| Forest Carbon Partnership Facility (FCPF)<br>Carbon Fund<br><br>**ER Monitoring Report (ER-MR)** | |
|---|---|
| **ER Program Name and Country:** | People and Forests- A Sustainable Forest Management -Based Emission Reduction Program in the Terai Arc Landscape, Nepal.<br>NEPAL |
| **Reporting Period covered in this report:** | 22-06-2018 to 31-12-2021 |
| **Number of FCPF ERs:** | 1 882 435 |
| **Quantity of ERs allocated to the Uncertainty Buffer:** | 395 467 |
| **Quantity of ERs to allocated to the Pooled Reversal Buffer:** | 358 557 |
| **Number of FCPF ERs from enhanced removals through afforestation/ reforestation** | 1 146 591 |
| **Number of FCPF ER from High Forest Low Deforestation (HFLD)** | NA |
| **Date of Submission:** | 16-06-2025 |
| **Version** | 2.0 |

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## ACRONYMS

| | |
|---|---|
| AD | Activity Data |
| AEPC | Alternative Energy Promotion Center |
| AFOLU | Agriculture Forestry and Other Land Use |
| AGB | Above-ground Biomass |
| BGB | Below-ground Biomass |
| BSM | Benefit Sharing Mechanism |
| BSP | Benefit Sharing Plan |
| CA | Conservation Area |
| CATS | Carbon Assets Tracking System |
| CBFM | Community based forest management |
| CBO | Community Based Organization |
| CCBA | Climate, Community and Biodiversity Alliance |
| CCDC-SMA | Continuous Change Detection and Classification – Spectral Mixture Analysis |
| CCSP | Concentric Circular Sample Plot |
| CEO | Collect Earth Online |
| CF | Carbon Fund |
| CFUG | Community forest user group |
| CI | Confidence interval |
| CODED | Continuous Degradation Detection |
| CSO | Civil Society Organization |
| dbh | Diameter at breast height |
| DFMP | District Forest Management Plan |
| DFO | Division Forest Office |
| DFRS | Department of Forest Research and Survey |
| DNPWC | Department of National Parks and Wildlife Conservation |
| EF | Emission Factors |
| EIA | Environmental impact assessment |
| ER | Emission reduction |
| ERPA | Emission Reduction Program Agreement |
| ERMR | Emission Reduction Monitoring Report |
| ERPD | Emission Reduction Program Document |
| ESMF | Environmental and Social Management Framework |
| ESMP | Environmental and social management plan |
| FAO | Food and Agricultural Organization |
| FCPF | Forest Carbon Partnership Facility |
| FDF | Forest Development Fund |
| FECOFUN | Federation of Community Forest Users, Nepal |
| FGRM | Feedback and Grievance Redress Mechanism |
| FMT | Fund Management Team |
| FPIC | Free, Prior and Informed Consent |
| FRA | Forest Resource Assessment |

| | |
|---|---|
| FREL | Forest reference Emission Level |
| FRL | Forest Reference Level |
| FRTC | Forest Research and training Center |
| FSCMD | Forest Survey and Carbon Monitoring Division |
| FUG | Forest User Group |
| GEE | Google Earth Engine |
| GESI | Gender, Equality, and Social Inclusion |
| GFOI | Global Forest Observations Initiative |
| GHG | Greenhouse Gases |
| GRM | Grievance redressal mechanism |
| GoN | Government of Nepal |
| ha | hectares |
| HR | High Resolution |
| ICS | Improved Cook Stove |
| ID | Inventory Design |
| IEE | Initial Environmental Examination |
| ILO | International Labour Organization |
| IP | Indigenous People |
| IPCC | Inter-governmental Panel on Climate Change |
| IPLC | Indigenous Peoples and Local Communities |
| IPO | Indigenous People Organization |
| IPP | Indigenous Peoples Plan |
| LC | Land Cover(s) |
| LHF | Leasehold Forestry |
| LiDAR | Light Detection and Ranging |
| LPG | Liquefied Petroleum Gas |
| MC | Monte Carlo |
| MGD | Methods Guidance Document |
| MoFE | Ministry of Forests and Environment |
| MoITC | Ministry of Industry, Tourism, Forests and Environment |
| MoITFE | Ministry of Industry, Tourism, Forests and Environment (Province level) |
| MoLCPA | Ministry of Land Management, Cooperatives and Poverty Alleviation |
| MRV | Measurement, Reporting and Verification |
| MSPA | Morphological Spatial Pattern Analysis |
| MTDD | Multivariate Time-series Disturbance Detection |
| NEFUG | Nepalese Federation of Forest User Groups |
| NP | National Park |
| NFDI | Normalized Degradation Fraction Index |
| NDVI | Normalized Difference Vegetation Index |
| NDWI | Normalized Difference Water Index |
| NFD | National Forest Database |
| NFI | National Forest Inventory |

| | |
|---|---|
| NFIS | National Forest Information System |
| NFMIS | National Forest Monitoring and Information System |
| NGO | Non-Governmental Organization |
| NLCMS | National Land Cover Monitoring System |
| NRC | National REDD+ Center |
| NRCC | National REDD+ Coordination Committee |
| NRSC | National REDD+ Steering Committe |
| NTFP | Non-Timber Forest Production |
| OC | Operation Committee |
| PA | Protected Area |
| PDF | Probability Density Function |
| PPE | Personal Protective Equipment |
| PSP | |
| QA/QC | Quality Assurance and Quality Control |
| REDD IC | REDD Implementation Centre |
| RIC | REDD Implementation Center |
| RL | Reference Level |
| RP | Reference Period |
| RWG | REDD Working Group |
| SAVI | Soil-Adjusted Vegetation Index |
| ScFM | Scientific forest management |
| SD | Standard Deviation |
| SE | Standard Error |
| SESA | Strategic environmental and social assessment |
| SFM | Sustainable Forest Management |
| SIS | Safeguards Information System |
| SOC | Soil Organic Carbon |
| SoI | Summary of information (on safeguards) |
| SU | Sampling Unit |
| SWIR | Short Wavelength InfraRed |
| TAL | Terai Arc Landscape |
| TCC | Tree Canopy Cover |
| UNDRIP | United Nations Declaration on the Rights of Indigenous Peoples |
| USGS | United States Geological Survey |
| VHR | Very High Resolution |
| WB | The World Bank |

# 1 IMPLEMENTATION AND OPERATION OF THE EMISSION REDUCTION (ER) PROGRAM DURING THE REPORTING PERIOD

## 1.1 Implementation status of the Emission Reduction (ER) Program and changes compared to the Emission Reduction Program Document (ER-PD)

The Government of Nepal (GoN) has been implementing the Emissions Reduction (ER) program "People and Forests - A Sustainable Forest Management-Based Emission Reduction Program in the Terai Arc Landscape, Nepal" since 22 June 2018. This ER program is based on the Emission Reduction Program Document (ERPD) finalized and submitted to the Forest Carbon Partnership Facility (FCPF) on May 23, 2018.[1] Nepal's ERPD was accepted into the Carbon Fund Portfolio during the Carbon Fund meeting held from June 20–22, 2018 in Paris. Subsequently, on February 24, 2021, the GoN and the World Bank entered into Emission Reductions Payment Agreement (ERPA),[2] which establishes the two reporting periods for performance-based payment (Table 1):

**Table 1: Reporting Periods and Contract Emission Reductions (ERs)**

| SN | Period | Minimum Contract ERs | Cumulative Contract ERs |
|---|---|---|---|
| 1 | June 22, 2018, to December 31, 2021 | 4,000,000 | 4,000,000 |
| 2 | January 1, 2022, to December 31, 2024 | 5,000,000 | 9,000,000 |

The ERPA establishes the contract for the ER program to transfer 9,000,000 ER units to FCPF over the entire duration at the rate of USD 5.00 per transferred ER unit. This Emission Reduction Monitoring Report (ER-MR) covers performance of the ER program for the first reporting period (June 22, 2018, to Dec 31, 2021), **consisting the time period of 3.53 years**. This ER-MR follows the FCPF ER monitoring report template, version 2.4 issued in May 2022,[3]based on consultation with the FCPF's Fund Managment Team (FMT).

The ER Program covers a geographic area of 2,287,325 hectares of Nepal's lowlands (called "Terai") and some of the adjoining Chure hills spread over jurisdictionally delineated 13 districts[4] that together comprises the Terai Arc Landscape (TAL). These districts are spread across five of Nepal's seven provinces – Madhesh, Bagmati, Gandaki, Lumbini, and Sudurpaschim. Uniquely rich in culture and natural resources, the TAL represents approximately 15% of Nepal's total area, 20% of its forests, 25% of its total population. This area is the country's most productive agricultural region. The ER program is expected to be a model for the implementation of performance-based activities to address drivers of deforestation and degradation, as it is aligned with the National REDD+ strategy.The ER program is being implemented in both government-owned land and private forests. However, the area of private forests in the TAL is only 2-3 %

Nepal viewed the ER program as an opportunity for aligning the priorities laid out in the country's policies with the opportunities in the land sector in the Terai region. The region supports the most productive forests, rich biodiversity and most significant protected areas (PAs) in the country. But the region also has the highest population growth and urbanization in the country, and offers greater economic development opportunities than elsewhere. Similarly, the livelihood and well-being of many communities in the region are linked to the health and productivity of the forests. Forestry, agroforestry, fuelwood and fodder collection and non-timber forest products directly support the livelihoods and customary practices of people in the region. As a consequence, the natural resources in the region face significant threats, which were identified in the ERPD as drivers of deforestation and forest degradation.

[1] People and Forests – A Sustainable Forest Management-Based Emission Reduction Program in the Terai Arc Landscape, Nepal. Date of Revision – 23 May 2018. Available at https://www.forestcarbonpartnership.org/system/files/documents/Nepal%20ERPD%2024May2018final_CLEAN_0.pdf.

[2] ERPA texts, Tranche A: https://www.forestcarbonpartnership.org/system/files/documents/FCPF%20Carbon%20Fund%20ERPA-Nepal%20Tranche%20A.pdf and Tranche B: https://www.forestcarbonpartnership.org/system/files/documents/FCPF%20Carbon%20Fund%20ERPA-Nepal%20Tranche%20B.pdf

[3] This version is available at https://www.forestcarbonpartnership.org/resources.

[4] While ERPD mentions 12 districts for the ER program area, presently it has 13 districts, as one of the districts (Nawalparasi) was divided into two.

The ERPD states that **deforestation** accounted for approximately two-thirds of land-based emissions in the Terai. It was driven by **immigration and unplanned settlement, encroachment of government-managed forests, illegal and unsustainable logging (mostly in government-managed forests) and expanding infrastructure development**.

The ERPD further states that **forest degradation** accounts for approximately one-third of land-based emissions and is driven by an **overall supply-demand gap for forest products, in particular for fuelwood and fodder, and illegal and unsustainable logging in government-managed forests.** Unmanaged grazing, particularly outside community forests, exacerbates these drivers and likely plays a role in inhibiting forest regeneration and enhancement in many areas. High fire frequency also plays a significant role in Terai. While fire is part of a natural disturbance regime in many of Nepal's forests and grasslands, most fires also occur intentionally, either as part of a prescribed burning regimen in protected areas (e.g. to enhance wildlife habitat) or to enhance grazing conditions in unmanaged areas. ERPD suggested that fires were not a significant source of emission.
ERPD also notes that regeneration appeared significant in the ER program area, with roughly 60,000 ha of regrowth (non-forest to forest) during the Reference Period (2004-2014). It may represent benefits already generated by community-based forest management.

There has not been any key change or deviation in the ER program's design and key assumptions for the reporting period and the ER program continues to implement the seven interventions identified in the ERPD.

### *1.1.1 Progress on the actions and interventions under the ER program*

The ER program envisioned a total of seven interventions to achieve emission reductions.[5] They include (1) improving forest management; (2) localizing forest governance through hand-over of forest to local user groups; (3) expanding private sector forestry; (4) expanding access to alternative energy with biogas and improved cookstoves; (5) scaling up pro-poor leasehold forestry; (6) improving integrated land-use planning to reduce forest conversion; and (7) strengthening the management of protected areas. Some of them, especially interventions 1 and 2 were already being implemented since July 2018 before the approval of ERPD was approved. Hence Nepal intends to claim retroactive results-based payments for the ER credit generated from the interventions 1 and 2.

The central theme of interventions under the ER program was to expand community-based forest management regimes (community forestry and collaborative forestry), reducing the land area in less-managed government forests and enhancing the benefits of localized forest management with increased knowledge and application of sustainable forest management principles. These activities were implemented under the Ministry of Forest and Environment (MoFE) by supporting the actual "handover" process – by transferring the management rights of the forests to local forest user groups, and by working with forest user groups to upgrade management plans to reflect SFM guidelines.

**Table 2** shows the progress made, as of 2021, against the targets set for the seven interventions for the duration of the ER program. Subsequent paragraphs provide description of these interventions.

**Table 2: Intervention Targets (2018-2028) and Progress as of 2021**

| SN | Intervention | Target | Start Date of Interventions | Progress 2018-2021[6] | Description / remarks |
|---|---|---|---|---|---|
| 1 | Improve management practices on existing community and collaborative forests building on | 336,069 ha | July 12, 2018 (Janajagriti CFUG, Ghodaghodi | 154,766 ha (total) Community Forests: 94,236 ha; | Data up to December 31, 2021 |

[5] People and Forests – A Sustainable Forest Management-Based Emission Reduction Program in the Terai Arc Landscape, Nepal. Date of Revision – 23 May 2018. Available at https://www.forestcarbonpartnership.org/system/files/documents/Nepal%20ERPD%2024May2018final_CLEAN_0.pdf.

[6] Progress data drawn from two sources: a) REDD IC (2021, March). Implementation Status of Emission Reduction Program Intervention in Terai Landscape Nepal (From June 2018 to July 2020); and b) REDD IC (2022, May). Nepal Emissions Reduction Program: Environmental and Social Safeguards Consistency and Gap Assessment Report of Program Interventions for Retroactive GHG Emissions Reduction Crediting.

| SN | Intervention | Target | Start Date of Interventions | Progress 2018-2021[6] | Description / remarks |
|---|---|---|---|---|---|
| | traditional and customary practices | | Municipality, Kailali district) | Collaborative Forests Management: 52,515 ha; Block Forest: 8,015 ha | https://drive.google.com/drive/folders/1Te05MYER7NABe_gu1iQiPcSguUWqJa76 |
| 2 | Localize forest governance through transfer of National Forests to Community and Collaborative Forest User Groups | 200,937 ha | July 10, 2018 (Betaldeu CFUG, Gauriganga Municipality – Kailali District) | 12,107 ha of forest handed over to communities. (9,454 ha of CF; 2,653 ha of collaborative forest) | Data up to December 31, 2021<br><br>https://drive.google.com/drive/folders/1Te05MYER7NABe_gu1iQiPcSguUWqJa76 |
| 3 | Expand private sector forestry operations through improved access to extension services and finance | 30,141 ha | Bara district - Name of the owner: Yashoda Rai; Date of Registration: July 9, 2019; Area: 0.55 ha,<br><br>b. Name of the owner: Sampatiya Devi; Date of registration: January 12, 2021; Area: 0.4 ha | 2,127 ha new plantation | Data up to December 31, 2021<br><br>190 new private forests (114 ha) registered.<br><br>https://drive.google.com/drive/folders/1Te05MYER7NABe_gu1iQiPcSguUWqJa76 |
| 4 | 4a. Expand access to alternative energy with biogas | 60,000 units | | 2,382 units (July 2018 to June 2021) | Data up to June 2021 |
| | 4b. Expand access to alternative energy with improved cookstoves | 60,000 units | | 3,728 units (July 2018 to June 2021) | Data up to June 2021 |
| 5 | Scale up pro-poor leasehold forestry | 12,056 ha | Chitwan district, Padherikhola Leasehold Forest User Group, Ikshyakamana, registered date: fiscal year 2018/19, area: 5.90 ha, household: 5)<br><br>(Chitwan district, Bhalu dhunga | 3030 ha (Chitwan and Nawalpur divisions) | Data up to December 31, 2021<br><br>https://drive.google.com/drive/folders/1Te05MYER7NABe_gu1iQiPcSguUWqJa76 |

| SN | Intervention | Target | Start Date of Interventions | Progress 2018-2021[6] | Description / remarks |
|---|---|---|---|---|---|
| | | | LHFUG, Ikshyakamana, registered date: fiscal year 2019/20, area: 4.59 ha, household; 6) | | |
| 6 | Improve integrated land use planning to reduce forest conversion associated with infrastructure development | 9,000 ha | October 2019 to March 2020 | Land use planning in 44 (out of 144) local government jurisdictions in ER program area | Data up to December 31, 2021<br><br>https://www.redd.gov.np/post/tor-for-preparation-of-land-use-plans-of-municipalities-in-and-around-the-emissi (Terms of Reference for land use preparation) |
| 7 | Improve management of existing Protected Areas (PAs) | 6 PAs | July 17, 2021<br><br>(grassland management – Bardiya National Park – 10 ha)<br><br>July 17, 2019 ( Grassland management in chitwan National park - 745 ha, newly constructed grassland - 600 ha, old grassland managed - 145 ha) | The PAs being managed under PA legislation and institutional arrangement | Data up to December 31, 2021<br><br>https://chitwannationalpark.gov.np/index.php/reports/annual-reports (annual report fiscal year 2020/21) |

**Intervention 1. Improve management practices on existing community and collaborative forests building on traditional and customary practices**. This is the one of the two main interventions of the ER program, for which a target was set to improve management practices in 336,069 hectares in the 13 districts of the ER program. This

intervention consists mainly of the adoption of Sustainable Forest Management (SFM), aiming to increase the production of timber and fuelwood as well as biomass, by integrating local needs as well as the traditional and customary practices. Under the intervention, silviculture system-based forest management is being undertaken in community forests, collaborative forests, and government-managed "block forests". Accordingly, not only in community forest and collaborative forests, the block forests in Rautahat, Nawalparasi, Dang and Banke districts of the ER program area are implementing SFM as the regular government-led activity. REDD Implementation Center (REDD IC) supported the preparation of SFM plans, while Divisional Forest Offices (DFOs) are responsible to implement these plans.

A total of 154,766 ha of forest has been brought under improved management practice in the 13 districts of the ER program as of December 31, 2021. This area consists of community forest (94,236 ha); collaborative forest (52,515 ha) and Block Forest (8015 ha). The activities under this intervention included sustainable forest management; silvicultural system; silvicultural treatments; forest protection activities including the control of illegal cutting of trees and ban on grazing, such as through strict law enforcement as well as community-level anti-encroachment teams monitoring the SFM sites. They also included forest plantation in open space and public land and adoption of more effective harvesting and utilization of forest produce.

**Intervention 2. Localize forest governance through transfer of National Forests to Community and Collaborative Forest User Groups**. This intervention targeted the hand-over of approximately 200,937 ha of government managed forests (equivalent to 40 percent of the remaining government forests in the Terai) to community or collaborative forest management user groups. By the end of 2021, a total of 12,107 ha of forest has been handed over to communities under community forest or collaborative forest models. Of this, 9454 ha of forest was handed over as community forests within seven districts of the ER program area. This handover involved the transfer of forest management responsibility, custodianship and tenurial rights to 60 community forest user groups (CFUGs), consisting of a total of 13,793 households. Similarly, 2653 ha of forest was handed over to communities as a collaborative forest in Kailali. This intervention is closely linked to the first intervention - the forest management operational plans approved as a requirement of the hand-over were drawn up following the principles of scientific/sustainable forest management.

**Intervention 3. Expand private sector forestry operations through improved access to extension services and finance**. The ERPD set the target of supporting 30,141 ha of private forest in the ER program area during 2018-2024. This is additional to the private forests that existed earlier. At the beginning of the ER program, there were a total of 639 registered private forests in the TAL area covering 550 ha of forests. A total of 190 new private forests which include an area of 114 ha, have been registered in eight districts as of December 31, 2021. At the same time, many private forest owners operate without registering their forest – and a substantial number of private forests is expected to have developed during this period. Records show that a total of 8.5 million tree seedlings were distributed during this period. With the assumption of 1,600 seedlings planted per ha and with 40% survival, this amounts to the raising of 2,127 ha of new private forests in the ER program area. Because of low land-holding size in the ER program area – and in Nepal more generally – these plantations are assumed to be scattered in small areas in and around the settlements.

**Intervention 4. Expand access to alternative energy with (4a) biogas and (4b) improved cookstoves.** This intervention targeted the installation of 60,000 biogas plants and 60,000 improved cookstove (ICS) units over the duration of the ER program. The installation of biogas plants and ICS units is carried out by Alternative Energy Promotion Center (AEPC), which sells ER credits of alternative energy installations in the international market. Accordingly, ER credits from biogas plants and ICS are not included in this ER program. The MoFE, as the designated national authority for carbon services including the accounting of the ER from reduction in deforestation and forest degradation, ensures that the double counting of this ER does not occur. Furthermore, the Gold Standard methodologies for accounting ER from biogas plants[7] and ICS[8] do not include ER from reduction in deforestation and forest degradation.

[7]https://globalgoals.goldstandard.org/433-ee-ics-methodology-for-animal-manure-management-and-biogas-use-for-thermal-energy-generation/

[8]https://globalgoals.goldstandard.org/standards/412_V1.1_ICS_SLCP_Black-Carbon-and-Co-emitted-Species-due-to-the-replacement-of-less-efficient-cookstoves-with-improved-efficiency-cookstoves.pdf

Over the first three years of the ER program, biogas plant installation was carried out in 11 districts of ER program area and 2,382 units were installed. Similarly, a total of 3,728 ICS units were installed in 11 districts. The adoption of biogas plants as a source of household energy and energy saving from improved cookstoves contribute to emission reductions from the land use sources.

**Intervention 5. Scale up pro-poor leasehold forestry.** Nepal's pro-poor leasehold forestry (LHF) program has been acknowledged to increase the livelihoods and employment opportunities of the rural poor. ERPD set the target of scaling up pro-poor LHF in 12,056 ha in 12 districts, excluding Bardia district. The intervention was implemented in only two (Chitwan and Nawalpur) of the 13 ER program districts. By the end of 2021, 584 LHF groups with 4,567 households were managing 3,030 ha of forest in these two districts.[9]

**Intervention 6. Improve integrated land use planning to reduce forest conversion associated with infrastructure development.** Main objective of this intervention was to reduce deforestation of 11,736 ha of forest area through integrated land use planning and implementation in infrastructure development in the ER program districts. REDD Implementation Centre supported the land use plan preparation in 31% of the local governments (municipalities or rural municipalities in the ER program area. The REDD IC accomplished major background works and prepared the plans of 44 local governments in 10 of the 13 districts (Table 3). Of the 44 plans, nine were prepared in Fiscal Year 2018/19 and 35 in FY 2019/20. Further, the integrated land use plans require review and minor updates to ensure consistency and alignment with the recently endorsed Land Use Regulation 2022 before the local governments can proceed with the plans' implementation.

**Table 3. Local governments in ER Program Area Supported with Integrated Land Use Planning**

| District | Municipality/Rural Municipality | Fiscal Year |
|---|---|---|
| Rautahat | Chandrapur | 2018/19 |
| | Kataharia, Phatuwa Bijayapur, Dewahni Gonahi, Molapur, Bodhimai, Gujara, Ghadimai, Brindaban | 2019/20 |
| Bara | Jitpur Simara, Nijgadh | 2018/19 |
| | Pheta, Parawanipur, Kohabi, Kalaiya, Kataiyamai, Debatal | 2019/20 |
| Parsa | Parsagadhi | 2018/19 |
| | Bahuharmai, Pokhariya, Birgunj, Thori, Satuwaparsoni, Parera Sugauli | 2019/20 |
| Parasi | Bardaghat, Sunwal, Sarawal | 2019/20 |
| Rupandehi | Devdaha, Kanchan, Lumbini Sanskritik, Gaidahawa, Tilottama, Sainamaina, Butwal | 2019/20 |
| Kapilvastu | Banganga, Kapilvastu, Buddhabhumi, Shivaraj, Bijayanagar | 2019/20 |
| Dang | Tulasipur | 2018/19 |
| Banke | Kohalpur | |
| Bardia | Barhbardia | |

[9] MoFE, 2020. Current Status of Community Based Forest Management Models in Nepal. Ministry of Forests and Environment, Singhadurbar, Kathmandu. https://mofe.gov.np/uploads/documents/current-status-of-cbfm-in-nepal20201629351493pdf-3355-366-1658827849.pdf, p.101-02

| | | |
|---|---|---|
| Kailali | Dhangadhi, Lamkichuha | |

**Intervention 7. Strengthen the management of protected areas (PAs).** The ER program area contains six PAs, that include five National Parks and a Conservation Area. These six PAs cover a total area of 341,997 hectares (Table 4). The five National Parks have buffer zones in their peripheries that cover a total area of 210,617 ha spread over 39 local government jurisdictions. As carbon stocks in the PAs are generally much higher than that under other management regimes (National forests, community forest, collaborative forests, leasehold forests, religious forests), strengthening the PA management to conserve and enhance the forest carbon stocks is important. Once established as PAs, various conservation measures are adopted in these jurisdictions. All of these PAs are managed under the Department of National Parks and Wildlife Conservation (DNPWC). Owing to stricter protection, these areas are not subject to historical deforestation and forest degradation. These areas are included in the ER Program for the significant non-carbon benefits that they provide and to safeguard against any social and environmental impacts (e.g. human wildlife conflict) that could arise due to the implementation of REDD+ program. Accordingly, no direct activities were proposed under this intervention.

**Table 4. Protected Areas in Nepal ER Program Area**

| SN | National Parks (NPs) and Conservation Area (CA) | | | Buffer zone | |
|---|---|---|---|---|---|
| | NP or CA | Area sq.km. | Districts | Area sq.km. | No of Local Governments |
| 1 | Parsa NP | 627.39 | Bara, Parsa, Makwanpur | 285.3 | 4 |
| 2 | Chitwan NP | 952.63 | Chitwan, Nawalpur, Parsa, Makwanpur | 729.37 | 12 |
| 3 | Banke NP | 550 | Banke | 343 | 6 |
| 4 | Krishnasar CA | 16.95 | Bardia | - | - |
| 5 | Bardia NP | 968 | Bardia | 505 | 10 |
| 6 | Shuklaphanta NP | 305 | Kanchanpur | 243.5 | 7 |
| **Total** | | **3,419.97** | | **2,106.17** | **39** |

Source: REDD IC. 2021, March. Implementation Status of Emission Reduction Program Intervention in Terai Landscape Nepal, p.25.

### *1.1.2 Update on the strategy to mitigate and/or minimize potential displacement*

The Nepal ER Program carried out efforts to mitigate or minimize displacement of emissions to areas outside the Program boundaries. The program's main thrust in achieving this was through improving forest management in existing community forestry and collaborative forest areas and government-managed block forests, and the handover of government forest to local communities – along with other interventions and policy/regulatory efforts to mitigate and/or minimize displacements. Key measures for displacement mitigation included the following.

- Handover of community forest
- Handover collaborative forest management
- Improve sustainable forest management, including scientific forest management
- Revise forest operational plans
- Community custodianship and control over local forest under community and collaborative forestry regimes

It is expected that all forms of forest management will implement measures to mitigate potential displacement. Additionally, in the next decade, all community forests, collaborative forests, and government-managed forests will adhere to sustainable forest management (SFM), ensuring a continuous supply of forest products.

Table 5 shows specific risk levels and the strategies adopted for addressing the drivers of deforestation and forest degradation.

**Table 5: Update on Strategies to Mitigate and/or Minimize Potential Displacement**

| Drivers of deforestation and degradation | Risk of displacement | Strategies for mitigating / minimizing displacement |
|---|---|---|
| A. DEFORESTATION | | |
| 1. Encroachment | Low | Encroachment to forest fringes occurred mostly in the context of open access to government owned land. The clear demarcation of forest land as collaborative and community forestry establishes both statutory basis and community custodianship to reduce and avoid encroachment. |
| 2. Infrastructure Development | Low | Infrastructure development – such as road, hydropower, school construction – are typically designed to serve a given area and do not pose significant risk of displacement outside the ER program area. For new infrastructure projects, the developers have to follow Nepal's laws and technical procedures on environmental impact assessment and associated mitigation measures. These include initial environmental examination (IEE) |

| Drivers of deforestation and degradation | Risk of displacement | Strategies for mitigating / minimizing displacement |
|---|---|---|
| | | and environmental impact assessment (EIA) that are conducted for all Community or Collaborative Forests for implementing SFM as required by the Environment Protection Act 2019[10] and Environment Protection Rules 2020.[11] Therefore, the risk of displacement due to this driver is low.<br><br>The Government of Nepal was in the process of preparing Eco-friendly Linear Infrastructure Directive and conducted series of consultations with the stakeholders. In 2022, the government has endorsed wildlife-friendly Linear Infrastructure Directives which is currently under implementation. The Directive also addresses and mitigates the risks and threats to forests and ecosystems to a certain extent. |
| 3. Resettlement | Low | Planned resettlement has not occurred in the ER program area during 2018-2021, and the risk of displacement due to this remains low. Whenever resettlements are considered, they are expected to be within the ER program area and, also subject to social and environmental management / safeguard frameworks. |
| B. FOREST DEGRADATION | | |
| 1. Unsustainable / illegal timber extraction | Medium | During Nepal's transition period of state restructuring, the demand for timber in the ER program area and throughout Nepal exceeds the sustainable supply. Trade involves both intra- and inter-district, going into and out of the ER program area.<br>Major approach in this ER program to address this driver is to establish clearer community rights and custodianship over forest, so that local community have the incentive to manage and utilize forests more sustainably within the local areas. Improvement in forest management in community forests, collaborative forests, and block forest also help optimize timber production and extraction. The formulation of new policy, particularly provincial forest regulation and "Silviculture based forest management procedure," will increase the availability of timber from the ER program area.<br>With forest policies and procedures in place, sustainable forest management practices have been initiated in most of the forest management regimes in the ER program area. Additionally, private plantation and forestry practices have been initiated to fulfill people's demand for timber and fuelwood. These have promoted an increase in timber availability in the different districts of the ER program area where the measures have been put into practice. |
| 2. Fuelwood extraction | Low | Fuelwood is extracted locally only. Improved forest management is expected to improve the supply of fuelwood locally. Similarly, the establishment of new biogas and ICS plants further reduces the demand for fuelwood, and hence forestalls potential displacement. |

[10] Available at https://drive.google.com/file/d/1nfz5FaB1lYx3R9bPMP0Ub11Ha9e1V57M/view?usp=drive_link
[11] Available at https://drive.google.com/file/d/1Veey_JjUlZ9_uVE_joJlt5aKayVaeCoV/view?usp=drive_link

| Drivers of deforestation and degradation | Risk of displacement | Strategies for mitigating / minimizing displacement |
|---|---|---|
| 3. Overgrazing | Low | Grazing is typically limited within the vicinity of villages – and increasingly stall feeding is bring practiced in the ER program area. Accordingly, the risk of displacement from overgrazing remains low. While some displacement may exist around the boundaries of the ER program area, the presence of community forests immediately outside the area reduces this risk. |
| 4. Forest fire | Low | Forest management plans for community forestry, collaborative forestry and block forests mostly include measures to control and mitigate forest fires. In many plans, the provision of fire lines and training to local people for fire control and support on simple equipment are provided. Different capacity building activities from the divisional forest offices and awareness raising and information and communication materials help people to manage and control the forest fire. |

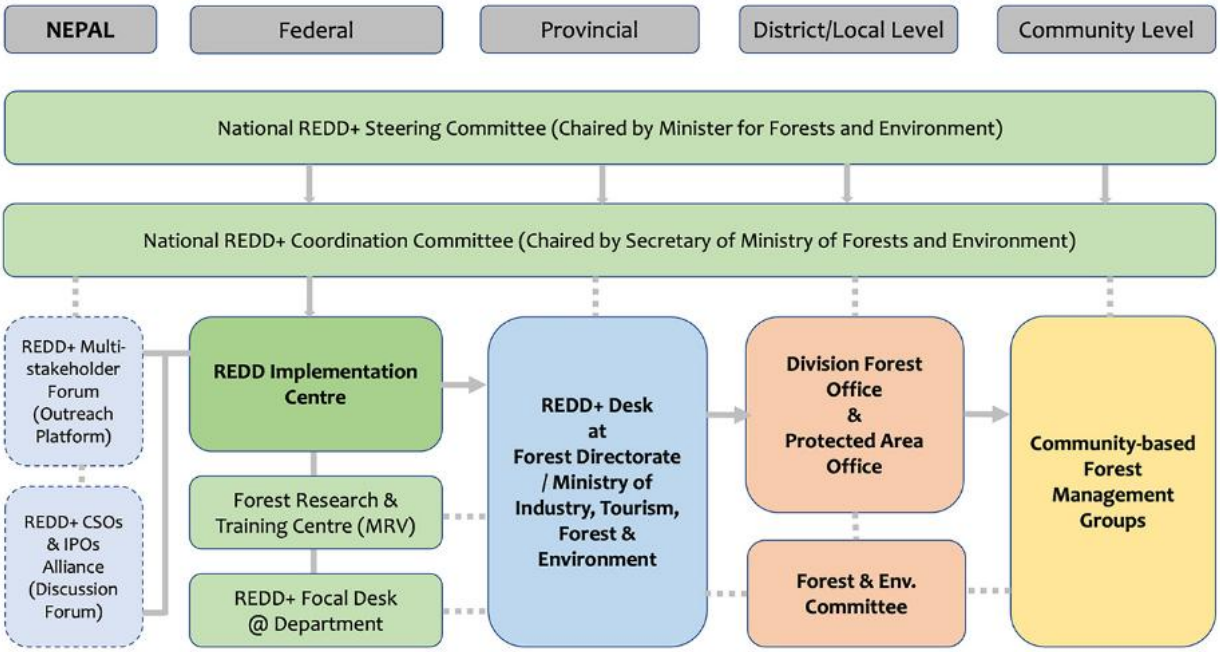
### *1.1.3 Effectiveness of the organizational arrangements and involvement of partner agencies*

The Nepal ER Program and its effective implementation depend on the effective engagement of stakeholders. The program was initiated while Nepal was transitioning from a centralized, unitary state into a federal one. The new structure has three tiers of government, consisting of federal, provincial and local levels, constituting the federation. The organizations involved in the ER program are not only the federal institutions, including the Ministry of Forest and Environment (MoFE), but also provincial and local governments. Current institutional mechanisms have evolved from those that existed during the REDD readiness phase until 2018. The readiness phase was governed through a three-tier institutional mechanism – consisting of REDD Multi-sectoral, Multi-stakeholder Coordinating and Monitoring Committee as the apex body; the REDD Working Group (RWG) as the decision-making body; and REDD implementation Center as the implementing entity.[12] Two peripheral mechanisms, including a Stakeholder Forum and a REDD+ CSO Alliance and IPOs Alliance, were established to develop a common understanding on REDD+ among stakeholders including women, Indigenous People's organizations, Madhesis, Dalits and civil society organizations. All four departments under the MoFE have varied roles in REDD+ implementation.

During the implementation of the ER program, the previous institutional mechanism was restructured with the adoption of National REDD+ Strategy in 2018. In the ER program implementation period, institutional mechanism has been adapted to the federal set up of the country- specifying the three governance tiers – federal, provincial and local levels – and at the same time asserting the prominent role of local of communities. Existing structure shown in Figure 1, followed by a brief description in subsequent paragraphs.

[12] MoFE, 2018. Nepal National REDD+ Strategy. Kathmandu, Ministry of Forest and Environment. Available at https://www.forestcarbonpartnership.org/system/files/documents/Nepal%20National%20REDD%2B%20Strategy.pdf, p.12-13.

**Figure 1. Institutional Mechanism for REDD+ in Nepal**




Source: REDD IC website, https://redd.gov.np/page/institutional-mechanism-for-redd-nepal, downloaded Dec 24, 2022.

