026.

| | | |
|---|---|---|
| **NFMS TWG** | Technically review the MMR results. Collaborate with other TWGs. | Technically review the monitoring results. Collaborate with other TWGs. |
| **NRTF** | Endorse the MMR results. Facilitate collaboration with other concerned sectors | Facilitate collaboration with other concerned sectors following the monitoring results |
| **MAF or new MAE** | As the executing agency, responsible for the MMR | 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 5: 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<br>"Potential Forest": forest land which are in temporarily un-stocked state (for details see next section.) |
| **Sources and Sinks** | Carbon emissions from deforestation; and<br>Carbon emissions from forest degradation.<br>Enhancement of carbon stocks through forest restoration; and<br>Enhancement of forest carbon stock through reforestation. |
| **Carbon pools** | Above Ground Biomass (AGB).<br>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.dof.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 6: Data presented in the NFMS web-portal.**

| Data related to Activity Data (AD) | Data type |
|---|---|
| Forest Type Map 2000, 2005, 2010, 2015, 2019, 2022 [12] | 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 |

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[12] 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 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. |
| 4th NFI data (2025) | 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 7: National documents and reports related to GHG.**

| Document | Data storage |
|---|---|
| National FREL/FRL Report to the UNFCCC including annexes (2018) | Report<br>https://redd.unfccc.int/submissions.html?country=lao |
| 1st National REDD+ Results to the UNFCCC including annexes (2020) | Report and technical annex<br>https://redd.unfccc.int/submissions.html?country=lao |
| 1st National Communication to the UNFCCC (2000) | https://unfccc.int/documents/116663 |
| 2nd National Communication to the UNFCCC (2013) | https://unfccc.int/documents/116664 |
| 1st Biennial Update Report to the UNFCCC (contains a Technical Annex on REDD+) (2020) | https://unfccc.int/documents/274307<br>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.

**Table 8: 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. This SOP supported the implementation of the 3rd NFI. For the 4th NFI, the SOP is under revision. It will be completed and shared by the end of 2025. |
| 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***

In principle, the systems and processes have not changed since the ERPD to maintain full consistency with the Reference Level (RL)[13]. 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. For the 1st MMR, Lao PDR made a technical correction [14] to the RL (see Section 4.1) that is also valid for the 2nd 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, facilitated by the SilvaCarbon Program, brought forest inventory experts from the University of Göttingen in Germany and the US Forest Service who provided advices for the improvements in the NFI methodological approach. The revised approach improves the accuracy and range of the NFI data to be collected

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[13] 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).

[14] 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.

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. Follow-up training were provided by the same FAO expert in 2024 and March 2025 but focusing on the NFI revised design.

- ***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 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.

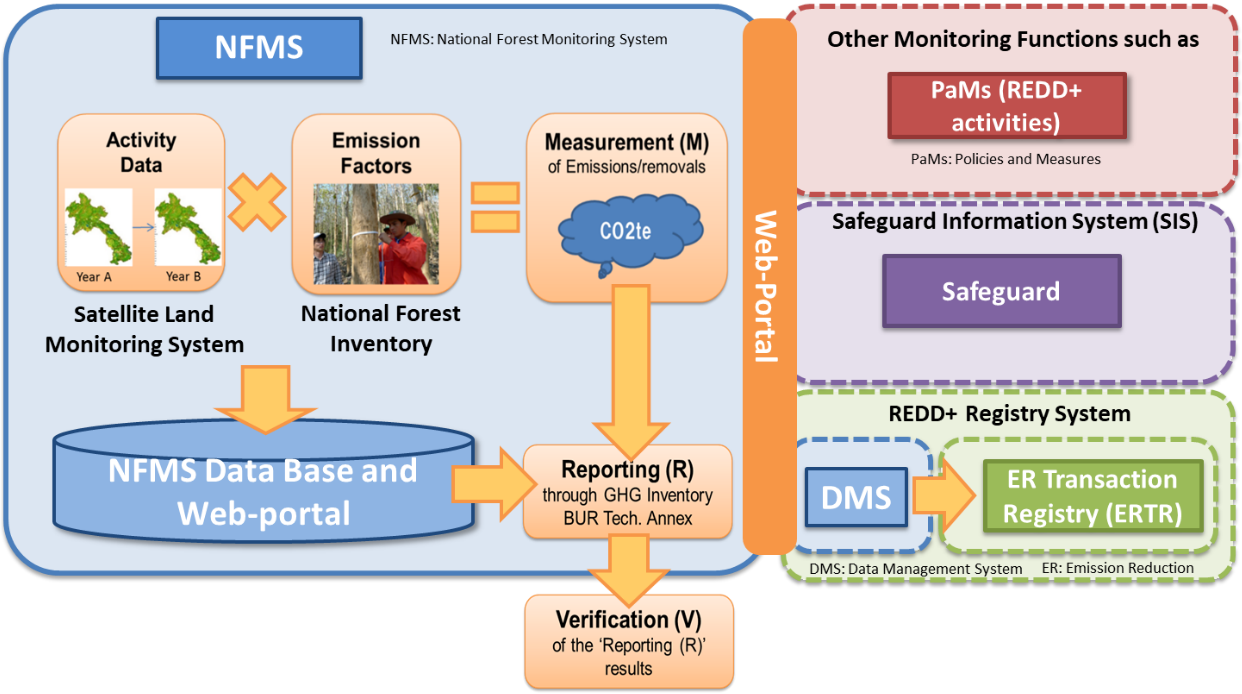

**Figure 1: Conceptual diagram of Lao PDR's NFMS and its interactions with other REDD+ systems**

- ***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 system has been endorsed by the MAF in 2024 and has been deployed in nearly all the country (16 among 18 provinces).
- The PDMS was actually launched initially in 2018 in three of the six ER-Program provinces (Xayaboury, Luang Prabang and Houaphan) with the CliPAD project from the GIZ. Since then the PDMS has been extended to Luang Namtha, Bokeo, and Oudomxay, through collaboration among the ER Program, I-GFLL, SU-I-GFLM, 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 in 2018/2019 but was discontinued at the end of the projects. The KfW is currently supporting a follow-up system called MILD (Monitoring of Illegal Logging and Deforestation) leveraging Sentinel-1 radar satellite.

- ***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 proposed and applied a technical correction to the RL for the 1st MMR (see Section 4.1 of the 1st ERMR for details).

The applied approach for the technical correction provided a higher level of accuracy for the forest degradation emissions, however with a quite large difference in the estimated volume compared to the previous RL. By applying this technical correction, the national-level and the ER Program estimates for forest degradation emissions are 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 Updates to the monitoring approach

With the expertise from the University of Göttingen in Germany and the US Forest Service, facilitated by the Silva Carbon Program, the methodological approach of the National Forest Inventory was revised to improve its robustness and statistical soundness. The 4th NFI was launched in October 2024. It is funded by the WB, the GIZ and the JICA, technically supported by the Kokusai Kogyo Company and implemented by the DOF in collaboration with PAFO, DAFO and local communities.

The Lao ER Program proposed to leverage the implementation of the 4th NFI [15] for improving the monitoring approach. The second MMR uses the same Emission Factors as the RL and the 1st MMR derived from the 3rd NFI and the 2nd Regenerating Vegetation Survey. The 4th NFI contributes to the two points indicated below and not to the Emission Factors themselves.

- The 4th NFI combines a visual interpretation of plots throughout the country and field visit of a sub-sample. This allowed conducting the **sample-based estimation** for the Activity Data with increased sampling density.
- The 4th NFI also included collection of stump data necessary for the estimation of **emissions from logging**.

Further details are as described below.

**Sample-Based Estimation**
One of the main improvements is the use of a new sampling design.

The sampling design of the 3rd NFI uses a double-stage random approach: the first stage is a random selection of cells among a three kilometers grid, and the second stage distributes randomly a plot located in forested area within the cell. This design brings complication to the statistical estimators. The 4th NFI now uses a systematic sampling, including the key features as below:

- The sampling design follows a two-phase design called Double Sampling for Post-Stratification (DSPS) (Westfall et al. 2019) [16];

- Phase I uses a systematic grid of 6 by 6 kilometers. This is a visual interpretation of all the plots throughout the country covering all land and forest cover classes. For the 4th NFI, the total number of plots is 6,409 plots. The visual interpretation uses the CEO and identifies the current land and forest cover class, historical changes, drivers of land use and forest cover changes; (the results of the interpretation for the 2nd MMR)

- Phase II is a field visit of the sub-sample of plots selected from a coarser grid of 18 by 12 kilometers, establishing PSPs in current forest and potential forest areas. For th 4th NFI, 540 plots were selected for a field visit.

Lao PDR uses the interpretation of the 4th NFI plots for the sample-based estimation of the AD map for the 2nd MMR. As shown in the Figure 2 below, the 1st MMR used a stratified random sampling approach with a total of 1,105 plots, while for the 2nd MMR, there are 2,259 plots on the Phase 1 (6 X 6 kilometers) grid within the ER Program area. The increased number of plots should reduce the uncertainty of the area estimates. As mentioned in the section 3.2, 41 additional plots were randomly distributed to ensure a minimum of 30 for each type of forest cover change.

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[15] The 4th NFI was conducted through the dry season 2024-2025. The implementation and technical support were co-financed by the World Bank, GiZ and JICA. SilvaCarbon Program and FAO also provided technical advices to the NFI design and data analysis.

[16] https://www.fs.usda.gov/nrs/pubs/jrnl/2019/nrs_2019_westfall_001.pdf

The approach for the CEO interpretation, such as the interpretation keys and satellite information used, is technically consistent with the 1st MMR.

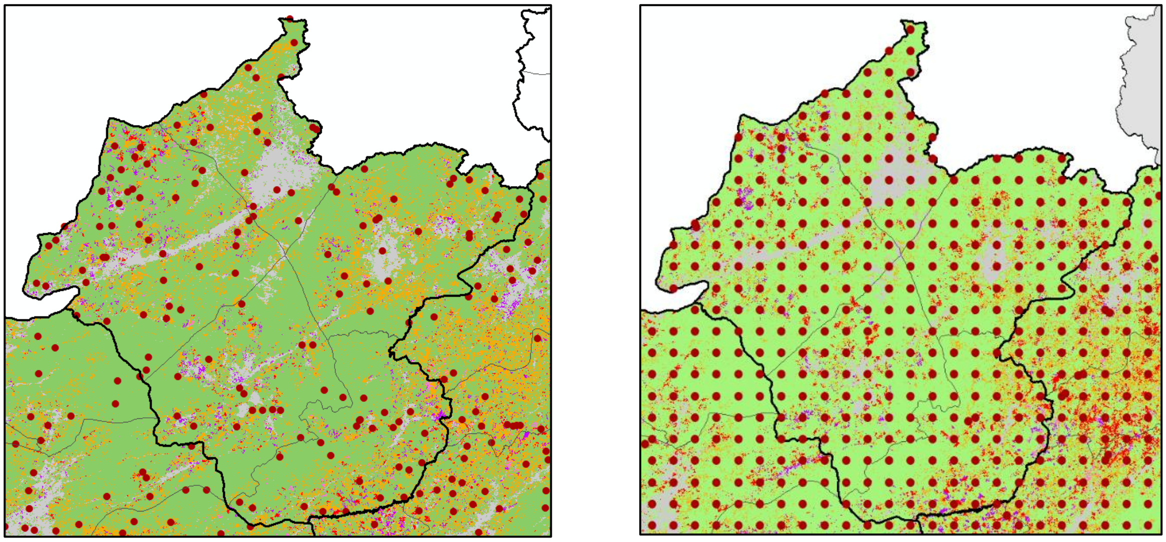

**Figure 2: Left: Stratified Random Sample for the 1st MMR, right: Systematic Sample (4th NFI) and random distribution (including 41 additional plots) for the 2nd MMR**

***Emissions from logging***

As part of the Measurements made for the ERP in Lao PDR, emissions from logging are estimated with a proxy-based approach triggering a 15% conservativeness factor, that uses stump diameter measured in the field.