- REDD+ Implementation Center is re-envisioned as National REDD+ Center (NRC) to function as the primary operational body to provide national program leadership, coordinate ER program planning, and bridge province and district-level planning and priorities under the National REDD+ Strategy. It is expected to serve as REDD+ programs management entity. It is expected to fulfill the basic fiduciary standards of financing institutions, generate its own fund and compete to access international REDD+ related funds by maintaining an effective fund administration. For this, it will establish independent internal and external audit systems.
- The National REDD+ Steering Committee (NRSC), which is chaired by the Minister of Forests and Environment, has been established. It consists of secretaries of five federal Ministries, the National Planning Commission, National Natural Resources and Fiscal Commission, three representatives from the networks of local governments, seven provincial secretaries (Ministry of Industry, Tourism, Forests and Environment) as well as up to six representatives (at least two women) from civil society organizations drawn up from amongst IPs and other communities engaged in forest resource management. The Head of NRC serves as its Member Secretary.
- National REDD+ Coordination Committee (NRCC), which is chaired by the Secretary of the MoFE, is another structure established as per the National REDD+ strategy. It is mandated to make decisions on technical matters such as endorsing research documents, implementation and monitoring of REDD+ programs and recommending the agenda for NRCC meetings. It consists of Joint Secretaries and Directors General of the MoFE's departments, Chief of Forests Research and Training Center as well as up to nine representatives (at least three women) from civil society organizations drawn up from amongst IPs and other communities engaged in forest resource management. The Head of NRC serves as its Member Secretary.
  On June 5, 2021, a meeting of NRCC was held, with the participation of six women and 19 men members. The meeting discussed the internal procedure for the working of the NRCC.

- REDD+ Multistakeholder Forum is another structure, consisting of representatives from the private sector, civil society, media, government organizations, community-based organizations, IP organizations, local and international NGOs, donors, academic and research institutions.

- REDD+ CSOs and IPOs Alliance is expected to discuss and develop a common understanding on REDD+ on behalf of women, IP organizations, Madhesis, Dalits and CSOs.
- REDD+ Focal Desks have been established in each of the four departments under the MoFE; the focal desks are required to liaise with NRC, and sub-national level REDD+ Focal Desks.
- The provincial Ministry of Industry, Tourism, Forests and Environment (MoITC) in each of Nepal's seven provinces have established provincial level REDD+ Desks.
- Forest and environment-related sections in local governments are tasked with coordinating the REDD+ programs in the relevant local government jurisdictions.
- At the community level, community-based forest management (CBFM) – such as those management community forest or collaborative forest are required to implement REDD+ as outlined in their respective forest management plans.

In addition to the above structures, the REDD+ implementation requires the participation of different government agencies and departments as well as other stakeholders. There is a need for cooperation from other federal ministries, such as the Ministry of Agriculture and Livestock Develoment (MoALD), Ministry of Land Management, Cooperatives and Poverty Alleviation (MoLCPA), Presidential Terai-Chure - Madhesh Conservation Development Board, Alternative Energy Promotion Center (AEPC), UN agencies, and other national and international organizations.

The following are the key milestones to be achieved for more effective institutionalization of REDD+

- Consolidate REDD Implementation Centre as National REDD+ Center with its expanded capacity and mandate, envisioned in the REDD+ strategy 2018.
- Regular convening of the meetings of the structures envisioned through the REDD+ strategy – including the NRSC and NRCC.
- More engagement and coordination with other federal ministries as well as the provincial and local governments.

### *1.1.4 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*

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The section has been intentionally left black because the Benefit Sharing Plan (BSP), which will inform the financial plan and implementation of the ER program, is in the approval process.

## 1.2 Update on major drivers and lessons learned

The three drivers of deforestation identified in the ERPD – encroachment, infrastructure development and resettlement – pose low levels of risks to deforestation. Encroachment of forestlands by squatters and the expansion of informal settlement (called *sukumbasi basti*) were encouraged in the past in times of political turmoil. Recent years have seen a more smooth, peaceful transition of power and consequently a more effective rule of law means reduced risks for encroachment.

On the other hand, greater political stability and social order achieved in the recent past is likely to contribute to greater infrastructure development. The successful elections for three tiers of the federation and peaceful transfers of power as well as the consolidation of the new governance / administrative structures in Nepal in the recent past have fostered political stability and encouraged infrastructure development. Infrastructure development is also politically and socially desirable, given the huge infrastructure gap that currently exists in the country. In addressing emission risks emerging from new infrastructure, enough safeguards exist in Nepal, especially on environmental legislation, which is enforced by the MoFE.

Similarly, planned resettlement is only likely in mega-projects, such from new hydropower projects' dam constructions or unforeseen disasters. These risks are not imminent in the ER program area.

Th four drivers of forest degradation identified in the ERPD – unsustainable/illegal timber extraction, fuelwood extraction, overgrazing and forest fire – pose low to medium level of risks to forest degradation. The risks associated with overgrazing and forest fire continue to be low and no apparent change to these drivers have been noted.

However, some broad patterns of change have helped to mitigate two other drivers—unsustainable timber extraction and fuelwood extraction. Firstly, Nepal has seen a steady and continuous increase in the production of hydroelectricity and Nepal Electricity Authority is encouraging the use of electricity for domestic use. This is expected to reduce demand for LPG and fuelwood. Similarly, the adoption of the use of biogas and improved cookstoves reduce the per capita demand for fuelwood. Thus, the pressures from the demand for fuelwood on forest degradation has been gradually reducing.

Similarly, greater political stability and law enforcement situation as well as improved community control and custodianship under participatory forest management regimes reduce illegal timber extraction. The availability of alternative building materials (including aluminum) is also expected to have alleviated some pressure on timber extraction.

## 1.3 Methodological deviations

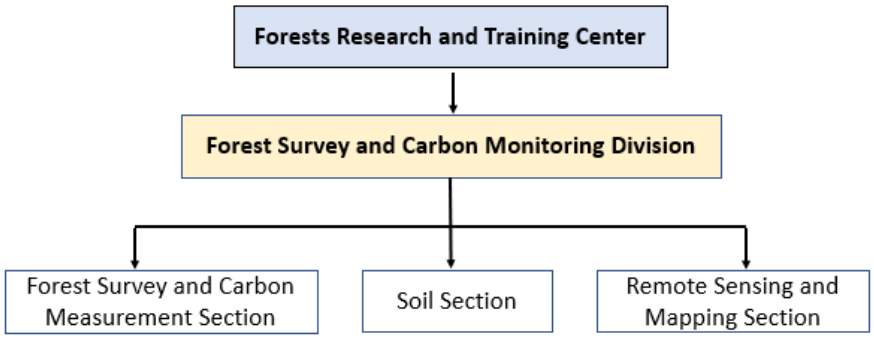
No methodological deviations are proposed to correct material or non-material error or misstatement impacting the estimation of the validated Reference Level and verified Emission Reductions.

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

## 2.1 Forest Monitoring System

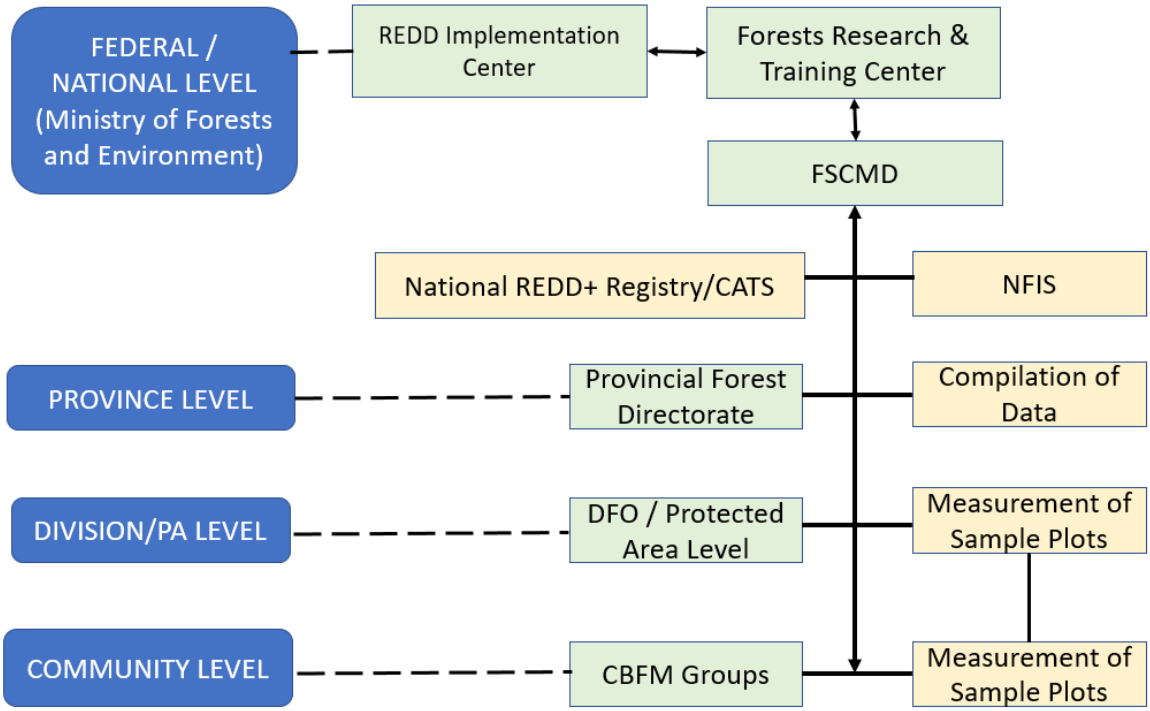
Nepal has established a comprehensive and systematic forest monitoring system. Forest cover monitoring and periodic national forest inventory have been functioning well under the Forest Research and Training Center (FRTC), Ministry of Forests and Environment. Permanent sample plots for national forest inventory have been established and measured at an interval of five years. Under the broader theme of National Land Cover Monitoring System (NLCMS), forest cover monitoring and mapping using satellite images are carried out on an annual basis. Furthermore, for precise estimation of volume and biomass, a program to develop allometric equations of 16 major tree species of the country has been initiated in 2022. The Forest Survey and Carbon Monitoring Division (FSCMD) of FRTC is the focal institution for forest monitoring systems. The organizational structure of the Division is presented in Figure 2. Though the ER-MR does not report emission from soil carbon pool, soil monitoring is part of National Forest Inventory (NFI and thus, the soil section is part of the FSCMD.

**Figure 2: Organizational Structure of Forest Survey and Carbon Monitoring Division in FRTC**




On the national scale, forest survey and monitoring require engagement of federal, provincial (state), and local (divisional) and community level actors and agencies. The relationship of these organizations is illustrated in Figure 3. Until REDD + Registry is fully established/operationalized, it has been agreed that the Government of Nepal deploys the World Bank's Carbon Assets Tracking System (CATS).

**Figure 3. Multi-Level Structure for Forest Inventory and Carbon Monitoring**




The aren't major changes in this section compared to the ERPD. The changes in the methodology to estimate Activity Data are presented in detail in Annex 4 - Carbon Accounting: Addendum to the ERPD of the ER-MR.

### *2.1.1 The selection and management of GHG related data and information*

The Forest Research and Training Centre (FRTC) and the REDD Implementation Center are responsible for generating data for the Land Use, Land-Use Change, and Forestry (LULUCF) component of the national greenhouse gas (GHG) inventory. In the context of the Emission Reductions Monitoring Report (ERMR), only carbon dioxide ($CO_2$) is considered as the relevant GHG. To address this, FRTC has operationalized the National Land Cover Monitoring System (NLCMS), which provides annual updates on land cover changes across the country. Additionally, the five-year National Forest Inventory (NFI) feeds plot-level carbon density data into the system, which is used to calculate emission factors for different strata, including deforestation, forest degradation, and gain/loss areas.

The focus on $CO_2$ in the ERMR is aligned with the REDD+ framework, which prioritizes $CO_2$ emissions and removals from forests due to their significant role in climate change mitigation. While other GHGs, such as methane ($CH_4$) and nitrous oxide ($N_2O$), are not explicitly addressed in the ERMR, this approach ensures robust and consistent reporting on forest-related carbon fluxes, which are the primary contributors under the LULUCF sector.

The periodic Forest Resource Assessment (FRA) / National Forest Inventory (NFI) of Nepal produces the estimates on Emission Factors and generates information on tons of biomass (and carbon) stored per hectare of forest. Nepal has conducted three national forest inventories: NFI (1987-1998), FRA (2010-2014), and FRA (2016-2021). The FRA

(2010-2014) produced the Emission Factors used for the FREL submitted to the UNFCCC in 2017 (Reference level mentioned in section 8 (page 120) of ERPD.[13]

FRA (2010–2014) was designed to carry out national level forest resource assessment for providing comprehensive and up-to-date national-level forest resource information to support forest policy formulation, national-level forestry sector decision-making and international reporting. FRA Nepal implemented multi-source forest resources inventory by using high-resolution satellite imagery, field inventory as well as other existing data sources such as digital elevation model and national topographic maps. Categorization of land cover followed in FRA Nepal is based on current international practices of FAO which is also adopted by Intergovernmental Panel on Climate Change (IPCC) for greenhouse gases (GHG) emission estimation and reporting. The inventory design was largely based on the principle adopted for NFI (1999) developed by Kleinn (1994). Two-phase systematic cluster sampling was adopted for field measurement.

In order to have more accurate estimates for the Terai Arc Landscape (TAL) area, the plots located in this area were used to generate TAL-specific Emission Factors.

The Inventory design (ID) for national forest inventory has been created. The ID is based on two-phase sampling with stratification and, in case of TAL area with LiDAR Working Areas, the three-phase sampling with stratification has also been done. Different sampling intensity and design has been applied for each stratum depending on a priori information and results from the visual interpretation of satellite imageries per stratum. However, the strata for calculation of results are five physiographic zones. Both High Resolution (HR) and Very High Resolution (VHR) satellite images are used for the first phase of the sampling to classify clusters and sample points of forest coverage and to assess the accessibility of sample plots. Based on this, sample plots for the second phase of the sampling (field inventory work) are defined. The second phase of the sampling refers to the actual clusters and permanent sample plots that were measured in the field.[14]

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

National Forest Inventory (Forest Resource Assessment) data has been collected as per the FRA Field Manual, 2022 approved by FRTC.[15] The field manual contains detailed methodology of the Inventory Design and field measurement procedures.

The Forest Survey and Carbon Measurement section of FRTC validates the field data. In doing so, it deploys a validated method, stipulated in the Manual on Data Analysis and Results Generation (2021), which is available at the FRTC website.[16] The FRTC will operationalize the National Forest Monitoring Portal which will store and manage GHG related data and information.

### *2.1.3 Systems and processes that ensure the accuracy of the data and information*

The overall National Forest Inventory (NFI) Forest Resource Assessment (FRA) data collection procedure has always been accompanied by various levels of Quality Assurance and Quality Control (QA/QC) to ensure that the recorded data and followed procedures are reliable and meet minimum measurement standards. A refresher's training on NFI before field data collection, hot checks by FRTC officers during the field measurement, re-measurement of 10 % forest plots to assure that collected data has error less than 5 %, QA/QC for lab measurements and data entry &

[13] Available at https://www.forestcarbonpartnership.org/system/files/documents/Nepal%20ERPD%2024May2018final_CLEAN_0.pdf
[14] The details can be accessed at: https://drive.google.com/file/d/142FYFebXTCruimqe1wKbDoi-oBdwfERh/view?usp=drive_link
https://drive.google.com/file/d/1VRGGNoMOy-_92qg8ktk3xH82YNsEraym/view?usp=sharing

[15] Field Manual, 2022 is available at: https://drive.google.com/file/d/1EvrStTmfNAZVW7ewAqEXuKiUm-OzqUVB/view?usp=drive_link
[16] Go to: https://frtc.gov.np/uploads/files/Final_FRA_data_analysis_manual_2021.pdf
https://drive.google.com/file/d/1Z1h0Q2JiXlEXCHW1qDNcBrj1B38GEhi7/view?usp=drive_link

archiving, etc. are some of the tools under overall system and process that ensure the accuracy of the data and information.[17]

Accordingly, the forest inventory system is well established. Periodic forest cover monitoring system using remotely sensed data (satellite images) has been put in place. The FRTC will operationalize the National Forest Monitoring Portal which will incorporate design and maintenance of the Forest Monitoring System.

**Systems and processes that support the Forest Monitoring System, including Standard Operating Procedures and QA/QC procedures.** A well-established National Land Cover Monitoring System is functioning in Nepal under Google Earth Engine (GEE) platform[18]. Forest Resource Assessment manual is in operation for conducting Forest Resource Assessment (FRA) [19]. There is a standard operating procedure for QA/QC process[20].

**Role of communities in the forest monitoring system.** The communities are directly involved in forest resource assessment directly and indirectly contribute to the national forest monitoring system. Forest resource assessment (periodic NFI) is an important part of the national forest monitoring system in Nepal. During inventory of each sample plot, concerned forest communities were informed prior to the field measurement and were encouraged to participate during forest resource assessment. Their role is significant in terms of getting access to plot location, species identification, characteristics of deforestation and forest degradation including driver, causes and impacts as well. Furthermore, all community-based forest management (CBFM) committees prepare and submit the annual monitoring reports to respective Division Forest Offices (DFO). While their involvement in monitoring data is not explicit, community participation is vital for implementing forest management plans, protecting forests, and sharing benefits. Forest management groups offer support during the inventory of the Permanent sample plot (National Forest Inventory) and participate in sharing the benefits accrued from non-carbon benefits.

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

Nepal has developed a system for continuous monitoring of land cover using consistent methodology, following "National Land Cover Monitoring System (NLCMS) of Nepal" (2022), which is available at FRTC website.[21] Forest cover from NLCMS is the one of the input variables for generation of Activity Data. The Activity Data were prepared using ensemble methods. This method include four algorithms (please refer to Nepal Forest Change Area Estimation Tool), that include CODED (Continuous Degradation Detection), CCDC-SMA (Continuous Change Detection and Classification- Spectral Mixture Analysis), LandTrendr, and MTDD (Multivariate Time-series Disturbance Detection).

[17] Refer to Forest Resource Assessment in Nepal [Re-Measurement of Permanent Sample Plots] Field Manual, 2022: page 58, Chapter 5. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC). Available at https://drive.google.com/file/d/1EvrStTmfNAZVW7ewAqEXuKiUm-OzqUVB/view?usp=drive_link

[18] Available at https://drive.google.com/file/d/19Dd_AYZMQ0iOBi33Fj-eCXJ_LVZV7uMA/view?usp=drive_link

[19] Available at https://drive.google.com/file/d/1EvrStTmfNAZVW7ewAqEXuKiUm-OzqUVB/view?usp=sharing

[20] Go to https://drive.google.com/file/d/1YmbHZSOIxfsnfotBbb3elCBSemh4cA8h/view?usp=drive_link

[21] Go to: https://drive.google.com/file/d/19Dd_AYZMQ0iOBi33Fj-eCXJ_LVZV7uMA/view?usp=drive_link

## 2.2 Updates to the monitoring approach

Not applicable. This section applies only to ER Programs that have already concluded the validation assessment.

## 2.3 Measurement, monitoring and reporting approach

Table 6 provides a systematic and step-by-step description of the measurement and monitoring approach applied for the establishment of the Reference Level and estimating Emissions and Emissions Reductions during the Monitoring and Reporting Period for estimating the emissions and removals from the Sources/Sinks, Carbon Pools, and greenhouse gases selected in the ER-PD.

**Table 6: Step-by-step description of the monitoring parameter and data integration tools to establish the Reference Level and estimate Emissions and Emissions Reductions during the Monitoring Period for the Carbon Pools and greenhouse gases (GHGs) selected in the ER-PD.**

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| 1 | **Activity Data estimate and associated uncertainty.** | **CCDC-SMA**[22]:<br>1_CCDC_SMA_UI_C2<br>2_ViewExportDegDefMapp<br>3_LTMakeLossGainPostprocessed<br>4_AssembleMap<br>**CODED**[23]<br>Forest Disturbance Mapping GUI<br>**LandTrendr**[24]<br>1_UI-ImageScreener (optional)<br>2_LT-Data-Visualization-NepalTool<br>**MTDD**[25]<br>1MTDD_app_trainingpoints<br>2MTDD_app_changemap<br><br>**Forest change maps** | **Nepal Forest change area estimation tool**: Documentation on how to use this tool and a compiled set of links to user interfaces of all the tools needed to complete the forest change area estimation for Nepal can be accessed at the following link: https://training.sig-gis.com/NEPALworkshopAE/<br>1. **Forest change mapping**: To estimate the area, Nepal employs a sample-based approach. For the sample design, a forest change map spanning from 1983 to 2021 was prepared. The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis were used to map areas experiencing forest loss, degradation, and/or regrowth.<br>i. **CCDC-SMA**: Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation.<br>ii. **CODED**: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).<br>iii. **LandTrendr**: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.<br>iv. **MTDD**: Multi-variate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification. |
| | | **Map Visualization tool**<br>**1_VisualizationApp_Nepal** (in Visualization App folder of GEE repository) | 2. **Map visualization and comparison**: Each of the mapping algorithms is useful for detecting changes in a slightly different manner. However, all maps are susceptible to bias, which is why the area of map classes from the resulting maps should not be directly used for Activity Data reporting. Each map is visually assessed so any concerning results can be addressed with parameter adjustment as needed. |

[22] Procedure document of CCDCSMA can be accessed at the following link https://github.com/shijuanchen/forest_degradation_georgia

[23] Tools CODED of the GEE repository can be accessed at the following link https://code.earthengine.google.com/?accept_repo=users/bullocke/coded

[24] Procedure document of LandTrendr can be accessed at the following link https://docs.google.com/document/d/1GfdMSSaU4tiDv1Sf2L8S4k2144ptpU9seB1UkPURDCA/edit

[25] Procedure document of MTDD can be accessed at the following link https://docs.google.com/document/d/1TukNQOuEqw9OoeZgcHWUrv-ER-87TkhU9HVuV_x6HZA/edit

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | **Agreement map preparation 1_MakeAgreementMap_Nepal**[26] (Agreement Map in Google Drive folder)<br><br>**Forest Change Agreement Map**[27]<br><br>**Area available in each stratum**[28]<br><br>**Spreadsheet for Sample Size/Distribution Design**[29] | 3. **Sample design**: A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and allows calculation of the uncertainty of each estimate. An agreement map generated from the results of all four methods is used for sample design. The goal is to ensure that no strata is under-sampled. The 1_MakeAgreementMap_Nepal tool (in Map Agreement App folder of GEE repository) is used to combine the maps of the four forest change detection algorithms. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest.<br><br>When combining the results of the four algorithms into one map, the following logic rules are applied for each pixel:<br>● A GAIN supersedes all other labels.<br>● If an equal number of DEG and LOSS labels occur across the four algorithms, LOSS supersedes.<br>● If the number of DEG labels is more than the number of LOSS labels or DEG is the only type of change detected, a DEG label is given.<br>● If the number of LOSS labels is more than the number of DEG labels or LOSS is the only type of change detected, a LOSS label is given.<br>● A Non-forest label is given only if all four algorithms label it as Non-forest.<br>● A Forest label is given only if all four algorithms label it as Forest.<br><br>Final strata definitions:<br>DEG (1) = more algorithms detected degradation than loss, and GAIN is not detected<br>LOSS (2) = more algorithms detected LOSS than DEG or an equal number of algorithms detected LOSS and DEG, and GAIN is not detected<br>GAIN (3) = one or two algorithms labeled the pixel as GAIN, even if others detected LOSS or DEG<br>Non-forest (4) = all algorithms labeled pixel as stable Non-forest<br>Forest (5) = all algorithms labeled pixel as stable Forest<br>4. The number of points randomly selected depends on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. The linked spreadsheet in tools columns contains equations needed to calculate the ideal sample size to hopefully achieve the target standard error. A total of **1,522** points were selected via stratified random sampling to be used for sample-based area estimation. For the smaller strata a minimum of 110 points was required. |
| | | **Nepal's CEO institution Interpretation key** | **5. Reference data collection (completed in CEO):** To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were collected through visual imagery interpretation and **time series analysis** of 1,522 sampling plots in CEO[30]. The sampling points were visually interpreted for the same period that the forest change map was created (2004 to 2021). However, to identify the age of forests in order to differentiate between secondary and permanent forests, an additional pre-period was examined. The time period of examination was divided into four subperiods with distinct sets of survey questions: 1984-2003, 2004-2014, 2015-2017 and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021. |

[26] https://drive.google.com/drive/folders/1SJq6ZGzVTM4g1IB5ALSq6z2JHJdyFX7d?usp=sharing
[27] https://drive.google.com/file/d/1VtYM-xCunuRpjfOgeAO9aLDMMGwj_H71/view?usp=drive_link
[28] https://docs.google.com/spreadsheets/d/1Wp0lxDpqKMFlro7OdeTuaLwAQSVb2VqJ/edit?usp=sharing&ouid=101304895378504185754&rtpof=true&sd=true
[29] https://docs.google.com/spreadsheets/d/1AfZTmd-KQHMy_amBkz03ZepFhrUIcqCG/edit?usp=sharing&ouid=101304895378504185754&rtpof=true&sd=true
[30] https://drive.google.com/file/d/1PI95tEihWMqXNE9QORqgjdg8d9B5oEN6/view?usp=sharing

<table>
<tr><th>Step</th><th>Monitoring parameters and Data Integration tools</th><th>Tools and datasets</th><th>Description of the measurement and monitoring approach</th></tr>
<tr><td></td><td></td><td></td><td>i. <u>Generating a CEO project from a template:</u> FRTC created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[31]) for the following periods: Pre-reference period (t0) - 1983-2003, Reference Period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.<br>ii. <u>Sampling unit</u>: The Sampling Unit (SU) is a 70 x 70 meter plot. Inside the SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit. Negative changes in this value were used to indicate whether a degradation event had occurred.<br>iii. <u>Number of Sampling Units</u>: A total of 1,522 sampling points, selected via stratified random sampling, were visually assessed.<br>iv. <u>Interpretation key[32]</u>: Nepal produced an interpretation key that should be reused and updated as needed. The key was used to increase consistency across the team of interpreters. The land use categories considered are the following:<br><table><tr><th>Forest lands:</th><th>Non-forest lands</th></tr><tr><td>1 Intact Forest<br>2 Degraded Forest<br>3 Very Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands</td><td>7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less)</td></tr></table>● Note, the first three types of forest land (intact, degraded, and very degraded) were indirectly labeled in post-processing using the number of tree-covered points out of a 9-point grid over each plot.<br>v. <u>Performing QA/QC with reference data collection[33]</u></td></tr>
<tr><td></td><td></td><td><u>Reference data compilation R-script CompiledData_CEO</u></td><td>6. Reference data compilation: The data collected in the CEO was compiled in R for each period (t0, t1, t2, and t3) to obtain necessary information that was then used to estimate the Activity Data:<br>i. Deforestation Activity Data<br>● tx_disturbance_type_subcat: type of forest loss and gain, stable forest, and stable non-forest.<br>● Non.forest.land.use.type.in.[year of interest] Non forest land use type in the period.<br>● Number.of.tree.covered.samples.[year of interest]: Number from 9-point grid of sample points within the plot that are covered by tree canopies.<br>● GEEcombo_strata_readable: Agreement map strata.<br>● tx_type_final: Land use / land cover type<br>● tx_yr_secondaryforest_establ: year of secondary forest establishment<br>ii. Forest gain Activity Data<br>● tx_disturbance_type_subcat: type of forest loss and gain, stable forest, and stable non-forest.<br>● GEEcombo_strata_readable: Agreement map strata.<br>iii. Degradation Activity Data<br>● tx_type_final: Land use / land cover type<br>● tx_numbretrees: canopy cover<br>● GEEcombo_strata_readable: Agreement map strata</td></tr>
<tr><td></td><td></td><td><u>Activity Data Tool</u></td><td>7. Area and uncertainty estimation: Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522</td></tr>
</table>

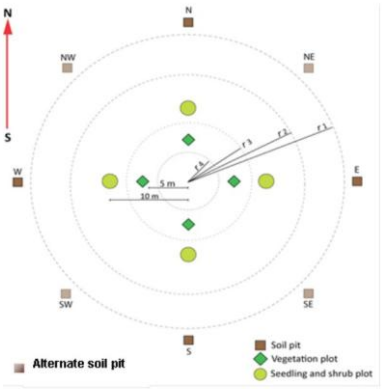
[31] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).

[32] https://docs.google.com/document/d/1z-jMtUqBjFt9z7atHKv2kr9nt6r57eS7/edit?usp=drive_link&ouid=101304895378504185754&rtpof=true&sd=true

[33] https://docs.google.com/document/d/17ui9eYcPciKghHKHUS34f5hqv80QrT0B/edit

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | (Please read this file "READ" before accessing it) | samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[34]. Estimates are made for each of the land use categories considered (10 classes) and in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9).<br>With Cochran (1977) formulas it is not possibles to calculate a standard deviation (SD) for the activity data estimate. Instead, the sampling error calculation is based on the standard error (SE), which quantifies the precision of the estimates based on the sample data. In Monte Carlo simulations de SD is used to represent the variability of input parameters. Initially, because no SD was available for the activity data, the country used the 90th percentile confidence interval and the normal probability density function (PDF). Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available.<br>Estimates and associated uncertainties are produced in the Activity Data Tool (**Nepal_TAL_AD_tool.xlsx**) for each combination considering the stratification applied. The Activity Data tool comprises various spreadsheets that estimate different types of Activity Data. These include the Dataset that is used to estimate sample-based Activity Data (CompiledData_CEO_GEE(7) sheet), as well as spreadsheets for estimating Activity Data for deforestation (Deforestation sheet), forest restoration (Forest_gain sheet), and area of change in canopy cover (loss and gain) in permanent forest lands (Degradation sheet).<br>To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheets. This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok". |
| **2** | **Forest regrowth removal rates and forest carbon densities calculation, including the uncertainty estimate.** | **NFI dataset** | 1. **National Forest Inventory**:<br>The biomass estimates used for the ER monitoring report are Tier 2 (country specific data) and has been derived from the National Forest Inventory-Forest Resource Assessment (NFI-FRA). The NFI-FRA involved remeasurement of the permanent sample plots established by the FRA Nepal Project (2010-2014) in addition to an additional number of plots established and measured using the same methodology. The Inventory Design adopted was based largely on methods developed by Kleinn (1994) [35]and finalized by the DFRS/FRA 2010-2014. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years. One of the important characteristics of NFI in Nepal is hidden permanent sample plots leaving "no marks" above ground. Instead, the plots are georeferenced and plot centers consist of metal pegs inserted a few inches below the ground level. The reason behind hidden plots in NFI is to maintain consistency in anthropogenic activities and forest products used by local people both inside and outside the plots. These characteristics of NFI plots of Nepal might even aid to control leakage of GHG emission.<br>The detailed methodology adopted for sample selection is presented in DFRS, 2014[36]. NFI data from 622 permanent sample plots located within the Emission Reduction Program area were derived.<br>**i. Inventory / Sample plot design and data collection**: The Concentric Circular Sample Plot (CCSP) design was adopted as used by the FRA Nepal Project (2010-2014). Each sample plot had four concentric circles of different radii (see Figure below), which were used to measure trees with different DBH as follows:<br>▪ trees having 30 cm DBH or more enumerated within a 20 m radius plot (area: 1256.6 m2) |

[34] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.
[35] Kleinn, C. 1994. Forest Resources Inventories in Nepal: Status Quo, Needs, Recommendations. FRISP. His Majesty's Government of Nepal, Kathmandu, Nepal.
https://drive.google.com/file/d/1yD2AuvJjAtptFTzorisLAfJWAEzY0W-D/view?usp=drive_link
[36] https://drive.google.com/file/d/1EFpJXYa7GZRiGfP0WJIWwu-zljs9C65v/view?usp=drive_link

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | | ▪ trees having 20-29.9 cm DBH enumerated within a 15 m radius plot (area:706.9 m2)<br>▪ trees having 10-19.9 cm DBH enumerated within an 8 m radius plot (area:201.0 m2)<br>▪ trees having 5-9.9 cm DBH enumerated within a 4 m radius plot (area: 50.3 m2)<br>  <br><br>Layout of the concentric circular plot with other sub-plots<br><br>Other subplots were established to assess forest attributes other than trees, such as dead woods and disturbances, seedlings, saplings, shrubs, and herbs, etc.<br>**ii. Volume and Biomass estimation**: Tree stem volumes and biomass were estimated using standard methodology with national allometric equations adopted since NFI / FRA 2010-2014. Details provided in the manual[37] .<br>**iii. Quality assurance of forest inventory data:** Use of periodically revised field manual, training to field crews and regular monitoring and feedback were some of the measures applied to maintain the quality of the inventory results. For the statistical analysis to check for the quality of the results, over 10% of the total PSPs measured were systematically selected (with a random start) and re-measured. Details can be referred to: https://frtc.gov.np/uploads/files/1_%20QAQC_manual.pdf [38]<br>Furthermore, standard protocols and manuals on modeling of required parameters e.g. diameter-height modeling & taper function curve, calculation of volume and biomass using the allometric models, and error estimation were developed under supervision of the experts from Finnish Forest Research Institute (METLA, now LUKE Finland) during the FRA 2010-2014. |
| | | **Nepal's CEO institution**<br>**NFI CEO Survey Questions** | 2. **Land use change analysis of the NFI permanent plots stratification for carbon densities, and removal rate estimate**. To ensure consistency, the Emission Factors (EF) have been aligned with the estimates of land-use transitions area (AD). To achieve this, the same time series analysis and data collection methods that were used in CEO were replicated for the NFI permanent plot's locations. The NFI plots have been classified as Non-forest land use (grassland, other land, unshaded cropland), Permanent Forest, or Secondary Forests. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). |
| | | **CarbonDensitiesTools.xlsx**<br>(Please read this file "READ" before accessing it) | 3. **Carbon densities and removal rates calculation**: Nepal developed a calculation tool (CarbonDensitiesTools.xlsx), to estimate carbon densities for both forest and non-forest areas based on the NFI plots dataset. This tool also facilitates the determination of forest regrowth removal rates. Confidence intervals and errors are computed based on the number of sampling plots and standard deviation within each respective land use type or removal rate: |

[37] https://drive.google.com/file/d/1Z1h0Q2JiXlEXCHW1qDNcBrj1B38GEhi7/view?usp=drive_link

[38] https://drive.google.com/file/d/1YmbHZSOIxfsnfotBbb3elCBSemh4cA8h/view?usp=drive_link

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | | i. *Natural Forest carbon densities calculation*: The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from NFI's 388 plots (pl_total_bio_mrv)[39].<br>ii. *Non-Forest carbon densities calculation*: The determination of average carbon densities for non-forest lands was based on 21 NFI plots[40], which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the initial measurement phase of the NFI (pl_total_bio_mspa).<br>iii. *Forest regrowth removal rates estimate*: The forest regrowth removal rate calculation is based on a sample of sixteen NFI plots[41] established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years between measurements (pl_yr) was used to estimate the average removal rate. |
| **3** | **Emission and removals calculation** | **Nepal_TAL_Integration_tool.xlsx**<br>(Please read this file "READ" before accessing it) | To calculate the Emission Reductions of the Nepal Emission Reduction Program, an Excel tool named Nepal_TAL_Integration_tool.xlsx is used. This tool generates estimates for emissions and removals, along with their associated uncertainties, for both the reference and reporting periods. The estimates are generated for Deforestation, Carbon Enhancement, and Degradation - the three REDD+ activities involved in the carbon accounting of the program.<br>i. *Calculation of emissions and removals*: **The Parameters and Model sheet** generate estimates for Emissions and Removals. These estimates are calculated using Activity Data and Carbon Density tools.<br>ii. *Emission Reductions calculation*: **Results sheet** generates estimates of Emission Reductions for the Reporting Period (June 22, 2018 – December 31, 2021). These estimates are calculated using the Parameters and Model sheet calculations.<br>iii. *Emission Reductions available for transfer to the Carbon Fund*: The **Table-8-ER-MR sheet** computes the available ER for transfer in accordance with Section 8 of the ER monitoring report. |
| **4** | **Emission reduction uncertainty estimate and sensitivity analysis.** | **NEPAL_TAL_Integration_tool_MC.xlsx**<br>**NEPAL_TAL_Integration_tool_SensitivityAnalysis.xlsx**<br>(Please read this file "READ" before accessing it) | Nepal has developed two distinct Excel tools utilizing the ER calculation tool (NEPAL_TAL_Integration_tool.xlsx). The first one, NEPAL_TAL_Integration_tool_MC.xlsx, is designed to carry out Monte Carlo simulations and estimate the uncertainty of the ER calculation. The second tool, NEPAL_TAL_Integration_tool_SensitivityAnalysis.xlsx, is utilized for sensitivity analysis purposes. |

[39] https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[40] https://docs.google.com/spreadsheets/d/1FMv1JAN7wekSt7cASCiIoyVpPpgmCbRx/edit?usp=sharing&ouid=101304895378504185754&rtpof=true&sd=true

[41] https://docs.google.com/spreadsheets/d/1e3REqxI3Oa7KqpC2vfHEdgZMUELQQ52w/edit?gid=967026738#gid=967026738&range=A1

**Figure 4. Activity Data Estimate (A), Data Requirements (B) and Degradation (C)**

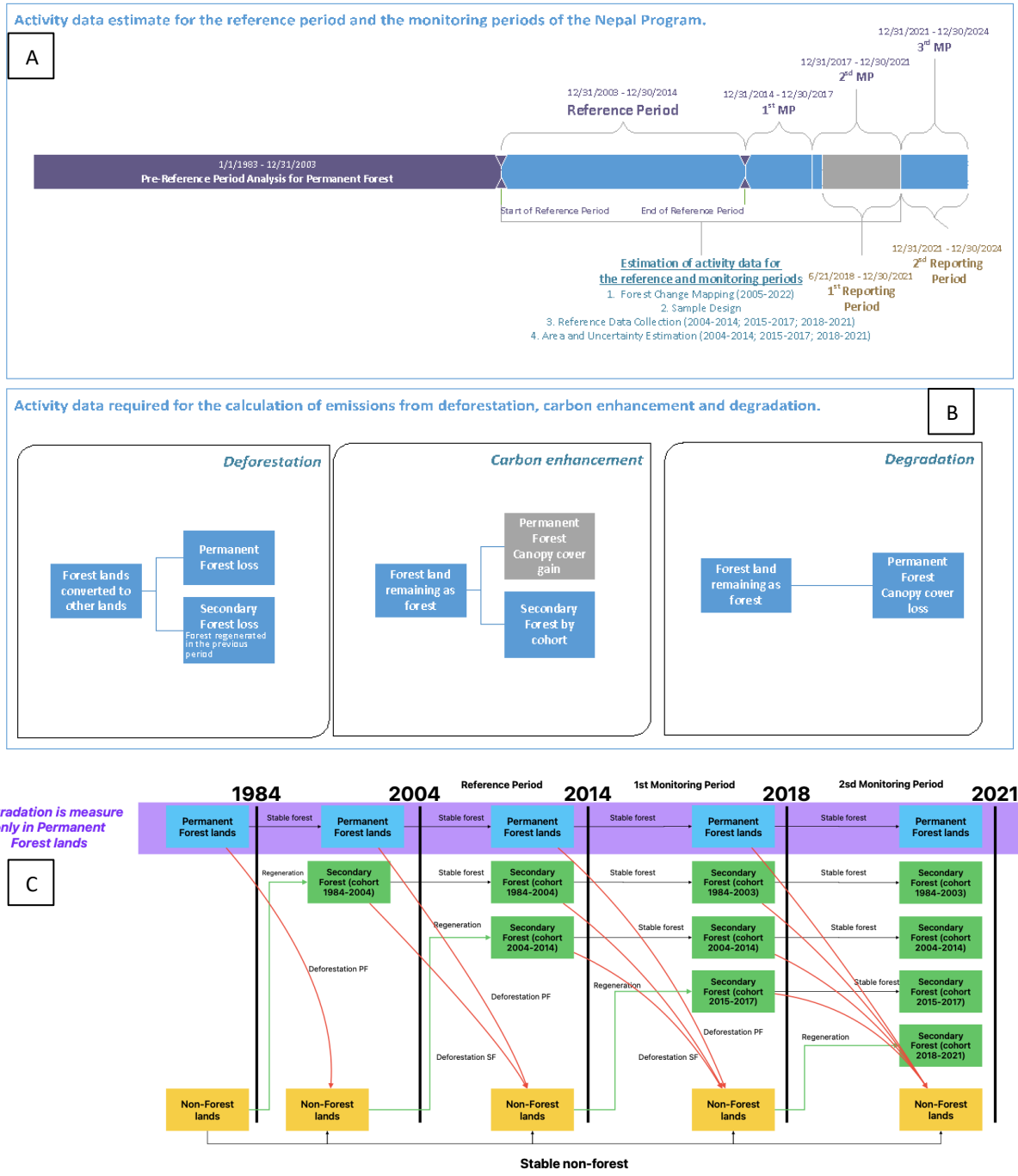
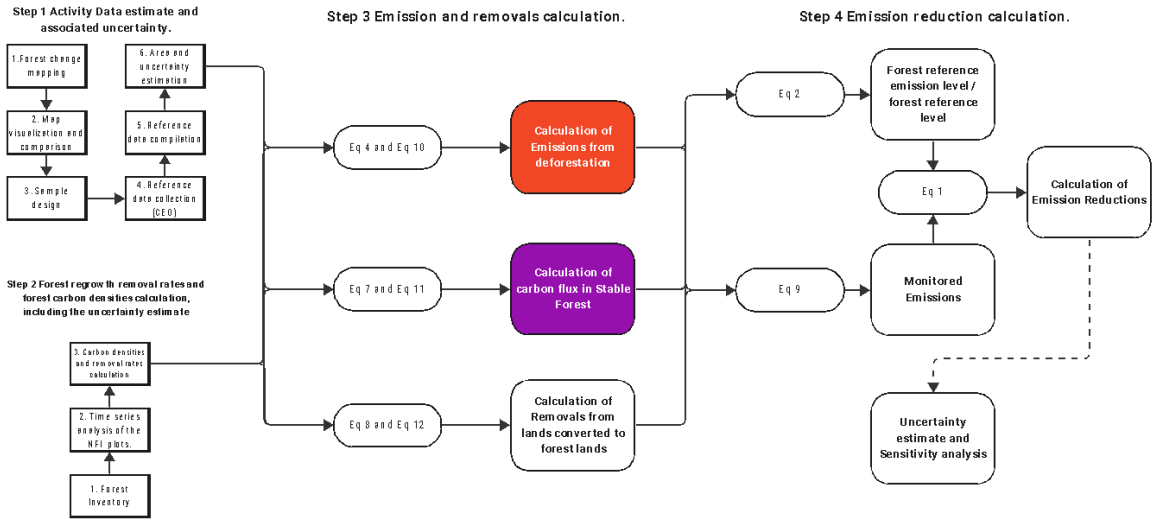



**Figure 4: A.** Reference Period and monitoring periods considered in collecting reference data for AD estimate. **B.** Activity Data that is required for the estimate of emissions from deforestation, carbon enhancement removals, and emissions from degradation. **C.** Forest cover type definition (permanent and secondary) based on time-series analysis.

### 2.3.1 Line Diagram

Figure 5 presents the emissions reductions calculation workflow during the monitoring period. Activities listed under steps 1 to 4 are all performed by the Forest Research and Training Centre (FRTC).

**Figure 5. Line Diagram- Emissions reduction calculation workflow**




### 2.3.2 Calculation

**Emission reduction calculation** $(ER_{ERP,t})$**:**

To determine GHG emission reductions, the IPCC methods and equations described in Annex 4 Section 8.3 were used over the monitoring period.

$$ER_{ERP,t} = RL_t - GHG_t \qquad \textbf{Equation 1}$$

Where:

$ER_{ERP}$ = Emission Reductions under the ER Program in the Reporting Period; $tCO_2e*year^{-1}$.

$RL_{RP}$ = Net emissions of the Reference Level over the Reference Period; $tCO_2e/yr$. This is sourced from Annex 4 to the ER Monitoring Report and equations are provided below.

$GHG_t$ = Monitored gross emissions from deforestation during the Reporting Period; $tCO_2e$;

$T$ = Number of years during the reporting period; dimensionless.

**Reference Level (**$RL_{RP}$**)**

The RL estimation may be found in Annex 4, yet a description of the equations is provided below. Net emissions of over Reference Period ($RL_{RP}$) are estimated as the sum of annual change in total biomass carbon stocks (deforestation and degradation), and annual removals ($\Delta C_{B_t}$).

$$RL_{RP} = \frac{\sum_t^{RP} \Delta C_{LU_{RP,i,t}}}{RP} \qquad \textbf{Equation 2}$$

Where:

$\Delta C_{LU_{RP,i,t}}$ = Balance of emissions during the Reference Period in the Accounting Area of the ER Program that corresponds to the sum of annual change in carbon stocks and removals for each REDD+ activity *i* at year t; $tCO_2*year^{-1}$.

RP = Reference period; years.

**Technical corrections**:
**Reference Period:** There is an error in the ER-PD's Reference Period (RP) , the number of years was mistakenly defined as 10 years which should have been 11 years, considering the start and end of the RP (Start 1/1/2004, End 31/12/2014). Therefore, the Forest Reference Emission Level was calculated considering a Reference Period of 11 years.

**Annual change in total biomass carbon stocks forest land converted to another land-use category ($\Delta C_{B_{defo,t}}$)**

Emissions from deforestation were estimated based on the Deforestation Sheet of Activity Data tool following the 2006 IPCC Guidelines, the annual change in total biomass carbon stocks forest land converted to other land-use category ($\Delta C_{B_{defo,t}}$) would be estimated through the following equation:

$$\Delta C_{B_{defo,t}} = \Delta C_G + \Delta C_{CONVERSION} - \Delta C_L \qquad \textbf{Equation 3}$$

Where:

| | |
|---|---|
| $\Delta C_{B_{defo,t}}$ | Annual change in carbon stocks in biomass on land converted to other land-use category, in tones C $yr^{-1}$; |
| $\Delta C_G$ | Annual increase in carbon stocks in biomass due to growth on land converted to another land-use category, in tones C $yr^{-1}$; |
| $\Delta C_{CONVERSION}$ | Initial change in carbon stocks in biomass on land converted to other land-use category, in tones C $yr^{-1}$; and |
| $\Delta C_L$ | Annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use categories, in tones C $yr^{-1}$. |

Following the recommendations set in chapter 2.2.1 of the GFOI Methods Guidance Document[42] for applying IPCC Guidelines and guidance in the context of REDD+, the above equation will be simplified and it will be assumed that: a) the annual change in carbon stocks in biomass ($\Delta C_B$) is equal to the initial change in carbon stocks ($\Delta C_{CONVERSION}$); b) it is assumed that the biomass stocks immediately after conversion are the biomass stocks of the resulting land-use. Therefore, the annual change in carbon stocks would be estimated as follows:

$$\Delta C_{Bt} = \Delta C_{CONVERSION}$$

$$\Delta C_{B_t} = \sum_{j,i} \left(B_{Before,j} - B_{After,i}\right) x\ CF\ x \frac{44}{12} \times A(j,i)_{RP}$$

**Equation 4**

Where:

| | |
|---|---|
| $A(j,i)_{RP}$ | Area converted/transited from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, sixteen forest land conversions are possible:<br><br>1 Intact Forest to Grasslands<br>2 Intact Forest to Other Land<br>3 Intact Forest to Settlements<br>4 Intact Forest to Unshaded Cropland (TCC 10% or less) |

[42]Page 44, GFOI (2013) Integrating remote-sensing and ground-based observations to estimate emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative: Pub: Group on Earth Observations, Geneva, Switzerland, 2014.

5 Degraded Forest to Grasslands
6 Degraded Forest to Other Land
7 Degraded Forest to Settlements
8 Degraded Forest to Unshaded Cropland (TCC 10% or less)
9 Very Degraded Forest to Grasslands
10 Very Degraded Forest to Other Land
11 Very Degraded Forest to Settlements
12 Very Degraded Forest to Unshaded Cropland (TCC 10% or less)
13 Secondary natural forest to Grasslands
14 Secondary natural forest to Other Land
15 Secondary natural forest to Settlements
16 Secondary natural forest to Unshaded Cropland (TCC 10% or less)

**Technical corrections.**
**Activity Data:** The ER-PD Activity Data assessment is a yearly analysis of tree canopy cover estimations, done in collaboration with the University of Maryland and supported by the USGS SilvaCarbon program. The assessment involves removing bias and making area estimates based on stratified random sampling. This method is used to establish changes observed between 2004 and 2014 and to determine the extent of deforestation and forest degradation. The emissions estimates for deforestation and forest degradation are based on the changes observed in the tree canopy cover.

For the current monitoring report, Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation. This approach ensures unbiased estimates of the area and the error associated with the map. The forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO.

To differentiate between secondary and permanent forests and identify the age of forest gain cohorts, the sampling points are visually interpreted for the same period that the forest change map was created. This period is divided into four subperiods: 1984-2003, 2004-2014. 2015-2017, and 2018-2021. The canopy cover is visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.

$B_{Before,j}$ Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground ($AGB_{Before,j}$) and belowground biomass ($BGB_{Before,j}$) and it is defined for each forest type.

$B_{After,i}$ Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest Land Use categories.

**Technical corrections**.
**Forest carbon densities**: In the ERPD, the NFI provided average estimates for each independent physiographic region by combining all sampled forest types based on the stratification used. For the ERPD, a single average was proposed for CORE and EDGE classes based on MSPA analysis results. The existing total

biomass stocks calculated for each NFI plot were reclassified into an overall CORE and EDGE class using the MSPA analysis. The mean biomass and variance were calculated following Birigazzi et al (2018) [43].

To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from 388 NFI plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the initial measurement phase of the NFI. The forest regrowth removal rate calculation is based on a sample of 16 NFI plots established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years between measurements was used to estimate the average removal rate.

| | |
|---|---|
| $CF$ | Carbon fraction of dry matter in tC per ton dry matter. The value used is:<br>● **0.47** is the default for (sub)tropical forest as per IPCC AFOLU guidelines 2006, Table 4.3. |
| $44/12$ | Conversion of C to $CO_2$ |
| R: S | Root-to-shoot ratio (0.44). |

**Annual change in carbon stocks in biomass on forestland remaining forestland** ($\Delta C_{B_{deg,t}}$)

Following the 2006 IPCC Guidelines, the annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{DEG}}$) could be estimated through the Gain-Loss Method or the Stock-Difference Method as described in Chapter 2.3.1.1 of Volume 4 of the 2006 IPCC Guidelines.

$$\Delta C_B = \Delta C_G - \Delta C_L$$ **Equation 5** (Equation 2.7, 2006 IPCC GL)

$$\Delta C_B = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$ **Equation 6** (Equation 2.8 (a), 2006 IPCC GL)

| | |
|---|---|
| $\Delta C_B$ | Annual change in carbon stocks in biomass for each land sub-category, in tones C $yr^{-1}$ |
| $\Delta C_G$ | annual increase in carbon stocks due to biomass growth for each land sub-category, considering the total area, tones C yr- |
| $\Delta C_L$ | annual decrease in carbon stocks due to biomass loss for each land sub-category, considering the total area, tones C yr-1 |
| $C_{t_2}$ | total carbon in biomass for each land sub-category at time $t_2$, tonnes C |
| $C_{t_1}$ | total carbon in biomass for each land sub-category at time $t_1$, tonnes C |

[43] Birigazzi, L, JGP Gamarra, TG Gregoire. 2018. Unbiased emission factor estimators for large-area forest inventories: domain assessment techniques. Environmental and Ecological Statistics. https://doi.org/10.1007/s10651-018-0397-3

Following the recommendations set in chapter 2.2.2 of the GFOI Methods Guidance Document[44] for applying IPCC Guidelines and guidance in the context of REDD+, the above equation will be simplified, and it will be assumed that: a) the annual change in carbon stocks in biomass ($\Delta C_B$) due to degradation is equal to the annual decrease in carbon stocks; (b) the decrease in carbon stocks occurs the year of conversion. The long-term decrease in carbon stocks indicated in equation (1) of the GFOI MGD is assumed here to be zero. Therefore, considering the GFOI MGD the IPCC equation for forest degradation could be expressed as an Emission Factor time Activity Data as follows:

$$\Delta C_{B_{DEG}} = \sum_j \{EF_j \times A(a,b)_{RP}\} \qquad \textbf{Equation 7}$$

Where:

$EF_j$ Emission Factor for degradation of forest type a to forest type b, tones CO2 ha$^{-1}$.

$A(a,b)_{RP}$ Area of forest type a converted to forest type b (transition denoted by a,b) during the Reference Period, ha yr$^{-1}$.

**Technical corrections**. Nepal initially did not include increased forest biomass observed in forests remaining as forests. For this monitoring report a net emission from forest degradation was calculated, including biomass recovery.

**Annual change in carbon stocks in biomass on non-forestland converted in forestland** ($\Delta C_{B_{reg}}$)

Land converted to forest land $CO_2$ removals has been estimated following the recommendations set in the Guidance Note for accounting of legacy emissions/removals of the FCPF (version 1). When non-forest land is converted to forest land, the removal of $CO_2$ has been estimated based on the assumption that the conversion from non-forest to forest occurs over a conservative default period of 20 years.

The removal estimate takes into account changes in carbon stocks in aboveground and belowground biomass. The changes in total carbon stocks in biomass (removals) during the Reference Period were determined as the sum of the total carbon stocks in biomass of all land units with forest cohorts with ages no longer than 20 years.

The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by their land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.

A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (8.97 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1].

| Statistics | Biomass increment Opt 1 tdm/ha/yr | MAI Opt 2 tdm/ha/yr |
|---|---|---|
| **Average** | **7.27** | **9.69** |
| **Standard deviation** | **5.82** | **8.97** |
| **n** | **3** | **8** |

[44]Page 48, GFOI (2013) Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative: Pub: Group on Earth Observations, Geneva, Switzerland, 2014.

| | | |
|---|---|---|
| **CI** | **9.82** | **6.01** |
| **ERROR%** | **135%** | **62%** |

[1]The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link: https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[2]Joshi, V. C., Negi, V. S., Bisht, D., Sundriyal, R., & Arya, D. (2021). Tree biomass and carbon stock assessment of subtropical and temperate forests in the Central Himalayas, India. Trees, Forests and People, 6, 100147. https://doi.org/10.1016/j.tfp.2021.

The net annual $CO_2$ removals are calculated using equation 8. It was determined the changes in the total carbon stocks in biomass (removals) during the Reference Period as the sum of the total carbon stocks in biomass of all land units.

$$\Delta C_{B_{reg}} = \sum_{LU=1}^{n} \{RF_{reg} \times A(i,j)_{RP}\} \quad \textbf{Equation 8}$$

Where:

$RF_{reg}$ Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$].

$A(j,i)_{RP}$ Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Reference Period, ha yr$^{-1}$.

**LU** Land unit.

**Technical corrections:** The ERPD biomass removal factors were estimated using LiDAR data. Average removal factors were estimated based on areas reported as gain under the reference level submitted to the UNFCCC, which used LiDAR to estimate biomass and compared it with IPCC default values. To produce reference level estimates, a Monte Carlo analysis was applied to all biomass and Activity Data estimates, resulting in 10,000 randomized iterations.

For this monitoring report, NFI plots were evaluated and categorized based on their land use type, including non-forestland use, Permanent Forest, or Secondary Forests. This ensures consistency between the Emission Factors and land-use transition areas. To replicate CEO's data collection methods, the same time series analysis was used for NFI permanent plot locations.

The forest regrowth removal rate calculation is based on 16 NFI plots established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years was used to estimate the average removal rate.

***Monitored emissions ($GHG_t$)***

Annual gross GHG emissions over the monitoring period in the Accounting Area ($GHG_t$) are estimated as the sum of annual change in total biomass carbon stocks ($\Delta C_{B_t}$).

$$GHG_t = \frac{\sum_t^T \Delta C_{LU_{MP,i,t}}}{T} \quad \textbf{Equation 9}$$

Where:

$\Delta C_{LU_{MP,i,t}}$ = Balance of emissions during the Monitoring Period in the Accounting Area of the ER Program that corresponds to the sum of annual change in carbon stocks and removals for each of i REDD+ activities at year t; $tCO_2$*year$^{-1}$.

$T$ = Number of years during the monitoring period; dimensionless.

**Annual change in total biomass carbon stocks forest land converted to another land-use category ($\Delta C_{B_{defo,t}}$)**

The annual change in total biomass carbon stocks forest land converted to other land-use category ($\Delta C_{B_{defo,t}}$) would be estimated through **Equation 4** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

$$\Delta C_{B_t} = \sum_{j,i} \left(B_{Before,j} - B_{After,i}\right) x\ CF\ x \frac{44}{12} \times A(j,i)_{MP} \qquad \textit{Equation 10}$$

Where:

$A(j,i)_{RP}$ Area converted/transited from forest type j to non-forest type *i* during the Monitoring Period, in hectares per year. In this case, sixteen forest land conversions are possible:

1 Intact Forest to Grasslands
2 Intact Forest to Other Land
3 Intact Forest to Settlements
4 Intact Forest to Unshaded Cropland (TCC 10% or less)
5 Degraded Forest to Grasslands
6 Degraded Forest to Other Land
7 Degraded Forest to Settlements
8 Degraded Forest to Unshaded Cropland (TCC 10% or less)
9 Very Degraded Forest to Grasslands
10 Very Degraded Forest to Other Land
11 Very Degraded Forest to Settlements
12 Very Degraded Forest to Unshaded Cropland (TCC 10% or less)
13 Secondary natural forest to Grasslands
14 Secondary natural forest to Other Land
15 Secondary natural forest to Settlements
16 Secondary natural forest to Unshaded Cropland (TCC 10% or less)

$B_{Before,j}$ Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground ($AGB_{Before,j}$) and belowground biomass ($BGB_{Before,j}$) and it is defined for each forest type.

$B_{After,i}$ Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest IPCC Land Use categories.

$CF$ Carbon fraction of dry matter in tC per ton dry matter. The value used is:

- **0.47** is the default for (sub)tropical forest as per IPCC AFOLU guidelines 2006, Table 4.3.

$44/12$ Conversion of C to $CO_2$

R: :S Root-to-shoot ratio (0.44).

**Annual change in carbon stocks in biomass on forestland remaining forestland** ($\Delta C_{B_{deg,t}}$)

The Annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{deg,t}}$) would be estimated through **Equation 7** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

$$\Delta C_{B_{DEG}} = \sum_{j} \{EF_j \times A(a,b)_{MP}\}$$ **Equation 11**

Where:

| | |
|---|---|
| $EF_j$ | Emission Factor for degradation of forest type a to forest type b, tones CO2 ha$^{-1}$. |
| $A(a,b)_{MP}$ | Area of forest type a converted to forest type b (transition denoted by a, b) during the Monitoring Period, ha yr$^{-1}$. |

**Annual change in carbon stocks in biomass on non-forestland converted in forestland** ($\Delta C_{B_{reg}}$)

Annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{reg}}$) would be estimated through **Equation 8** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

$$\Delta C_{B_{reg}} = \sum_{LU=1}^{n} \{RF_{reg} \times A(i,j)_{MP}\}$$ **Equation 12**

Where:

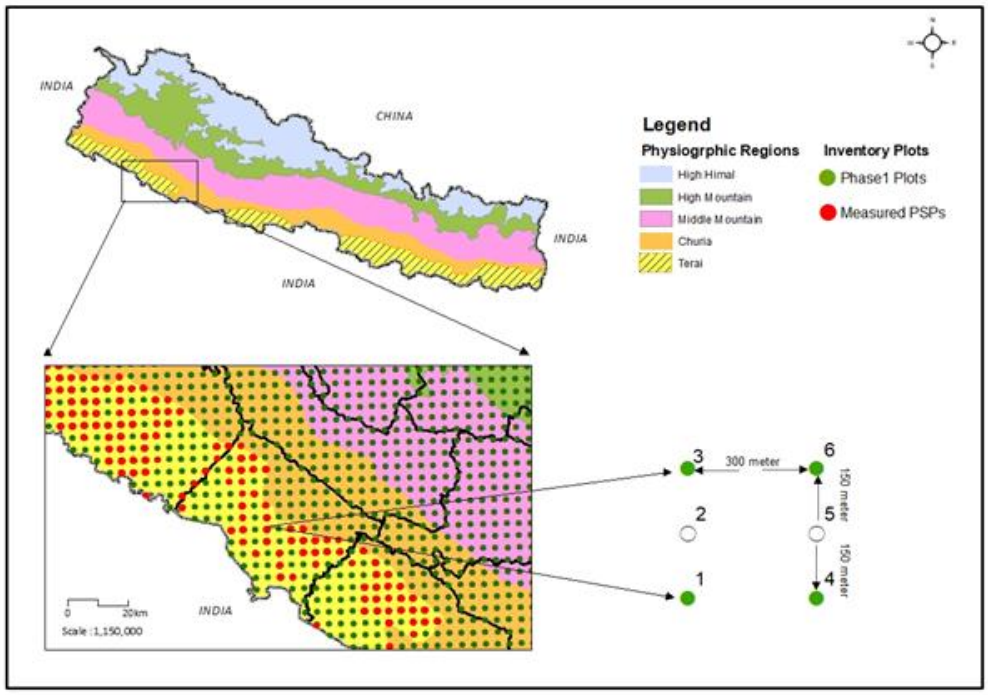
| | |
|---|---|
| $RF_{reg}$ | Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$]. |
| $A(j,i)_{MP}$ | Area of non-forestland *i* converted to forestland *j* (transition denoted by *i,j*) in the Monitoring Period, ha yr$^{-1}$. |
| ***LU*** | Land unit. |

# 3 DATA AND PARAMETERS

## 3.1 Fixed Data and Parameters

| | |
|---|---|
| **Parameter:** | $B_{Before,j}$ **Equation 4;** $B_{After,i}$ **Equation 4** |
| **Description:** | **B Before**: Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground (AGB_(Before,j)) and belowground biomass (BGB_(Before,j)) and it is defined for each forest type.<br>**B after**: Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest Land Use categories. |
| **Data unit:** | Tonne/ha (dry matter), |
| **Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):** | The carbon densities used for the ER monitoring report are Tier 2 (country specific data) and has been derived from the latest NFI (FRA) except the removal rates for forest plantation and shaded crops. The NFI (FRA) involved remeasurement in 2022 of the permanent sample plots established by the FRA Nepal Project (2010-2014) including an additional number of plots established and measured using the same methodology. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years.<br>**NFI (FRA) Inventory Design**: The Inventory Design adopted was based largely on methods developed by Kleinn (1994)[45] and finalized by the DFRS/FRA 2010-2014 (see Figure below). The detailed methodology adopted for sample selection is presented in DFRS, 2014, link: https://frtc.gov.np/downloadfile/The-TeraiForestsofNepal_1579845265.pdf. NFI data from 622 permanent sample plots located within the ER accounting area were derived (see NFI_dataset sheet in Carbon density calculation tool – **CarbonDensitiesTools.xlsx**). |

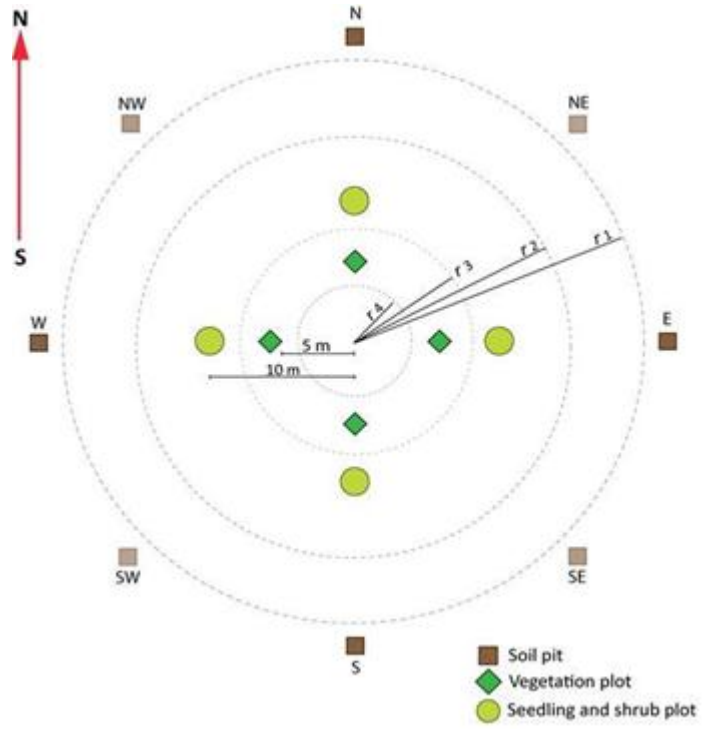
[45] Kleinn, C. 1994. Forest Resources Inventories in Nepal Status, Qou, Needs, Recommendations. FRISP, HMGN/FINNIDA




**Inventory Sample plot design and data collection**: The Concentric Circular Sample Plot (CCSP) design was adopted as used by the FRA Nepal Project (2010-2014). Each sample plot had four concentric circles of different radii (see Figure below), which were used to measure trees with different DBH as follows:

- trees having 30 cm DBH or more enumerated within a 20 m radius plot (area: 1256.6 $m^2$)
- trees having 20-29.9 cm DBH enumerated within a 15 m radius plot (area:706.9 $m^2$)
- trees having 10-19.9 cm DBH enumerated within an 8 m radius plot (area:201.0 $m^2$)
- trees having 5-9.9 cm DBH enumerated within a 4 m radius plot (area: 50.3 $m^2$)

Other subplots were established to assess forest attributes other than trees, such as dead woods and disturbances, seedlings, saplings, shrubs, and herbs, etc.




Layout of the concentric circular plot with other sub-plots

The plots were used for data collection of standing trees (diameter at breast height (dbh) ≥5 cm), which were used in the estimation of the biomass and carbon stocks. Data collected included tree information (bearing, distance from plot center, species code, local name, scientific name, DBH, quality class, crown class and total and crown heights. In addition, data on other important variables like dead woods, disturbances, shrub and small trees, soil characteristics and soil samples, leaf litter and debris, non-wood forest products, epiphytes, parasites, herbaceous plants, bamboo, invasive and alien plant species, forest diseases and pests, etc. have been collected in regular NFI/FRA. One of the important characteristics of NFI in Nepal is hidden permanent sample plots leaving "no marks" above ground. Instead, the plots are georeferenced and plot centers consist of metal pegs inserted a few inches below the ground level. The reason behind hidden plots in NFI is to maintain consistency in anthropogenic activities and forest products use by local people both inside and outside the plots. This characteristics of NFI plots of Nepal might even aid to control leakage of GHG emission.

**Volume and Biomass estimation**: Tree stem volumes and biomass were estimated using standard methodology with national allometric equations adopted since NFI / FRA 2010-2014[46]. To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was evaluated to

[46] https://drive.google.com/file/d/1Z1h0Q2JiXlEXCHW1qDNcBrj1B38GEhi7/view?usp=drive_link

determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points).

**Carbon density estimates:** The carbon density estimates for forest and non-forest areas are calculated using data from the NFI biomass plots. The NFI gives two measurements of biomass: the first was taken between 2011 and 2013, and the second in 2022. It's important to note that the first measurement was made during the ER-Program Reference Period 2004-2014.

The determination of average carbon densities for non-forest lands is based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the NFI's initial measurement phase, which was measured between 2011 and 2013.

The initial carbon density estimates for natural forests were based on the second measurement. However, these estimates were made after the signing of the ERPA in February 2021. Therefore, the carbon densities of natural forests were recalculated using only the first measurement (2011-2013) [1]. The carbon densities of intact, degraded, and very degraded natural forests were recalculated using the first measurement from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were also obtained during the initial measurement phase of the NFI. The plots are classified as unshaded cropland based on experts' knowledge, experiences, the extent of the forest patch, and analysis of near-temporal images and changes in the land cover. In a conservative approach, Nepal has decided to use the country-specific average value for unshaded crops instead of the IPCC default factor. This is because the country-specific value is larger than the IPCC default value, resulting in a smaller emission factor for the transition from forest to unshaded crops.

[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link:
https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

**Value applied:**

Due to the homogeneity of the forest in the Emission Reduction Program accounting area, the whole forest was considered as the same unit for the calculation.

| Forest type | Average | CI | Unit |
|---|---|---|---|
| **Natural intact forest** | 202.08 | 9.78 | tdm/ha |
| **Natural degraded forest** | 101.93 | 37.93 | tdm/ha |
| **Natural very degraded forest** | 18.49 | 10.68 | tdm/ha |

| Non- Forest Lands | Average | CI | Unit |
|---|---|---|---|
| **Grassland** | 20.95 | 17.96 | tdm/ha |
| **Other land** | 27.37 | 32.32 | tdm/ha |

| | | | | |
|---|---|---|---|---|
| **Unshaded cropland** | 57.54 | 28.67 | tdm/ha | |

Note: It was assumed the carbon density of grasslands for Settlements.

| Land Cover | AGB (tCO2e/ha) | BGB (tCO2e/ha) | Total Biomass (AGB+BGB) |
|---|---|---|---|
| **Intact Forest** | 348.26 | 153.23 | 501.49 |
| **Degraded Forest** | 175.65 | 77.29 | 252.94 |
| **Very Deg Forest** | 31.86 | 14.02 | 45.88 |
| **grassland** | 36.10 | 68.12 | 104.22 |
| **other land** | 47.17 | 89.01 | 136.18 |
| **unshaded cropland** | 99.16 | 187.11 | 286.27 |

Below-ground biomass for forest lands was estimated using a root-to-shoot ratio of 0.44 (2019 refinement to the 2006 IPCC guidelines for national GHG inventory, Table 4.4 -Subtropical dry Asia, . B > 125 tons/ha). BGB for non-forest lands was estimated using R::S 1.887 (Mokany et al., 2006; Table 2).

**QA/QC procedures applied**

**Quality assurance of forest inventory data:** Use of periodically revised field manual, training to field members and regular monitoring and feedback were some of the measures applied to maintain the quality of the inventory results. For the statistical analysis to check the quality of the results, over 10% of the total Permanent Sampling Plots measured were systematically selected (with a random start) and re-measured (QAQC manual[47]). Furthermore, standard protocols and manuals on modeling of required parameters e.g., diameter-height modeling & taper function curve, calculation of volume and biomass using the allometric models, and error estimation were developed under supervision of the experts from Finnish Forest Research Institute (METLA, now LUKE Finland) during the FRA 2010-2014. Also, documentation on the assemble of the QAQC protocol and QAQC report of 2022[48] are available in the QAQC manual.

**Uncertainty associated with this parameter:**

To determine the uncertainty in carbon density, we calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions. This calculation only takes sampling errors into account and does not consider model or allometric errors. The Country used a local volume tree equation to estimate biomass. The volume of the tree, which is further converted into biomass and carbon, is calculated using the allometric equation developed by Sharma and Pukala in 1990. There are more than 21 species of trees with specific parameters, along with two additional groups of species found in lower and higher altitudes, each with their respective parameters. The maximum and minimum standard error percentages of the regression model are 9.9% and 5.8%, respectively. The R2 of the model for every species is higher than 95% (Sharma and Pukala, 1990). The country has not determined whether the uncertainty from this source is lower than the uncertainty from sampling error. Since the country is unable to include this error source in the Monte Carlo simulation due to a lack of covariance table, the sampling uncertainty of carbon density in different land uses based on the

[47] https://drive.google.com/file/d/1YmbHZSOIxfsnfotBbb3elCBSemh4cA8h/view?usp=drive_link

[48] https://drive.google.com/file/d/1Xhboag3rtykW2p0oilYuz9Rj0H6VQsg8/view?usp=drive_link

NFI dataset has been increased by 10% at a 90% confidence level using the quadrature approach (see %E adj in tables below). The combined error was then included in the Monte Carlo simulation.

| Forest type | Average | CI | %E | %E adj | n | Std Dev | Unit |
|---|---|---|---|---|---|---|---|
| **Natural intact forest** | 202.08 | 9.78 | 5% | 11% | 367.00 | 113.57 | tdm/ha |
| **Natural degraded forest** | 101.93 | 37.93 | 37% | 39% | 14.00 | 80.15 | tdm/ha |
| **Natural very degraded forest** | 18.49 | 10.68 | 58% | 59% | 7.00 | 14.54 | tdm/ha |

| Non- Forest Lands | Average | CI | % E | %E adj | n | Std Dev | Unit |
|---|---|---|---|---|---|---|---|
| **Grassland** | 20.95 | 17.96 | 86% | 86% | 10 | 30.99 | tdm/ha |
| **Other land** | 27.37 | 32.32 | 118% | 118% | 6 | 39.28 | tdm/ha |
| **Unshaded cropland** | 57.54 | 28.67 | 50% | 51 | 5 | 30.07 | tdm/ha |

The table below displays the results of the normality test conducted on carbon densities and removal rate estimations for various land uses in Nepal's ER-Program. The test was based on NFI biomass plots and utilized the Shapiro-Wilk Test calculated with the Real Statistics Resource Pack [1]. All parameters demonstrate a normal distribution, with the exception of Intact Forest and Grasslands.

It's worth noting that four out of the seven parameters are calculated using less than eight data points, which makes it challenging to fit a probability density function (PDF) distribution to these parameters. As a result, following the FCPF Guidance note on estimating the uncertainty of Emission Reductions (ERs) using Monte Carlo simulation, the country has opted to use the bootstrapping approach instead of a specific non-normal distribution to sample the values of Carbon Densities for use in the simulation. According to the FCPF guidance, sampling from a dataset has the advantage that no assumptions are needed about the nature of the distribution. If the distribution is not normal, then bootstrapping would be more accurate, unless the data are not representative.