For the Reference Level, stumps measurements came from the 2nd NFI[17] that was conducted in 2016/2017. The 3rd NFI [18]conducted in 2019 applied the same design with some minor modifications in survey protocols where the full details are documented in the Standard Operating Procedures[19]. For the 1st MMR, as no NFI was planned for this period, a specific "Stump Survey" was conducted in February 2022, using the exact same design as the 3rd NFI.

For the 2nd MMR, the emissions from logging are estimated using the stumps measurement made during the 4th NFI. As indicated above in Section 2.2, the field sample plots for the 4th are distributed systematically, and the plot design has also been improved. For the purpose of ensuring the robustness of the statistical estimator, the improved design does not allow randomness in subplot locations,  instead adhering to a systematic design. The pilot study conducted in March 2024 to test the plot design, agreed on using L-shape plot design with four subplots and revised circular nest sizes.

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[17] https://drive.google.com/file/d/1IgpOgKxNZju8yh5sW_mbKHcaclub73Qo/view?usp=drive_link

[18] https://drive.google.com/file/d/19cneF6ChY_4szR1cC96mrJzji3UJskZB/view?usp=drive_link

[19] https://drive.google.com/file/d/1RA3JUlilc2Wx5D8f3BeRSbZ-pCv38Z8_/view?usp=drive_link

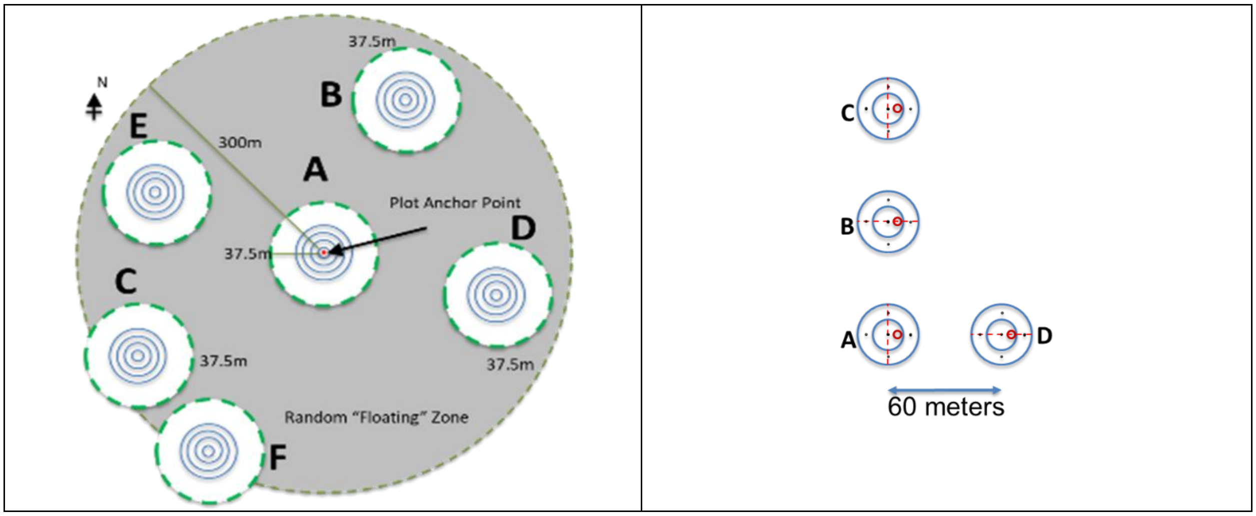

**Figure 3: Left: 3rd NFI plot design, Right: 4th NFI new plot design**

However, the procedure to measure stumps has not changed.

For the 1st MMR stump survey, a total of 120 plots were distributed within Natural Forest classes areas according to the Forest Type Map 2019 and 114 plots were suitable for the emissions estimation. For the 4th NFI, 218 plots were distributed within the ER Program area, with 131 plots being into Natural Forest classes according to the Forest Type Map 2022. 90 plots were used in the logging emissions estimates for the 2nd MMR.

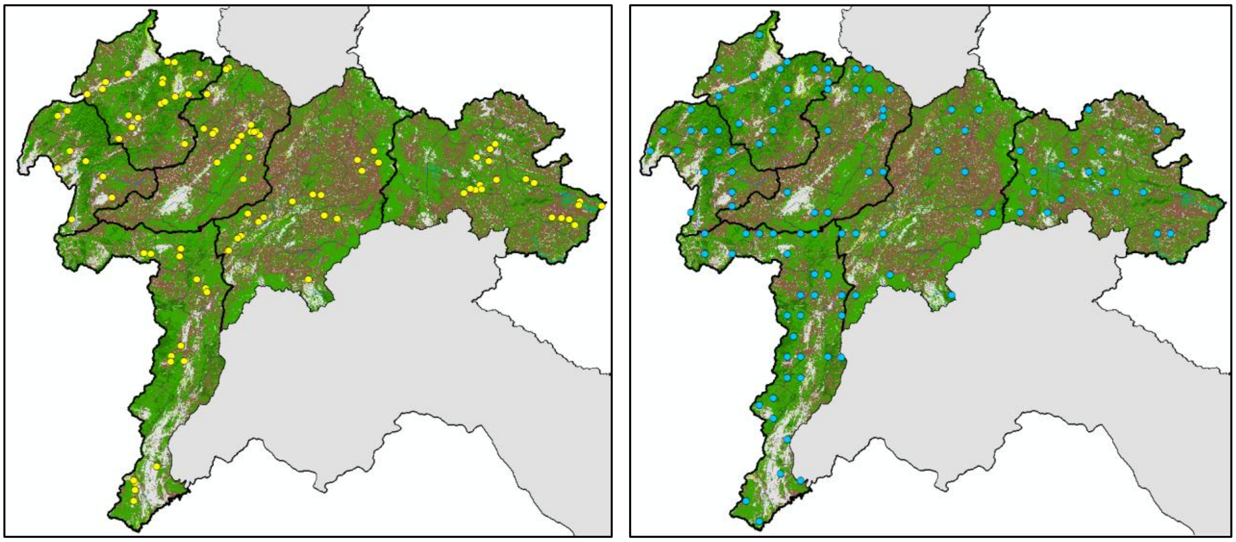

**Figure 4: Distribution of the field survey plots - Left: Stump survey 2023, Right: 4th NFI 2025**

## 2.3 Measurement, monitoring and reporting approach

### 2.3.1 Line Diagram

The diagram shown as Figure 5, 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.

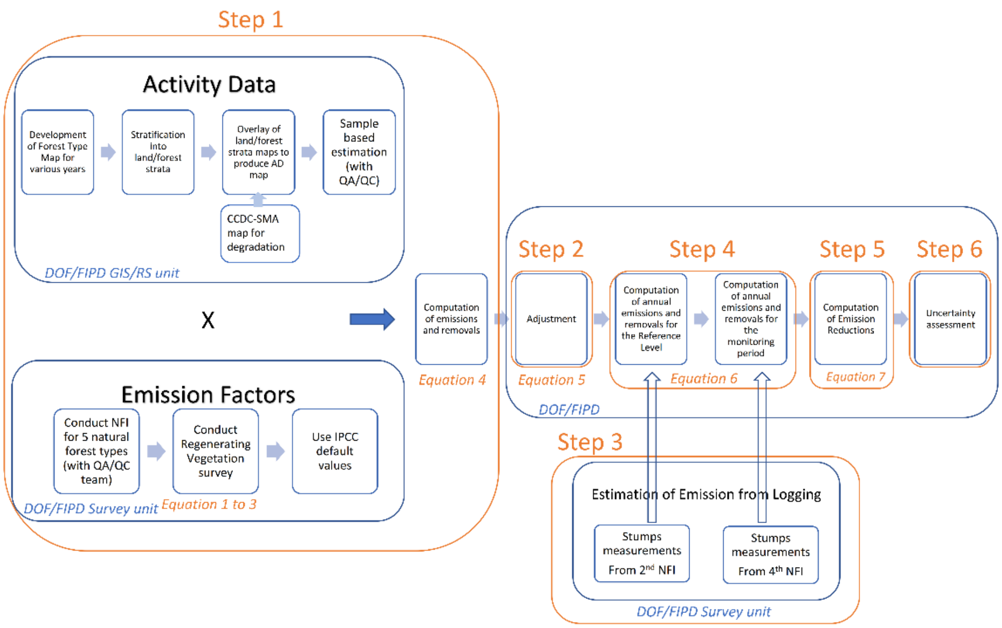

**Figure 5: Line Diagram that outlines the overall approach for the MMR**

### 【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 (2022-2024) 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, 2022 and 2025 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 9: 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 (P) | **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)[20] 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[21] to ensure the quality and accuracy of the measurements conducted at the plot location. Another SOP[22] 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 10. Adjustments for 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)[23] |

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[20] 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).

[21] Standard Operating Procedures (SOP) for the Terrestrial Carbon Measurement as listed in Table 8.

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

[23] 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.

| | | | |
|---|---|---|---|
| | | | In principle, 40-years[24] 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)<br>Stratum 3 (DD) | Stratum with higher biomass | In principle, 20 years[25] 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)[26].<br>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 from deforestation and forest degradation are estimated and deducted, respectively. The same rationale was applied for the monitoring period, but considering the period 2019-2021 and 2022-2024

**【Step 3】**

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[24] 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.

[25] 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.

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

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 second Monitoring Period uses data from the 4th NFI conducted in 2025. 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 2025 respectively for the Reference Level and the second 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.

### *2.3.2 Calculation*

In this section, the various steps for the carbon accounting as outlined in Figure 5 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 2nd 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. This steps was conducted for the 1st MMR and thus was not necessary to be done again for the 2nd MMR as the same E/R factors were used.
Equation 1 (from 1a to 1e) outlines how the carbon stock of a forest type is calculated using the field measurements conducted during the NFI. 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 9. 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 11 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 11. RS ratio by forest types and AGB threshold**[27]

| 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) | |

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[27] 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

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

*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

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

*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 “MMR2_AD_ERs_20250624.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 9 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

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

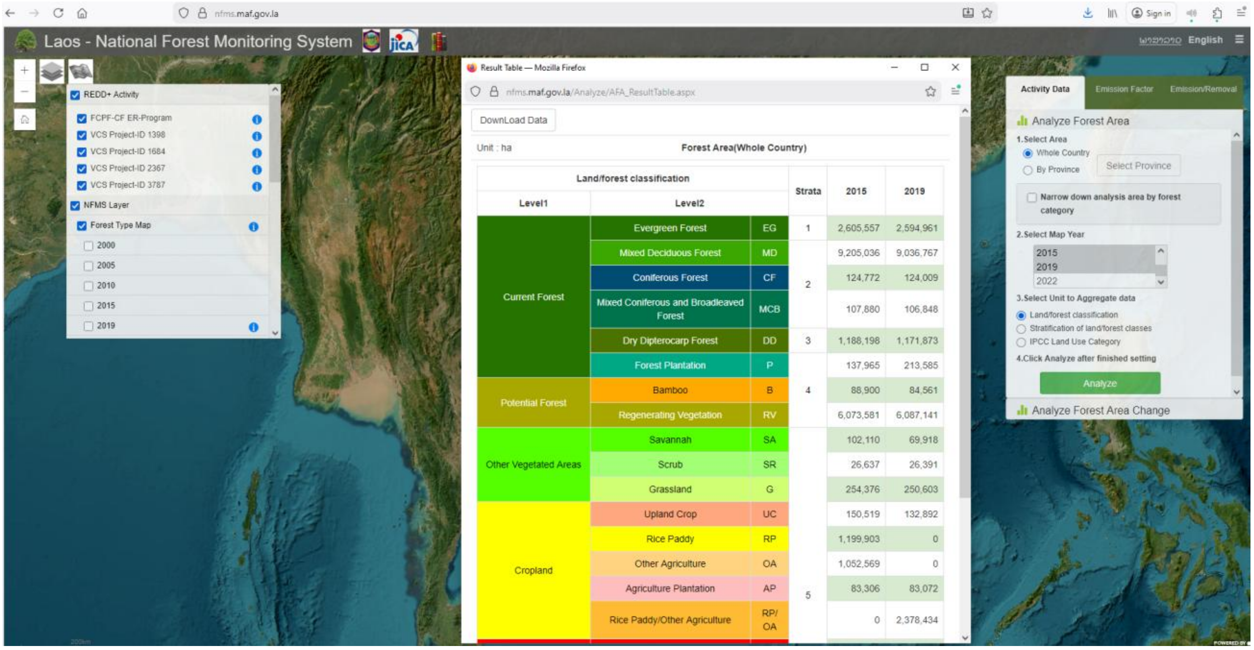
*Where:*

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. These areas which are found in the tab “EF”, column N, are copied from the NFMS web-portal (https://nfms.dof.maf.gov.la). The web-portal enables any user to get information and download for instance a table with the areas of the land/forest covers type for any year covered by the Forest Type Maps, as shown in the Figure 6 below.



☑ REDD+ Activity
- ☑ FCPF-CF ER-Program
- ☑ VCS Project-ID 1398
- ☑ VCS Project-ID 1684
- ☑ VCS Project-ID 2367
- ☑ VCS Project-ID 3787

☑ NFMS Layer
- ☑ Forest Type Map
  - ☐ 2000
  - ☐ 2005
  - ☐ 2010
  - ☐ 2015
  - ☐ 2019

1.Select Area
- ● Whole Country
- ○ By Province (Select Province)

☐ Narrow down analysis area by forest category

2.Select Map Year
- 2015
- 2019
- 2022

3.Select Unit to Aggregate data
- ● Land/forest classification
- ○ Stratification of land/forest classes
- ○ IPCC Land Use Category

4.Click Analyze after finished setting

Unit : ha

Forest Area(Whole Country)

| Land/forest classification | | | Strata | 2015 | 2019 |
|---|---|---|---|---|---|
| Level1 | Level2 | | | | |
| Current Forest | Evergreen Forest | EG | 1 | 2,605,557 | 2,594,961 |
| | Mixed Deciduous Forest | MD | 2 | 9,205,036 | 9,036,767 |
| | Coniferous Forest | CF | | 124,772 | 124,009 |
| | Mixed Coniferous and Broadleaved Forest | MCB | | 107,880 | 106,848 |
| | Dry Dipterocarp Forest | DD | 3 | 1,188,198 | 1,171,873 |
| | Forest Plantation | P | 4 | 137,965 | 213,585 |
| Potential Forest | Bamboo | B | | 88,900 | 84,561 |
| | Regenerating Vegetation | RV | | 6,073,581 | 6,087,141 |
| Other Vegetated Areas | Savannah | SA | 5 | 102,110 | 69,918 |
| | Scrub | SR | | 26,637 | 26,391 |
| | Grassland | G | | 254,376 | 250,603 |
| Cropland | Upland Crop | UC | | 150,519 | 132,892 |
| | Rice Paddy | RP | | 1,199,903 | 0 |
| | Other Agriculture | OA | | 1,052,569 | 0 |
| | Agriculture Plantation | AP | | 83,306 | 83,072 |
| | Rice Paddy/Other Agriculture | RP/<br>OA | | 0 | 2,378,434 |

**Figure 6. Getting information from the NFMS web-portal**

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 "MMR2_AD_ERs_20250624.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

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

*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 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 "MMR2_AD_ERs_20250624.xlsx" and the tab "AD_Uncertainty".

As displayed in the Figure 5, 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 "MMR2_AD_ERs_20250624.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 for the Reference Period.

**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 "MMR2_AD_ERs_20250624.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 from land and forest cover change 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 NFI4 ERPA_20250624.xlsx".

The calculation using Equation 6 below is presented in spreadsheet "MMR2_AD_ERs_20250624.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:

**<u>Equation 7</u>:** 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; tCO₂e;*

$RL_{RP}$ = *Expected net emissions of the RL over the Reporting Period; tCO₂e;*

$GHG_{RP}$ = *Monitored net emissions over the Reporting Period; tCO₂e;*

Steps 4 and 5 are presented in the spreadsheet "MMR2_AD_ERs_20250624.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 '"MMR2_AD_ERs_20250624.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,** | Carbon stocks for each forest/land classes of the level 2 of the Lao classification are collected through various sources, as described below:<br>**Natural forest**<br>• 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).<br>• 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. |

<table>
<tr>
<td>**regional, national, international ):**</td>
<td>
• Country-specific allometric equations [28] 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 [29] were used without applying correction factors.
<table>
<tr><td>Evergreen Forest (EG)</td><td>$0.3112*DBH^{2.2331}$</td></tr>
<tr><td>Dry Deciduous Forest (DD)</td><td>$0.2137*DBH^{2.2575}$</td></tr>
<tr><td>Mixed Deciduous Forest (MDF)</td><td>$0.523081*DBH^{2}$</td></tr>
<tr><td>Coniferous Forest (CF)</td><td>$0.1277*DBH^{2.3944}$</td></tr>
<tr><td>Mixed Coniferous and Broadleaf Forest (MCB)</td><td>$0.1277*DBH^{2.3944}$</td></tr>
</table>
**Regenerating Vegetation (RV)**<br>
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.<br>
**Bamboo (B)**<br>
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)<br>
In Table 3.6 copied below from the Vietnam modified REL report, Bamboo is the Forest type code 6.
</td>
</tr>
</table>

---

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

[29] 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.

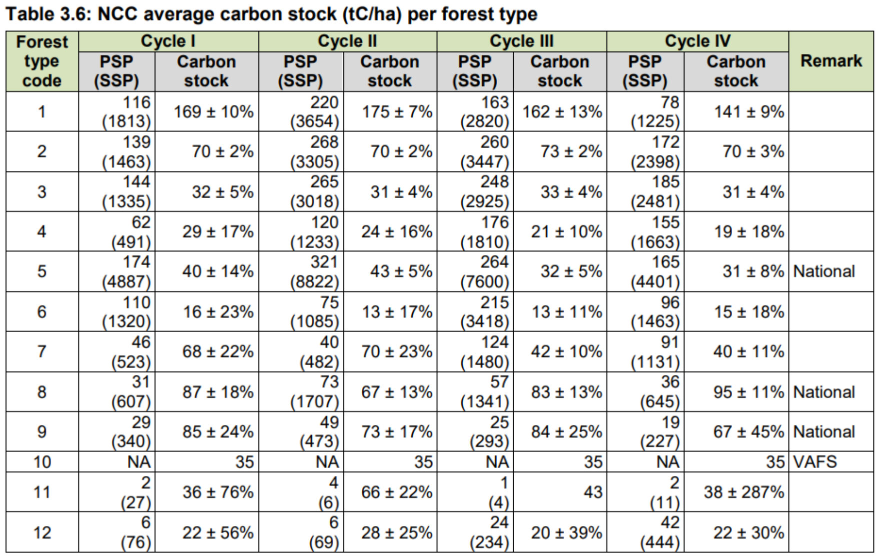


Table 3.6: NCC average carbon stock (tC/ha) per forest type

| 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 11 in section 2.3.2
- 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 2$^{nd}$ 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 | REDD+ strata |
|---|---|---|---|
| Forest Land | Evergreen Forest (EG) | 205.8 | 1 |
| | Mixed Deciduous Forest (MD) | 87.9 | 2 |
| | Coniferous Forest (CF) | 77.1 | |
| | Mixed Coniferous/Broadleaved Forest (MCB) | 87.6 | |
| | Dry Dipterocarp (DD) | 50.8 | 3 |
| | Forest Plantation (P) | 37.2 | 4 |
| | Bamboo (B) | 24.4 | |
| | Regenerating Vegetation (RV) | 10.4 | |
| Grassland | Savannah (SA) | 16.4 | 5 |
| | Scrub (SR) | 38.6 | |
| | Grassland (G) | 7.4 | |
| Cropland | Upland Crop (UC) | 5.0 | |
| | Rice Paddy and Other Agriculture (RP/OA) | 3.8 | |
| | Agriculture Plantation (AP) | 38.8 | |
| Settlements/Otherland/Wetlands | Urban (U) | 0.0 | |
| | Bare Land (BR) | 0.0 | |
| | Other (O) | 0.0 | |
| | Water (W) | 0.0 | |
| | Swamp (SW) | 0.0 | |

Using the REDD+ strata and the equation 2 and 3 (Section 2.3.2), 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 |