The Monte Carlo simulation has been updated [2] and now includes the bootstrapping sampling method for all carbon density parameters except for the Natural Forest Removal Rate. Since the removal rate follows a normal distribution, we used a normal probability density function (PDF) in the Monte Carlo simulation. The bootstrapping sampling was done using Infostat software with the Resampling method (Randomly with replacement). The resampling results for the different carbon density parameters can be found in [4], [5], [6], [7], [8], and [9].

| Parameter | n | Shapiro-Wilk Normality test results | | | |
|---|---|---|---|---|---|
| | | W-stat | p-value | alpha | Normal |

| | | | | | | |
|---|---|---|---|---|---|---|
| Natural Forest Removal rate | 8 | 0.836001505 | 0.068507908 | 0.05 | Yes |
| Intact Forest Carbon Density [4] | 367 | 0.965272874 | 1.18349E-07 | 0.05 | No |
| Degraded Forest Carbon Density [5] | 14 | 0.942524 | 0.451617 | 0.05 | Yes |
| Very Degraded Forest Carbon Density [6] | 7 | 0.952499 | 0.752377 | 0.05 | Yes |
| Grassland Carbon Density [7] | 5 | 0.728652 | 0.001962 | 0.05 | No |
| Other Land Carbon Density [8] | 4 | 0.722904 | 0.010679 | 0.05 | No |
| Unshaded Crops Carbon Density [9] | 5 | 0.90192 | 0.420587 | 0.05 | Yes |

[1] Real Statistics Resource Pack is available at the following link: https://real-statistics.com/free-download/

[2] The updated Monte Carlo simulation tool can be accessed at the following link: https://docs.google.com/spreadsheets/d/11mM9bnqVLZ6hiFvupfaviTksvHlfpF3u/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[3] Infostat software is available at the following link: https://www.infostat.com.ar/

[4] Intact Forest bootstrapping https://docs.google.com/spreadsheets/d/1tD49N6OB-5qAPEIeH8y4oPeTRwTQQ0nD/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[5] Degraded Forest bootstrapping https://docs.google.com/spreadsheets/d/1IWhWH_KQsWlrh3qz_-X-Ur5AH3OliN5e/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

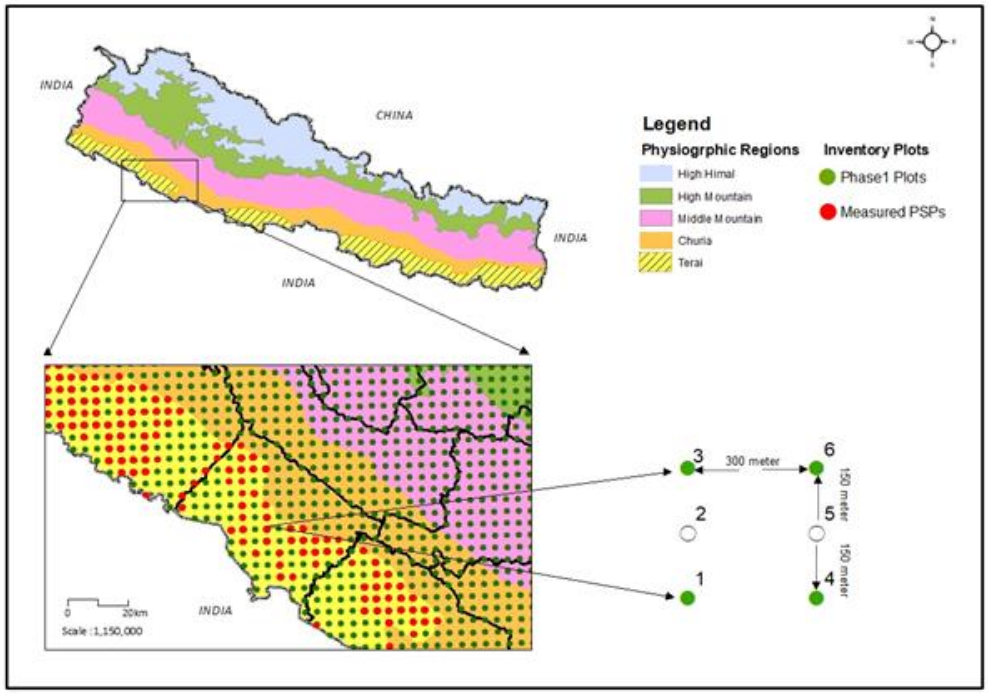
[6] Very Degraded Forest bootstrapping https://docs.google.com/spreadsheets/d/14rMgD0_PZeYLwBO9PXBIWjt_98NtUo1a/edit?usp=drive_link

[7] Grassland bootstrapping https://docs.google.com/spreadsheets/d/1AaSR6NDF86Xqn3G67axs2xAAWTfjBhiX/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[8] Other Land bootstrapping https://docs.google.com/spreadsheets/d/1zNyRyyK-vNAZGeQ5GFJwtvFwQYePdVDq/edit?usp=drive_link

[9] Unshaded Crops bootstrapping https://docs.google.com/spreadsheets/d/192L-jqRohxAZiX3R_KLWvPoks4TbGYCJ/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

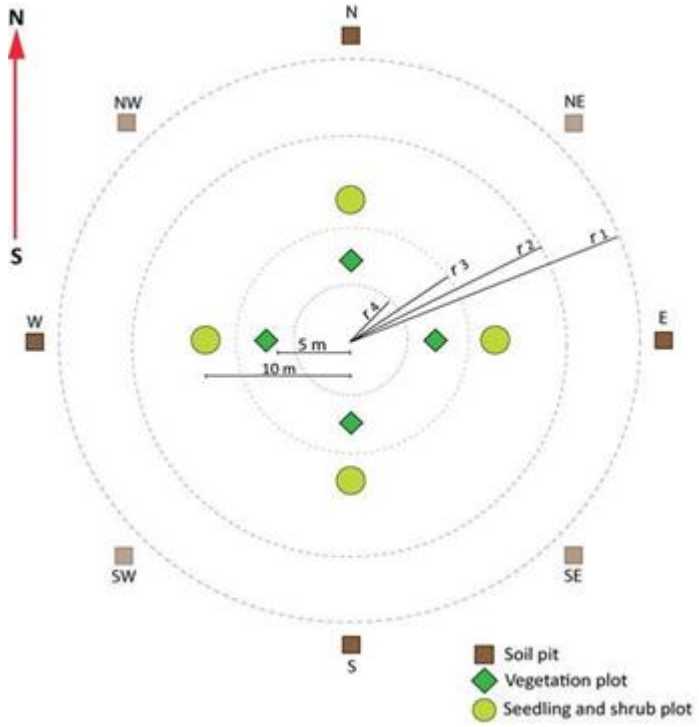
| | |
|---|---|
| **Any comment:** | |

| | |
|---|---|
| **Parameter:** | $RF_{reg}$ **Equation 8** |
| **Description:** | $RF_{reg}$ : Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$]. |
| **Data unit:** | Tonne/ha (dry matter), |
| **Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):** | The removal rates used for the ER monitoring report are Tier 2 (country specific data) and has been derived from the latest NFI (FRA) except the removal rates for forest plantation and shaded crops. The NFI (FRA) involved remeasurement in 2022 of the permanent sample plots established by the FRA Nepal Project (2010-2014) including an additional number of plots established and measured using the same methodology. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years.<br>**NFI (FRA) Inventory Design**: The Inventory Design adopted was based largely on methods developed by Kleinn (1994)[49] and finalized by the DFRS/FRA 2010-2014 (see Figure below). The detailed methodology adopted for sample selection is presented in DFRS, 2014, link: https://frtc.gov.np/downloadfile/The-TeraiForestsofNepal_1579845265.pdf. NFI data from 622 permanent sample plots located within the ER accounting area were derived (see NFI_dataset sheet in Carbon density calculation tool – **CarbonDensitiesTools.xlsx**).<br>  <br>**Inventory Sample plot design and data collection**: The Concentric Circular Sample Plot (CCSP) design was adopted as used by the FRA Nepal Project (2010-2014). Each sample plot had four concentric circles of different radii (see Figure below), which were used to measure trees with different DBH as follows: |

[49] Kleinn, C. 1994. Forest Resources Inventories in Nepal Status, Qou, Needs, Recommendations. FRISP, HMGN/FINNIDA

- trees having 30 cm DBH or more enumerated within a 20 m radius plot (area: 1256.6 $m^2$)
- trees having 20-29.9 cm DBH enumerated within a 15 m radius plot (area:706.9 $m^2$)
- trees having 10-19.9 cm DBH enumerated within an 8 m radius plot (area:201.0 $m^2$)
- trees having 5-9.9 cm DBH enumerated within a 4 m radius plot (area: 50.3 $m^2$)

Other subplots were established to assess forest attributes other than trees, such as dead woods and disturbances, seedlings, saplings, shrubs, and herbs, etc.




Layout of the concentric circular plot with other sub-plots

The plots were used for data collection of standing trees (diameter at breast height (dbh) ≥5 cm), which were used in the estimation of the biomass and carbon stocks. Data collected included tree information (bearing, distance from plot center, species code, local name, scientific name, DBH, quality class, crown class and total and crown heights. In addition, data on other important variables like dead woods, disturbances, shrub and small trees, soil characteristics and soil samples, leaf litter and debris, non-wood forest products, epiphytes, parasites, herbaceous plants, bamboo, invasive and alien plant species, forest diseases and pests, etc. have been collected in regular NFI/FRA. One of the important characteristics of NFI in Nepal is hidden permanent sample plots leaving “no marks” above ground. Instead, the plots are georeferenced and plot centers consist of metal pegs inserted a few inches below the ground level. The reason behind hidden plots in NFI is to maintain consistency in anthropogenic activities and forest products use by local people both inside and outside the plots. This characteristics of NFI plots of Nepal might even aid to control leakage of GHG emission.

**Volume and Biomass estimation**: Tree stem volumes and biomass were estimated using standard methodology with national allometric equations adopted since NFI / FRA 2010-2014[50]. To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points).

**Removal Factor Calculation:** The calculation for the rate of regrowth removal in the forest is based on a sample of sixteen NFI plots set up in secondary forests. Three plots have biomass measurements for both 2022 and 2011-2014, five have measurements only for 2022, and eight have measurements only for 2011-2013.

The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by their land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.

A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (9.69 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1].

| Statistics | Biomass increment Opt 1 tdm/ha/yr | MAI Opt 2 tdm/ha/yr |
|---|---|---|
| Average | 7.50 | 9.69 |
| Standard deviation | 5.98 | 8.97 |
| n | 3 | 8 |
| CI | 10.09 | 6.01 |
| ERROR% | 134% | 62% |

[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link: https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

**Value applied:**

In order to calculate the Emission Reductions, the entire forest was treated as a single unit due to its uniformity. The removal rate in new forests is country specific data and has been derived

[50] https://drive.google.com/file/d/1Z1h0Q2JiXlEXCHW1qDNcBrj1B38GEhi7/view?usp=drive_link

| | |
|---|---|
| | from the NFI (FRA). For Plantation forests and Shaded croplands, removal factors established by the IPCC were utilized.<br><br>**Forest type** / **Average** / **CI** / **Unit**<br>**Natural secondary forest gain** / -9.69 / 6.01 / tdm/ha/yr<br>**Plantation forest gain** [1] / -13.79 / 4.40 / $tCO_2$/ha/yr<br>**Shaded cropland gain** [2] / -10.23 / 2.46 / $tCO_2$/ha/yr<br><br>[1] Table 4.10 (Updated) ABOVE-GROUND NET BIOMASS GROWTH IN TROPICAL AND SUB-TROPICAL PLANTATION FORESTS (TONNES D.M. HA-1 YR-1). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 4: Forest Land.<br>[2] Table 5.2 (Updated) DEFAULT COEFFICIENTS FOR ABOVE- AND BELOW-GROUND BIOMASS IN AGROFORESTRY SYSTEMS CONTAINING PERENNIAL SPECIES. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 5: Cropland. |
| **QA/QC procedures applied** | **Quality assurance of forest inventory data:** Use of periodically revised field manual, training to field members and regular monitoring and feedback were some of the measures applied to maintain the quality of the inventory results. For the statistical analysis to check the quality of the results, over 10% of the total Permanent Sampling Plots measured were systematically selected (with a random start) and re-measured (QAQC manual[51]). Furthermore, standard protocols and manuals on modeling of required parameters e.g., diameter-height modeling & taper function curve, calculation of volume and biomass using the allometric models, and error estimation were developed under supervision of the experts from Finnish Forest Research Institute (METLA, now LUKE Finland) during the FRA 2010-2014. Also, documentation on the assemble of the QAQC protocol and QAQC report of 2022[52] are available in the QAQC manual. |
| **Uncertainty associated with this parameter:** | To determine the uncertainty in removal rates, we calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions. However, for Natural Secondary Forest gain, this calculation only considers sampling errors and does not consider model or allometric errors. In the case of forest plantations, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4 - Forest Land, Table 4.10 does not provide any reference to uncertainty. Therefore, it was assumed that the uncertainty of Natural Secondary Forests gain applies to Plantation Forests as well. When it comes to shaded cropland gain, we used the 2006 IPCC reference to uncertainty in Table 5.2.<br><br>**Forest type** / **Average** / **CI** / **% Error** / **n** / **Dev Std** / **Unit**<br>**Natural secondary forest gain** / -9.69 / 6.01 / 62% / 8 / 8.97 / tdm/ha/yr<br>**Plantation forest gain** / -13.79 / 4.40[1] / 32% / - / - / $tCO_2$/ha/yr<br>**Shaded cropland gain** / -10.23 / 2.46[2] / 24% / - / - / $tCO_2$/ha/yr<br><br>[1] In the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4 – Forest Land, the Table 4.10 does not have any reference to uncertainty. As a result, it was assumed that the uncertainty of Natural secondary forest for Plantation Forest. |

[51] https://drive.google.com/file/d/1YmbHZSOIxfsnfotBbb3elCBSemh4cA8h/view?usp=drive_link

[52] https://drive.google.com/file/d/1Xhboag3rtykW2p0oiIYuz9Rj0H6VQsg8/view?usp=drive_link

| | |
|---|---|
| | [2] Uncertainty indicated in Table 5.2 (Updated) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 5: Cropland. |
| **Any comment:** | |

| | |
|---|---|
| **Parameter:** | Activity Data: $A(j,i)_{RP}$ Equation 4; $A(a,b)_{RP}$ Equation 7; $A(j,i)_{RP}$ Equation 8. |
| **Description:** | ● Deforestation: Area converted/transited from forest type j to non-forest type I during the Reference Period<br>● Degradation: Area of forest type a converted to forest type b (transition denoted by a,b) during the Reference Period, ha $yr^{-1}$<br>● Forest gain: Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Reference Period, ha $yr^{-1}$. |
| **Data unit:** | hectare |
| **Source of data and description of measurement /calculation methods and procedures applied:** | Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation. This approach ensures unbiased estimates of the area and the error associated with the map. A forest change map[53] spanning from 2004 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO.<br><br>**Forest change mapping**: The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis were used to map areas experiencing forest loss, degradation, and/or regrowth.<br>i. **CCDC-SMA**: Continuous Change Detection and Classification – Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation.<br>ii. **CODE**D: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).<br>iii. **LandTrend**r: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.<br>iv. **MTD**D: Multi-variate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification. |

[53] https://drive.google.com/file/d/1VtYM-xCunuRpjfOgeAO9aLDMMGwj_H71/view?usp=drive_link

**Sample design**: A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and the error associated with map. An agreement map generated from the results of all four methods is used for sample design. The goal is to ensure that no strata is under-sampled. The resulting strata is anywhere where 1-4 algorithms agreed there was a certain kind of change event or forest/non-forest remained stable, anywhere the different algorithms labeled different types of change events, anywhere all 4 algorithms labeled non-forest, and anywhere all 4 algorithms labeled forest. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest. The number of points randomly selected depend on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. A total of **1,522** points were selected via stratified random sampling to be used for sample-based area estimation.

**Reference data collection (completed in CEO):** To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were collected through a time series analysis of 1,522 sampling plots in CEO. To identify the age of forest gain cohorts and differentiate between secondary and permanent forests, the sampling points were visually interpreted for the same period that the forest change map was created (1983 to 2021). This period was divided into four subperiods: 1984-2003, 2004-2014, 2015-2017, and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.

i. *Generating a CEO project from a template:* Nepal created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[54]) for the following periods: Pre-reference period (t0) – 1983-2003, Reference period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.
ii. *Sampling unit*: The Sampling Unit (SU) is a 70 x 70 meter plot. Inside SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit.
iii. *Number of Sampling Unit*s: A total of 1,522 sampling points, selected via stratified random sampling, were visually assessed.
iv. *Interpretation ke*y: Nepal produced an interpretation key that should be reused and updated as needed. The land use categories considered are the following:

| **Forest lands**: | **Non-forest lands** |
|---|---|
| 1 Intact Forest<br>2 Degraded Forest Very<br>3 Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands | 7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less) |

**Area and uncertainty estimation:** Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522 samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[55]. Estimates are made for each of the land use categories considered (10 classes) and

[54] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).
[55] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

| | |
|---|---|
| | in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9). |
| **Value applied** | **Deforestation**<br><br>**2004-2014**<br>**Initial** / **Final** / **Area (ha)** / **±90% CI** / **Area (ha*yr-1)**<br>Intact Forest / Grasslands / 391 / 639 / 35.55<br>Intact Forest / Other Land / 1,564 / 1,261 / 142.18<br>Intact Forest / Settlements / 1,676 / 2,199 / 152.36<br>Intact Forest / Unshaded Cropland (TCC 10% or less) / 4,818 / 3,983 / 438.00<br>Degraded Forest / Grasslands / - / - / -<br>Degraded Forest / Other Land / 3,506 / 3,672 / 318.73<br>Degraded Forest / Settlements / 2,017 / 2,748 / 183.36<br>Degraded Forest / Unshaded Cropland (TCC 10% or less) / 3,897 / 3,726 / 354.27<br>Very Degraded Forest / Grasslands / - / - / -<br>Very Degraded Forest / Other Land / - / - / -<br>Very Degraded Forest / Settlements / - / - / -<br>Very Degraded Forest / Unshaded Cropland (TCC 10% or less) / - / - / -<br>Secondary Natural Forest / Other Land / - / - / -<br><br>**Forest gain**<br><br>**Forest Type** / **2004-2014** / **Area (ha)** / **±90% CI** / **Area (ha*yr-1)**<br>natural secondary forest gain / 17,136 / 8,467 / 1,557.82<br>plantation forest gain / - / - / -<br>shaded cropland gain / - / - / -<br><br>**Degradation**<br><br>**2004-2014**<br>**Initial** / **Final** / **Area (ha)** / **±90% CI** / **Area (ha*yr-1)**<br>Intact forest / Intact forest / 1,125,747 / 22,515 / 102 340.64<br>Degraded forest / Degraded forest / 56,347 / 14,799 / 5 122.45<br>Very degraded forest / Very degraded forest / 10,546 / 6,585 / 958.73<br>Intact forest / Degraded forest / 5,991 / 4,120 / 544.64<br>Intact forest / Very degraded forest / 391 / 639 / 35.55<br>Degraded forest / Very degraded forest / 1,627 / 2,672 / 147.91<br>Degraded forest / Intact forest / 7,904 / 5,553 / 718.55<br>Very degraded forest / Intact forest / - / - / -<br>Very degraded forest / Degraded forest / 3,254 / 3,780 / 295.82 |
| **QA/QC procedures applied:** | **<u>Reference data collection</u>:**<br>**Reference data compilation:** To ensure accuracy, the data collected from the CEO was compiled in R for each period of the time series analysis (t0, t1, t2, and t3). The compilation process identifies land-use interpreted points with impossible transitions, and these points are sent back to the interpreted for review, until the compilation process detects no inconsistencies. |

**Area estimate**: To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheet[56]. This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok".

**Uncertainty for this parameter:**

The determination of the uncertainty Activity Data was not done using the standard deviation (SD) given that the formulas (Cochran, 1977) used to estimate the Activity Data do not allow for the calculation of SD. To determine the uncertainty for Activity Data, initially the country used the calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions and the normal probability density function (PDF). This calculation only takes sampling errors into account and does not consider the interpreter error. Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available.

**Deforestation**

| Initial | Final | 2004-2014 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | %E |
| Intact Forest | Grasslands | 391 | 639 | 164% |
| Intact Forest | Other Land | 1,564 | 1261 | 81% |
| Intact Forest | Settlements | 1,676 | 2199 | 131% |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | 4,818 | 3983 | 83% |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | 3,506 | 3672 | 105% |
| Degraded Forest | Settlements | 2,017 | 2748 | 136% |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | 3,897 | 3726 | 96% |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| secondary natural forest | other land | - | - | - |
| secondary natural forest | other land | - | - | - |

**Forest gain**

| Forest Type | 2004-2014 | | |
|---|---|---|---|
| | Area (ha) | ±90% CI | %E |
| natural secondary forest gain | 17,136 | 8,467 | 49% |
| plantation forest gain | - | - | - |
| shaded cropland gain | - | - | - |

**Degradation**

| Initial | Final | 2004-2014 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | %E |
| Intact forest | Intact forest | 1,125,747 | 22,515 | 2% |
| Degraded forest | Degraded forest | 56,347 | 14,799 | 26% |

[56] https://docs.google.com/spreadsheets/d/1G3ToJYNA-n8kl12GfFBurQ-m9C1bcVyr/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true
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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Very degraded forest | Very degraded forest | 10,546 | 6,585 | 62% | |
| | | Intact forest | Degraded forest | 5,991 | 4,120 | 69% | |
| | | Intact forest | Very degraded forest | 391 | 639 | 164% | |
| | | Degraded forest | Very degraded forest | 1,627 | 2,672 | 164% | |
| | | Degraded forest | Intact forest | 7,904 | 5,553 | 70% | |
| | | Very degraded forest | Intact forest | - | - | - | |
| | | Very degraded forest | Degraded forest | 3,254 | 3,780 | 116% | |
| **Any comment:** | | | | | | | |

### 3.2 Monitored Data and Parameters

| | |
|---|---|
| **Parameter:** | Activity Data: $A(j,i)_{MP}$ Equation 10; $A(a,b)_{MP}$ Equation 11; $A(j,i)_{MP}$ Equation 12. |
| **Description:** | • Deforestation: Area converted/transited from forest type j to non-forest type i during the Monitoring Period<br>• Degradation: Area of forest type a converted to forest type b (transition denoted by a,b) during the Monitoring Period, ha $yr^{-1}$<br>• Forest gain: Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Monitoring Period, ha $yr^{-1}$. |
| **Data unit:** | hectares per year |
| **Value monitored during this Monitoring / Reporting Period:** | **Deforestation** |

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | Area (ha*yr-1) |
| Intact Forest | Grasslands | - | - | - |
| Intact Forest | Other Land | 1,627 | 2,674 | 406.75 |
| Intact Forest | Settlements | - | - | - |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | - | - | - |
| Degraded Forest | Settlements | - | - | - |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| secondary natural forest | other land | - | - | - |

**Forest gain**

| Forest Type | 2018-2021 | | |
|---|---|---|---|
| | Area (ha) | ±90% CI | Area (ha*yr-1) |
| natural secondary forest gain | 19,156 | 8,888 | 4789.00 |
| plantation forest gain | - | - | - |
| shaded cropland gain | 1,627 | 2,674 | 406.75 |

**Degradation**

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | Area (ha*yr-1) |
| Intact forest | Intact forest | 1,128,443 | 22,067 | 282,110.75 |
| Degraded forest | Degraded forest | 64,950 | 15,825 | 16,237.50 |
| Very degraded forest | Very degraded forest | 9,309 | 6,060 | 2,327.25 |

| | | | | | |
|---|---|---|---|---|---|
| Intact forest | Degraded forest | 391 | 639 | 97.75 |
| Intact forest | Very degraded forest | - | - | |
| Degraded forest | Very degraded forest | 782 | 900 | 195.50 |
| Degraded forest | Intact forest | 3,505 | 3,671 | 876.25 |
| Very degraded forest | Intact forest | - | - | |
| Very degraded forest | Degraded forest | 1,627 | 2,672 | 406.75 |

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

Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation. This approach ensures unbiased estimates of the area and the error associated with the map. A forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO.

**Forest change mapping**: The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis were used to map areas experiencing forest loss, degradation, and/or regrowth.

v. **CCDC-SMA**: Continuous Change Detection and Classification–- Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation.
vi. **CODE**D: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).
vii. **LandTrend**r: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.
viii. **MTDD**: Multi-variate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification.

**Sample design**: A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and the error associated with your map. An agreement map generated from the results of all four methods is used for sample design. The goal is to ensure that no strata is under-sampled. The resulting strata is anywhere 1-4 algorithms agreed there was a certain kind of change event or stable forest/non-forest, anywhere the different algorithms labeled different types of change events, anywhere all 4 algorithms labeled non-forest, and anywhere all 4 algorithms labeled forest. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest. The number of points randomly selected depend on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. A total of **1,522** points were randomly selected, with a specified number from that total within each strata, to be used for sample-based area estimation.

**Reference data collection (completed in CEO):** To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were

collected through a time series analysis of 1,522 sampling plots in CEO. To identify the age of forest gain cohorts and differentiate between secondary and permanent forests, the sampling points were visually interpreted for the same period that the forest change map was created (1983 to 2021). This period was divided into four subperiods: 1984-2003, 2004-2014. 2015-2017 and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.

v. *Generating a CEO project from a template:* Nepal created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[57]) for the following periods: Pre-reference period (t0)–- 1983-2003, Reference Period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.

vi. *Sampling unit*: The Sampling Unit (SU) is a 70 x 70 meter plot. Inside SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit.

vii. *Number of Sampling Unit*s: A total of 1,522 sampling points, selected via stratified random sampling, were visually assessed.

viii. *Interpretation ke*y: Nepal produced an interpretation key that should be reused and updated as needed. The land use categories considered are the following:

| **Forest lands**: | **Non-forest lands** |
|---|---|
| 1 Intact Forest<br>2 Degraded Forest Very<br>3 Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands | 7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less) |

- Note, the first three types of forest land (intact, degraded, and very degraded) were indirectly labeled in post-processing using the number of tree-covered points out of a 9-point grid over each plot.

**Area and uncertainty estimation:** Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522 samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[58]. Estimates are made for each of the land use categories considered (10 classes) and in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9).

**QA/QC procedures applied:**

**QAQC manual Manual Reference data collection:**

**Reference data compilation:** To ensure accuracy, the data collected from the CEO was compiled in R for each period of the time series analysis (t0, t1, t2, and t3). The compilation process identifies land-use interpreted points with impossible transitions, and these points are sent back to the interpreted for review, until the compilation process detects no inconsistencies.

[57] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).

[58] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

| | |
|---|---|
| | **Area estimate**: To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheet[59] (**Activity Data Tool**). This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok". |
| **Uncertainty for this parameter:** | The determination of the uncertainty Activity Data was not done using the standard deviation (SD) given that the formulas (Cochran (1977)) used to estimate the Activity Data do not allow for the calculation of SD. To determine the uncertainty for Activity Data, initially the country used the calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions and the normal probability density function (PDF). This calculation only takes sampling errors into account and does not consider the interpreter error. Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available. |

**Deforestation**

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | %E |
| Intact Forest | Grasslands | - | - | - |
| Intact Forest | Other Land | 1,627 | 2,674 | 164% |
| Intact Forest | Settlements | - | - | - |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | - | - | - |
| Degraded Forest | Settlements | - | - | - |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| secondary natural forest | other land | - | - | - |

**Forest gain**

| Forest Type | 2018-2021 | | |
|---|---|---|---|
| | Area (ha) | ±90% CI | %E |
| natural secondary forest gain | 19,156 | 8,888 | 46% |
| plantation forest gain | - | - | - |
| shaded cropland gain | 1,627 | 2,674 | 164% |

**Degradation**

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | %E |
| Intact forest | Intact forest | 1,128,443 | 22,067 | 2% |
| Degraded forest | Degraded forest | 64,950 | 15,825 | 24% |
| Very degraded forest | Very degraded forest | 9,309 | 6,060 | 65% |

[59] https://docs.google.com/spreadsheets/d/1G3ToJYNA-n8kl12GfFBurQ-m9C1bcVyr/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true
(Please read this file "READ" before accessing it)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Intact forest | Degraded forest | 391 | 639 | 164% | |
| | | Intact forest | Very degraded forest | - | - | - | |
| | | Degraded forest | Very degraded forest | 782 | 900 | 115% | |
| | | Degraded forest | Intact forest | 3,505 | 3,671 | 105% | |
| | | Very degraded forest | Intact forest | - | - | - | |
| | | Very degraded forest | Degraded forest | 1,627 | 2,672 | 164% | |
| **Any comment:** | | | | | | | |

# 4 QUANTIFICATION OF EMISSION REDUCTIONS

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

**Technical Corrections applied to the Reference Level**

The technical corrections applied to the original Reference Level have been made. All the technical modifications are in line with paragraphs 2 and 3 of the "Guideline on the application of the methodological framework Number 2: Technical corrections to GHG emissions and removals reported in the Reference Period". Technical corrections do not compromise the consistency of GHG emissions and removal estimates between the Reference Period and monitoring periods, as both calculations apply the improvements. None of the improvements relate to a change in policy and design decisions affecting the Reference Level. Carbon pools and gases, GHG sources, Reference Period, forest definition, REDD+ activities and Accounting Area remain unchanged. Changes in data sources, methods, and the re-estimation of Activity Data and Emission Factors have been made in calculating the FREL/FRL of Nepal ER-P. The changes made are detailed below.

i. **Reference Period**: There is an error in the ER-PD's Reference Period (RP); the number of years was mistakenly defined as 10 years, which should have been 11 years, considering the start and end of the RP (Start 1/1/2004, End 31/12/2014). Therefore, the Forest Reference Emission Level was calculated considering a Reference Period of 11 years.

ii. **Reported Accounting Area for the ER-Program.** Differences were found in the reported ER Program Boundary between the ER-P boundary shapefile and the pixel count stratification map (Agreement map) used for estimating activity data. This discrepancy arose because the strata areas in the Agreement map were projected in degrees (EPSG 4326-WGS 84) based on pixel count areas, incorrectly assuming a pixel size of 30m x 30m. To address this, the Agreement map file was reprojected to the local projection EVEREST 1830_LCC_NEPAL to determine the pixel size in meters [1]. After reprojection, the pixel size measured 27.0814 m x 27.0814 m, resulting in slight adjustments to the pixel count values (see table below). The changes in pixel count values are a result of the reprojection. Consequently, the activity data has been recalculated using the map projected with EVEREST 1830_LCC_NEPAL for strata area calculations.

**Agreement map pixel count area used to estimate activity data calculated with two different map projections.**

| Map value | Pixel count | | Area (ha) | | Strata |
|---|---|---|---|---|---|
| | EPSG:4326 - WGS 84 | EVEREST 1830_LCC | EPSG:4326 - WGS 84 | EVEREST 1830_LCC | |
| 1 | 1,787,371 | 1,927,955 | 160,863 | 141,397 | DEG |
| 2 | 543,523 | 586,327 | 48,917 | 43,001 | LOSS |
| 3 | 2,068,731 | 2,230,870 | 186,186 | 163,613 | GAIN |

| | | | | | |
|---|---|---|---|---|---|
| 5 | 11,453,138 | 12,353,207 | 1,030,782 | 905,989 | Forest |
| 4 | 13,037,220 | 14,089,421 | 1,173,350 | 1,033,324 | Nonforest |
| Total | 28,889,983 | 31,187,780 | 2,600,098 | 2,287,325 | |

[1] FCPF_2004_2021_TAL_clipped_Agreement_Everest1830_LCC_NEPAL accessible at the following link https://drive.google.com/drive/folders/1ehLiof_pj4JpsXtRk-CioWi2cPEQOJgP?usp=sharing

iii. **Activity Data:** The ER-PD Activity Data assessment is a yearly analysis of tree canopy cover estimations, done in collaboration with the University of Maryland and supported by the USGS SilvaCarbon program. The assessment involves removing bias and making area estimates based on stratified random sampling. This method is used to establish changes observed between 2004 and 2014 and to determine the extent of deforestation and forest degradation. The emissions estimates for deforestation and forest degradation are based on the changes observed in the tree canopy cover. Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation for the current monitoring report. This approach ensures unbiased estimates of the area and the error associated with the map. The forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO. To differentiate between secondary and permanent forests to avoid overestimating emissions from deforestation, as well as to identify the age of forest gain cohorts for applying accurate emission factors and estimating removals, the sampling points are visually interpreted for the same period that the forest change map was created. This period is divided into four subperiods: 1984-2003, 2004-2014. 2015-2017, and 2018-2021. The canopy cover is visually evaluated in the permanent forest only for 2003/2004, 2014/2015, 2017/2018, and 2021.

iv. **Forest carbon densities**: In the ER-PD, the NFI provided average estimates for each independent physiographic region by combining all sampled forest types based on the stratification used. For the ERPD, a single average was proposed for CORE and EDGE classes based on MSPA analysis results. The existing total biomass stocks calculated for each NFI plot were reclassified into an overall CORE and EDGE class using the MSPA analysis. The mean biomass and variance were calculated following Birigazzi et al. (2018) [60].

The carbon density estimates have been updated using data from the NFI biomass plots for forest and non-forest areas. The NFI conducted two biomass measurements, one between 2011 and 2013 and the other in 2022. It's important to note that the first measurement was taken during the ER-Program Reference Period 2004-2014, while the second was taken after the signing of the ERPA in February 2021.

As a result, the carbon densities of natural forests were recalculated using only the first measurement (2011-2013) based on 388 biomass NFI plots. The determination of average carbon densities for non-forest lands is based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were also obtained during the NFI's first measurement phase.

To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement

[60] Birigazzi, L, JGP Gamarra, TG Gregoire. 2018. Unbiased emission factor estimators for large-area forest inventories: domain assessment techniques. Environmental and Ecological Statistics. https://doi.org/10.1007/s10651-018-0397-3

from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland.

v. **Removal Factor**: The ERPD biomass removal factors were estimated using LiDAR data. Average removal factors were calculated based on areas reported as gain under the reference level submitted to the UNFCCC, which used LiDAR to estimate biomass and compared it with IPCC default values. A Monte Carlo analysis was applied to all biomass and Activity Data estimates to produce reference level estimates, resulting in 10,000 randomized iterations.

For this monitoring report, NFI plots were evaluated and categorized based on their land use type, including non-forestland use, Permanent Forest, or Secondary Forests. This ensures consistency between the Emission Factors and land-use transition areas. The same time series analysis was used for NFI permanent plot locations to replicate the CEO's data collection methods.

The forest regrowth removal rate calculation is based on 16 NFI plots established in secondary forests. The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.

A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (8.97 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1].

[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link:
https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

vi. **Forest degradation**: Nepal initially did not include increased forest biomass observed in forests remaining as forests. For this monitoring report, a net emission from forest degradation was calculated, including biomass recovery.

The following table shows the Reference Level for the ER Program for the Reporting Period .

| Year of Monitoring/Reporting period *t* | 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, average annual historical removals by sinks over the Reference Period ($tCO_2$-$_e$/yr) | Adjustment, if applicable ($tCO_2$-$_e$/yr) | Reference level ($tCO_2$-$_e$/yr) |
|---|---|---|---|---|---|
| 2018 | 273 539 | 182 182 | -571 348 | 0 | -115 627 |
| 2019 | 273 539 | 182 182 | -598 102 | 0 | -142 381 |
| 2020 | 273 539 | 182 182 | -624 855 | 0 | -169 134 |
| 2021 | 273 539 | 182 182 | -651 608 | 0 | -195 887 |
| **Total** | **1 094 156** | **728 728** | **-2 445 913** | **0** | **-623 029** |

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

Quantifying emissions by sources and removals by sinks from the ER Program during the Monitoring Period is shown below. Emission Reductions calculation tool (Nepal_TAL_Integration_tool.xlsx) can be accessed at https://docs.google.com/spreadsheets/d/1yV0gmmYaYZj8O4Eg7loG_DmbZ9uIyZlY/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true [61]. ER estimate tool provides sample calculations using the actual values from section 3 above. This tool also includes all formulas used for the ER estimate.

| Year of Monitoring/Reporting Period | Emissions from deforestation ($tCO_{2-e}$/yr) | If applicable, emissions from forest degradation ($tCO_{2-e}$/yr)* | If applicable, removals by sinks ($tCO_{2-e}$/yr) | Net emissions and removals ($tCO_{2-e}$/yr) |
|---|---|---|---|---|
| 2018 | 148 615 | 64 764 | -972 888 | -759 509 |
| 2019 | 148 615 | 64 764 | -1 083 295 | -869 916 |
| 2020 | 148 615 | 64 764 | -1 193 701 | -980 32 |
| 2021 | 148 615 | 64 764 | -1 304 108 | -1 090 729 |
| **Total** | **594 460** | **259 056** | **-4 553 992** | **-3 700 476** |

## 4.3 Calculation of emission reductions

The Reporting Period does not coincide with the Monitoring Period. The Monitoring Period starts on January 1st, 2018, and ends on December 31st, 2021. The Reporting Period begins on June 22, 2018, and ends on December 31st, 2021. A pro-rata allocation was needed by multiplying the net ERs during the Monitoring Period by the ratio of the Length of the Reporting Period and the Length of the Monitoring Period. Length of the Reporting period / Length of the Monitoring Period is 0.88.

**ER Program measures other than A/R that are being considered to generate enhanced removals**:
Forest degradation accounts for approximately one-third of land-based emissions and is driven by an overall supply-demand gap for forest products, particularly fuelwood and fodder, as well as illegal and unsustainable logging in government-managed forests. Unmanaged grazing, especially outside community forests, exacerbates these drivers and likely inhibits forest regeneration and carbon enhancement in permanent forest areas.

The ER program envisioned a total of seven interventions to achieve emission reductions. They include (1) improving forest management; (2) localizing forest governance through the handover of forests to local user groups; (3) expanding private sector forestry; (4) expanding access to alternative energy with biogas and improved cookstoves; (5) scaling up pro-poor leasehold forestry; (6) improving integrated land-use planning to reduce forest conversion; and (7) strengthening the management of protected areas. Some of these interventions, specifically 1, 3, 4, and 7, are implemented to reduce forest degradation and consequently enhance carbon in remaining or permanent forest lands.

| SN | Intervention | Target | Progress 2018-2021[62] |
|---|---|---|---|
| 1 | Improve management practices on existing community and collaborative forests building on traditional and customary practices | 336,069 ha | 154,766 ha (total)<br>Community Forests: 94,236 ha;<br>Collaborative Forests Management: 52,515 ha;<br>Block Forest: 8,015 ha |

[61] (Please read this file "READ" before accessing it)

[62] Progress data drawn from two sources: a) REDD IC (2021, March). Implementation Status of Emission Reduction Program Intervention in Terai Landscape Nepal (From June 2018 to July 2020); and b) REDD IC (2022, May). Nepal Emissions Reduction Program: Environmental and Social Safeguards Consistency and Gap Assessment Report of Program Interventions for Retroactive GHG Emissions Reduction Crediting.

| SN | Intervention | Target | Progress 2018-2021[62] |
|---|---|---|---|
| 3 | Expand private sector forestry operations through improved access to extension services and finance | 30,141 ha | 2,127 ha new plantation |
| 4 | 4a. Expand access to alternative energy with biogas | 60,000 units | 2,382 units (July 2018 to June 2021) |
| | 4b. Expand access to alternative energy with improved cookstoves | 60,000 units | 3,728 units (July 2018 to June 2021) |
| 7 | Improve management of existing Protected Areas (PAs) | 6 PAs | The PAs being managed under PA legislation and institutional arrangement |

| | 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 ($tCO_{2-e}$)** | 1 094 156 | 728 728 | -1 540 009* | -959 411 | -676 536 |
| **Emissions or removals under the ER Program during the Monitoring Period ($tCO_{2-e}$)** | 594 460 | 259 056 | -3 346 045 | -1 207 948 | -3 700 477 |
| **Emission Reductions during the Monitoring Period ($tCO_2$-e)** | 499 696 | 469 672 | 1 806 036 | 248 537 | 3 023 941 |
| **Length of the Reporting period / Length of the Monitoring Period (# days/# days)** | 0.53 for 2018 and 1.0 for 2019, 2020, 2021 | | | | |
| **Emission Reductions during the Reporting Period ($tCO_2$-e)** | 440 666 | 414 189 | 1 670 940 | 219 180 | 2 744 975 |

*These removals were estimated using the average of removals during the reference period.

| | |
|---|---|
| **Emission reductions from enhanced removals from afforestation/reforestation as a percentage of the total removals (%)** | 60.87271449% |

## 5. UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

As the reporting period differed from the monitoring period, a pro-rata factor of 0.88 was applied to estimate the Emission Reductions. The uncertainty of ERs was estimated with and without applying the pro-rata factor[63]. The pro-rata factor does not impact the overall uncertainty. The uncertainty of ERs, with and without the pro-rata factor, is estimated at 123%.

### 5.1 Identification, assessment and addressing sources of uncertainty

Table 7 shows the nature and level of uncertainty associated with Activity Data, Emission Factors as well as integration model.

**Table 7. Levels of Uncertainty in Activity Data, Emission Factors and Integration**

| Sources of uncertainty | Systematic | Random | Analysis of contribution to overall uncertainty | Contribution to overall uncertainty (High -H /Low - L) | Addressed through QA/QC? | Residual uncertainty estimate? |
|---|---|---|---|---|---|---|
| **Activity Data** | | | | | | |
| *Measurement* | ☑ | ☑ | Activity Data is based on sampling. Systematic and random errors during the visual interpretation of land-use and land-use change in satellite imagery contribute to the overall uncertainty. Nepal has taken measures to address this issue by implementing QA/QC procedures for collecting reference data. This involves using the best available imagery and providing detailed interpretation keys. The interpreters have been trained to follow the correct land-use and land-use change interpretation procedures. To guarantee accuracy, the collected reference data is compiled in R for each period of the time series analysis (t0, t1, t2, and t3). During the compilation process, land-use interpretation points with impossible transitions are identified and sent back to the interpreter for review until the compilation process detects no inconsistencies.<br><br>Using a requirement in R, a quality control search is used to find impossible transitions that do not meet the logic requirement. This refers to sequential events that do not make sense between forest changes indicated in the three time periods or do not make sense with the land covers (LC) indicated in each time-period. For example, a forest gain event could not have occurred in period 2 if period 1 already had a land cover of the forest. This requirement is using the answer to the survey question "Is this answer different from the label in (previous period)", and the questions about "Forest in (current time period)" and "Forest in (previous time period)".<br><br>**Logic requirements (all other transitions would be flagged as** **Explanation** | H (bias/random) | Yes | No |

[63] Uncertainty calculation tool can be accessed at the following link: https://docs.google.com/spreadsheets/d/1yV0gmmYaYZj8O4Eg7loG_DmbZ9uIyZIY/edit?gid=1389608781#gid=1389608781

| Sources of uncertainty | Systematic | Random | Analysis of contribution to overall uncertainty | Contribution to overall uncertainty (High -H /Low - L) | Addressed through QA/QC? | Residual uncertainty estimate? |
|---|---|---|---|---|---|---|
| | | | **logically impossible and requiring correction)** \| <br>An answer of "No - consistent land cover of forest or non-forest" requires the previous LC and the current LC to be the same. \| It is impossible to have a stable forest or stable other LC type if the LC labels for period A and period B are different.<br>An answer of "Yes - forest was GAINED…" requires the previous LC to be non-forest and the current LC to be a forest. \| Tree densification does not count as a forest gain; it must be a conversion of LC from non-forest to forest.<br>An answer of "Yes - forest was LOST…" requires the previous LC to be forest and the current LC to be non-forest. \| A degradation of trees does not count as a forest loss, as it requires a change in land cover from a forest to a non-forest<br><br>If any of these requirements are not met, an 'impossible transition' has occurred, and the QA/QC team reviews the sample plot to make sure the marked events make sense with the marked LC types. | | | |
| *Representativeness* | ☑ | ☒ | Sampling was carried out over the entire accounting area and all reference and monitoring periods. It can therefore be concluded that the impact of this source of uncertainty is low. | H (bias) | Yes | No |
| *Sampling* | ☒ | ☑ | To determine the number of points needed for the study, we must consider the area of each stratum. Once the total number of samples is calculated, they must be distributed across the strata proportionally. If any of the strata receive too few samples, they should have a minimum sample size requirement, and the remaining points should be proportionally distributed to the larger strata. However, changes in the study area are small, resulting in a high variance in some change categories. To select the estimator, we follow Cochran's (1977) recommendations. | H (random/bias) | Yes | Yes |
| *Extrapolation* | ☑ | ☒ | The estimates were made based on the samples collected for which the interpretation of the land cover classes is exhaustive and covers the whole reference and monitoring periods. This source of error is therefore unlikely to be present in the approach adopted. | L (bias) | Yes | No |
| *Approach 3* | ☑ | ☒ | This source of uncertainty exists when there is no land monitoring or IPCC Approach 3 of monitoring, which is not valid for the Nepal ER program. Four non-independent surveys were conducted covering reference and monitoring periods (t0, t1, t2, and t3), conducting lands tracking. | Not apply | Yes | No |
| **Emission Factors** | | | | | | |
| *DBH measurement* | ☑ | ☑ | The permanent sample plots were selected from the National Forest Resource Assessment. The sampling design was adopted from Forest Resource Assessment Design 2011[64].<br><br>In the selected sample plots, all trees with more than 5 cm diameter were measured. For more details, please refer to the FRA field manual[65].<br><br>The height of every fifth tree was measured and for the remaining trees, their height was predicted using the model developed based on the height-diameter relationship of neighboring trees. The model prepared and used during the calculation is presented in Annex 2 of the report "Terai Forests of Nepal"[66].<br><br>A strong QA/QC was carried out for all the above-mentioned processes using the QA/QC Manual approved by the FRTC. Comprehensive training was conducted for field staff to minimize field measurement errors. In addition, the continuous | L (bias) & L (random) | Yes | No |
| *H measurement* | ☑ | ☑ | | L (bias) & L (random) | Yes | No |
| *Plot delineation* | ☑ | ☑ | | L (bias) & L (random) | Yes | No |

[64] https://drive.google.com/file/d/142FYFebXTCruimqe1wKbDoi-oBdwfERh/view?usp=drive_link
[65] https://drive.google.com/file/d/1EvrStTmfNAZVW7ewAqEXuKiUm-OzqUVB/view?usp=drive_link
[66] https://drive.google.com/file/d/1EFpJXYa7GZRiGfP0WJIWwu-zljs9C65v/view?usp=drive_link

| Sources of uncertainty | Systematic | Random | Analysis of contribution to overall uncertainty | Contribution to overall uncertainty (High -H /Low - L) | Addressed through QA/QC? | Residual uncertainty estimate? |
|---|---|---|---|---|---|---|
| | | | monitoring of the field personnel was carried out by the FRTC's officials. As a result of the robust QA/QC process, the error for field measurement is below 5%. | | | |
| *Wood density estimation* | ☑ | ☑ | The species-specific wood density is referenced from Table 1 of Sharma and Pukkala, 1990[67], Master Plan for the Forestry Sector Nepal[68], and Devagiri et al., 2013[69]. | H (bias) & L (random) | Yes | No |
| *Biomass allometric model* | ☑ | ☑ | The country used a local volume tree equation to estimate biomass. The volume of the tree, which is further converted into biomass and carbon, is calculated using the allometric equation developed by Sharma and Pukkala, 1990. [Table 2 of Sharma and Pukkala 1990 Volume equations and biomass prediction of forest trees of Nepal.pdf]. Note that for the species not included in Table 2-7 of Sharma and Pukkala 1990, the parameters from the Miscellaneous Categories were used, depending on the sample plots' locations (Terai or Hills).<br><br>There are more than 21 species of trees with specific parameters and an additional two groups of species found in lower altitudes and higher altitudes with their respective parameters. The maximum and minimum standard error percentage of the regression model is 9.9 % and 5.8 % respectively. The $R^2$ of the model for every species is higher than 95 % (Sharma and Pukkala, 1990). The country has not determined whether the uncertainty from this source is lower than the uncertainty from the sampling error. Since Nepal is unable to include this error source in the Monte Carlo simulation, due to the lack of a covariance table, the sampling uncertainty of carbon density in different land uses based in the NFI dataset has been increased by 10% at a 90% confidence level using the quadrature approach. The combined error was included in the Monte Carlo simulation. | L (bias) & L (random) | Yes | Yes |
| *Sampling* | ☒ | ☑ | The sampling is done based on the Inventory Design (ID) of the National Forest Inventory. The error of the Inventory Design is 7.34% at a 95 % confidence interval. [Please refer to page 40 of the report "State of Nepal's Forests"[70]. However, despite the low error of the Inventory Design, the sampling error of the carbon densities for the different land uses based on the NFI varies from 5% (Intact Forest) to 148% (Grassland). Therefore, this source of uncertainty is considered high. | H (random/bias) | Yes | Yes |
| *Other parameters (e.g. Carbon Fraction, root-to-shoot ratios)* | ☑ | ☑ | Other relevant parameters includes root-to-shoot ratio and carbon fraction. Booth parameters are taken from the 2006 IPCC guideline. The error provided by the IPCC guideline is also factored in while carrying out the Monte Carlo simulation for uncertainty estimation. | H (bias/random) | Yes | Yes |
| *Representativeness* | ☑ | ☒ | The carbon densities and removal rates used for the ER monitoring report are Tier 2 (country-specific data) and have been derived from the latest NFI (FRA) except the removal rates for forest plantation and shaded crops. The NFI (FRA) involved remeasurement in 2022 of the permanent sample plots established by the FRA Nepal Project (2010-2014) including an additional number of plots established and measured using the same methodology. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years. The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the initial measurement phase of the NFI. The forest regrowth removal rate calculation is | L (bias) | Yes | No |

[67] https://drive.google.com/file/d/1SRAc-nT7xhc8Sf3UjZGe2zhDJi2NX5d9/view?usp=drive_link

[68] https://drive.google.com/file/d/12FGaJnNuMBB1zMJEoqSNexfYvW451uvH/view?usp=drive_link

[69] https://drive.google.com/file/d/1zaQKB5Xl_qIqB8SXPTQ2yf50XgSH4L1n/view?usp=drive_link

[70] https://drive.google.com/file/d/10csi8kI5M-08AL6RZLekZg_QJrtowADk/view?usp=sharing

| Sources of uncertainty | Systematic | Random | Analysis of contribution to overall uncertainty | Contribution to overall uncertainty (High -H /Low - L) | Addressed through QA/QC? | Residual uncertainty estimate? |
|---|---|---|---|---|---|---|
| | | | based on a sample of sixteen NFI plots established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years between measurements was used to estimate the average removal rate. | | | |
| **Integration** | | | | | | |
| *Model* | ☑ | ☒ | To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheets. This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "OK". | L (bias) | Yes | No |
| *Integration* | ☑ | ☒ | Activity Data and Emission Factors are comparable. Carbon densities have been estimated according to the forest types, and non-forest land uses interpreted in the visual assessment. To ensure consistency, the Emission Factors (EF) have been aligned with the estimates of land-use transition area (AD). To achieve this, the same time series analysis and data collection methods that were used in CEO were replicated for the NFI permanent plot's locations. The NFI plots have been classified as Non-Forest land use (grassland, other land, unshaded cropland), Permanent Forest, or Secondary Forests. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). | L (bias) | Yes | No |

## 5.2 Uncertainty of the estimate of Emission Reductions

### Parameters and assumptions used in the Monte Carlo method

Nepal's ER Program applied Monte Carlo methods (IPCC Approach 2) for quantifying the Uncertainty of the Emission Reductions. Because the MC propagation analysis includes 39 parameter values, it has been provided access to uncertainty calculation tool[71] to see all parameter values used in the analysis. The sources of uncertainty propagated in the Monte Carlo (MC) analysis are provided in the following Table.

| Parameter included in the model | Parameter values | Range or standard deviations | | Error sources quantified in the model (e.g. measurement error, model error, etc.) | Probability distribution function | Assumptions |
|---|---|---|---|---|---|---|
| | | Range | %Error | | | |
| ratio R::S | 0.44 | 0.30 | 68% | 90% Confidence Interval | Normal Mean 0.44, SD 0.184 | Only values > 0. |
| ratio R::S Grassland | 1.887 | 0.499 | 26% | 90% Confidence Interval | Normal Mean 1.887, SD 0.304 | |
| CF | 0.47 | 0.020 | 4% | 90% Confidence Interval | Normal Mean 0.47, SE 0.0120 | |
| CD-natural intact forest | 202.08 | 9.78 | 5% | 90% Confidence Interval | Bootstrapping | Only values > 0. |

[71] Uncertainty calculation tool can be accessed at the following link: https://docs.google.com/spreadsheets/d/1AOT_hd6qw4yVZsGWiQ5MwiwnnZH4I-V4/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

| Parameter included in the model | Parameter values | Range or standard deviations | | Error sources quantified in the model (e.g. measurement error, model error, etc.) | Probability distribution function | Assumptions |
|---|---|---|---|---|---|---|
| | | Range | %Error | | | |
| CD-natural degraded forest | 101.93 | 37.93 | 37% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-natural very degraded forest | 18.49 | 10.68 | 58 | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-grassland | 20.95 | 17.96 | 86% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-other land | 27.37 | 32.32 | 118% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-settlements | 20.95 | 17.96 | 86% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-unshaded cropland | 57.54 | 28.67 | 50% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| RF-natural secondary forest gain | 16.69 | 9.41 | 56% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| RF-plantation forest gain | 13.79 | 9.41 | 68% | 90% Confidence Interval | Bootstrapping | Only values > 0. It is assumed the same SD as Nat Sec forest gain removal rate |
| RF-shaded cropland gain | 10.23 | 2.46 | 24% | 90% Confidence Interval | Normal Mean 2.79, %E 24% | Only values > 0. |
| AD-Defo_Intact Forest-Grasslands-2004-2014 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-Defo_Intact Forest-Other Land-2004-2014 | 1,564 | 1,261 | 81% | 90% Confidence Interval | Normal Mean 1564, SE 767 | Only values > 0. |
| AD-Defo_Intact Forest-Settlements-2004-2014 | 1,676 | 2,199 | 131% | 90% Confidence Interval | Normal Mean 1676, SE 1337 | Only values > 0. |
| AD-Defo_Intact Forest-Unshaded Cropland-2004-2014 | 4,818 | 3,983 | 83% | 90% Confidence Interval | Normal Mean 4818, SE 2422 | Only values > 0. |
| AD-Defo_Degraded Forest-Other Land-2004-2014 | 3,506 | 3,672 | 105% | 90% Confidence Interval | Normal Mean 3506, SE 2233 | Only values > 0. |
| AD-Defo_Degraded Forest-Settlements-2004-2014 | 2,017 | 2,748 | 136% | 90% Confidence Interval | Normal Mean 2017, SE 1670 | Only values > 0. |
| AD-Defo_Degraded Forest-Unshaded Cropland-2004-2014 | 3,897 | 3,726 | 96% | 90% Confidence Interval | Normal Mean 3897, SE 2265 | Only values > 0. |
| AD-Defo_Intact Forest-Other Land-2018-2021 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1626 | Only values > 0. |
| AD-Defo_Secondary natural forest 2007-other land-2015-2017 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1626 | Only values > 0. |
| AD-Deg_Inctact forest-Degraded forest -2004-2014 | 5,991 | 4,120 | 69% | 90% Confidence Interval | Normal Mean 5991, SE 2505 | Only values > 0. |
| AD-Deg_Inctact forest-Very degraded forest-2004-2014 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |

| Parameter included in the model | Parameter values | Range or standard deviations | | Error sources quantified in the model (e.g. measurement error, model error, etc.) | Probability distribution function | Assumptions |
|---|---|---|---|---|---|---|
| | | Range | %Error | | | |
| AD-Deg_Degraded forest -Very degraded forest-2004-2014 | 1,627 | 2,672 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1625 | Only values > 0. |
| AD-Deg_Degraded forest - Inctact forest-2004-2014 | 7,904 | 5,553 | 70% | 90% Confidence Interval | Normal Mean 7904, SE 3376 | Only values > 0. |
| AD-Deg_Very degraded forest-Degraded forest -2004-2014 | 3,254 | 3,780 | 116% | 90% Confidence Interval | Normal Mean 3254, SE 2298 | Only values > 0. |
| AD-Deg_Inctact forest-Degraded forest -2018-2021 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-Deg_Degraded forest -Very degraded forest-2018-2021 | 782 | 900 | 115% | 90% Confidence Interval | Normal Mean 782, SE 547 | Only values > 0. |
| AD-Deg_Degraded forest - Inctact forest-2018-2021 | 3,505 | 3,671 | 105% | 90% Confidence Interval | Normal Mean 3505, SE 2232 | Only values > 0. |
| AD-Deg_Very degraded forest-Degraded forest -2018-2021 | 1,627 | 2,672 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1625 | Only values > 0. |
| AD-ForestGain_Natural Forest_1983-2003 | 7,996 | 5,869 | 73% | 90% Confidence Interval | Normal Mean 7996, SE 3570 | Only values > 0. |
| AD-ForestGain_Natural Forest_2004-2014 | 17,136 | 8,467 | 49% | 90% Confidence Interval | Normal Mean 17136, SE 5150 | Only values > 0. |
| AD-ForestGain_Natural Forest_2015-2017 | 3,114 | 3,615 | 116% | 90% Confidence Interval | Normal Mean 3114, SE 2199 | Only values > 0. |
| AD-ForestGain_Natural Forest_2018-2021 | 19,156 | 8,888 | 46% | 90% Confidence Interval | Normal Mean 19156, SE 5406 | Only values > 0. |
| AD-ForestGain_Plantation Forest_1983-2003 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |
| AD-ForestGain_Plantation Forest_2015-2017 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |
| AD-ForestGain_Shaded cropland_2015-2017 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-ForestGain_Shaded cropland_2018-2021 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |

### Quantification of the uncertainty of the estimate of Emission Reductions

| | | Reporting Period | Crediting Period |
|---|---|---|---|
| | | Total Emission Reductions* | Total Emission Reductions* |
| A | **Median** | **3 924 264** | **3 924 264** |
| B | **Upper bound 90% CI** (Percentile 0.95) | **8 742 875** | **8 742 875** |
| C | **Lower bound 90% CI** (Percentile 0.05) | **737 138** | **737 138** |

| | | | |
|---|---|---|---|
| **D** | **Half Width Confidence Interval at 90% (B – C / 2)** | **4 002 869** | **4 002 869** |
| **E** | **Relative margin (D / A)** | **102%** | **102%** |
| **F** | **Uncertainty discount** | **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 following table show each parameter's contribution to the Emissions Reduction's uncertainty. Four parameters represent 30% of total ER's uncertainty: i. RF-natural secondary forest gain (8.9%), ii. AD-Deg_Degraded forest -Inctact forest-2018-2021 (8.3%), iii. ratio R::S (7.5 %), and iv. AD-Defo_Intact Forest-Unshaded Cropland-2004-2014 (5.9%).

| Input Variable | Corresponding Input Value | | | Swing | Percent Swing^2 |
|---|---|---|---|---|---|
| | Low Output | Base Case | High Output | | |
| RF-natural secondary forest gain | 7.28 | 16.69 | 26.11 | 1 650 439 | 8.9% |
| AD-Deg_Degraded forest -Inctact forest-2018-2021 | 0 | 3 505 | 7 176 | 1 593 741 | 8.3% |
| ratio R::S | 0.13972875 | 0.44 | 0.74027125 | 1 514 096 | 7.5% |
| AD-Defo_Intact Forest-Unshaded Cropland-2004-2014 | 835 | 4 818 | 8 801 | 1 346 873 | 5.9% |
| AD-ForestGain_Natural Forest_2018-2021 | 10 268 | 19 156 | 28 044 | 1 296 364 | 5.5% |
| AD-Deg_Inctact forest-Degraded forest -2004-2014 | 1 871 | 5 991 | 10 111 | 1 153 765 | 4.4% |
| AD-ForestGain_Natural Forest_2004-2014 | 8 670 | 17 136 | 25 603 | 1 151 627 | 4.3% |
| AD-Deg_Very degraded forest-Degraded forest -2018-2021 | 0 | 1 627 | 4 299 | 1 122 340 | 4.1% |
| AD-ForestGain_Natural Forest_2015-2017 | 0 | 3 114 | 6 729 | 1 089 324 | 3.9% |
| AD-Defo_Intact Forest-Settlements-2004-2014 | 0 | 1 676 | 3 875 | 1 058 275 | 3.7% |
| AD-Defo_Degraded Forest-Unshaded Cropland-2004-2014 | 170 | 3 897 | 7 623 | 1 016 134 | 3.4% |
| AD-Defo_Degraded Forest-Other Land-2004-2014 | 0 | 3 506 | 7 178 | 1 009 569 | 3.3% |
| AD-Defo_Intact Forest-Other Land-2004-2014 | 303 | 1 564 | 2 825 | 992 054 | 3.2% |
| AD-Defo_Degraded Forest-Settlements-2004-2014 | 0 | 2 017 | 4 765 | 944 836 | 2.9% |
| AD-ForestGain_Plantation Forest_2015-2017 | 0 | 1 627 | 4 301 | 939 220 | 2.9% |
| AD-Deg_Degraded forest -Very degraded forest-2004-2014 | 0 | 1 627 | 4 299 | 933 264 | 2.8% |
| AD-Deg_Inctact forest-Very degraded forest-2004-2014 | 0 | 391 | 1 030 | 882 357 | 2.5% |
| AD-Defo_Intact Forest-Grasslands-2004-2014 | 0 | 391 | 1 030 | 879 568 | 2.5% |
| AD-ForestGain_Shaded cropland_2018-2021 | 0 | 1 627 | 4 301 | 878 089 | 2.5% |
| RF-plantation forest gain | 4.37 | 13.79 | 23.20 | 864 142 | 2.4% |
| AD-ForestGain_Shaded cropland_2015-2017 | 0 | 391 | 1 030 | 845 541 | 2.3% |
| RF-shaded cropland gain | 7.77 | 10.23 | 12.69 | 842 785 | 2.3% |
| AD-ForestGain_Plantation Forest_1983-2003 | 0 | 1 627 | 4 301 | 768 219 | 1.9% |
| AD-Deg_Inctact forest-Degraded forest -2018-2021 | 0 | 391 | 1 030 | 739 501 | 1.8% |
| AD-Defo_Secondary natural forest 2007-other land-2015-2017 | 0 | 1 627 | 4 301 | 687 204 | 1.5% |
| AD-Deg_Degraded forest -Very degraded forest-2018-2021 | 0 | 782 | 1 682 | 682 401 | 1.5% |

| | | | | | |
|---|---|---|---|---|---|
| AD-Deg_Very degraded forest-Degraded forest -2004-2014 | 0 | 3 254 | 7 034 | 609 083 | 1.2% |
| AD-ForestGain_Natural Forest_1983-2003 | 2 127 | 7 996 | 13 865 | 576 330 | 1.1% |
| AD-Deg_Degraded forest -Inctact forest-2004-2014 | 2 351 | 7 904 | 13 457 | 382 444 | 0.5% |
| AD-Defo_Intact Forest-Other Land-2018-2021 | 0 | 1 627 | 4 301 | 233 072 | 0.2% |
| CD-natural degraded forest | 63.99 | 101.93 | 139.86 | 209 285 | 0.1% |
| ratio R::S Grassland | 2.38556 | 1.887 | 1.38844 | 193 860 | 0.1% |
| CD-natural inctat forest | 192.31 | 202.08 | 211.86 | 171 449 | 0.1% |
| CF | 0.450401 | 0.47 | 0.489599 | 139 312 | 0.1% |
| CD-settlements | 38.91 | 20.95 | 2.98 | 138 429 | 0.1% |
| CD-other land | 59.69 | 27.37 | 0.00 | 37 002 | 0.0% |
| CD-natural very degraded forest | 29.17 | 18.49 | 7.81 | 18 476 | 0.0% |
| CD-grassland | 38.91 | 20.95 | 2.98 | 14 650 | 0.0% |
| CD-unshaded cropland | 28.87 | 57.54 | 86.21 | - | 0.0% |

To reduce uncertainty in estimating emission reductions in subsequent crediting periods, the following actions will be considered:

For Activity data

1. Improve the activity data interpretation by using high-resolution imagery.

2. Further improve the interpretation key

3. Train the interpreter for the CEO

For carbon densities and removal factors

1. Updating allometry equation

# 6. TRANSFER OF TITLE TO ERS

## 6.1 Ability to transfer title

The Carbon Fund (Carbon Fund) of the FCPF requires the ER Program Entity to demonstrate its ability to transfer Title to Emission Reductions (ERs). The term 'Title to ERs' has been defined in the Methodological Framework to mean "full legal and beneficial title and exclusive right to ERs contracted for under the ERPA." Indicator 36.2 of the Framework requires that the Program Entity "demonstrates its ability to transfer to the Carbon Fund Title to ERs, while respecting the land and resource tenure rights of the potential rights-holders, including Indigenous Peoples (i.e., those holding legal and customary rights, as identified by the assessment conducted under Criterion 28), in the Accounting Area." Indicator 36.3 of the Framework also specifies that the Program Entity needs to demonstrate its ability to transfer Title to ERs before signing the ERPA, or at the latest, before transferring of ERs to the Carbon Fund.

Further, Section 15.01(a) of the General Conditions Applicable to ERPAs for FCPF Emission Reductions Programs (November 1, 2014) provides that "the Program Entity shall ensure throughout the [term of the ERPA] and in accordance with the Methodological Framework that the Program Entity has the ability to transfer Title to ERs to the Trustee, free of any interest, encumbrance or claims of a Third Party other than in accordance with the ERPA."

While the ERPD (p.194) of this ER Program has established the MoFE as the national authority and REDD Implementation Center (and its subsequent version National REDD+ Center) as the duly recognized legal entity to transfer the Title to ER, further opinion was sought from the Attorney General of Nepal on this matter in view of the changes in some legislation. The opinion from Nepal's Attorney General concludes that "the Government of Nepal has the ability to transfer Title to Emissions Reductions as required to the Carbon Fund Methodological Framework of the Forest Carbon Partnership Facility."[72] The following constitutional and legal instruments define the Ministry of Forests and Environment (MoFE) as the national authority on forests and REDD+, and as the legal entity with the ability to transfer Title of ERs, including to the Carbon Fund under the Emission Reductions Program Documents (ER-PD).

**Constitution of Nepal:** The Constitution of Nepal Schedule 5 (27) has identified carbon as a service. According to article 57(1) and Schedule 5 (27) of the Constitution, national forest policy and carbon services shall be regulated by the Federal government in accordance with federal laws. The Government of Nepal, in February 2017, approved an unbundling report[73] by detailing the list of exclusive and concurrent powers of the Federation, the Province and the Local Level. This report specified carbon service as the jurisdiction of the federal level and clearly stated that authority on the enhancement of carbon stocks, as well as fiscal management of the carbon service will be under federal jurisdiction.

**Forest Act 2019:** According to the Forest Act 2019, carbon stocks are not included under forest products and not counted as forest products/goods, but included under or counted as an environmental service, which will be managed and utilized based on Forest Regulation. Section 2 of the Forest Act defines forest carbon stocks as environmental services. Section 44 (1.a) of the Act authorizes the Government of Nepal to make arrangements for the management, utilization and distribution of benefits arising out of the environmental services, including carbon stock from emission reduction program. Similarly, the sub section (1) of section 3 states that the land ownership of the national forest lies with the Government of Nepal. As such, this Act defines forest carbon as an environmental service, and gives resource rights to communities on the products or goods produced in the forest but not to the land, intangible property, nor environmental services (e.g., carbon stocks).

FUGs prepare forest management plans and get them approved by DFOs as per Section 18 of the Forest Act 2019. According to the Community Forest Development Guideline 2015 (revised), FUGs may include provisions for the conservation and utilization of environmental services, including carbon stocks, in their plans. Section 44 (1.b) of the Act empowers the FUG to manage, use and distribute benefits arising out of the environmental services other than carbon stock and emission reduction. The use rights of communities and individuals are also established for PA Buffer Zones and Conservation Areas, according to National Parks and Wildlife Conservation (NPWC) Act, 1973. Thus, the forestry and protected area legislation provide resource rights to communities on the products or goods produced in the forest but not to the land, intangible property, nor environmental services (e.g., carbon stocks).

**Environment Protection Act 2019:** The Act's Section 28 of the Act authorizes the GoN to participate in carbon trading for emission reduction and carbon stock enhancements with international mechanism,

[72] Attorney General of Nepal. 2020. Note on the Ability of Program Entity to Transfer Title to Emission Reductions. October 21, 2020. Letter from Attorney General to Ministry of Forest and Environment, Ref 48-077/078.

[73] Government of Nepal, 2017. Unbundling/Detailing of List of Exclusive and Concurrent Powers of the Federation, the State and the Local Level Provisioned in the Schedule 5,6,7,8,9 of the Constitution of Nepal (report), Federalism Implementation and Administration Restructuring Coordination Committee, February, 2017

foreign Governments or entity or professional entity or private sector established under international conventions.

**Government of Nepal (Business Allocation) Regulation 2018:** This Regulation authorizes MoFE to develop and approve plans and programs related to carbon service and carbon stock. National REDD+ Steering Committee (NRSC) formed as per Nepal National REDD+ Strategy (2018 – 2022) as the apex decision-making body endorsed REDD+ ER Program for the 13 Terai Arc Landscape Districts through its meeting on April 19, 2018. The Ministry of Finance signed the ERPA with the FCPF Carbon Fund upon the request of REDD IC as the Secretariat of the NRSC, as forwarded through MoFE, pursuant to Section 2(9) of the Government of Nepal (Business Allocation) Regulation 2018. The Regulation authorizes the Ministry of Finance to sign an Emission Reductions Payment Agreement with an international entity, including FCPF's Carbon Fund.

**Assessment of carbon rights**

The Constitution of Nepal (2015) Schedule 5, No 27, puts the following matter under the sole jurisdiction of federal power. The following matter is dealt with by the Federal Government, as opposed to the provincial or local government: "National and international environment management, national parks, wildlife reserves and wetlands, national forest policies, carbon services." Therefore, it is clear that the Government of Nepal has the right to transfer the Title to ER to international entities on the basis of this jurisdiction. However, it may transfer the Title to ER generated by private person or entity only when there is equitable benefit sharing, as the Constitution's commitment in its State Policy and Principles imply that the benefits to natural resources, including the benefits from carbon services, are equitably distributed.

The National REDD+ Strategy, 2018 states that "*under the existing land and forest tenure regimes, substantive measures will be taken to secure carbon rights of the right holders. For this, forest legislation will clearly define carbon rights and its right holder.*" Consequently, Forest Act, 2019 included carbon sequestration/stock as an environmental service, which should be regulated according to the constitutional provision and the regulations.

**Carbon rights and emission reduction title**

REDD+ comes under both national and international environment management. On the one hand, the activities and interventions for implementing Emission Reduction Programs, or any other programs in the National REDD+ Strategy, are guided by national laws, policies and the annual budget/program of the government. On the other hand, REDD+ is also guided by UNFCCC and any contract made by the Government of Nepal with any international entities such as the World Bank's Carbon Fund and UN-REDD. Therefore, carbon rights and Emission Reduction Title directly belong to national and international environment management and carbon services. They are also a matter of national forest policies as defined by the constitution.

It is clear that the Federal Government (that is, the Government of Nepal) has the right to transfer Title of Emission Reduction to international entities based on its right over national and international environment management and carbon services, as well as the right to issue national forest policies. There has been no contestation on the ability and jurisdiction of the Government of Nepal to transfer the Title of ER in the program area. The Federal Government has power over carbon services as well as the land ownership of national forests. The land under national forests, including community forests, collaborative forest, block forest or protected areas is owned by the Federal Government and authority over carbon services is vested in the Federal government (Constitution Schedule 5 (27)), no person (biological or legal) can transfer Title to ERs apart from the Federal Government. The Federal Government pursuant to other legislation (Article 25) and equitable benefit-sharing plans (Article 51) can transfer Title to ERs to any entity.