<table>
<tr><td><b>QA/QC procedures applied</b></td><td>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 ;</td></tr>
<tr><td><b>Uncertainty associated with this parameter:</b></td><td>For the ERPD, the uncertainty analysis used the propagation error approach. The following sources of uncertainty were assessed:<br>• Uncertainty of AGB originating from sampling error<br>• Uncertainty of AGB originating from biomass equation<br>• Uncertainty of Root-to-Shoot ratios due to the use of IPCC default values<br>• Uncertainty of Carbon Fraction factor due to the use of IPCC default values<br>• Uncertainty of AGB originating from measurement error<br>By using the propagation error approach, the uncertainty for the E/R factors are as in the table below.<br><br>E/R factors (Uncertainty %)
<table>
<tr><th></th><th>EG</th><th>MD/CF/MCB</th><th>DD</th><th>P/B/RV</th><th>NF</th></tr>
<tr><td>EG</td><td>0.0%</td><td>12.0%</td><td>13.3%</td><td>15.3%</td><td>15.7%</td></tr>
<tr><td>MD/CF/MCB</td><td>12.0%</td><td>0.0%</td><td>10.5%</td><td>12.5%</td><td>13.3%</td></tr>
<tr><td>DD</td><td>13.3%</td><td>10.5%</td><td>0.0%</td><td>13.2%</td><td>14.4%</td></tr>
<tr><td>P/B/RV</td><td>15.3%</td><td>12.5%</td><td>13.2%</td><td>0.0%</td><td>15.1%</td></tr>
<tr><td>NF</td><td>15.7%</td><td>13.3%</td><td>14.4%</td><td>15.1%</td><td>0.0%</td></tr>
</table>
<br>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.<br><br>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.
<table>
<tr><th></th><th>Value</th><th>Uncertainty (95%)</th><th>SE</th></tr>
<tr><td>Carbon Fraction</td><td>0.470</td><td>2.7</td><td>0.00647</td></tr>
<tr><td>R:S for stratum 3 and 4</td><td>0.200</td><td>11.5</td><td>0.01173</td></tr>
<tr><td>R:S for stratum 1 and 2</td><td>0.240</td><td>20.3</td><td>0.02486</td></tr>
<tr><td>AGB (Strata 1) kg/ha</td><td>353.1</td><td>10.9</td><td>19.636</td></tr>
<tr><td>AGB (Strata 2) kg/ha</td><td>150.6</td><td>6</td><td>4.610</td></tr>
<tr><td>AGB (Strata 3) kg/ha</td><td>90.1</td><td>9</td><td>4.136</td></tr>
<tr><td>AGB (Strata 4) kg/ha</td><td>20.4</td><td>19.6</td><td>2.038</td></tr>
</table>
</td></tr>
</table>

| | | | |
|---|---|---|---|
| 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:

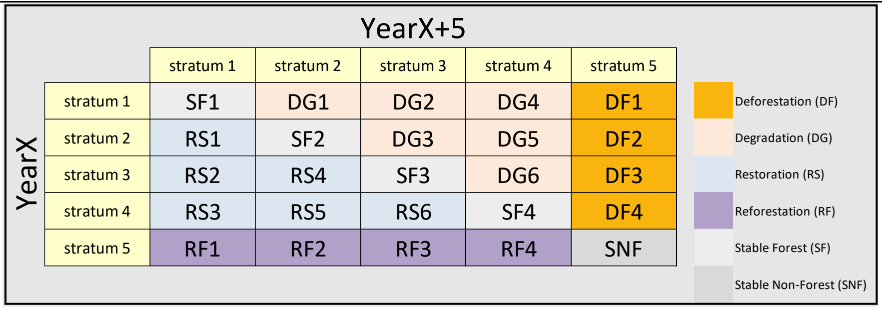
| Class | Uncertainty from 3rd NFI Sampling | Uncertainty from allometric equation |
|---|---|---|
| EG | 10.2 | 3.9 |
| MDF | 4.8 | 3.8 |
| CF | 11.1 | 18.0 |
| MCB | 14.1 | 18.0 |
| DD | 8.2 | 3.6 |
| P | - | 18.0 |
| B | 15.7 | 0.3 |
| RV | 22.2 | - |

**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+5 | | | | |
|---|---|---|---|---|---|---|
| | | stratum 1 | stratum 2 | stratum 3 | stratum 4 | stratum 5 |
| YearX | 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 “MMR2_AD_ERs_20250624.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, national, international):**

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** |
| | | 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 [30] (2014).

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

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

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:**

2010

| | Stratum 1 | Stratum 2 | Stratum 3 | Stratum 4 | Stratum 5 |
|---|---|---|---|---|---|
| Stratum 1 | 473,906 | 355 | 0 | 482 | 154 |

---

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

| | | | | | |
|---|---|---|---|---|---|
| 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 |

2015

| | | Stratum 1 | Stratum 2 | Stratum 3 | Stratum 4 | Stratum 5 |
|---|---|---|---|---|---|---|
| 2010 | 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 "MMR2_AD_ERs_20250624.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.

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 "MMR2_AD_ERs_20250624.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 "MMR2_AD_ERs_20250624.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. |  |  |

<table>
<tr><td><b>Parameter: :</b></td><td>$Regrowth\ Rate$, $Reversal$ and $Doublecounting(stumps)$ Adjustments to emissions and removals (Reference Level) to account for previous change in cover class.</td></tr>
<tr><td><b>Description:</b></td><td>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.</td></tr>
<tr><td><b>Data unit:</b></td><td>tCO2eq</td></tr>
<tr><td><b>Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):</b></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[31]).<br>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.<br>For the reference period, the number of years of each time period is used in the calculation.<br>Adjustment use a time-series analysis to identify the land cover change patterns that leads to over-estimation.<br>Forest Type Maps 2005, 2010 and 2015 were used for the time-series analysis.<br>As indicated in section 2.2.2, adjustments are implemented in equation5a and equation5b.<br>The time-series analysis as well as the calculation of the adjusted emissions and removals are in the spreadsheet '"MMR2_AD_ERs_20250624.xlsx", in tab “TSA_Remove”, “TSA_Emission” and “Total”.</td></tr>
<tr><td><b>Value applied:</b></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.<br><br>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>
</table>
</td></tr>
</table>

---

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

| | | | | | |
|---|---|---|---|---|---|
| Change patterns from time series | 4 | 2 | 4 | 1,492 | -345,787 |
| | 4 | 2 | 5 | 1,467 | -370,226 |
| | 4 | 3 | 5 | 1 | -153 |

| | |
|---|---|
| | Over estimation of emissions from deforestation equals 370,379 tCO2e and 345,787 tCO2e from degradation. |
| **QA/QC procedures applied** | The calculation steps are reviewed by a second technician. |
| **Uncertainty associated with this parameter:** | 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. |
| **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:<br>• Height (H) - below 1.3m<br>• Smallest Diameter (D1) – the smallest diameter across the top of the stump<br>• D2 – the diameter at a 90° angle to D1.<br>• Instrument used for tree felling (e.g. machine, saw axe)<br>With these measurements, the biomass loss is estimated as follows:<br>1. Calculate the average diameter D from D1 and D2 for each stump<br>2. Exclude stumps that were not felled by "machine" or "saw axe" (to exclude incidents of natural disturbances)<br>3. Estimate the DBH from the diameter at the base and height by using the following equation developed in Cambodia[32]:<br>DBH=D – (-C1 ln (H+1.0)-C1 ln (2.3))<br>*Where:*<br>*D=Average Diameter of stump, H=Height of stump,*<br>*Ln (\|C1\|)=d0+d1*D+d2*H+d3*D*H*<br>*d0=1.68, d1=0.0146, d2=-0.82, d3=0.0068*<br>5. Estimate the AGB by using the allometric equation used in the 2nd NFI<br>6. Convert the AGB loss by using an area ratio (t/ha)<br>7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots) |

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[32] 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

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, [33] 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 NFI4 ERPA_20250624.xlsx" spreadsheet, tab "StumpWork_2ndNFI FCPF CF". The figures for the table above are presented in the cells AS11:AV17 and the Annual Average value is in the cell AY17

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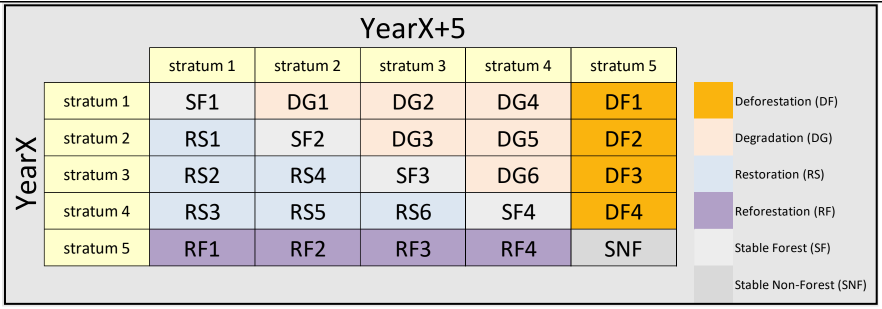
[33] Yoneda et al., 2016. Inter-annual variations of net ecosystem productivity of a primeval tropical forest basing on a biometric method with a long-term data in Pasoh, Peninsular Malaysia. TROPICS Vol. 25 (1) 1-12

| | |
|---|---|
| **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.<br>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.<br>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 "MMR2_AD_ERs_20250624.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 2022-2024 (3 years) |
|---|---|
| **Description:** | Area of REDD+ strata change over the Reporting Period (2022-2024) 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.<br>• Deforestation: loss of forest carbon stock due to conversion of a forest land stratum to non-forest land stratum.<br>• 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.<br>• Forest Restoration: upward shift of a forest/land stratum with lower carbon stock to another forest/land stratum with higher carbon stock.<br>• 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 |

In the spreadsheet "MMR2_AD_ERs_20250624.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 "MMR2_AD_ERs_20250624.xlsx", tab "AD_Area" at the exception for degradation (DG), for which the value is calculated in tab "Total", cell I135.

| Area (ha) | 2022-2024 |
|---|---|
| DF | 291,727 |
| RS | 11,555 |
| RF | 97,933 |
| DG | 28,390 |

**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 2022, and 2025 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) | |

<table>
<tr>
<td></td>
<td>
<table>
<tr><td></td><td></td><td>Rice Paddy (RP)</td><td></td></tr>
<tr><td></td><td></td><td>Other Agriculture (OA)</td><td></td></tr>
<tr><td></td><td></td><td>Agriculture Plantation (AP)</td><td></td></tr>
<tr><td>Settlement</td><td>Settlements</td><td>Urban (U)</td><td></td></tr>
<tr><td>Other Land</td><td>Other Land</td><td>Barren Land (BR)</td><td></td></tr>
<tr><td></td><td></td><td>Other (O)</td><td></td></tr>
<tr><td>Wetland</td><td>Wetlands</td><td>Water (W)</td><td></td></tr>
<tr><td></td><td></td><td>Swamp/Wetland (SW)</td><td></td></tr>
</table>
<p>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.</p>
<p>For both Forest Type Map 2022 [34] and Forest Type Map 2025 maps, Sentinel-2 imagery was used in combination with Planetscope imagery.</p>
<p>The maps are stratified according to the five REDD+ strata and overlaid to produce the AD maps for the period 2022-2024. 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).</p>
<p>The sample used for the Sample-Based Estimation is the subset of the plots, from the systematic sample used for the 4th NFI which is a systematic grid of 6 X 6 kilometers, that are located within the six provinces of the Program. This subset has 2,259 plots to which 41 plots (25 for restoration and 16 for reforestation) were added for a total of 2,300 to ensure that each Activity Data have a minimum of 30 plots.</p>
</td>
</tr>
<tr>
<td><b>QA/QC procedures applied:</b></td>
<td>
<p>A SOP for the update of the Forest Type Map was followed.</p>
<p>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.</p>
<p>The Quality Assurance/Quality Control (QA/QC) involved a second round of independent interpretation of the plots. This round focused on 689 plots (30% of the plots) that were identified as having a forest cover change or a low level of confidence from the initial interpreter (self-assessment). This approach was discussed and acknowledged by the World Bank Task team during an online call on March 21st. As more than 60% of the checked plots did not match the initial interpretation, to finalize the QA/QC, a third round of interpretation was conducted on 440 plots. For this final check and validation of the interpretation work, a specific workshop was organized where the technical staff of FIPD were</p>
</td>
</tr>
</table>

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[34] The Forest Type Map 2025 is regarded as a map that represents the land and forest cover of 2025/01/01, and the Forest Type Map 2022 is regarded as the map that represents the land and forest cover of 2022/01/01. The ERs for the exact three years from January 1, 2022 - December 31, 2024 is reported in this 2nd ER-MR by using these two maps.