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

Existing REDD Implementation Center, under the Ministry of Forest and Environment (MoFE), is the program entity for ER program. It has been mandated as the entity for the development, implementation and management of ER programs on behalf of the Government of Nepal. It is a specialized body within MoFE and is dedicated to the implementation of the National REDD+ Strategy and associated implementation plan. Its main function is to coordinate with all stakeholders, including government agencies, civil society, academia and practitioners for the development and implementation of REDD+ in Nepal. It also serves as the operating entity for the Forest Carbon Partnership Facility (FCPF), the Forest Investment Program (FIP) and the UN-REDD Program. The following are key responsibilities of REDD IC:[74]

- Identification of and access to national and international funds for results-based REDD+ payments
- Coordination with different sectors and stakeholders for the development of REDD policies and decision-making
- Coordination for the regulation of greenhouse gas emissions from the forest sector
- Coordination for the sharing of benefits arising from REDD+
- Coordination of the implementation and monitoring of REDD+ safeguards
- Establishment and operation of national forest information system
- Coordination for the implementation of National REDD+ strategy and emissions reduction program
- Studies, research, and publication on REDD issues and their dissemination
- Establishment forest carbon registry and national forest monitoring system and coordination with Forests Research and Training Center for carbon measurement, report preparation and verification
- Development of a system/procedure for entering into agreements with private forest owners for encouraging them in emissions reduction program.

Further institutional evolvement of REDD IC is currently under process. Nepal's REDD+ Strategy 2018 as well as fourteenth periodic plan (2017-19) had committed to the establishment of National REDD Center (RIC). The RIC is envisioned to evolve as semi-autonomous, designated entity according to the Warsaw Framework for REDD+. The upgradation of the REDD IC into the National REDD Center by issuance of a federal "formation order" or other legal instrument is currently under consideration. Until that materializes, all functions of designated national REDD+ entity will be served by REDD IC. The administrative procedures for the REDD+ programs are defined and elaborated in Section 1.1.3 of the ERMR.

**Projects Data Management System**. REDD IC has developed National Forest Database (NFD) and National Forest Information System (NFIS, website: http://nfis.redd.gov.np/nfis) as web-based platforms for the entry and visualization of data on forest and ER projects. The REDD IC is responsible for the development and implementation of ER projects across the country's national forests, ensuring a centralized approach that prevents multiple claims to the same ER credits. The NFIS system has been designed with a clear administrative procedure for data management, allowing for input and updates at both district and central levels. Forest officers in each district can enter management-level data, while the REDD IC has appointed a focal person in every forestry directorate and district to load primary information into the system. The REDD IC plays a key role in monitoring, controlling, and managing the data, with stakeholders having access to major open-source data through NFIS. Because REDD IC (and subsequent NRC) will be responsible for ER project development and implementation for all of country's government-owned forests, this arrangement forestalls and avoids multiple claims to ER. It requires updating and consolidation to account for and updating project data, by including the following information:

- The proponent of the ER program or project
- Geographic boundaries of the ER program or project
- Scope of REDD+ activities and carbon pools

[74] ToR of REDD Implementation Center, in REDD IC. 2022 Sep. Proactive Disclosure Shrawan to Ashoj 2079. Available at https://redd.gov.np/assets/2/Proactive_Disclosure_Shravan_to_Ashoj_2079_REDDIC.pdf/file. The text is the translation from original Nepali version.

- The reference level used
- MRV data to specific REDD+ projects or programs
- Safeguard plans of specific REDD+ projects or programs.

Further, the Forest Research and Training Center (FRTC) is developing a database management system, National Forest Monitoring Portal, with support from the UN REDD Programme which is scheduled to be deployed by December 2024. This portal, already installed, will house all data necessary for the Measurement, Reporting, and Verification (MRV) and Methodological Framework (MF) of the ER-MR. The manual for this database management system will be prepared following the deployment of the National Forest Monitoring Portal and the update of the NFIS.

### 6.3 Implementation and operation of ER transaction registry

"People and Forests- A Sustainable Forest Management -Based Emission Reduction Program in the Terai Arc Landscape" is the first ER program primarily implemented in Nepal's government-owned forests, with a minor presence (2-3%) in privately-owned forests. Accordingly, Nepal is still in the process of preparing to design and develop national ER transaction registry, for future programs and it has not been implemented and operationalized yet. Thus, Nepal's REDD entity has decided to use a centralized ER transaction registry managed by a third party on its behalf – the REDD IC will use the World Bank ER transaction registry.

### 6.4 ERs transferred to other entities or other schemes

"People and Forests- A Sustainable Forest Management -Based Emission Reduction Program in the Terai Arc Landscape" is the first REDD+ program that is being implemented in Nepal in government-owned forests. After the approval of this ER Monitoring Report and according to the ERPA, the contract ER units will be transferred to FCPF Carbon Fund on a 100% basis. No ERs will be transferred from this program to other entities during the crediting period.

Since the Emission Reduction Purchase Agreement (ERPA) between the World Bank and the Forest Carbon Partnership Facility (FCPF) has already outlined the boundary area and the activities for emission reductions, the national authority will ensure that there is no double counting of the emission reductions. Meaning that Nepal's Ministry of Forest and Environment (MoFE) is the national authority that will ensure there is no double counting of emission reductions.

**Rights to carbon emissions reductions/removals generated on private land.**

The ER Program does not have rights to carbon emissions reductions/removals generated on private land. The ER program includes the area of national forest (Community managed and government managed forest only. However, carbon service is the sole authority of the federal government. The government has not managed the ER rights for the private sector until now. But, private sector can develop the ER projects with the consent from National Designated Authority (NDA). There are no projects designed, registered, and running in the ERP area. In our record there are no projects that have taken the consent from the NDA for ER program on private land. We have published public notification related to ER program on private land (https://mofe.gov.np/notices/details/%E0%A4%B5%E0%A4%BF%E0%A4%9C%E0%A5%8D%E0%A4%9E%E0%A4%AA%E0%A5%8D%E0%A4%A4%E0%A4%BF-%E0%A5%A4-0417). Though the ERMR assumes that the total private forest area in ER program area is 2-3%, the total area of private forest in ER program area from 2018-2021 is 664 hectares (less than 0.04 % of the total forest area in ER Program area). The Benefit Sharing Plan (BSP) has ensured 5 % of the benefits to the private forest.

**Projects using the AMS-I.C CDM and Gold Standard methodologies for Biogas and Improved Cook Stoves.**

**Use of the methodology AMS-I.C in Nepal**.

A total of seven projects have been registered within the CDM Registry of Programs of Activities for Nepal (please refer to the table below). Among these, only project 0139, the Biogas Support Program - Nepal (BSP-Nepal) Activity-2, is included in the official project list (https://cdm.unfccc.int/Projects/projsearch.html), indicating its association with Methodology AMS-I.C. version 6. However, it is important to clarify that, despite the designation of project 0139 with methodology AMS-I.C in this list, the detailed project description (https://cdm.unfccc.int/Projects/DB/DNV-CUK1132671435.09/view ) actually specifies the methodology as AMS-I.E. version 9. Consequently, no projects utilizing the AMS-I.C. methodology have been implemented in Nepal.

**Double-counting risk analysis**:

An analysis of the double-counting risk between biogas/improved cook stove initiatives and the FCPF Carbon Fund ER Program was conducted. The table below summarizes the key elements considered in this analysis. Consequently, Nepal concludes that there is no risk of double-counting with projects utilizing the Gold Standard methods for quantifying climate-related emission reductions of Black Carbon and Co-emitted Species [1], as well as for animal manure management and biogas for thermal energy [2]. Regarding the Gold Standard for improved efficiency in cook stoves, it is determined that there is no double-counting risk between the FCPF ERP and these projects, since this Gold Standard methodology specifically addresses non-CO2 gases emitted from biomass burning. Conversely, the ERP program's carbon accounting does not factor in non-CO2 gases from forest degradation due to fuelwood consumption. For the Gold Standard methods focused on animal manure management and biogas for thermal energy, it is similarly concluded that there is no risk of double-counting between the FCPF ERP and biogas projects employing this methodology, as the ERP's carbon accounting excludes emissions from animal manure management.

Concerning the AMS-I.E and AMS-II.G methodologies used in biogas and improved cook stove projects in Nepal, the country identified a potential risk of double-counting between the FCPF ERP and CDM projects. The ERP is working to reduce forest degradation driven by fuelwood demand. Simultaneously, the CDM projects aim to lower the demand for firewood by:

- Completely replacing existing biomass-fired cookstoves, ovens, or dryers with more efficient appliances to reduce non-renewable biomass use.
- The project aims to promote biogas digesters (biogas units) to households in rural Nepal. This will reduce GHG emissions by displacing conventionally used fuel sources for cooking, such as non-renewable woody biomass (firewood) and/or fossil fuels (kerosene and/or LPG).

However, the CDM methodologies differ in how they calculate ERs. The CDM methodologies assume that, without the project, the baseline scenario would rely on fossil fuels to meet thermal energy needs. Consequently, the ERs are calculated based on reducing fossil fuel use rather than concentrating on the decreased demand for fuelwood sourced from permanent natural forests.

The complete deduction of all CERs may not be justified because there is no one-to-one equivalence among the emission reductions. Additionally, it remains uncertain whether all non-renewable biomass used in the Clean Development Mechanism (CDM) project is sourced from within the boundary of the Emission Reduction Project (ERP) accounting area.

| Parameter | Gold Standard Quantification of climate-related emission reductions of Black<br><br>Carbon and Co-emitted Species<br><br>[1] | Gold Standard animal manure management and biogas for thermal energy [2] | AMS-I.E. Switch from non-renewable biomass for<br><br>thermal applications by the user [3] | AMS-II.G. Energy efficiency measures in thermal<br><br>applications of non-renewable biomass [4] | Avoided degradation in the FCPF Carbon Fund ER Program |
|---|---|---|---|---|---|
| Project Boundary | The project boundary is to be the physical, geographical site of the baseline and the proposed<br><br>cookstoves project and fuel collection area. | The project boundary is the physical, geographical sites of<br><br>•The livestock<br><br>•Animal manure management system<br><br>•Biogas<br><br>•Digestate treatment, usage, and or disposal | Geographical site of the use of biomass or renewable energy | The project boundary is the physical, geographical site of the efficient devices that utilize<br><br>biomass. | Permanent Natural Forest Areas degradation, driven by demand for fuelwood and fodder, contributes significantly to land-based emissions. |
| Methodology Scope / Project Activity | This methodology applies to project activities that introduce efficient<br><br>cookstove technologies and/or practices or switch from non-renewable to<br><br>renewable biomass for meeting thermal energy requirements for cooking regimes. | This methodology applies to activities that involve the recovery and use of methane<br><br>from manure and agricultural wastes that would be decaying anaerobically, emitting<br><br>methane to the atmosphere in the absence of the implemented activity | The project activity will reduce GHG<br><br>emissions by displacing conventionally used fuel sources for cooking, such as non-renewable<br><br>woody biomass (firewood) and/or fossil fuels (kerosene and/or LPG) | The use of fuel-efficient improved cooking stoves would lead to less consumption of<br><br>fuel-wood, which would thus reduce the emissions from the stove. | Degradation, driven by a forest product supply-demand gap, contributes significantly to land-based emissions. The ER Program aims to combat deforestation and degradation in Nepal by enhancing forest management and productivity. |
| Baseline Carbon Pool | Non-Renewable Woody Biomass | •Methane from manure, agricultural, and organic waste.<br><br>•Delivery of thermal energy<br><br>•Production of fuel, transport of fuel | Non-Renewable Woody biomass | Projected fossil fuel | AGB and BGB in permanent natural forest |

| | | | | | |
|---|---|---|---|---|---|
| Gases | Black Carbon (BC), Organic Carbon (OC), CO, Nox, Non-methane volatile organic compounds (NMVOCs) and Sulfates | CO2, CH4, N2O | CO2 | CO2 from fossil fuel | CO2 (Non-CO2 gases are excluded due to low accurate activity data) |

[1] Gold Standard cookstoves improved efficiency:
https://globalgoals.goldstandard.org/standards/412_V1.1_ICS_SLCP_Black-Carbon-and-Co-emitted-Species-due-to-the-replacement-of-less-efficient-cookstoves-with-improved-efficiency-cookstoves.pdf
[2] Gold Standard animal manure management and biogas for thermal energy:
https://globalgoals.goldstandard.org/433-ee-ics-methodology-for-animal-manure-management-and-biogas-use-for-thermal-energy-generation/
[3] AMS-I.E ver 9. Thermal energy production with or without electricity:
https://cdm.unfccc.int/methodologies/DB/JB9J7XDIJ3298CLGZ1279ZMB2Y4NPQ
[4]Energy efficiency measures in thermal applications of non-renewable biomass
https://cdm.unfccc.int/UserManagement/FileStorage/SG39AKEL4B2H5UJVPD86XN0I7OR1ZQ

**CER deduction calculation**

Based on the double-counting analysis a total of 123,055 CER units issued in the CDM projects has been calculated for deduction from the total ERs reported for the FCPF Carbon Fund ER Program for the reporting period from June 22, 2018, to December 31, 2021 (See Below Table). It is essential to note that the CER calculation includes non-CO2 gases; therefore, the CER deduction specific to the Nepal FCPF ERP is adjusted by the ratio of CO2 emissions to the total gases released during litter burning. This ratio is used to calculate only the CO2 emission reductions, excluding other gases like CH4, N2O, and CO because non-CO2 gases are not included in the carbon accounting for the Nepal FCPF ERP. This ratio derives from the calculations of the carbon pool significance analysis. Additionally, it is important to clarify that the deduction of Certified Emission Reductions (CERs) is determined by the CERs requested during the Nepal FCPF Emission Reduction Program (ERP) reporting period. Specifically for the Nepal FCPF ERP, this deduction depends on the share of biogas units within the ERP carbon accounting area for projects 3, 4, 5, and 6, while for project 7, the area proportion is utilized. Lastly, for projects 1 and 2, no deduction is made because, in the first case, there is no overlap between project boundaries, and for the second, there is no crediting period overlap. The calculation process of the CER deduction can be consulted in the Nepal_TAL_Integration_tool_V6, worksheet "DubleCounting", at the following link:

https://docs.google.com/spreadsheets/d/1yV0gmmYaYZj8O4Eg7loG_DmbZ9uIyZIY/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

| Number | Project | Crediting period | CERs requested | CER requested dates | Project Boundary | FCPF ERP boundary | Project boundary overlapping | Crediting period overapping with 1st ERMR (years) - 22/6/2018-31/12/2021 | Deduction tCO2 [5] [6] |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Improved Cook Stove Programme with Carbon Finance (ICF), Nepal 9811 | 22/05/2013 - 23/05/2023 | 129,132 | 19/12/2013-01/4/2017 | Districts Doti, Dadeldhura, Baitadi, Achham, Darchula, Bajhang & Bajura | | No | Yes | 0 |
| 2 | Promotion of the Improved Cooking Stove (ICS) 9902 | 2022-2029 | - | - | All 75 districts of Nepal | | Yes | No | 0 |
| 3 | Biogas Support Program - Nepal (BSP-Nepal) Activity-1 | 01/08/2018-31/07/2025 | 78,586 | 01/08/2018-31/12/2020 | 57 districts of Nepal | Rautahat, Bara, Parsa, Chitwan, Nawalparasi, Rupandehi, Kapilbastu, Dang, Banke, Bardia, Kailali, Kanchanpur | Yes | Yes | 23,203 |
| 4 | Biogas Support Program - Nepal (BSP-Nepal) Activity-2 | 01/08/2019-31/07/2026 | 41,607 | 01/08/2019-31/12/2020 | | | Yes | Yes | 12,285 |
| 5 | Biogas Support Program - Nepal Activity-3 | 13/12/2018 - 12/12/2025 | 140,025 | 13/12/2018-31/12/2020 | Districts in three regions: i)Remote/High Hills, ii) Hills and iii) Terai regions. | | Yes | Yes | 44,075 |
| 6 | Biogas Support Program - Nepal Activity-4 | | 134,736 | 13/12/2018-31/12/2020 | | | Yes | Yes | 42,411 |
| 7 | Efficient Fuel Wood Cooking Stoves Project in Foothills and Plains of Central Region of Nepal 4530 | 2011-2020 | 27,053 | 01/01/2013-31/12/2020 | Parsa, Bara, Rautahat, Sarlahi, Mahottari, and Dhanusa | | Yes | Yes | 1,081 |

**VCM Projects listed in the Verra registry and issue of double counting.**

The MRV team checked the Verra database and when filtered for Nepal, the Verra database shows no entries registered under the category 'Agriculture, Forestry and Land Use. (https://registry.verra.org/app/search/VCS/Registered) When the team filtered the database to include all projects within Nepal on AFOLU, there is only one (ID: 4046) but has the status "Registration and verification approval requested". The Government of Nepal, through the NDA for carbon trade, the Ministry of Forests and Environment, has issued a public notice informing all concerned parties that any initiative to implement carbon trading is against the prevailing law and subject to penalties (https://mofe.gov.np/notices/details/%E0%A4%B5%E0%A4%BF%E0%A4%9C%E0%A5%8D%E0%A4%9E%E0%A4%AA%E0%A5%8D%E0%A4%A4%E0%A4%BF-%E0%A5%A4-0417). Given this context, there is no potential for double counting from the mentioned VCS projects.

# 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)

INTENTIONALLY LEFT BLANK

The section has been left blank because there have been no 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).

## 7.2 Quantification of Reversals during the Reporting Period

**Intentionally left blank, reversals have not occurred in previous reporting periods.**

| | | | | |
|---|---|---|---|---|
| **A.** | **ER Program Reference Level for this Reporting Period ($tCO_2$-e)** | *from section 4.1* | | |
| **B.** | **ER Program Reference Level for all previous Reporting Periods in the ERPA (tCO2-e).** | *from section 4.1 of previous ER Monitoring Reports* | | + |
| **C.** | **Cumulative Reference Level Emissions for all Reporting Periods [A + B]** | | | |
| **D.** | **Estimation of emissions by sources and removals by sinks for this Reporting Period ($tCO_2$-e)** | *from section 4.2* | | |
| **E.** | **Estimation of emissions by sources and removals by sinks for all previous Reporting Periods in the ERPA ($tCO_2$-e)** | *From section 4.2 of previous ER Monitoring Reports* | | |
| **F.** | **Cumulative emissions by sources and removals by sinks including the current reporting period (as an aggregate accumulated since the Crediting Period Start Date) [D + E]** | | | – |

| | | | |
|---|---|---|---|
| **G.** | **Cumulative quantity of Total ERs estimated including the current reporting period (as an aggregate of ERs accumulated since the Crediting Period Start Date) [C – F]** | | |
| **H.** | **Cumulative quantity of Total ERs estimated for prior reporting periods (as an aggregate of ERs accumulated since the Crediting Period Start Date)** | *from previous ER Monitoring Reports* | |
| **I.** | **[G – H], negative number indicates Reversals** | | |
| **If I. above is negative and reversals have occurred complete the following:** | | | |
| **J.** | **Cumulative quantity FCPF ERs (as an aggregate of FCPF ERs accumulated since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 8* | |
| **K.** | **Cumulative ER Program´s Pooled Reversal Buffer contributions (as an aggregate of Pooled Reversal Buffer ERs accumulated since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 8* | |
| **L.** | **Cumulative ER Program´s Uncertainty Buffer contributions (as an aggregate of Uncertainty Buffer ERs accumulated since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 8* | |
| **M.** | **Cumulative ER Program´s Pooled Reversal Buffer replenishments (as an aggregate of Reversal Buffer ERs replenished since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 7.3* | |
| **N.** | **Cumulative amount of FCPF ERs , Uncertainty and Pooled Reversal Buffer contributions and replenishments (as an aggregate since the Crediting Period Start Date) [J + K + L + M ]** | | |

| | | | |
|---|---|---|---|
| **O.** | **Quantity of Buffer ERs to be canceled from the Pooled Reversal Buffer account [If I < N, report the value of I; if I > N, report the value of N]** | | |

### 7.3 Quantification of pooled reversal buffer replenishments

Intentionally left blank, reversals have not occurred in previous reporting periods.

| | | | |
|---|---|---|---|
| **A.** | **Emission Reductions during the Reporting period (tCO2-e)** | *from section 4.3* | |
| **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)** | | |
| **C.** | **Number of Emission Reductions estimated using measurement approaches (A-B)** | | - |
| **D.** | **Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested** | *from section 6.1* | |
| **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* | |
| **F.** | **Cumulative Pooled Reversal Buffer cancellations (as an aggregate since the Crediting Period Start Date)** | *from previous ER monitoring reports section 7.2, O* | |

| | | | |
|---|---|---|---|
| **G.** | **Cumulative ER Program´s Pooled Reversal Buffer contributions (as an aggregate of Pooled Reversal Buffer ERs accumulated since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 8* | |
| **H.** | **Proportion of cumulative Pooled Reversal Buffer cancellations/cumulative Pooled Reversal Buffer contributions [F / G]** | | #DIV/0! |
| **I.** | **Year of the Crediting Period where the latest reversal took place (e.g., 1,2,3…)** | *from previous ER monitoring reports* | |
| **J.** | **Cumulative Pooled Reversal Buffer cancellations (as an aggregate since the Crediting Period Start Date)** | *from previous ER monitoring reports and section 7.2, O* | |
| **K.** | **Cumulative previous Pooled Reversal Buffer replenishments (as an aggregate since the Crediting Period Start Date)** | *from previous ER monitoring reports, section 7.3 Q* | |
| **L.** | **Proportion of cumulative previous Pooled Reversal Buffer replenishments/cumulative Pooled Reversal Buffer cancellations [K / J]** | | #DIV/0! |
| **Complete either a), b) or c) below, depending on the situation, to estimate the amount of the replenishment:** | | | |
| **M.** | **a) If L < 0.5, Pooled Buffer replenishments equal (B+C)*D-E, noting that the replenishment should not be larger than the value of J-K** | | #DIV/0! |
| **N.** | **b) If L> 0.5, indicate the percentage of ERs generated that you wish to convert to Total ERs [0 to 0.3]** | | |
| **O.** | **Pooled Buffer replenishments [(B+C)*(D-E)*N], noting that the replenishment should not be larger than the absolute value of J-K** | | |

| | | |
|---|---|---|
| **P.** | **c) If the latest reversal has taken place from the third year of the Crediting Period on (as per L above) or if it represents more than 50% of the current net Pooled Reversal Buffer contributions (as per H above), Pooled Buffer replenishments equal (B+C)*D-E, noting that the replenishment should not be larger than the absolute value of J-K** | #DIV/0! |
| **Q.** | **Total Pooled Reversal Buffer replenishment for the reporting period** | #DIV/0! |

### 7.4 Reversal risk assessment

The ER-PD development team estimated that the risk of reversal, both natural and human-induced, was 11%. However, this estimate did not account for the default risk value of 10%. Therefore, the risk of reversal was reviewed and revised. The FCPF Buffer Guidelines were used to determine acceptable values, and the discounts were applied accordingly. The updated estimate of the overall risk due to reversals is 16%.

.

| 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** | Stakeholders have been engaged throughout the REDD+ process with multiple consultations at all levels. There is broad support for the ER Program across stakeholder groups.<br>There is a low risk of land conflict with the handover of forests to the communities, and the chances of internal migrations and forest land encroachments are also low. At places in the ERPA area, localized instances of forest land encroachment were observed. To address this, the government has put in place an institutional mechanism that includes the Ministry of Home Affairs, Ministry of Forests and Environment, Nepal Police and Provincial governments. Furthermore, handing over of the national forests to CBFM groups will result in management and protection of forest areas.<br>Nepal has recently formulated National Land Use Act 2019 and Land Use Regulation 2022. The Land Use Act has provision to safeguard land use classes and it requires a | **10%** | *10%* | *0%* |

| | | | | |
|---|---|---|---|---|
| | rigorous process to change and transform land use from one class to another. | | | |
| **Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination** | The forests are managed by 84 Division Forest Offices (DFOs) and 528 sub-division Forest Offices which are under the jurisdiction of the Provinces since 2018. This has enhanced the capacity of the provincial ministry and institutions to effectively carry out the mandates stipulated in the Nepal's constitution, Forest Act and Forest Regulation. The local levels have started establishing 'Forest and Environment Section' to implement the responsibilities as per the Forest Act and the Forest Regulation. These agencies are responsible for horizontal and vertical coordination. Since forest management is a concurrent power between federal, provincial and local governments, the Federation, Province and Local Level (Coordination and Inter-relation) Act, 2020, ensures collaboration between the three levels. In addition, Forest Act, pursuant to clause 121, has mandated that province and federal forestry sector bodies coordinate and collaborate on forest and forestry issues. This risk has been classified as low.<br>There is a broad buy-in for the ERPD process, and Annex 10 shows the strong level of commitment across ministries for the ER Program.<br>However, the evolving process of devolution represents a risk in terms of the vertical collaboration between the federal, provincial, local l and the community levels. The government is mitigating this risk through the development of a risk matrix that provides options for ERPD implementation under the different institutional arrangements that might emerge. | **10%** | *10%* | *0%* |
| **Lack of long term effectiveness in addressing underlying drivers** | Several factors may impact the risk of reversals due to a lack of long-term effectiveness in addressing the underlying drivers. These have overall been assessed to be low risk.<br>Infrastructure: The demand for infrastructure will keep growing with the growth in population. This risk is mitigated through land use planning intervention, which will help to minimize deforestation that may result from infrastructure development.<br>Trade disruption and road blockages resulting in demand for fuelwood: Nepal is a landlocked country and is dependent on neighboring countries for trade. Any delay in trade and transit arrangements may exert undue pressure on forests for various issues including fuel. Nepal has substantially increased hydropower capacity and is diversifying its energy mix by expanding biogas and solar programs, which will provide alternative energy sources and minimize the pressure on forests for fuelwood.<br>Uncontrolled grazing due to increased stray cattle: The handover of forests to communities will reduce the risks of uncontrolled grazing , but the stray cattle, especially oxen, may lead to uncontrolled grazing to some extent.<br>Nepal has developed government policies aimed at addressing climate change impacts. These include progressive NDC with sectoral goals, NDC implementation plans, long-term strategies, and environmental regulations addressing issues such as carbon trading, reducing | **5%** | *2%* | *3%* |

| | | | | |
|---|---|---|---|---|
| | deforestation, forest degradation, and environmental preservation.<br>Moreover, activities such as forest clearance by ranchers are not permitted in Nepal. The community forests are primarily focused on forest conservation, and therefore, grazing is strictly regulated. Most community forests do not allow cattle grazing, and to enforce this, many have implemented fencing. Divisional Forest Offices (DFOs) regularly assist Community Forest User Groups (CFUG) in installing fences to protect the forests from uncontrolled grazing. The Forest Operation Plans of CFUGs include a grazing management scheme and the practice of stall feeding for cattle. Additionally, communities receive support from DFOs to plant fodder trees in their farmlands. | | | |
| **Exposure and vulnerability to natural disturbances** | Several factors affect the risk due to climate-related and non- anthropogenic impacts. Overall, these have been given a low risk<br>Increased demand for timber due to non-climatic hazards such as earthquakes: Nepal lies in a seismic zone and there is potential of a big earthquake in the western region. The earthquake that struck Nepal in April 2015 saw an increased demand for home construction which caused limited pressure on forests for timber. The interventions proposed here should significantly increase the supply of timber, and this risk is considered to be low.<br>Floods, soil erosion, and landslides in riverine forest areas: Though there is the possibility of floods and soil erosion, the impact on forest loss has historically been low. Similarly, there is a chance of forest degradation on hill slopes, but generally, areas that have less vegetation bear the brunt of landslides compared to forested areas that hold the soil.<br>Climate change and droughts: Nepal faced acute droughts in 2009 and during winter and summer periods in 2016. The droughts have not impacted forest areas because there has been no demand for expansion of agricultural land and direct impact on tree mortality due to droughts. The ERPD also proposes several interventions to increase understanding of climate vulnerability and to address climate change impacts through improved tree species selection.<br>Forest Fire: the frequency and intensity of forest fires are increasing due to the impact of climate change. However, the majority of forest areas are under the CBFM and this has ensured timely action to mitigate the impact and losses from the forest fires. Further, the DFOs are well-equipped and are effectively managing forest fire incidents in collaboration with local communities.<br>Despite Nepal's anticipation of several potential risks to its forests and changes in product usage patterns following a disaster, they are currently unable to address these risks. This is due to the absence of data from reliable monitoring systems or studies, as well as a lack of long-term, strategic approaches to managing forests' vulnerability to climate change. There are still information, planning, and program design gaps that need to be filled to effectively address this challenge.<br>In the context of addressing the risk of forest fires in Nepal, it is important to note that previous assessments did not | **5%** | *2%* | *3%* |

| | | | | |
|---|---|---|---|---|
| | consider fires to be a significant source of historical emissions. Additionally, there is insufficient information to fully assess the impact of fires in the Terai on forests or emissions. While it's difficult to definitively determine whether fires pose a substantial risk of reversal based on existing information, it is worth noting that there has not been a documented case of stand-replacing fire in Nepal. This suggests that fire impacts on Nepal's forests are generally of low intensity, primarily affecting surface fuel while leaving the canopy mostly intact. | | | |
| | | **Total reversal risk set-aside percentage** | | *16%* |
| | | **Total reversal risk set-aside percentage from ER-PD or previous monitoring report (whichever is more recent)** | | *11* |

## 8. EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

| | | | 2018 | 2019 | 2020 | 2021 | Total |
|---|---|---|---|---|---|---|---|
| **A.** | **Emission Reductions during the Reporting period ($tCO_2$-e)** | *from section 4.3* | 311 407 | 700 783 | 811 189 | 921 596 | 2 744 975 |
| **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)** | | 0 | 0 | 0 | 0 | 0 |
| **C.** | **Number of Emission Reductions estimated using measurement approaches (A-B)** | | 311 407 | 700 783 | 811 189 | 921 596 | 2 744 975 |
| **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% | 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* | 16 227 | 30 763 | 30 763 | 30 763 | 108 516 |
| | **If applicable, any buffer replenishments** | *section 7.3 P* | 0 | 0 | 0 | 0 | 0 |
| **F.** | **Total ERs [(B+C)*D-E] minus, if applicable, any replenishments as per section 7.3, Q** | | 295 180 | 670 020 | 780 426 | 890 833 | 2 636 459 |
| **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% | 15% | 15% |
| **H.** | **Quantity of ERs to be allocated to the Uncertainty Reversal Buffer (0.15*B/A*F)+(G*C/A*F)** | | 44 277 | 100 503 | 117 063 | 133 624 | 395 467 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **I.** | **Total reversal risk set-aside percentage applied to the ER program** | *from section 7.4* | 16% | 16% | 16% | 16% | 16% |
| **J.** | **Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*I** | | 40 144 | 91 122 | 106 138 | 121 153 | 358 557 |
| **K.** | **Number of FCPF ERs (F- H – J)** | | 210 759 | 478 395 | 557 225 | 636 056 | 1 882 435 |
| **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* | 48.4265959% | 56.5518855% | 62.4653441% | 66.9619877% | |
| **M** | **Number of FCPF ERs from enhanced removals from afforestation/reforestation (L * K) [Optional if the country wishes to generate enhanced removals]** | | 102 063 | 270 541 | 348 072 | 425 915 | 1 146 591 |
| **N** | **Percentage of Emission reductions from HFLD [Optional if the country wishes to label HFLD units]** | *From section 4.3* | 0% | 0% | 0% | 0% | 0% |
| **O** | **Number of FCPF ERs from HFLD (L * K) [Optional if the country wishes to label HFLD units]** | | 0 | 0 | 0 | 0 | 0 |

# ANNEX 1: INFORMATION ON THE IMPLEMENTATION OF THE SAFEGUARDS PLANS

## I. Requirements of FCPF on Managing the Environmental and Social Aspects of ER Programs

### 1. Environmental and Social Management Framework (ESMF) for ER Program

The implementation of the E&S Safeguard Plans is critical to the success of the Nepal ER program. The General Conditions Applicable to ERPAs, Section 5.01(b)(i), requires the Program Entity to "*provide evidence satisfactory to the Trustee that the ER Program Measure(s) are being implemented in accordance with the Safeguards Plans.*" Section 16.01(vii) asserts that "*failure to observe, implement and meet all requirements contained in . . . a Safeguards Plan provided for under the ERPA (including any feedback and grievance redress mechanism provided for under the ER program, the Benefit Sharing Plan and/or a Safeguards Plan)*" is considered an Event of Default on the part of the Program Entity.

**From early on in the REDD+ preparation phase (R-PP), Nepal has been engaged in identifying and addressing the social and environmental risks associated with REDD programs and devising mitigation measures in addressing them.** For the implementation of the REDD project, Nepal developed the Framework for Strategic Environmental and Social Assessment (SESA) and Environmental and Social Management Framework (ESMF) which provided a solid analysis of the baseline conditions (environmental; climate; social; legislative, regulatory and policy regime, and institutional situation relevant to REDD+) and a solid analysis of environmental and social impacts likely to be associated with REDD+ in Nepal. Concurrent with the development of ERPD, the MoFE also approved Nepal REDD+ Strategy 2018-2022. The Strategy outlines REDD+ safeguard framework. The Strategy also acknowledges the potential positive and negative environmental and social impacts from implementation of REDD+ programs.

Building on this foundation, Nepal's REDD Implementation Centre adopted the Environmental and Social Management Framework (ESMF) for the ER Program in Terai Arc Landscape in 2019[75] to address social and environmental risks of the program. The ESMF identifies the World Bank's operational policies that are triggered by the seven interventions of this ER program. It also identifies other additional frameworks, especially the Cancun Safeguards Principles, that are applicable to REDD+ implementation. In addition, there are national and international policies and legislations which are relevant in managing the environmental and social safeguards issues in the ER Program. These policies and regulations include: The Constitution of Nepal, 2015; National Forest Policy, 2015; Forestry Sector Strategy (2016 - 2025); National Environmental Policy, 2019; National REDD+ Strategy 2018; Forest Act, 2019; Environment Protection Act, 2019. Being a member country of the UNFCCC and UN-REDD, Nepal also subscribes to seven UNFCCC safeguards for REDD+, known as Cancun REDD+ safeguards while implementing any REDD+ program activities.

The ESMF identifies that seven of the World Bank's 10 operational policies are triggered by the ER program's interventions (Annex Table 1).

**Annex Table 1. World Bank Safeguard Policies Triggered by ER Program Interventions**

| Operational Policy | Trigger | | ER Program Interventions that Trigger the Policy |
|---|---|---|---|
| | Yes | No | |
| 1. Environmental Assessment (OP/BP4.01) | X | | 1, 2, 3, 4, 5, 6 |
| 2. Natural habitats (OP/BP 4.04) | X | | 1, 2, 7 |
| 3. Forests (OP/BP 4.36) | X | | 1, 2, 3, 5, 6 |

[75] REDD IC. 2019. Environmental and Social Management Framework for the Proposed Emission Reduction Program Interventions in the Terai Arc Landscape. Kathmandu: REDD IC (REDD Implementation Center). Available at https://www.forestcarbonpartnership.org/system/files/documents/NEPAL%20ER%20Program%20ESMF%20October%202019%20for%20FCPF%20website.pdf

| | | | |
|---|---|---|---|
| 4. Pest management (OP/BP 4.09) | X | | 3, 5 |
| 5. Physical cultural resources (OP/BP4.11) | X | | 6 |
| 6. Indigenous peoples (OP/BP4.10) | X | | 1, 2, 4, 5, 6, 7 |
| 7. Involuntary resettlement (OP/BP 4.12) | X | | 1, 5, 7 |
| 8. Safety of dams (OP/BP4.37) | | X | - |
| 9. Projects on international waterways (OP/BP 7.50) | | X | - |
| 10. Projects on disputed areas (OP/BP7.60) | | X | - |

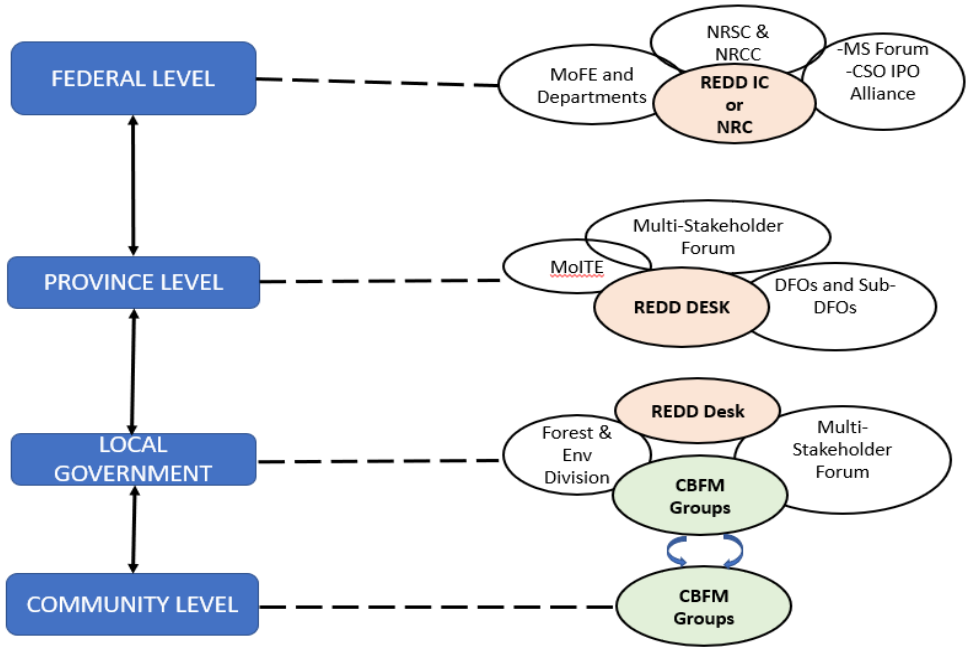
The ESMF 2019 outlines Nepal's regulatory framework and its overarching approach to addressing social and environmental risks—thereby addressing the World Bank safeguard policies and safeguard commitments vis-à-vis Cancun principles. Subsequently, the ESMF recommends mitigation measures to social and environment risks (Chapter 4), indigenous and vulnerable community development framework (chapter 5), gender mainstreaming plan (Chapter 6), decent work planning framework (Chapter 7), and resettlement policy framework (Chapter 8), even though the ER program interventions do not require land or property acquisition in an involuntary manner.