<table>
<tr><td></td><td>invited to share their interpretation experience and conduct interpretation in small groups to reach consensus on the plots.</td></tr>
<tr><td><strong>Uncertainty for this parameter:</strong></td><td>The uncertainty is calculated through the sample-based estimation. The values are in the spreadsheet “MMR2_AD_ERs_20250624.xlsx", tab “AD_Uncertainty”, cells T166 to W166), except for DG which is specifically the uncertainty for Degradation from shifting cultivation that is in the spreadsheet “ERPA_SBE_ActivityData_CEO_FTM2025.xlsx”, tab "AD by DG driver", cell E38.
<table>
<tr><th>Uncertainty (%)</th><th>2022-2024</th></tr>
<tr><td>DF</td><td>17.0</td></tr>
<tr><td>RS</td><td>73.7</td></tr>
<tr><td>RF</td><td>24.6</td></tr>
<tr><td>DG</td><td>30.7</td></tr>
</table></td></tr>
<tr><td><strong>Any comment:</strong></td><td>n.a.</td></tr>
</table>

<table>
<tr><td><strong>Parameter:</strong></td><td>$RegrowthRate$ , $Reversal$ and $Doublecounting(stumps)$ Adjustments to emissions and removals for the Reporting Period to account for previous change in cover class</td></tr>
<tr><td><strong>Description:</strong></td><td>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.<br>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).<br>As indicated in section 2.2.2, adjustments are implemented in equation5a and equation5b.<br>The time-series analysis as well as the calculation of the adjusted emissions and removals are in the spreadsheet '"MMR2_AD_ERs_20250624.xlsx", in tab “TSA_Remove_MMR”, “TSA_Emission_MMR” and “Total”.</td></tr>
<tr><td><strong>Data unit:</strong></td><td>tCO2eq</td></tr>
<tr><td><strong>Value monitored during this Monitoring / Reporting Period:</strong></td><td>Adjustment – Over estimation of removals
<table>
<tr><th></th><th>Stratum in 2019</th><th>Stratum in 2022</th><th>Stratum in 2025</th><th>Estimated area (ha)*</th><th>Emissions to be deducted from Removals? ($tCO_2e$)</th></tr>
<tr><td>Change patterns from time series</td><td>4</td><td>2</td><td>4</td><td>2,462</td><td>59,012</td></tr>
<tr><td></td><td>4</td><td>2</td><td>5</td><td>1,656</td><td>39,700</td></tr>
</table></td></tr>
</table>

In total, 98,711 tCO2e would be deducted from removals from restoration for the period 2022-2024.

Adjustment – Over estimation of emissions

| | Stratum in 2019 | Stratum in 2022 | Stratum in 2025 | Estimated area (ha)* | Emissions to be deducted from Emissions ($tCO_2e$) |
|---|---|---|---|---|---|
| Change patterns from time series | 4 | 2 | 4 | 1,274 | -325,632 |
| | 4 | 2 | 5 | 4,278 | -1,191,602 |
| | 4 | 5 | 4 | 11,327 | -170,170 |

Over estimation of emissions from deforestation equals 1,361,772 tCo2e and 325,632 tCo2e from degradation respectively.

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

Forest Type Maps 2019, 2022 and 2025 are used for the time-series analysis.

**QA/QC procedures applied:**

The initial information used for the calculation of the adjustments is the time-series analysis conducted by a technician who runs GIS analysis with the Forest Type Maps and populates the spreadsheet.Then, the resulting adjustments are reviewed and validated by a senior 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 plots surveyed in the six northern provinces of the ER Program during the 4th NFI conducted from December 2024 to April 2025.

**Data unit:**

tCO2eq

**Value monitored during this Monitoring /**

| | **Average loss tCO2e/ha** | **Area (ha) Forest type map 2025** | **tCO2e (12 years)** |
|---|---|---|---|
| **EG: Evergreen Forest** | - | - | - |

**Reporting Period:**

| | | | |
|---|---|---|---|
| **MD: Mixed Deciduous Forest** | 0.5 | 3,493,325 | 1,906,168 |
| **DD: Dry Dipterocarp** | 2.5 | 16,519 | 41,298 |
| **CF: Conifer Forest** | - | - | - |
| **MCB: Mixed Conifer and Broadleaved forest** | - | - | - |
| | Total | | 1,947,466 |
| | Annual average (tCO2e) (Total divided by 12 years) | | 162,289 |
| | Emissions for the Monitoring Period (3 years) | | 486,867 |

The detail of the calculation is available in the “Emissions from logging NFI4 ERPA_20250624.xlsx” spreadsheet, tab “4thNFI”.

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

The 4th NFI sampling design and plot design differ from the 2nd NFI. However, the procedure for measuring a stump in the plot is the same.
For the 4th NFI, 218 plots were distributed in the six northern provinces and 216 were surveyed. For the estimation of emissions from logging, the calculation used plots for which at least 3 among 4 subplots are located in natural forest class, for the purpose of maintaining a consistency with the plots used from the 2nd NFI. As such, 90 plots were used.

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 [35]:

   $DBH=D-(-C1\ln(H+1.0)-C1\ln(2.3))$

   *Where:*

   *D=Average Diameter of stump, H=Height of stump,*

   $Ln(|C1|)=d0+d1*D+d2*H+d3*D*H$

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[35] 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.

| | |
|---|---|
| | *d0=1.68, d1=0.0146, d2=-0.82, d3=0.0068*<br>5. Estimate the AGB by using the allometric equation used in the 2nd NFI<br>6. Convert the AGB loss by using an area ratio (t/ha)<br>7. Sum up the AGB loss by sub-plot (one survey plot consists of four sub-plots)<br>8. Estimate the plot average AGB loss (t/ha) by dividing the sum of AGB loss above by four (including non- stump plot)<br>9. Estimate the average AGB loss(t/ha) for each forest class by dividing the total number of plots of each forest class<br>10. Estimate the BGB loss by using default conversion factor found in the IPCC 2006 Guidelines<br>11. Convert biomass to CO2 with the same conversion factor for estimating the carbon stock<br>12. Estimate the total loss tCO2e by multiplying above value by the area of Forest Type Map 2025 for each forest class.<br><br>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.<br>An equation, developed in an experimental study in Pasoh in the Malaysian Peninsula [36], 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.<br>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.<br>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.<br>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.<br>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 “MMR2_AD_ERs_20250624.xlsx” and tab “logging uncertainty”. It uses a propagation of error approach. The uncertainty calculated for emissions from logging for the monitoring period is 22.11% |

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[36] 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 most recent Forest Type Map 2025 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 2nd MMR uses the Accuracy assessed for the Forest Type Map 2022. |
| **Any comment:** | n.a. |

# 4 QUANTIFICATION OF EMISSION REDUCTIONS

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

The 2nd ERMR carries forward the three technical corrections that were applied to the Reference Level for the 1st ERMR:

- The Emission and Removal Factors are based on the 3rd NFI and the 2nd Regenerating Vegetation Survey,
- The CCDC-SMA script is used to supplement the Activity Data map and support the calculation of the area estimates,
- The correction of a calculation error in the estimation of emissions from logging for the Reference Level.

The technical corrections are further described in Annex 4 of the 1st ERMR and additionally explained in the technical note[37].

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 '"MMR2_AD_ERs_20250624.xlsx". In the tab Summary, the average annual emissions and removals over the three year reporting period 2022-2024 are displayed in the column B. The values displayed in the Table 12 below, can be found from left to right, in the cells B4, B7, B9, B10, and B11. To trace back the detailed calculation, the column B refers to the tab "Total" where the annual average is calculated for deforestation in cell R103, reforestation in cell R105 and cell R106 for removals from other activities (restoration). The figure for the emissions from forest degradation comes from the sum of the emissions obtained from the Activity Data map after the technical correction, tab "Total", cell P138 and the emissions from logging calculated in a specific spreadsheet "Emissions from logging NFI4 ERPA_20250624.xlsx" spreadsheet, tab "StumpWork_2ndNFI FCPF CF", cell AY17.

For rounding and truncation of the raw figures, the FCPF ER-MR Template tool was used and the result is shown in the following Table 12, 13 and 14.

**Table 12: ER Program Reference Level**

| Year of Monitoring period 2 | Average annual historical emissions from deforestation over the Reference Period ($tCO_{2-e}$/yr) | If applicable, average annual historical emissions from forest degradation over the Reference Period ($tCO_{2-e}$/yr) | If applicable, enhanced removals from afforestation/reforestation (AR) (tCO2-e/yr) | If applicable, enhanced removals from other activities besides A/R ($tCO_{2-e}$/yr) | Adjustment, if applicable ($tCO_{2-e}$/yr) | Reference level ($tCO_{2-e}$/yr) |
|---|---|---|---|---|---|---|
| **2022** | 3,015,638 | 10,627,760 | -743,589 | -593,805 | na | 12,306,004 |
| **2023** | 3,015,638 | 10,627,760 | -743,589 | -593,805 | na | 12,306,004 |
| **2024** | 3,015,638 | 10,627,760 | -743,589 | -593,805 | na | 12,306,004 |
| **Total** | **9,046,914** | **31,883,280** | **-2,230,767** | **-1,781,415** | **na** | **36,918,012** |

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

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[37] 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.

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 9**). 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 “MMR2_AD_ERs_20250624.xlsx” and the tab “AD_Uncertainty”.