The ESMF then presents a "process framework" (Chapter 9), outlining process and procedures for addressing aspects such as resource access, the identification of vulnerable groups, assistance to communities, and grievance redress mechanism. Subsequently, in Chapter 10, the ESMF presents an implementation framework – including institutional framework, stakeholder engagement plan, grievance redress mechanism, and training and capacity building framework.

**INSTITUTIONAL ARRANGEMENT FOR E&S RISK MANAGEMENT**

The Institutional arrangements for the implementation of safeguard plans is shown in Figure 6, followed by brief discussions on key components. Nepal ER Program's ESMF has been implemented through an institutional arrangement, engaging three tiers of governments (federal, provincial, and local levels) and the local communities. The structure is consistent with relevant constitutional and legal provisions on the allocation of jurisdictions and division of power between the different tiers of government. The budget for the implementation of ESMF recommendations and monitoring of the safeguard system is included in the ER program implementation budget.

**Figure 6. Institutional Arrangement for ESMF Implementation**




Source: adapted from REDD IC. 2019. Environmental and Social Management Framework, p.128

**Federal Level Mechanism**

- At the federal / national level, National REDD+ Steering Committee (NRSC)[76] , national REDD+ Coordination Committee (NRCC)[77], REDD+ Multistakeholder Forum[78], and a REDD+ CSOs and IPOs Alliance[79] are supporting REDD IC[80] to implement the Nepal ER Program and its environmental and social risk management activities. REDD IC is the REDD+ programs management entity and is responsible for implementing ER program effectively.

[76] NRSC is chaired by the Minister of Forests and Environment and consists of secretaries of five federal Ministries, the National Planning Commission, National Natural Resources and Fiscal Commission, three representatives from the networks of local governments, seven provincial secretaries (Ministry of Industry, Tourism, Forests and Environment) as well as up to six representatives (at least two women) from civil society organizations drawn up from amongst IPs and other communities engaged in forest resource management. The Head of NRC serves as its Member Secretary.

[77] NRCC has been established as per the provision of National REDD+ strategy, 2018 and is chaired by the Secretary of MoFE, and other members consist of Joint Secretaries and Director Generals of MoFE's departments, Chief of Forest Research and Training Center as well as up to nine representatives (at least three women) from civil society organizations drawn up from amongst IPs and other communities engaged in forest resource management. The Head of NRC serves as its Member Secretary. The NRCC is mandated to make decisions on technical matters such as endorsing research documents, implementation, and monitoring of REDD+ programs and recommending the agenda for NRCC meetings.

[78] REDD+ Multistakeholder Forum consists of representatives from the private sector, civil society, media, government organizations, community-based organizations, IP organizations, local and international NGOs, donors, academic and research institutions.

[79] REDD+ CSOs and IPOs Alliance is a platform for raising rights issues and concerns of indigenous Dalit and vulnerable groups. The Alliance develops a common understanding on REDD+ on behalf of women, IP organizations, Madhesis, Dalits and CSOs through discussion.

[80] Existing REDD+ Implementation Center is re-envisioned as National REDD+ Center (NRC) to function as the primary operational body in the federal level to provide national program leadership, coordinate ER program planning, and bridge province and district-level planning and priorities under the National REDD+ Strategy.

- A permanent E&S safeguard unit has been proposed at the REDD IC with dedicated environmental and social specialists for E & S risk management in the Organization and Management (O&M) report, but which is pending endorsement by the Government of Nepal (GoN, Cabinet level decision). Decision on this is expected within six months. The proposed unit will constitute one Undersecretary and two forest officials, E&S specialist, gender focal person.

- As of now a functional mechanism for safeguards is already operational at the REDD IC. The Climate Management section of REDD IC, led by an Undersecretary (Tech.) is designated for safeguards. A Forest Officer from the Climate Management section serves as the focal person for safeguards. Additionally, one social and one environmental safeguard expert/consultant support REDD IC on an intermittent basis. The specialists, focal person, and staff of REDD IC are receiving training on E&S risk management regularly.

**Provincial Level Mechanism**

- The provincial Ministry of Industry, Tourism, Forests and Environment (MoITFE) in each of Nepal's seven provinces has established provincial-level REDD+ Desks within the Provincial Forest Directorate. These desks are responsible for coordinating efforts and facilitating dialogues with various stakeholders through the Multistakeholder Forum. REDD desk includes one Undersecretary, one forest official and one technician (Ranger).
- Division Forest Offices in ERP districts have dedicated REDD desk that, among others, also manage safeguard activities and coordination with provincial and local governments. REDD desk has dedicated team consisting of REDD focal person, GESI focal person.
- REDD Desk focal persons in both province and Division Forest Offices receive regular training on sustainable forest management and E&S risk management. In Madhesh and Lumbini Provinces, which are part of the Forests for Prosperity Program (FFPP), REDD Desk focal persons coordinate with the RIC and Provincial Project Management Unit (PPMU) Environmental and Social Safeguards consultants on safeguard-related issues. A safeguards unit is being proposed for the Provincial Ministries under the ER program.

**Local Level Mechanism**

- Forest and Environment Section/Division of local governments (Rural Municipality, Municipality, Sub-Metropolitan City, or Metropolitan City. They are tasked with coordinating the REDD+ interventions and E&S risk management measures/activities in their respective local government jurisdictions.

**Community Level Mechanism**

- At the community level, community-based forest management (CBFM) groups (such as community forest users, collaborative forest users, buffer zone users, leasehold forest users, etc.) with technical guidance from Division Forest Offices implement REDD+ activities, including the E&S risk management activities, as outlined in their respective forest management plans.

- CBFM groups also participate in conversations at the local government level processes and raise their concerns and voice and make reasonable demands.

**BUDGET:**

The REDD IC has dedicated budget for ERP-related E&S safeguard activities. Provincial governments also allocate budgets for E&S activities through their regular budget line from which ERP related E&S activities are implemented. Division Forest Offices implements E&S activities through regular budget received from the federal and provincial level governments. However, after federalization there are budget gaps at provincial and DFO level.

**E&S ASSESSMENT AND FINDINGS FOR RETROACTIVE CREDIT**

The Safeguards Consistency study was carried out by REDD IC which was conducted in 2021-22 documented the ER program's actions and their material consistency with the ESMF. This assessment covered mainly interventions 1 and 2 of the ER Program as these two interventions were being already implemented and considered for retroactive ER credit. ERPA was signed only in February 2021 therefore in Interventions 1 and 2 of ER program was being implemented as regular programs of the government, which were not focused to Emission Reduction under the REDD+ initiatives and therefore, Environmental and Social Safeguards was not being implemented as per the requirements of WB . In this context, compliance of various safeguards standards was not mandatory resulting in limited records of various environmental and social safeguards measures applied in the field**.** This assessment evaluated the implementation of safeguards in order to ascertain material consistency of the activities implemented under the ER program interventions 1 (Improve management practices in existing community and collaborative forests, including by building on traditional and customary practices) and 2 (Localize forest governance through transfer of government forests to Community and Collaborative Forest User Groups) from June 2018 with applicable environmental and social safeguards principles and procedures provided in the ESMF, and recommend measures to address gaps through an Action Plan for future implementation.[81]

The assessment however had limitations in terms of documentation and data to support the findings this gap assessment and consistency study. The assessment as such was qualitative due to comparatively limited data and documentation at the field level. Another reason for limited data was due to the recent changes in the government structure and the restructuring of districts forest offices to Division Forest Offices where most of these Division Forest Offices have not been able to organize themselves.

However, despite the lack of documentation, reporting, and data; field observations, stakeholder consultations, and reviews of IEE reports and the Forest Operation Plan revealed that specific measures in the ESMF and several Safeguards Plans, such as ESMPs, are being implemented."

Table 2. provides overview of these measures implemented and evaluated and gaps identified as part of E&S consistency report.

Table 2. E&S measures implemented, and GAPs identified by consistency report

| SN | ESMF Suggested mitigation measures. | Measures implemented first accounting period (Retroactive) | Identified Gaps |
|---|---|---|---|
| 1 | • Environmental and Social risk screening of all sub-project activities should be conducted | • Scoping exercise as required by the Environment Protection Regulations 2020 were done. | • Environmental and Social risk screening of sub-project activities was not conducted as prescribed in the ESMF. |

[81] REDD IC. 2022. Nepal Emission Reduction Program: Environmental and Social Safeguards Consistency and Gap Assessment Report or Program Interventions for the Retroactive GHG Emission Reduction Crediting. May 2022. Kathmandu: REDD Implementation Center, May 2022. This assessment also served to determine whether implementation of ER interventions as well as safeguards principles justified for ER Program's retroactive claims for ER credits from FCPF, specifically for the period between ERPD adoption (June 2018) and ERPA date (Feb 2021).

| | | | |
|---|---|---|---|
| 2 | • Prepare IEE or EIA as required by the Environmental Protection Act of the country. | • All Community Forest User Groups and Collaborative Forest User Groups implementing SFM have prepared IEE, or EIA as required by the Environment Protection Act.<br>• IEE or EIA have been prepared and approved for the Forests managed under the Block Forest Management as well<br>• IEE and EIA are prepared as required by the Environment Protection Act 2019 and Environment Protection Regulations 2020.<br>• IEE and EIA are approved by MoFE | Fully consistent |
| **3** | • Maintain mixed forests to the extent possible while implementing harvesting operations following principles of SFM.<br>• Maintain record of pre- harvesting species composition for future reference | • Forest User Groups are aware that complete monoculture is not good from environmental and ecological point of view and therefore, they have tried to keep mix forests considering the biodiversity as far as possible during different operations. In most cases, natural regeneration is very good and therefore plantation is not required. When it is required, local native species are preferred in plantation.<br>• Most of the forests where SFM are being implemented are Sal forests where Sal is the dominant species that has reached the Steady state. SFM practices therefore are focused to the Sal. However, during mother tree selection as well as regeneration protection and thinning, 10-20 percent of other species are retained whenever it is possible. Pre- harvesting record of all species are well mentioned. | Fully consistent |
| **4** | • Biodiversity-rich and wildlife hotspot should be protected excluding such areas from harvesting sites.<br>• Harvesting should be carried out ensuring natural regrowth, avoiding damage to regeneration and biodiversity protection.<br>• Law enforcement should be applied effectively to control encroachment and other illegal activities. | • Biodiversity rich areas and hotspots are identified in the Forest Management Plans and completely protected.<br>• Any harvesting activities are not being carried out in these areas. For example, forest areas with Bijaya Sal are protected and excluded from the harvesting blocks (signhapur CF, Kanchanpur, Jaya Durga CF, Banke)<br>• FUGs are trying various approaches including law enforcement to control encroachment if required. There are so many examples in different districts where FUGs were able to reclaim encroached forest area with mutual agreement at local level (Bhulkepanik CF, Rupandehi, Jaya Durga CF, Banke, Jana Jagriti CF, Kailali, Singhpur CF, Kanchanpur). | Fully consistent |

| | | | |
|---|---|---|---|
| **5** | • Cleaning and weeding operations should be conducted to avoid invasion of unintended species to ensure natural regeneration and growth of major tree species. | • Special attention has been given to control the growth of invasive species in the open area (felled area)<br>• Regular cleaning and weeding operations are being conducted. | Fully consistent |
| **6** | • Mitigation measures should be applied to maintain the resilience of the forests that may be reduced because of selective logging and pests and pathogens.<br>• Pest and pathogen control protocol need to be developed | • Biodiversity rich hotspots are protected.<br>• Any pest/insect outbreaks are not observed until now. In case of such outbreaks, biological pests and pathogens control mechanism will be applied.<br>• | Pest and pathogen control protocol has not been developed |
| **7** | • Harvesting protocol should be developed and applied to minimize harvesting damages | • FUGs are following Scientific Forest Management Guidelines.<br>• Trained labor has been used in harvesting.<br>• Heavy machineries are avoided as far as practicable in harvesting to reduce the damages related to harvesting. | Harvesting protocol has not been developed |
| **8** | • Riverbanks and other flood and erosion prone area should be protected from harvesting activities. | • All the riverbanks and other flood and erosion prone areas have been protected from any harvesting activities. | Fully consistent |
| **9** | • Debris and slash should be managed to prevent forest fire.<br>• Fireline's should be constructed and maintained.<br>• An effective participatory monitoring system should be developed. | • After harvesting, debris and slash are removed from the area regularly.<br>• Fireline are constructed as required and maintained to control fire incidence.<br>• Local people are mobilized for monitoring.<br>• In many Community Forests, Watch Towers have been built, which are used to watch fire incidence as well as other illegal activities. Number of Forest Watchers are hired. | Fully consistent |
| 10 | • It should be ensured that local people and communities including Indigenous People of the area can be involved and participate in implementation of the activities. | • When Community Forests or Collaborative Forests Users Groups are formed, respective guidelines[16] are followed which ensures the involvement and participation of concerned local people and communities including indigenous people. | Fully consistent |

| | | | |
|---|---|---|---|
| 11 | • It should be ensured that local and customary practices are not neglected during the implementation of the Forest Management Plans | • Forest Users Groups are using local and customary practices as far as practicable during implementation of the Forest Management Plans such as selective native species, collective system (work together in voluntary way) and others. This is provisioned in Forest Regulations, 2020. | Fully consistent |
| **12** | • Awareness of campaign on theory, principles, and outcomes of ER program should be conducted regularly so that people can understand the limitations of the ER program and realistic about its expected benefits. | • Province REDD Desk with the support from REDD IC has organized orientation and capacity building program on REDD Plus and ER Program to DFO staffs.<br>• REDD IC has planned to organize such programs in this fiscal year. | Division Forest Offices and Forestry Users Groups itself have not implemented as much awareness programs as required to disseminate the different aspects of the ER Program. |
| 4 | • Workers' safety protocol should be prepared and implemented complying with human rights and other safeguard principles | • The national law on labor has provisions for Workers' health and safety.<br>• Some FUGs have started groups insurance scheme for labors. | Forest Users Groups have not yet developed safety protocols, workers involved in harvesting of trees are not provided Personnel Protective Equipment (PPE) such as helmets, gloves, steel-caped shoes. Implementation of such protocols is weak due to financial constraints and lack of awareness. |
| 5 | • Local people should be capacitated through training programs on various aspects of Forest Management so that they can get employment opportunities. | Forest Users Groups supported by the government organize some basic awareness and training programs on forest management. . | However, skill-based training for local people focusing on the employment opportunities have not been organized |
| 6 | Specific sites (and species) that are culturally sensitive and important should be identified and protected from harvesting and other activities. | • Culturally sensitive and important sites and species are identified and recorded in the Management Plans. They are protected from harvesting and other activities. | Fully consistent |
| 7 | Specific sites that are important for forest dependent people (who collect edible forest products such as mushrooms and other NTFP) should be identified and protected so that livelihoods of forest dependent people arenot affected. | • Specific sites that are important for edible forest products and other NTFP are identified and protected as far as possible while implementing SFM. | Fully consistent |

| | | | |
|---|---|---|---|
| 8 | • Need for GRM | There is a default ongoing process through with CFUGs manage complaints and grievances with provisions for escalating unresolved complaints to Divisional Forest offices. | The process is not regularized and not documented |

The *environmental and social safeguards consistency and gap assessment report reveal that E&S risk management measures implemented for the interventions 1 and 2 were materially consistent with the procedures and provisions of the ESMF of the ER Program. However, the report also* recommends several corrective actions to improve E&S risk management, which includes:

Table 3: Status of corrective actions identified by Consistency Report

| S.N.1 | **Corrective action** | **Implementation status** |
|---|---|---|
| 1. | An Environmental and Social Safeguards unit with adequate staff will be established in the REDD IC /national entity responsible for implementation of the ER program and the ESMF. | A permanent unit has been proposed at the REDD IC with dedicated environmental and social specialists for E & S risk management in the Organization and Management (O&M) report, and this is pending endorsement by the Government of Nepal (GoN, Cabinet level decision). A decision on this is expected within six months. The proposed unit will constitute one Undersecretary and two forest officials, E&S specialist, gender focal person. The E&S experts hired through the Forests for Prosperity Project have been periodically conducting E&S monitoring and supervision of the ER Program ensuring compliance with the ESMF and helping to build the capacity of the REDD IC on E&S monitoring. |
| 2. | The responsible officer and other staff of the Unit will be provided with capacity-building training on Safeguards and ESMF implementation. | Capacity building activities are being conducted regularly under ERP program as well as through Forests for Prosperity Project supported by WB, Technical Assistance (TA) supported by UN REDD, and other donor agencies. |
| 3. | Responsible officer/Dedicated officer of the Provincial REDD Desk and other project implementation partners and stakeholders including Indigenous People and Local Communities will also be provided required trainings on Safeguards and implementation of the ESMF. | Trainings are being conducted regularly under ERP program as well as through other forestry related projects supported by WB, and other funding agencies. |
| 4. | An adequate budget will be allocated for implementation of the ESMF as provided in the ESMF report. | The REDD IC has dedicated budget for ERP-related E&S safeguard activities. Provincial governments also allocate budgets for E&S activities through their regular budget line from which ERP related E&S activities are implemented.<br>Division Forest Offices implements E&S activities through regular budget received from the federal and provincial level governments. However, after federalization there are budget gaps at provincial and DFO level. |
| 5. | Initial screening of the sub-project activities of the ER program including the SMF and preparation of other safeguards plans/instruments as required by the ESMF will be ensured before the formal commencement of the ER program. | Each DFO prepare a Division-level five-year periodic plans undergo an Initial Environmental Examination (IEE). The IEE report does not identify specific impacts and measures at the sub-project level, but it assesses, identifies potential E&S risks and offers mitigation measures for the overall plan. A letter/memo has also been circulated to all the DFOs in ERP districts by the REDD IC requesting the concerned agencies to ensure E&S the screening is conducted for all the sub-activities proposed in the CBFM group's Forest Operational Plan. |
| 6. | An effective coordination mechanism among the implementing partners will be developed and implemented. | REDD focal persons have been appointed at the Province Forest Directorate and within each Division Forest Office (DFO) in ERP area. These REDD focal persons also act as safeguards focal person for the program and provide implementation support as well as E&S support to the program. The REDD focal persons at the DFOs are responsible for |

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|---|---|---|
| | | coordinating with the Province Forest Directorate at the provincial level and the REDD Implementation Centre (REDD IC) at the federal level. However, the focal persons from the DFOs have not regularly provided the implementation support report and E&S monitoring report to the REDD IC. |
| 7. | Safeguards focal persons of all levels will be provided a platform for routine sharing of experiences to enhance quick adaptation to work requirements. | The REDD IC has been conducting training to the safeguards focal persons which have allowed some level of sharing and exchange of experiences between the focal persons. |
| 8. | Stakeholder sensitization and engagement will be ensured, which is necessary for successful implementation of the ESMF. | Through various events (trainings, orientations, etc. -the Annex Table 2) stakeholders are being sensitized on the implementation of ESMF and ERP to enhance their engagement in the process. However, due to budget constraints, only limited consultations and other awareness activities have been conducted. |
| 9. | Occupational Health and safety protocol of the ER program implementation will be developed and implemented to ensure health and safety of labors and other workers involved in the timber harvesting and other ER program activities. | Several OHS trainings are being delivered jointly by the REDD IC and World Bank targeting decision makers, technicians and stakeholders to ensure health and safety of labors and other workers involved in the timber harvesting and other ER program activities. Parallelly, guidelines are being developed to address the OHS issues in the forestry sector and is being piloted in a several areas. |
| 10. | A functional Grievance Redress Mechanism as suggested in the ESMF will be established. | GRM for ERP program is largely operational. Respective units at different levels (federal, provincial, DFO and community level/LGs) are handling grievances that come under their jurisdiction. Safeguard Information System (SIS), a Web-based grievance redress mechanism, operated by REDD IC (http://sis.redd.gov.np/sis) provides different channels to file a complaint, track resolution status and ensure transparency.<br>However, overall grievance handling and documentation practices in GRM process is not consistent and systematic across the institution. ERP program is in the process of strengthening the GRM documentation and reporting. |
| 11. | Gender and Social Inclusion aspects of the ER program interventions as suggested in the ESMF will be considered during the implementation of the program. | Gender and Social Inclusion aspects have been considered in implementation of the program including the BSP.<br><br>As set out in the gender action plan and the Forest Regulation, CFUGs have ensured at least 50% of the women's engagement with two key posts (either chairperson or secretary and vice-chairperson or treasurer) in their executive committee. Gender integration is promoted in the ER Program- related institutional arrangements, decision-making, and field forest management activities (e.g., A woman representing FUGs' network (FECOFUN) has been nominated as a member of the FDF Program Selection and Operation Committee).<br>Employment opportunities have been prioritized for women. |
| 12. | When handing over forests to the community, wider consultation with the stakeholders including Indigenous and Local Communities, will be conducted. Consultation will be conducted following the Principles and Procedure of Free, Prior, Informed Consent (FPIC). | Consultations with the concerned IPs and LCs are being carried out during the handover of the forests to the community. Additionally, REDD IC has recently prepared and publicly disclosed FPIC guideline to guide the ERP implementation. |
| 13. | Gender and Social Inclusion in formation of Forest User Committee, preparing and implementation of Forest Management Plans will be ensured. | As set out in the gender action plan and the Forest Regulation, CFUGs have ensured at least 50% of the women's engagement with two key posts (either chairperson or secretary and vice-chairperson or treasurer) in their executive committee. Gender integration is promoted in the ER Program- related institutional arrangements, decision-making, and field forest management activities (e.g., A woman representing FUGs' network (FECOFUN) has been nominated as a member of the FDF |

| | | |
|---|---|---|
| | | Program Selection and Operation Committee). Employment opportunities have been prioritized for women. |
| 14. | Screening of subproject activities will be conducted, and IEE/EIA will be prepared as required. | A letter/memo has also been circulated to all the DFOs in ERP districts by the REDD IC requesting the concerned agencies to ensure E&S the screening is conducted for all the sub-activities proposed in the plan while it is being renewed and to incorporate/implement the necessary mitigation measures. |
| 15. | Various Safeguards Plans – such as Indigenous People Plan, Gender Mainstreaming Action Plan, Safety Protocol, Grievance Redress Mechanism, Capacity Building Trainings programs for all stakeholders, Monitoring and Evaluation Plan will be developed and included as parts of the Forest Management Plans. | Elements of these E&S plans are integrated into the CBFM level FOPs and implemented as well, although it is not done systematically and consistently.<br><br>At the field level, DFOs/Park authorities organized regular monitoring of activities, including E&S safeguards. Information materials, such as an information sheet and, issue brief, are also being published. There is a need to streamline E&S monitoring with the established government monitoring system, identifying key E&S safeguards interventions and their implementation at the field level. |

To implement the corrective actions, the REDD IC took several proactive steps to improve and enhance the E&S performance. As recommended a permanent unit has been proposed at the REDD IC with dedicated environmental and social specialists for E & S risk management in the Organization and Management (O&M) report, but which is pending endorsement by the Government of Nepal (GoN, Cabinet level decision). A decision on this is expected within six months. The proposed unit will constitute one Undersecretary and two forest officials, E&S specialist, gender focal person. In addition, REDD IC officially communicated to all ER program implementing units (REDD Desk at different level of the Government) to ensure that following were adhered to:

- Initial screening procedures outlined in the Environmental and Social Management Framework (ESMF) for the ER program should be followed during the implementation of activities identified in the Divisional Forest Management five-year plan (DFM) and its Initial Environmental Examination (IEE). Similarly, community level Forest Management Plan (FMPs) should follow screening procedures as outlined in the ESMF while implementing activities at the community level. This ensures that environmental and social issues are recognized, and appropriate management instruments such as Environmental and Social Code of Practice (ESCOPs), Environmental and Social Management Plans (ESMPs), and others are developed to address the impacts of the activities identified by DFM.
- Likewise, where opportunities exist Division Periodic five-year Plan and Community level FMPs which are being updated and implemented should be enhanced with safeguards measures/plans such as OHS and safety protocols; (ii) Group insurance; (iii) Strengthening GRM; (iv) allowing FUGs to grow forest crops of better economic value as appropriate, and (v) M&E arrangements.
- FMP have to be adjusted in line with new approved Sustainable Forest Management (SFM) standards and Guidelines (now known as Silviculture system-based forest management guidelines)
- Adequate budget allocation for preparation and implementation of the plans like ESMPs and ESCOPs, IEE developed as part of DFM and FMPs.
- Ensure consistent stakeholder sensitization and engagement for the effective implementation of the ER program and ESMF.
- Enhance and implement occupational health and safety protocols in the ER program to protect workers involved in timber harvesting and other activities.
- The existing functional Grievance Redress Mechanism needs to be strengthened to ensure all Grievances are managed systematically. This entails enhanced information dissemination about GRM to all stakeholders through different mediums, maintaining records of all grievances (verbal, written, etc.) received and resolutions in timely manner.

In parallel with these communications, REDD IC carried out consultations on gender, inclusion, ESMF, benefit sharing mechanisms and others with wider stakeholders including IPLCs covering all ERP Districts as part of the recommended actions.

The REDD IC, ER program implementing units through their own resources and ongoing projects have been delivering various awareness, capacity building programs and consultations.

All the Forest operational Plans are prepared in accordance to the Environment Protection Act (EPA 2019) and Environment Protection Rules (EPR 2020) which has established E&S procedures. Through regular government annual activities, funded by their own resources and supplemented by other forestry projects, Community and Collaborative Forest User Groups (supported by Division Forest Offices) are making concerted efforts to enhance environmental and social risk management procedures and measures. This includes improving occupational health and safety for workers, conducting stakeholder consultations, managing pests, and other related actions, as they prepare, revise, and implement their Forest Operational Plans.

Through the existing, updated, and new operational plans, the following actions/measures are continuously being enhanced:

- Sensitive areas from environmental or other cultural and religious point of views are restricted from harvesting and other activities. Sensitive areas are identified in the Management Plans, and they are not included in the felling coups.
- Prescribed silviculture system (mostly Irregular Shelterwood system) and treatments such as thinning, pruning, fire line construction, are applied.
- Regeneration of trees and transportation of timber to the depot are conducted in such a way that damage of regeneration is minimal. Heavy machinery is usually avoided in harvesting and transportation. The feelings of the trees are controlled and managed, ensuring that they fall where less damage is expected.
- Protection and conservation of biodiversity is given priority. Biodiversity hotspots are identified in the Management Plans, and they are not included in the felling coupes as far as possible.
- Gender mainstreaming in implementation of management plans is applied following the Community Forestry Guidelines.
- Community members are given priority in employment opportunities generated.
- Local people are supported in various income generating activities (processing of exotic oils, spices, NTFP and support to SMEs and others) and different capacity building training such as are provided especially for women.
- Local level development activities are supported by Forest Users Groups.

Similarly, through the Word Bank Funded FFPP project, E&S risk management approaches has been adopted in forest sector development and sustainable forest management through Community-Based Forest Management (CBFM) groups in TAL area, in collaboration with Division Forest Offices (DFOs) as follows:

- While forming CBFM groups and preparing and reviewing the constitution and Community Forest Operational Plan (CFOP), a specific chapter has been added to the CFOP for screening, assessing, managing, and monitoring the environmental and social impacts and their mitigation measures.
- The E&S screening process has been integrated into all Sustainable Forest Management (SFM) activities carried out by the respective CBFM groups.
- CBFM group representatives have been trained and provided with onsite coaching to enhance their capacity in E&S risk management.

It concludes that environmental and social risk management measures implemented for interventions 1 and 2 were materially consistent with the procedures and provisions of the ESMF. Therefore, these two interventions are eligible for retroactive ER credit vis-a-vis E&S risk management.

**CAPACITY BUILDING**

The primary goal of capacity building activities under the REDD+ process is to empower 'REDD+ focal persons' and representatives from different stakeholders, including government institutions and CBOs, CSOs and NGOs involved in Nepal's REDD+ process. These activities cover various aspects of the REDD+ process such as E&S Safeguards, Carbon Measurement, Community Monitoring, and MRV. These, capacity building efforts will support and improve in addressing Environmental and Social risk management, adopting procedures outlined in ESMF e.g. environmental social screening, and other international best practices, E&S assessment, stakeholder engagement and GRM.

Several capacity building training courses were identified and delivered during REDD readiness and preparation of ERP programs. These trainings were identified through consultation, field observation and constitutes of : role of forests in emission reduction and climate change; REDD+ related international and national legal frameworks; stakeholder engagement and GRM, benefit-sharing mechanism of REDD+; free, prior, and informed consent (FPIC) in the context of REDD+; Environmental and social risk management of REDD+ projects. Various capacity building measures have been implemented for all three tiers of government agencies and other stakeholders, specifically community and collaborative forest user groups engaged in Sustainable Forest Management (SFM). These groups are implementing the E&S Safeguards measures outlined in the ESMF. Furthermore, the scope of capacity building activities of FFPP and DGM has been extended to the ER program districts. All ERP related training materials have incorporated the ESMF, E&S risk management aspects. Dedicated trainings/orientations on ESMF for ERP and awareness on E&S risks management have also been carried out to implementing agencies and stakeholders such as organizations representing community forest, collaborative forest, Indigenous Peoples, and other vulnerable groups. The details of Capacity development activities conducted at different levels from fiscal year 2017/18 to 2022/23 are listed below in Annex Table 2.

**Annex Table 2. Capacity development activities conducted at different level from 2017/18 to 2022/23**

| SN | Fiscal Year | Activity | No of Events | Male Participants | Female Participants | Stakeholders involved |
|---|---|---|---|---|---|---|
| 1 | 2017/18 | Capacity building program for CBOs | 15 | | | CFUGs members |
| 2 | 2017/18 | Capacity building program on gender issues | 6 | | | Forest Officials, |
| 3 | 2018/19 | Capacity building workshop for indigenous leaders on REDD+ | 1 | | | NEFIN, FECOFUN |
| 4 | 2018/19 | Capacity building program on gender issues | 7 | | | Forest Officials, FECOFUN |
| 5 | 2018/19 | Capacity building program for REDD focal persons at district level | 3 | | | DFO REDD focal persons |
| 6 | 2019/20 | REDD+ TOT for gender and safeguard focal persons and related stakeholders | 3 | | | DFO staff, FECOFUN, NEFFIN, AFFON, |
| 7 | 2020/21 | Forest cover change and carbon monitoring training to technical | 1 | 13 | 11 | Focal persons |

| SN | Fiscal Year | Activity | No of Events | Male Participants | Female Participants | Stakeholders involved |
|---|---|---|---|---|---|---|
| | | personnel at MoFE, REDD IC, provincial REDD focal persons | | | | of REDD IC, MoFE, Provincial REDD Focal person |
| 8 | 2020/21 | REDD implementation training for REDD Focal Persons and stakeholders | 1 | 11 | 15 | REDD focal person |
| 9 | 2020/21 | Biodiversity monitoring training | 5 | 12 | 13 | Forest Officials |
| 10 | 2020/21 | Capacity development and management support for Provincial Forest Directorates' REDD Desk (provinces) | 2 | | | Provincial REDD Desk staff |
| 11 | 2020/21 | Gender conceptual capacity development workshop | 1 | 13 | 12 | DFO staffs, |
| 12 | 2020/21 | Forest fire management training | 3 | 44 | 32 | DFO staffs, CFUG members of Far western Province |
| 13 | 2020/21 | Forest Harvesting Skill development training for Field level staff and Forest laborers | 1 | 35 | 48 | DFO staffs, CFUG members and labors |
| 14 | 2021/22 | Dendrochronology and Its Application Training to FRTC personnel; Biometry training | 2 | | | FRTC Officials |
| 15 | 2021/22 | Forest cover change and carbon monitoring training | 1 | 10 | 14 | FRTC, DoFSC, DoP staff, |
| 16 | 2021/22 | REDD implementation training for REDD Focal Persons and stakeholders | 3 | 18 | 20 | REDD Focal Person, CFUG members |
| 17 | 2021/22 | Capacity development and management support for Provincial Forest Directorates' REDD Desk (provinces) | 5 | | | REDD Focal person, Forest officials |

| SN | Fiscal Year | Activity | No of Events | Male Participants | Female Participants | Stakeholders involved |
|---|---|---|---|---|---|---|
| 18 | 2021/22 | Gender conceptual capacity development workshop | 2 | 15 | 12 | NEFIN, FECOFUN, AFFON |
| 19 | 2021/22 | Capacity development training on ESMF and Safeguards for REDD+ stakeholders | 1 | 9 | 6 | DFO officials, CFUG, LHFUG, |
| 19 | 2022/23 | Safeguards Information System (SIS) orientation training | 5[82] | 90 | 14 | DFO Officials |
| 20 | | Training and orientation on Environment and Social Management Framework and Gender and Inclusion | | 9 | 21 | CFUGs, FECOFUN, NEFIN, |
| 21 | 2022/23 | Orientation on the REDD+ for stakeholders, REDD+ and Climate Change, Environmental and Social Safeguards, ESMF, SFM and REDD+, Awareness on REDD+, Social Inclusion etc. | 70 | 2219[83] | | Government Officials, CFUG members, |
| 22 | 2022/23 | Training and orientation on forest-based enterprises and forest development and management | | 26 | 10 | Entrepreneurs, FENFIT, FECOFUN |
| 23 | 2022/23 | Capacity Development Training for Forest Technicians | | 14 | 14 | REDD IC Officials, FRTC officials |

Source: REDD IC, May 2022. Consistency report, p.42; REDD IC Annual Report (2079/80); REDD IC Annual Report (2077/78)[84]; REDD IC Annual Report (2078/79).[85]

**Feedback and Grievance Redress Mechanism (FGRM)**

The Feedback and Grievance Redress Mechanisms (FGRM) for the ER Program was already largely operational during the preparation of the ERPD. The Nepal FGRM is envisioned not as a singular "mechanism" but rather as a web of existing informal and formal grievance mechanisms of the Nepal's forest governance.

The forestry sector policy, laws, by-laws and guidelines have a clear provision for reporting and redressing grievances related to forest governance. Related policy documents such as the Constitution (2015), Forest Policy (2019), Forestry Sector Strategy (2016-2025), Forest Act (2019), and Forest Regulation (2022) have not only encouraged citizens to report their forest governance-related grievances to the concerned authority but also instruct the

[82] SIS orientation was conducted in Bara (Nov 27-28, 222- 20 participants), Nawalpur (Nov 29-30,2022- 16 participants), Butwal ( Nov 30-Dec 01, 2022- 17 participants), Kohalpur (Jan 15-16, 2023- 27 participants), and Dhangadi (Jan 17-18, 2023- 24 participants)

[83] Out of 2219, male were 1813 and female were 406 (IP 547, Dalits 66,Muslim 24, Madhesi 598, and other 1138)

[84] REDD IC. 2022a (BS 2079 Asar), available at https://redd.gov.np/upload/e66443e81e8cc9c4fa5c099a1fb1bb87/files/Annual_Report_2079.pdf

[85] REDD IC. 2022a (BS 2079 Mangsir). Annual Report Fiscal Year 2078/79. Available at https://redd.gov.np/upload/e66443e81e8cc9c4fa5c099a1fb1bb87/files/Annual_Report_Final_2079(1).pdf

authority to redress them promptly and effectively. There are compulsory provisions for citizen's charters, complaint boxes, information officers, and gender focal officers in every government office at different levels. The largest "footprint" of the ER program is in existing and new community forests, for which guidelines and quasi-judicial processes[86] are already in place to resolve disputes. Division Forest Offices resolves the grievances that come under their jurisdiction. Division Forest officer works as a Grievance addressing official. Similarly, provincial forest directorate and provincial forest ministry can address the grievances related to division forest offices. Anti-corruption measures through the Hello Sarkar (Hello Government) public grievances redress mechanism of the Office of the Prime Minister and Council of Ministers (OPMCM), and the National Vigilance Centre (NVC) are also functioning to improve governance. Also, constitution of Nepal has envisioned Commission for the Investigation of Abuse of Authority as constitutional body for the investigation of complaints related to corruption and registrations to the court for judicial procedure, including complaints related to the forest sector and community forestry.