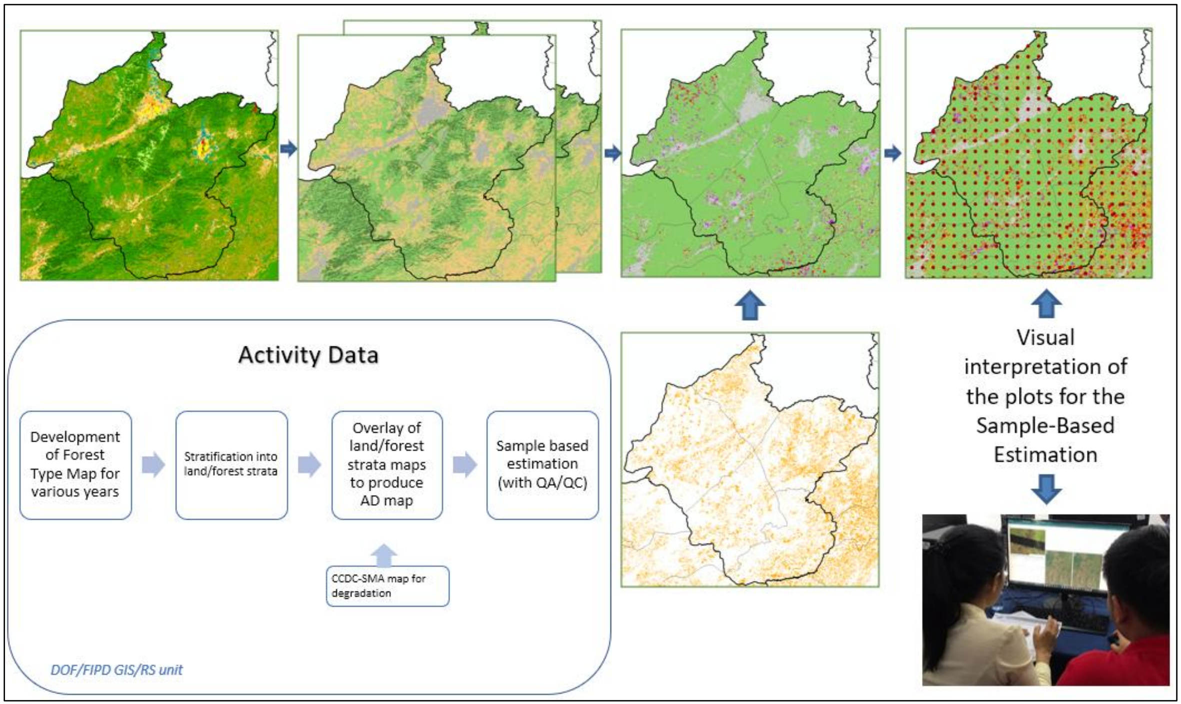
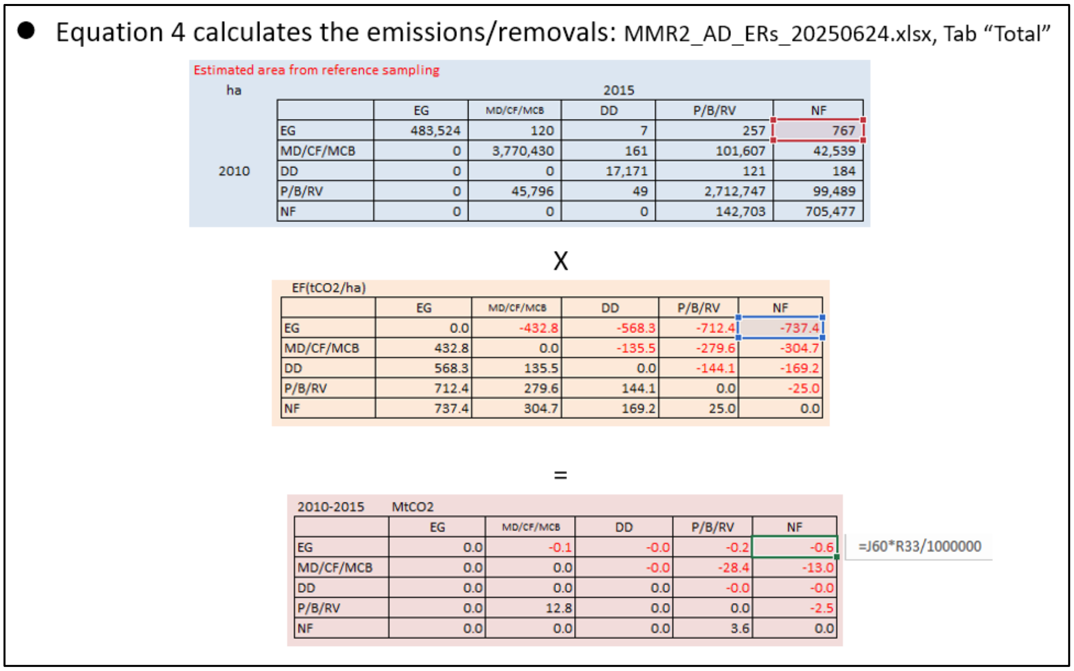


**Figure 7: Overview of the computation of the Activity Data**

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 3rd NFI.



- Equation 4 calculates the emissions/removals: MMR2_AD_ERs_20250624.xlsx, Tab “Total”

Estimated area from reference sampling

ha

2015

| | | EG | MD/CF/MCB | DD | P/B/RV | NF |
|---|---|---|---|---|---|---|
| 2010 | 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

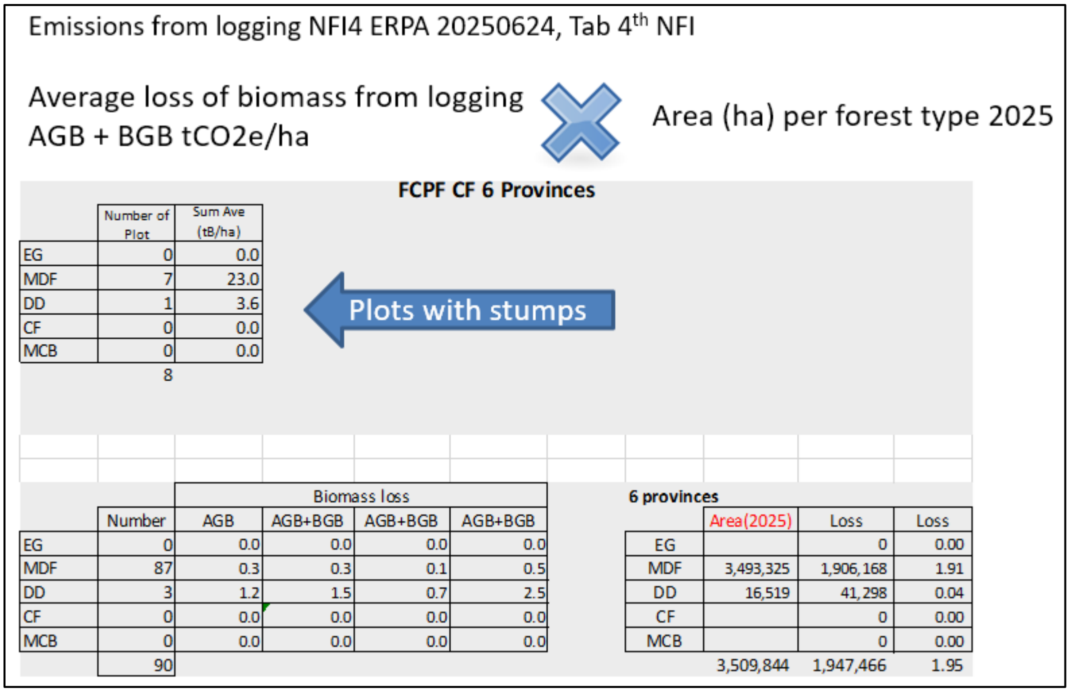
**Figure 8: Example of the calculation of emissions and removals for the Reference Period as conducted in the spreadsheet used for the 2$^{nd}$ MMR**

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

As shown in the Figure 8 above, 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) are presented in the spreadsheet “MMR2_AD_ERs_20250624.xlsx”.

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 NFI4 ERPA_20250624.xlsx” spreadsheet.



Emissions from logging NFI4 ERPA 20250624, Tab 4th NFI

Average loss of biomass from logging AGB + BGB tCO2e/ha

Area (ha) per forest type 2025

**FCPF CF 6 Provinces**

| | Number of Plot | Sum Ave (tB/ha) |
|---|---|---|
| EG | 0 | 0.0 |
| MDF | 7 | 23.0 |
| DD | 1 | 3.6 |
| CF | 0 | 0.0 |
| MCB | 0 | 0.0 |
| | 8 | |

| | | Biomass loss | | | |
|---|---|---|---|---|---|
| | Number | AGB | AGB+BGB | AGB+BGB | AGB+BGB |
| EG | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MDF | 87 | 0.3 | 0.3 | 0.1 | 0.5 |
| DD | 3 | 1.2 | 1.5 | 0.7 | 2.5 |
| CF | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| MCB | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 90 | | | | |

**6 provinces**

| | Area(2025) | Loss | Loss |
|---|---|---|---|
| EG | | 0 | 0.00 |
| MDF | 3,493,325 | 1,906,168 | 1.91 |
| DD | 16,519 | 41,298 | 0.04 |
| CF | | 0 | 0.00 |
| MCB | | 0 | 0.00 |
| | 3,509,844 | 1,947,466 | 1.95 |

**Figure 9: Example of the calculation of emissions from logging for the second monitoring period**

Figure 9 refers to the emissions from logging for the second 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 1,947,466 tCO2e is divided by 12 years using the assumed time for the wood materials to decompose, to obtain a yearly average of 162,289 tCO2e/year which is then used in Step 4 and in the spreadsheet "MMR2_AD_ERs_20250624.xlsx" in tab "summary".

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 displayed in Table 12 (for the RL, and Table 13 for this monitoring period.

The values displayed in the Table 13 below, can be found in the spreadsheet '"MMR2_AD_ERs_20250624.xlsx", tab "Summary" from left to right, in the cells E4, E7, E9, E10, and E11. To trace back the detailed calculation, the column B refers to the tab "Total" where the annual average is calculated for deforestation in cell R119, reforestation in cell R121 and cell R122 for removals from other activities (restoration). The figure for the emissions from forest degradation comes from the sum of the emissions obtained from the Activity Data map after the technical correction, tab "Total", cell R138 and the emissions from logging calculated in a specific spreadsheet "Emissions from logging NFI4 ERPA_20250624.xlsx" spreadsheet, tab "4thNFI", cell AX21.

**Table 13: Emissions by sources and removals by sinks**

| Year of Monitoring Period | Emissions from deforestation (tCO2-e/yr) | If applicable, emissions from forest degradation (tCO2-e/yr)* | If applicable, enhanced removals from afforestation/reforestation (AR) (tCO2-e/yr) | If applicable, enhanced removals from other activities besides A/R (tCO2-e/yr) | Net emissions and removals (tCO2-e/yr) |
|---|---|---|---|---|---|
| **2022** | 10,146,623 | 2,687,838 | -490,435 | -885,757 | 11,458,269 |

| | | | | | |
|---|---|---|---|---|---|
| **2023** | 10,146,623 | 2,687,838 | -490,435 | -885,757 | 11,458,269 |
| **2024** | 10,146,623 | 2,687,838 | -490,435 | -885,757 | 11,458,269 |
| **Total** | **30,439,869** | **8,063,514** | **-1,471,305** | **-2,657,271** | **34,374,807** |

### 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 14 below and also in the tab “summary” of the spreadsheet “MMR2_AD_ERs_20250624.xlsx”.

In the table below, enhanced removals from afforestation/ reforestation (A/R) are from Reforestation, and enhanced removals from other activities besides A/R are from Forest Restoration[38].

**Table 14: Calculation of emission reductions**

| | **Deforestation** | **If applicable, forest degradation** | **If applicable, enhanced removals from afforestation/ reforestation (A/R)** | **If applicable, enhanced removals from other activities besides A/R*** | **Total ($tCO_{2-e}$)** |
|---|---|---|---|---|---|
| **Emission or removals in the Reference Level ($tCO_{2-e}$)** | 9,046,914 | 31,883,280 | -2,230,767 | -1,781,415 | 36,918,012 |
| **Emission or removals under the ER Program during the Reporting Period ($tCO_{2-e}$)** | 30,439,869 | 8,063,514 | -1,471,305 | -2,657,271 | 34,374,807 |
| **Emission Reductions during the Reporting Period ($tCO_2$-e)** | -21,392,955 | 23,819,766 | -759,462 | 875,856 | 2,543,205 |

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[38] The Lao ER Program considers removals in Forest Restoration (either enhanced or through natural regeneration) as mostly coming from Regenerating Vegetation restoring to Mixed Deciduous Forest.

# 5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

## 5.1 Identification, assessment and addressing sources of uncertainty

**Table 15: 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 | þ | þ | 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 8 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 | High (bias/random) | YES | NO |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 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 | | | |
| Representativeness | **þ** | **ý** | This source of uncertainty is related to the representativeness of the estimate which is related to the sampling design.<br>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 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. . | Low (bias) | YES | NO |
| Sampling | **ý** | **þ** | 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 | High (random) | YES | YES |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | 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 | **þ** | **ý** | 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 | Low (bias) | YES | NO |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | source of uncertainty is considered to be low. | | | |
| Approach 3 | **þ** | **ý** | 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..<br>Due to the tracking and accounting, the degree of uncertainty is low | Low (bias) | YES | NO |

| **Sources of uncertainty** | **Systematic** | **Random** | **Analysis of contribution to overall uncertainty** | **Contribution to overall uncertainty (High/Low)** | **Adressed through QA/QC** | **Residual uncertainty estimated ?** |
|---|---|---|---|---|---|---|
| **Emission/Removal factors** | | | | | | |
| DBH measurement | þ | þ | The field measurements for the NFI are described in the SOP for the Terrestrial Carbon Measurement (presented in Table 8). Before each NFI campaign, field crew training is conducted. The data collection uses Open Data Kit (ODK)[39] 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.<br>The allometric equations of live trees use only diameter at breast height (DBH). Height measurement is done for the case of standing dead trees.<br>The plot delineation is not prone to error as the NFI uses circular plots and distance are measured with an ultrasound measurer (DME). | | | |
| H Measurement | þ | þ | | High (bias) & Low (random) | YES | NO |
| Plot delineation | þ | þ | | | | |
| Wood density estimation | þ | þ | The allometric equations developed and used for Lao PDR do not use wood density classes. | NA | NA | NA |
| Biomass allometric model | þ | þ | 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[40]. 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 | High (bias) & High (random) | NO | YES |

---

[39] 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.

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

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | forest types, namely CF and MCB forests use an equation used in Vietnam[29]. 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 | **ý** | **þ** | 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 | **þ** | **þ** | Lao PDR uses a Root-to-Shoot ratio to derive Below Ground Biomass from the AGB. Carbon fraction is also used in the | High (bias/random) | YES | YES |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | calculations. These parameters are not country-specific but sourced from the 2006 IPCC Guidelines.<br>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. | | | |
| Representativeness | **þ** | **ý** | Following the SOP for the Terrestrial Carbon Measurement (presented in Table 8), 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. | Low (bias) | YES | NO |

| Sources of uncertainty | Systematic | Random | Analysis of contribution to overall uncertainty | Contribution to overall uncertainty (High/Low) | Adressed through QA/QC | Residual uncertainty estimated ? |
|---|---|---|---|---|---|---|
| **Integration** | | | | | | |
| Model | þ | ý | 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 8). Therefore this source of uncertainty is considered to be low. | Low (bias) | YES | NO |
| Integration | þ | ý | 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), the first monitoring period (2019-2021), and the second monitoring period (2022-2024).
- 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 MMR2 20250624.xlsx".

**Table 16: Parameters used in the Monte Carlo simulation**

| 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 Restoration (REDD+ strata 4 to 2) 2005-2010 | 57,361 ha (SE=14,750 ha) | Sampling error | Normal | Above zero |
| 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 Deforestation (REDD+ strata 2 to 5) 2019-2021 | 20,067 ha (SE= 2,823 ha) | Sampling error | Normal | Above zero |
| 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 |
| | | | | |
| Activity Data Deforestation (REDD+ strata 1 to 5) 2022-2024 | 2,676 ha (SE=233 ha) | Sampling error | Normal | Above zero |
| Activity Data Deforestation (REDD+ strata 2 to 5) 2022-2024 | 80,544 ha (SE= 7,001ha) | Sampling error | Normal | Above zero |
| Activity Data Deforestation (REDD+ strata 3 to 5) 2022-2024 | 462 ha (SE=40 ha) | Sampling error | Normal | Above zero |
| Activity Data | 208,045 ha (SE=18,082 ha) | Sampling error | Normal | Above zero |

| | | | | |
|---|---|---|---|---|
| Deforestation (REDD+ strata 4 to 5) 2022-2024 | | | | |
| Activity Data Degradation (REDD+ strata 2 to 4) 2022-2024 | 119,240 ha (SE= 18,683 ha) | Sampling error | Normal | Above zero |
| Activity Data Restoration (REDD+ strata 2 to 1) 2022-2024 | 18 ha (SE=7 ha) | Sampling error | Normal | Above zero |
| Activity Data Restoration (REDD+ strata 4 to 2) 2022-2024 | 11,511 ha (SE=4,289 ha) | Sampling error | Normal | Above zero |
| Activity Data Restoration (REDD+ strata 4 to 3) 2022-2024 | 27 ha (SE= 10 ha) | Sampling error | Normal | Above zero |
| Activity Data Reforestation (REDD+ strata 5 to 4) 2022-2024 | 97,933 ha (SE= 12,266 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 | 815,197 tCO2e (SE= 90,171 tCO2e) | Sampling error | Normal | Above zero |

| | | | | |
|---|---|---|---|---|
| RL (annual average) | | | | |
| Emissions from logging for the 1st MMR (Annual average) | 904,308 tCO2e (SE=100,581 tCO2e) | Sampling error | Normal | Above zero |
| Emissions from logging for the 2nd MMR (Annual average) | 162,289 tCO2e (SE=18,299 tCO2e) | Sampling error | Normal | Above zero |

***Quantification of the uncertainty of the estimate of Emission Reductions***

**Table 17: Quantification of uncertainty**

| | | **Reporting Period** | | **Crediting Period** | |
|---|---|---|---|---|---|
| | | **Total Emission Reductions*** | **Forest degradation**** | **Total Emission Reductions*** | **Forest degradation**** |
| **A** | **Median** | 550,264 | 1,955,576 | 5,255,242 | 1,686,217 |
| **B** | **Upper bound 90% CI** (Percentile 0.95) | -6,270,209 | 1,498,402 | -7,350,701 | 900,036 |
| **C** | **Lower bound 90% CI** (Percentile 0.05) | 7,368,242 | 2,397,044 | 17,769,678 | 2487,108 |
| **D** | **Half Width Confidence Interval at 90% (B – C )/ 2** | 6,819,225 | 449,321 | 12,560,190 | 793,536 |
| **E** | **Relative margin (D / A)** | 1239% | 23% | 193% | 47% |
| **F** | **Uncertainty discount** | 15% | 15% | 15% | 15% |

*Remove forest degradation from the estimate if forest degradation has been estimated with proxy data.
**Remove the column if forest degradation has not been estimated using 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 with the uncertainty for all emission reductions including those from forest degradation estimated with proxy data. The results shown below can be found in the tab "Sensitivity Analysis MMR2", in the spreadsheet "LaoPDR_Uncertainty MC MMR2 20250624.xlsx". The sensitivity analysis is based on five additional spreadsheets, one for each individual parameter.

**Table 18: Sensitivity analysis**

| Parameter | Uncertainty with one turned on (%) |
|---|---|
| All ON | 272 |
| R:S Uncertainty ON | 11 |
| CF Uncertainty ON | 2 |
| AGB Uncertainty ON | 69 |
| E/Removal factors Uncertainty ON (with RS, CF and AGB ON) | 70 |
| Activity Data ON | 263 |

These results indicate that the uncertainty of the Emission Reductions comes mainly from the Activity Data as the uncertainty percentage is still very high, 263%, 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 compared to 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 19: Analysis uncertainty per specific AD**

| Parameter | Uncertainty (%) |
|---|---|
| Activity Data ON | 263 |
| Deforestation RL 2005-2010 ON | 16 |
| Deforestation RL 2010-2015 ON | 39 |
| Deforestation MMR2 | 144 |
| Degradation RL 2005-2010 ON | 159 |
| Degradation RL 2010-2015 ON | 102 |
| Degradation MMR2 | 81 |
| Restoration RL 2005-2010 ON | 32 |
| Restoration RL 2010-2015 ON | 27 |
| Restoration MMR2 | 7 |
| Reforestation RL 2005-2010 ON | 27 |
| Reforestation RL 2010-2015 ON | 12 |
| Reforestation MMR2 | 12 |

# 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 Program 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 started only after the 1st results-based payment was received in 2024. 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).

No titles to the ERs from the ER Program were contested during the 1st reporting period. Currently. 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).

In May 2025, the Government Decree on Carbon Credits (No. 292/was endorsed by the GoL. The Decree provides high-level institutional roles and responsibilities on carbon policy and project management; lists the requirements and expectations of project developers; and clarifies overarching processes on approval, registration, and implementation. The Decree specifies the role of the new Ministry of Agriculture and Environment (MAE) that merges with former MAF and MoNRE. The MAE plays a pivotal role in coordinating policy development and overseeing registration and reporting for the nation's international climate obligations. **The MAE has also succeeded the ability to transfer title from the MAF**.

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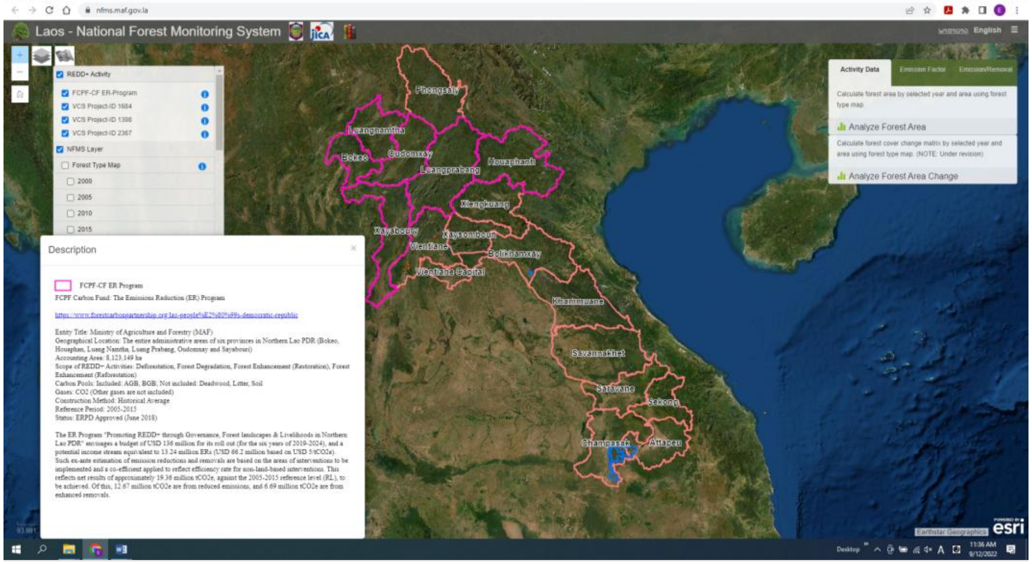
## 6.2 Implementation and operation of Program and Projects Data Management System

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

Lao PDR has developed its NFMS web-portal <https://nfms.dof.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[41].



Description

FCPF-CF ER Program

FCPF Carbon Fund: The Emissions Reduction (ER) Program

https://www.forestcarbonpartnership.org/lao-people%E2%80%99s-democratic-republic

Entity Title: Ministry of Agriculture and Forestry (MAF)
Geographical Location: The entire administrative areas of six provinces in Northern Lao PDR (Bokeo, Houaphan, Luang Namtha, Luang Prabang, Oudomxay and Sayabouri)
Accounting Area: 8,123,149 ha
Scope of REDD+ Activities: Deforestation, Forest Degradation, Forest Enhancement (Restoration), Forest Enhancement (Reforestation)
Carbon Pools: Included: AGB, BGB; Not included: Deadwood, Litter, Soil
Gases: CO2 (Other gases are not included)
Construction Method: Historical Average
Reference Period: 2005-2015
Status: ERPD Approved (June 2018)

The ER Program "Promoting REDD+ through Governance, Forest landscapes & Livelihoods in Northern Lao PDR" envisages a budget of USD 136 million for its roll out (for the six years of 2019-2024), and a potential income stream equivalent to 13.24 million ERs (USD 66.2 million based on USD 5/tCO2e). Such ex-ante estimation of emission reductions and removals are based on the areas of interventions to be implemented and a co-efficient applied to reflect efficiency rate for non-land-based interventions. This reflects net results of approximately 19.36 million tCO2e, against the 2005-2015 reference level (RL), to be achieved. Of this, 12.67 million tCO2e are from reduced emissions, and 6.69 million tCO2e are from enhanced removals.

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[41] 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

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 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 crediting period not being issued as FCPF ERs. Thus, 100% of the monitored ERs during the 1st reporting period, which are subject to verification, were offered to the Carbon Fund.

A Verified Carbon Standard (VCS) project [42] "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 Xayaboury 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 Xayaboury 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.

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[42] 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 Xayaboury 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)

No Reversal was observed in the 2nd ER monitoring period (see Section 7.2. below).

However, the 2nd ER monitoring period experienced an increase in emissions compared to the 1st ER monitoring period. As already analyzed in Section 1.2, more deforestation occurred than both the Reference Period, and the 1st ER monitoring period. Deforestation during the 2nd ER monitoring period occurred in relatively good forest (current forest strata with higher carbon stock) (29%), compared to 10% in the 1st ER monitoring period. The rest of deforestation occurred in degraded forestland (potential forest strata with lower carbon stock), which was 71% for the 2nd ER monitoring period compared to 90% for the 1st ER monitoring period.

The satellite-based interpretation using Collect Earth Online conducted as a part of the NFI 4 suggests that deforestation is still largely driven by upland cropping (classified as Upland Crop), in other words shifting cultivation. This is followed by permanent type of agriculture for  cash crop and cattle grazing (classified as Other Agriculture). The field spot check of deforestation area using the PDMS agrees with this result, showing upland cropping as the largest driver throughout the entire ER monitoring period[43].

The Lao Agricultural Statistics Book indicates a significant increase in cassava cultivation within the ER Program provinces. Both harvested area and production have shown obvious growth, starting gradually in 2018 and accelerating notably from 2021. This trend aligns with the observations of government and forestry experts, who note that the "cassava boom" began in southern Laos before moving northward to the central and northern regions.

## 7.2 Quantification of Reversals during the Reporting Period

Not applicable as no reversal was observed in the 2nd ER monitoring period.

## 7.3 Quantification of pooled reversal buffer replenishments

Not applicable as no reversal was observed in the 2nd ER monitoring period.

## 7.4 Reversal risk assessment

Reversal risk assessment for this Reporting Period was conducted based on the FCPF Buffer Guidelines (Version 4.2.1 March 2025). The assessment specifically followed the Reversal Risk assessment tool provided in the Buffer Guidelines, to determine the Reversal Risk level for specific Risk Factors. Risk Indicators assess the Reversal Risk for each factor. Then, the Risk Score is assessed for each Risk Factor separately as high, medium, or low.

The results indicate that all Risk Factors are Low, with details provided in Annex 5.

**Table 20: Summary of Reversal Risk Assessment**

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[43] Note that distuingishing upland cropping and perament type of agriculture is still challenging, as it requires time-series analysis of multiple years.

| Risk Factor | Description | Final score |
|---|---|---|
| Risk Factor A: Lack of broad and sustained stakeholder support | ER Program stakeholders are aware of, and/or provided feedback to and have positive experience with its FGRM and benefit sharing arrangements. To date, no grievances have been lodged with either the initial system or the modified system. A robust assessment of the effectiveness of stakeholder engagement, FGRM and benefit sharing will require more time, as the ER Program is still in the early stage of its community-level activities. | Medium |
| Risk Factor B: Lack of Institutional capacities and/or ineffective vertical/cross sectoral coordination | ER Program has been effective in institutional capacities and vertical/cross sectoral coordination | Low |
| Risk Factor C: Lack of long-term effectiveness in addressing underlying drivers | ER Program has been implemented under effective environment to address underlying drivers, and to systematically decouple deforestation and forest degradation from all economic activities. | Low |
| Risk Factor D: Exposure and vulnerability to natural disturbances | Although natural disasters remain a serious threat in Laos, their impacts on forests are limited. The government policies, legal system development, and collaboration with international organizations and local communities, which have been further strengthened since 2019, have made remarkable progress in enhancing forest resilience and actively mitigating their impacts. | Low |

Supplementary to the above assessment, there are several assumptions that support the ‘Low risk’ of reversals for the post-2nd ERMR period, despite that fact that deforestation and forest degradation has increased in the 2nd ERMR period (2022-2024) compared to the 1st ERMR period (2019-2021).

In the context of Lao PDR where market-driven agriculture commodity is the dominant driver of deforestation and forest degradation. The success in reducing emissions relies on decoupling deforestation and degradation from economic activities. As presented in Annex 5:

- The data produced for the 2nd ERMR shows that deforestation was observed more in Regenerating Vegetation areas (low carbon stock) and significantly less in intact natural forests (high carbon stock). This indicates that economic output from agriculture is occurring with reduced impact on high-value forests, reflecting the effectiveness of land use planning and law enforcement.
- This also suggests improved conservation of intact natural forests with high carbon stock, despite ongoing agricultural practices. Furthermore, time-series analysis indicates that degraded forests, once restored, are largely maintained as forests and have not reverted back to regenerating vegetation due to slash-and-burn activities: less than 0.5% (or 20,000 ha) for the 1st ERMR period (2019-2021) and less than 0.25% (or 10,000ha) for the 2nd ERMR period (2022-2024), showing a reduction in reversal risk related to these practices.
- The Lao government and the stakeholders are collaborating to expand the proven approach, including PLUP, alternative and sustainable livelihoods, forest management, and near-real time forest monitoring (PDMS). Land tenure and registration is a strong priority, as demonstrated in the NA Resolution 57 (Sep. 2024) followed by Prime Minister's Order No. 20 (November 2024), and the National Action Plan for the Recognition of Land Use Rights in Forestland. Furthermore, all safeguards will be fully respected to ensure positive, long-term impacts

This also implies the importance of looking at the quality of land-use changes. Discussing the results based only on area (ha) can be misleading, as the carbon stock of the respective changed areas is the crucial factor for deriving the final results in tCO2e. The increase or decrease in forest areas does not automatically translate to the same degree or trend in emissions and removals.

As presented in Section 1, there are increasing supports planned beyond the ER Program crediting period (2019-2024), providing large-scale investment and capacity building for the protection of forest landscapes and livelihoods in the ER Program area. The GFLL was limited in its field activities during the 2nd ERMR period (2022-2024), and most of the field interventions are starting from 2025, expected to generate its impacts.

The GFLL project had limited field activities during the 2nd ERMR period. Most field interventions are scheduled to begin in 2025, when they are expected to generate their intended impacts.

| **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** | • Are stakeholders aware of, and/or have positive experience with Emission Reduction Programs, FGRM, benefit sharing arrangements etc. or similar instruments in other contexts?<br>• Have complaints, claims or occurrences of conflicts over rights and tenure been addressed? | **10%** | Reversal Risk is considered medium:<br>5% | 5% |
| **Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination** | • Is there a track record of key institutions in implementing programs and policies?<br>• Is there experience of cross-sectoral cooperation?<br>• Is there experience of collaboration between different levels of government? | **10%** | Reversal Risk is considered low:<br>10% | 0% |
| **Lack of long term effectiveness in addressing underlying drivers** | • Is there experience in decoupling deforestation and degradation from economic activities?<br>• Is relevant legal and regulatory environment conducive to REDD+ objectives? | **5%** | Reversal Risk is considered low:<br>5% | 0% |
| **Exposure and vulnerability to natural disturbances** | • Is the Accounting Area vulnerable to fire, storms, droughts, etc.?<br>• Are there capacities and experiences in effectively preventing natural disturbances or mitigating2 their impacts? | **5%** | Reversal Risk is considered low:<br>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)** | 15% |

# 8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

| *Year* | | | 2022 | 2023 | 2024 | Total |
|---|---|---|---|---|---|---|
| **A.** | **Emission Reductions during the Reporting period ($tCO_2$-e)** | *from section 4.3* | 847,735 | 847,735 | 847,735 | 2,543,205 |
| **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)** | | 652,908 | 652,908 | 652,908 | 1,958,725 |
| **C.** | **Number of Emission Reductions estimated using Measurement approaches (A-B)** | | 194,827 | 194,827 | 194,827 | 584,480 |
| **D.** | **Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested** | *from section 6.1* | 100% | 100% | 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 | 0 | 0 | 0 |
| | **If applicable, any buffer replenishments** | *section 7.3 P* | 0 | 0 | 0 | 0 |
| **F.** | **Total ERs [(B+C)*D-E] minus, if applicable, any replenishments as per section 7.3, P** | | 847,735 | 847,735 | 847,735 | 2,543,205 |
| **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% | 15% | 15% | |
| **H.** | **Quantity of ERs to be allocated to the Uncertainty Reversal Buffer (0.15*B/A*F)+(G*C/A*F)** | | 127,160 | 127,160 | 127,160 | 381,480 |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| **I.** | **Total Reversal Risk set-aside percentage applied to the ER program** | *from section 7.4* | 15% | 15% | 15% |  |
| **J.** | **Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*I** |  | 108,086 | 108,086 | 108,086 | 324,258 |
| **K.** | **Number of FCPF ERs (F- H – J)** |  | 612,489 | 612,489 | 612,489 | 1,837,467 |
| **L.** | **Percentage of Emission reductions from enhanced Removals from afforestation/reforestation as a percentage of the total FCPF ERs [Optional if the country wishes to generate enhanced Removals]** | *From section 4.3* |  |  |  | 1,837,467 |
| **M** | **Number of FCPF ERs from enhanced Removals from afforestation/reforestation (L * K) [Optional if the country wishes to generate enhanced Removals]** |  | 0 | 0 | 0 | 0 |