The ERP has utilized existing GRM resources and developed local capacity in dealing with grievances to comply with the ESMF requirements. The REDD IC has assigned a GRM focal person at the federal level to oversight GRM for ERP program. The REDD desk at all levels have been capacitated to handle Grievances The existing five-level GRM, involving informal and formal processes, including those involving the courts of law, quasi-judicial and local-level mediation processes, is shown in Figure 8.

Each Division Forest Office maintains a Grievance logbook. However, it is to be noted that many grievances are being handled informally and not recorded. Verbal complaints that can be immediately resolved by DFOs and officials without legal procedures often go unrecorded. Grievances recorded are typically related to illegal tree removal, poaching, collection of forest resources, construction of infrastructure in forest area without permission and others. At the CFUG level, the community handles and resolves grievances informally.

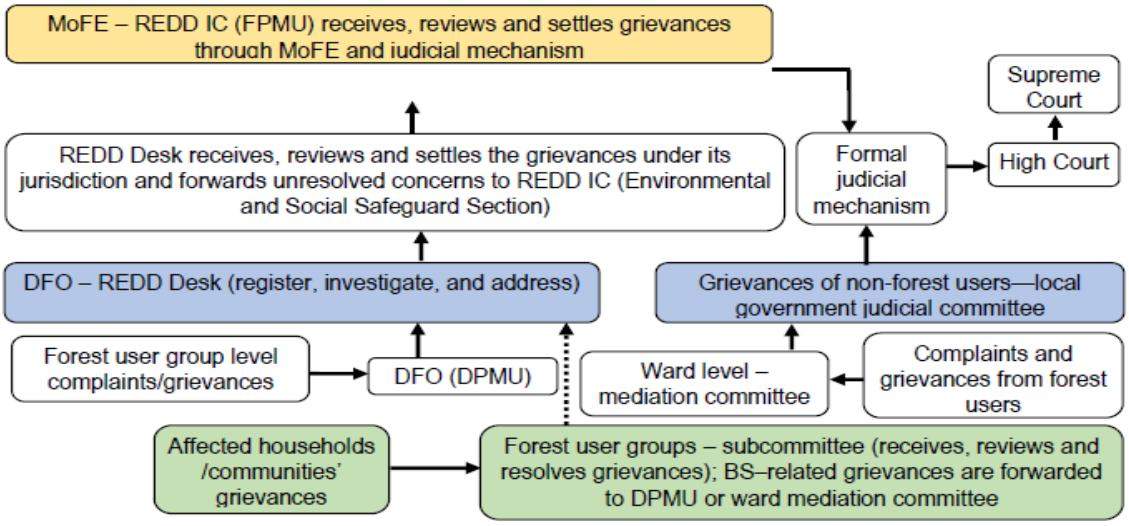
REDD IC is in the process of strengthening the GRM to systematically record and resolve grievances in a timely manner. In addition, REDD IC has also developed an interactive online platform which includes the feedback and grievance redress mechanism (FGRM), within its safeguards information system (SIS) portal (Figure 9). The portal is designed to allow relevant stakeholders to communicate and register their complaints or grievances and track the process and proceed to their satisfaction; however, it is not fully functional.

Similarly, each provincial (Division Forest Offices, forest directorate, provincial ministries) and federal government offices (REDD IC, Ministry of Forests and Environment) regularly and proactively discloses relevant information of function and their activities in their official website as per the Right to Information Act (2007). Information related to Grievances is also incorporated in proactive disclosure. The MoFE provides information on the number of complaints/grievances received through different agencies and their status as well as information provided on request as per the Right to Information Act (2007) in its proactively published information online every three months.

The feedback and grievances recorded in the Safeguard Information System (SIS) is also mainly of grievance related to activities concerning forest crimes (such as encroachment and illegal logging) and governance issues. Although different channels are in use for grievance handling, So far, a total of 55 feedback and grievances have been registered in SIS, all of which have been addressed and resolved.

[86] A quasi-judicial approach applies both judicial and pragmatic approaches to address grievance. The district-level forestry authority (Division Forest office), also known as quasi-judicial body, has defined procedures and powers in resembling those in a court of law and is obliged to objectively determine facts and draw conclusions from them so as to provide the basis of an official action. The DFO has been responsible for coordinating three important tasks for grievance handling: uptake, investigation, and decision making.

**Figure 7. Nepal's Feedback and Grievance Redress Mechanism**




**Safeguard Information System (SIS)**

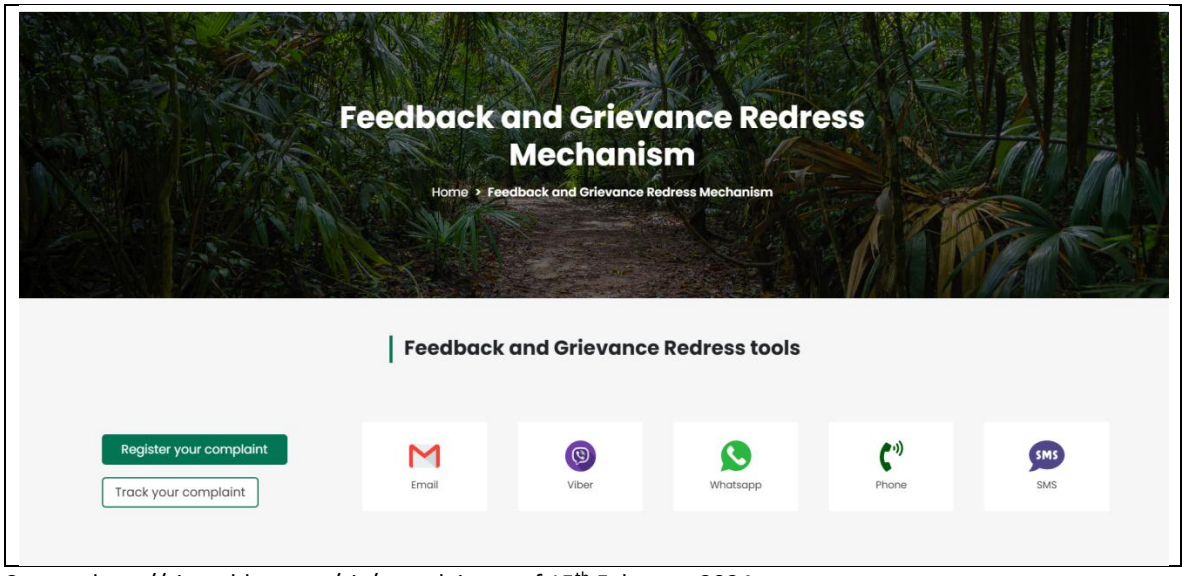
Nepal developed its Safeguards Information System (SIS) as required by the UNFCCC decision (Decision 12/CP.17) for providing information on how Cancun REDD+ safeguards are addressed and respected throughout the implementation of the REDD+ actions in Nepal. The system was first initiated during the second phase of REDD+ readiness project in 2019, which was disrupted because of the COVID 19 pandemic. The service provider (consultant) for the assignment, however, was able to design and establish the system by 2021 with limited information and functionality. The SOI document[87] available online at (http://sis.redd.gov.np/sis/documents/knowledge-center) provides country specific principles, criteria and indicators for the Cancun Safeguards.

The SIS developed for the country under the Country Approach to Safeguard takes account of national circumstances, legal and institutional framework, national development goals including the goals of the national forest programs and helps increase confidence of institutions and organizations implementing and providing support for the REDD+ including addressing and respecting Cancun Safeguards throughout the implementation of the REDD+ programs/actions in the country.

Grievance registration and tracking is an important function of SIS (Figure 9). This function is a part of the process of Grievance Redress Mechanisms, GRMs which are necessary as part of addressing and respecting the Cancun safeguards. Information on the application of these GRMs provides an important source of information for the national SIS. Any general people or related stakeholders can register his/her grievance through website along with different redressing tools such as toll-free number, email and social media platforms. Such grievances are received by the administrator of SIS website at REDD Implementation Centre and escalated to the concerned authorities. The complaints can be tracked at both ends. SIS Grievance Redress Mechanism has been designed to have significant impact on the execution of REDD+ or any other forest related activities.

[87] file:///C:/Users/user/Downloads/Draft%20SOI%20on%20SIS.pdf

**Figure 8. Feedback and Grievance Tools and Complaint Statistics in Safeguards Information System Portal**




Source: http://sis.redd.gov.np/sis/complain, as of 15th February 2024

## II. Monitoring and Reporting Requirements

There is a system for reporting and monitoring of forest related activities with limited information on E&S measures. Regular monitoring is carried out at all three levels of the government and the local communities. For internal monitoring of safeguard measures as prescribed in ESMF, REDD IC coordinates with those agencies to further monitor and report the actions. Apart from regular monitoring from REDD desk and Division Forest Offices, REDD IC has also mobilized human resource from the Forests for Prosperity Project (FFPP) to strengthen monitoring of E&S risks and impacts under ERPA.

Under the National REDD+ Strategy (2018-2022), MoFE established a multi-tiered institutional mechanism at Federal and Provincial levels to oversee and implement REDD+ actions, including ensuring that they are designed and implemented in consistency with the broader legal or policy framework of the forest sector of the country. At the national level, for example, the high-level, multi sector and multi stakeholder National REDD+ Steering Committee (NRSC) endorses ER programs, while the National REDD+ Coordination Committee (NRCC) makes decisions on technical matters, including oversight of the implementation and monitoring of REDD+ programs. The REDD IC, being the coordinating entity, is responsible for planning, development, implementation, and monitoring of the National REDD Strategy and REDD+ programs in the country.
Within the community forests regular monitoring is carried out by community itself and Sub Division Forest Office staffs. For regular reporting, a *Pandraroja* (list of fifteen days activities conducted i.e. Fortnightly report) is submitted by each sub division forest office to Division Forest office regularly. Also, each year Division forest office publishes yearly monitoring reports with the information collected during the monitoring. Division forest office submits regular monthly, quarterly and yearly reports based on monitoring checklist to province forest directorate which is then submitted to province forest ministry. Few Community User Groups are also publishing yearly reports. Some Division Forest Offices have also started maintaining digital database which are regularly updated. These annual reports and database maintained include information related to forest management activities, plantation/afforestation data, production and import data of NTFP, protection of wetlands, monitoring and evaluation of community forest user group activities, Human Wildlife Conflict (HWC) management, compensation to HWC victims, forest fires, CFUGs composition and meetings, controlling encroachment, and data/information on National forests handed to the community.

Based on the monitoring checklist, REDD desk reports to REDD IC who then submits monthly and annual reports to Planning, Monitoring and Coordination Division of MoFE. The Planning, Monitoring and Coordination Division of the MoFE submits periodic and annual progress reports on the work of the Ministry and its departments, REDD IC, committees, institutions, funds, companies and projects to the Office of the Prime Minister and Council of Ministers, the National Planning Commission and other designated bodies. In MoFE, there is a regular meeting on Pre-Ministerial Development Action Committee (Pre MDAC) chaired by Secretary and Ministerial Development Action Committee (MDAC) chaired by forest minister. In these meetings, there is a regular discussion on environment and safeguard issues. The monitoring report includes dedicated section on E&S status. However, it is to be noted that documentation of E&S performance is weak. REDD IC is also trying to establish a MIS system and enhance the monitoring and reporting template to effectively capture the implementation of Environmental and Social (E&S) measures.

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

## I. Requirements of FCPF on Benefit Sharing Plans

Criteria 29; 30; 31; 32; and 33 of the FCPF Methodological Framework require that the ER Program uses clear, effective, and transparent benefit-sharing mechanisms with broad community support and support from other relevant stakeholders.
The General Conditions Applicable to Emission Reductions Payment Agreements (EPRAs), Section 5.01(b)(i), requires the Program Entity to "*provide evidence satisfactory to the Trustee . . . that the Benefit Sharing Plan has been implemented in accordance with its terms*" as an annex to the ER Monitoring Report.

The General Conditions Applicable to ERPAs, Section 16.01(vii), also provides that "*failure to observe, implement and meet all requirements contained in . . . the Benefit Sharing Plan . . . provided for under the ERPA (including any feedback and grievance redress mechanism provided for under the ER program, the Benefit Sharing Plan and/or a Safeguards Plan)*" is considered an Event of Default on the part of the Program Entity.

The Methodological Framework, Criterion 32, requires that information on the implementation of the BSP is disclosed publicly.

> The ERPAs include an additional covenant requiring the Program Entity to "*monitor and report to the Trustee on the implementation of (…) the Benefit Sharing Plan during Reporting Periods (…) The Program Entity shall first monitor and report to the Trustee on the implementation of the Benefit Sharing Plan six (6) months after receipt of the first Periodic Payment and annually thereafter. The Program Entity may coordinate the annual monitoring and reporting of the Safeguards Plans and the Benefit Sharing Plan, provided that the Program Entity notifies the Trustee, and the Trustee accepts such coordinated timelines. The Trustee reserves the right to initiate a separate monitoring of the implementation of (…) the Benefit Sharing Plan annually after the date of this [ERPA] by an independent Third-Party monitor.*"

## II. Monitoring and Reporting Requirements

### 1. Benefit Sharing Plan Readiness

**1.1** As required by the FCPF Methodological Framework, the Benefit Sharing Plan (BSP) of the ER Program has been developed with wider consultation of all the stakeholders including women, IPs, Dalits, community forest user committee members, buffer zone community forest user groups, private forest owners and academic institutions at different level (district, province and national). Details of the consultations and their outcomes are provided in Annexes of the BSP (Annex 5-14). Furthermore, the BSP was revised and updated to address concerns of some of the stakeholders following the consultation workshops which was organized at the national level in March 2023 (list of participants is provided in Annex 16 of the final version of the BSP). The BSP was revised, updated, and finalized as per the inputs and feedback received from the participants of the national level stakeholder consultation. In October 2024, the BSP was again revised incorporating suggestions of the Ministry of Finance on benefit sharing arrangements and fund-flow mechanism and to make clear and specify the allocation of benefits among the broad category of the benefits and within the sub-groups of the beneficiaries. The plan was sent to the Ministry of Finance (MoF) for its review. The ministry provided its concurrence for the revised version of the BSP, which has been approved by the government of Nepal (Minister level decision of the Ministry of Forests and Environment) on October 17, 2024. Validation and verification process of the ERMR submitted to the World Bank is ongoing and it is expected to be completed by the end of June 2025 and it might take some time to receive the payments from the

Carbon Fund of the World Bank after Validation and verification process is completed. There are not any aspects of the BSP which remain unclear or require further review of endorsement by beneficiaries or other stakeholders.
This is the first Emissions Reduction Monitoring Report (ERMR) of Nepal ER Program; hence no performance-based payment has been received so far. Accordingly, the sections of this Annex outline primarily the performance of ER program entities on policy, legislative and institutional measures for an equitable Benefit Sharing Mechanism (BSM) consistent with relevant expectations. This mechanism entails determination of questions such as who gets rewarded with monetary or non-monetary benefits, why, under what conditions, in what proportions and for how long. The BSM includes legal and institutional means, structures and instruments for distributing funds and other benefits from Nepal ER program.
The Nepal ER Program was designed in a way that carbon finance would be directed mostly to support government's implementation of programs that directly benefit the people and forests of the Terai and Churia region. It was not designed to function primarily as a monetary distribution mechanism. The real, tangible benefits are envisioned for communities who, as a result of ER Program activities, manage their own forests, receive technical support and extension services from the MoFE and get trained in sustainable forest management techniques to generate higher productivity and revenues from their forests. Importantly, there are existing modalities for benefit sharing within CBFM whereby the forest user groups benefit from 50-100% of the revenues from their forests. Similarly, Nepal's Alternative Energy Promotion Center (AEPC) has a proven track record of installing biogas plants and cookstoves, and households derive the benefits of improved technologies and saving time for other economic pursuits. Accordingly, most of the program activities operate under existing modalities and associated benefit sharing arrangements. In some exceptions direct monetary or non-monetary benefits will be accessed through participation in program activities, and in cases where implementation partners are engaged to accelerate the program's implementation.

With the above scheme in consideration, the ER Program's Benefit Sharing Plan (BSP) was developed during 2019-2022.[88] This was made consistent with the 2018 REDD+ strategy, which stipulated that:

> A REDD+ program specific benefit sharing plan and service delivery mechanism will be developed to clarify the benefit sharing among the carbon rights holders at different levels. The mechanisms require schemes that address the issues of equity, exclusivity and conditionality. A specific regulatory provision and accompanying institutional arrangements will be defined in the future for the implementation of a benefit sharing plan and maintaining equitable benefit sharing arrangements at different levels. (REDD+ strategy, 2018, p.30).

The BSP has been developed, revised, and finalized incorporating the comments and suggestions received from all relevant parties.

**1.2** Capacity building initiatives taken so far mostly focused on the design and implementation of the REDD+ actions and mitigation of potential environmental and social risks of the program interventions and not particularly included as the part of the BSP. Institution arrangements for implementation of the BSP have already been established. Regarding the capacity of the FDF, as outlined in section 3, the Forest Regulation has been approved in May 2022 and Guidelines for the operation of the FDF is prepared and it is now under approval of the government. It is expected that the Guidelines will be approved by the end of June 2025 Once the operating guideline is approved, the FDF and associated delivery arrangements will undergo financial management and procurement assessments by the World Bank. This will occur as part of project due diligence and is required prior to the first ER transfer. The assessments will also identify gaps and needs to strengthen capacity, as appropriate. The REDD IC as the Program Entity will complete the required capacity building measures identified to ensure the system's effectiveness before the benefits distribution to the beneficiaries actually starts.

**1.3** Since this is the ER-MR for the 1st reporting period and actual benefits sharing has not started yet, there is no question of any agreed changes to the benefit sharing arrangement identified during the previous reporting period. From the learning and experience of the actual benefit sharing issues identified from this first reporting period, if

[88] REDD IC. 2022 May. Benefit Sharing Plan of the REDD+ Emission Reductions Program for 13 Terai Arc Landscape Districts. Kathmandu: REDD IC.

some changes in benefit sharing arrangements are required, they will be completed for the next round of reporting period.

The BSP was developed in the spirit of legislative provisions, sectoral policies, and practices, and it considered the local socioeconomic circumstances of the TAL region as appropriate. It builds on the benefit-sharing arrangements proposed in the ER Program's ERPD and provides information on aspects highlighted in the FCPF Methodological Framework and the Facility Management Team Note (2019). It provides scenarios illustrating indicative levels of performance for the achievement of 100%, 50%, 10% and 0% of the ER target of 9 MtCO2e.

First, the BSP sets out the eligibility criteria to become beneficiary of the ER program and identifies their categories. Its main criteria for eligible beneficiaries of ER payments include institutional factors, ER activities, degree of forest dependency and social justice. It recognizes four beneficiary categories:

(i) Government entities;
(ii) Community-based Forest management (CBFM) groups;
(iii) Private forest owners; and
(iv) Forest dependent households outside of the user groups.

Secondly, the BSP prescribes allocation of the proceeds from the performance-based payments, to be received by Forest Development Fund (FDF) as follows:

| | |
|---|---|
| Performance-based allocation to the government forest entities and CBFM groups | 80% |
| Private forest owners | 5% |
| Forest-dependent households and communities outside CBFM groups | 5% |
| Operation and management costs | 10% |
| TOTAL | 100% |

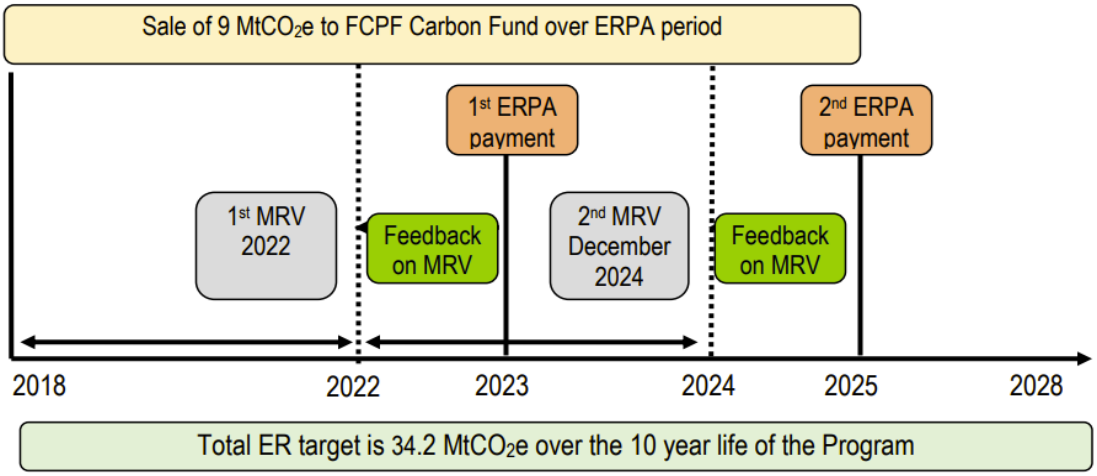
The above scheme is reconfirmed in the Forest Regulations 2022, Rule 115. Hence it is legally established.

Thirdly, it sets the following terms for benefit distribution:

- **For CBFM Groups.** ER benefits will be awarded to the government and CBFM groups based on their performance across the forest management units measured by total forest area where activities are being implemented, as reflected in their periodic Plan (DFO) and Investment Plan (forest user groups) respectively. The preparation of the above plans are preconditions for receiving ER benefits. The forest user groups utilize payments in accordance with current benefit sharing plans and existing policies. Specific details on planned and implemented activities and the distribution of benefits themselves will be contained in the respective forest user group's Investment Plans.
- **For private forest owners.** The total performance-based allocation will be distributed to private forest owners in kind—in the form of goods (seedlings) and services (technical input) for the protection and growth of the forest on their lands. The DFOs, provincial REDD Desks, and FDF and National REDD Coordination Committees are variously involved in the distribution of this fund. DFOs distribute goods (seedling), technology (training) and facilitation.
- The remaining 5% of total ER payments is a basic allocation (or fixed allocation) to forest-dependent households and communities not belonging to the CBFM group. Respective Division Forest Offices (DFOs) prepare the list of potential beneficiaries and corresponding non-monetary benefits in the form of Benefit Distribution Plan; this is then reviewed by local government's Forest and Environment Committees. The Plan is then forwarded to REDD IC through provincial REDD Desk, which tables for the decisions of REDD Coordination Committee and FDF Operation Committee (OC). Funds are transferred to DFOs according to the decision of the Coordination Committee and FDF
- **Non-monetary benefits** will be distributed to private forest owners and non-group members. The local municipality will administer the benefit sharing mechanism to the identified groups.

The payment milestone for the performance-based payment is shown in Figure 10.

**Figure 9. MRV and Payment Milestones of Nepal ER Program**




## 2. Institutional Arrangements

2.1 The agreed institutional arrangements under the BSP are in place. The institutional mechanism for benefit sharing consists of the arrangements established to receive and distribute performance-based payments and non-monetary benefits as well as those that manage grievances – including receiving, recording, settling of the grievances.

The National REDD+ strategy and the ER program's ERPD both envision the establishment of a dedicated body for the mobilization of funds in the forestry sector. Forest Act 2019 (Section 45) has provisioned the establishment of this body – called Forest Development Fund (FDF). Section 45 of the Act states that the Fund supports "the implementation of the Act, protection and promotion of the forest and performance of other promotional activities." It receives funds from Nepal's federal, provincial, and local governments; assistance or loans from international organizations which require a prior approval from the Ministry of Finance; and proceeds from environmental services or product sales. The Fund is required to deposit its fund in a Class A commercial bank and is audited by the Office of the Auditor General.

2.2 Regulatory or administrative approvals required for implementing the BSP have been obtained. With the issuance of Forest Regulations on July 1, 2022, the FDF has been officially established. According to Rule 108 of Forest Regulations, the Fund is housed at the Department of Forests and Soil Conservation. The Fund is governed by the Program Selection and Implementation Committee (PSIC) headed by the MoFE's Secretary. The Fund is responsible for implementing the BSP.

The FDF is established as per the Forest Regulations and the FDF operational guideline is being finalized. The Program selection and Implementation Committee of FDF, under the chair of secretary (MoFE) has reviewed and forwarded the guideline for further processing. Once the operational guideline of FDF is approved, the agreed institutional arrangements under the BSP will be in place and implementing entities will be provided with the required resources to carry out their respective responsibilities. This will ensure that all regulatory or administrative approvals required for implementing the BSP have been obtained.

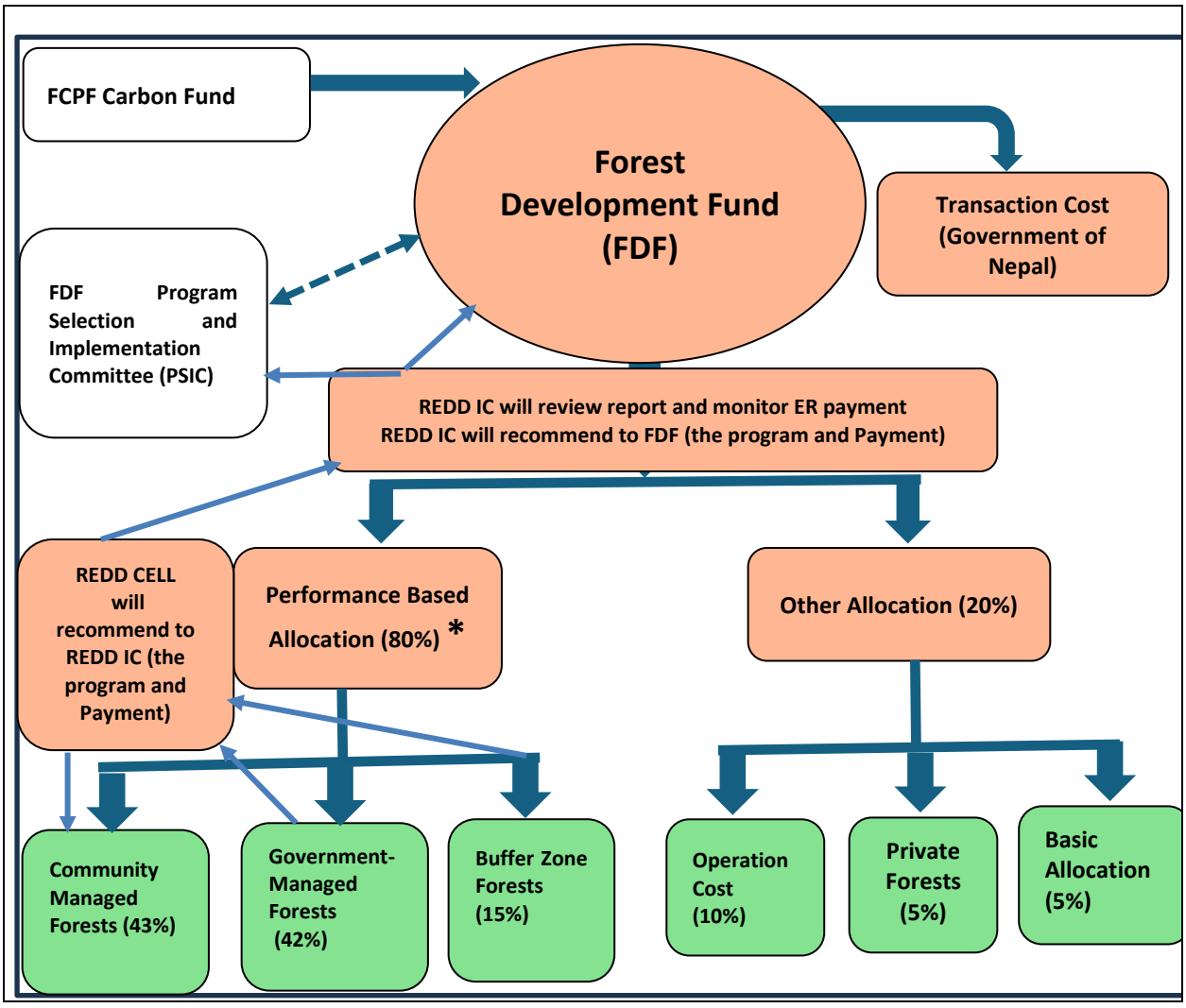
2.3 All BSP stakeholders (beneficiaries and administrators) clearly understand their obligations, roles and responsibilities associated with the BSP. This BSP together with FDF provides obligations, roles, and responsibilities of all stakeholders (beneficiaries and administrators) associated with the BSP. When BSP will be implemented after the results-based payments received through the FDF, an assessment will be carried out on various aspects of the

BSP, its implementation, and whether all BSP stakeholders (Beneficiaries and Administrators) understand their respective roles and responsibilities for effective implementation of the BSP.

2.4 A system is in place for recording the distribution of benefits and associated obligations to eligible beneficiaries. The BSP will be implemented through a Forest Development Fund (FDF) described in detail in the BSP Section 3.1, Box 2). The operating guideline of the FDF, which is under government approval process will ensure that a system is in place for recording the distribution of benefits and associated obligations to eligible beneficiaries including payment information systems, payment tracking and monitoring systems, bank accounts, accounting and financial control mechanisms, and payment modalities are in place and functional.

**Fund Flow Mechanism**. Figure 11 shows the mechanism of the flow of performance-based payment of Nepal ER program. It shows the different shares and pathways of the distribution of funds.

**Figure 10. Fund Flow Mechanism of Nepal ER Program**




* Considering 80% performance-based allocation as 100%.

2.5 All agreed accountability mechanisms will be in place and functional when FDF operational guideline is approved by the government by the end of June 2025. This) will ensure stakeholders' participation arrangement, public

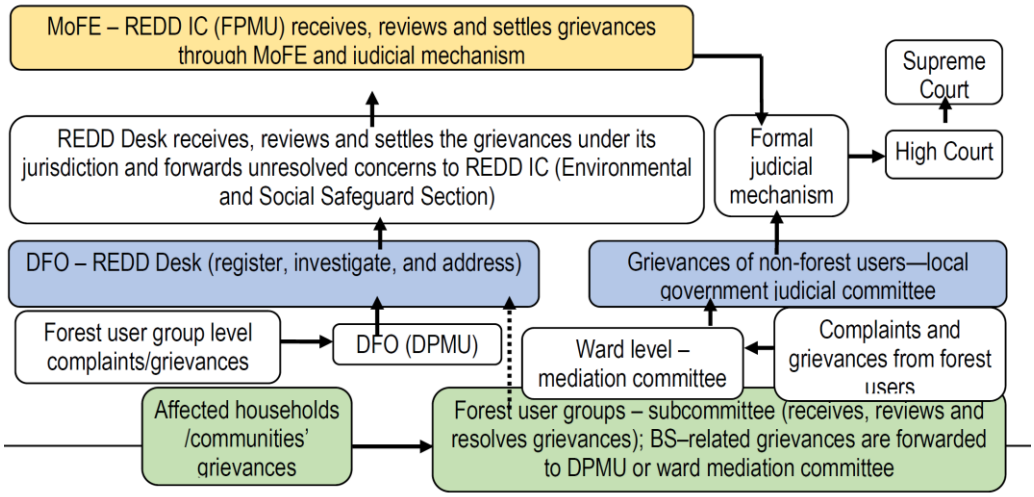
information disclosure procedures, independent third-party monitoring and or performance audit mechanism as well as dispute resolution and grievance redress mechanisms (proposed in the BSP) are in place and functional. Furthermore, it will be ensured that a full functional and effective Feedback and Grievance Redress Mechanism (FGRM) to record and address feedback and grievances related to the implementation of the BSP will be in place and records of the number and types of grievance received and submitted to the FGRM and how and whether they were addressed will be maintained, reported and made publicly available as appropriate.

**2.6** Feedback and Grievance Redress Mechanisms (FGRM) is functional to record and address feedback and grievances related to the implementation of the BSP.

**Feedback and Grievance Redress Mechanism**

Given the legal provisions and practices, benefit sharing–related grievances will generally be resolved at multiple levels through two pathways: (1) the forest authority and local government as described in the BSP. In the first instance, grievances filed by households will be handled by the respective forest user groups through their sub-committee. Unsettled grievances can be forwarded either to DFO through DPMU or to the ward level mediation committee or local judicial committee. (2) Forest group grievances can be registered with the DPMU hosted in DFO, with the ward level mediation committee, or local judicial committee (formed in coordination with the deputy mayor or vice-chairperson of the local government considering the nature of the issue or grievance). Based on where a grievance is registered, it will be resolved by DFO or the ward level mediation committee or local judicial committee. Proposed GRM provided in the BSP is as follows (Figure 12):

Figure 12: GRM proposed in the BSP.




Currently, the feedback and grievances recorded in the Safeguard Information System (SIS) is mainly of activities concerning forest crimes (such as encroachment and illegal logging) and governance issues. So far, a total of fifty-five (55) feedback and grievances have been registered, all of which have been addressed and resolved.

The Nepal Forest Governance and Redress Mechanism (FGRM) is a network consisting of both informal and formal grievance mechanisms. The feedback from indigenous peoples and local communities, which has been represented by organizations like FECOFUN, NEFIN, ACOFUN, has been taken into account. The feedback which was provided during consultation with FECOFUN, NEFIN, ACOFUN is mainly in regard to fund usage, allocation, spending priorities, and formation of task force at the district level. Such feedbacks have been incorporated in the revised BSP.

**2.7** Adequate human and financial resources have been allocated or maintained for implementing the BSP.

## 3. Status of Benefit Distribution

**3.1** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Information will be included in the ER Monitoring Report for the subsequent Reporting Period.

**3.2 Allocation of Benefits**

Monetary benefits will be distributed based on a combination of performance, equity, and social justice criteria. 80% of the total payments will be allocated for the local level beneficiaries as indicated in table 6 above. Out of total benefits to the local level beneficiaries, 80% will be disbursed to the government forest entities and community-based forest user groups based on performance. Furthermore, non-monetary benefits amounting to 5% would be distributed to private forest owners of the program area, and another 5% to forest-dependent communities not belonging to a forest group. The beneficiaries who receive 5% basic allocation are not the same as those who receive performance allocation. These are two different categories of beneficiaries, and no beneficiary would receive payment under both performance allocation and basic allocation. A further 10% will be allocated to federal, provincial and local government to cover the operational and management costs. The cost of activities for MRV, forest database management, forests carbon assessment, implementation and monitoring of environmental and social safeguards, implementation and monitoring of the ER Program, and resolution of benefit sharing–related complaints and grievances come under the transaction costs and are managed by government budget. This distribution of benefits is illustrated in Figure 13.

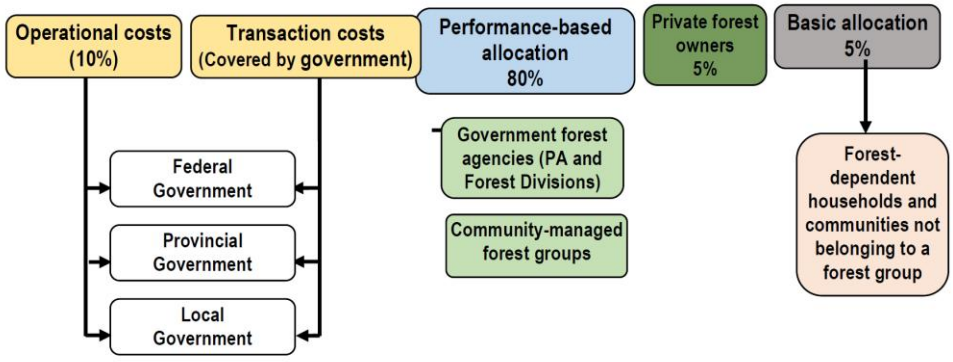



**Figure 13. Proposed allocation of the benefits**

As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Information on number and types of beneficiaries who received benefits during the reporting period, the type of benefits distributed, including monetary or non-monetary benefits, the criteria for distributing the benefits, the processes and timeline for distributing the benefits (e.g., whether the benefits are distributed one-time or continuous/periodic), who the beneficiaries are, including a break-down of the beneficiaries by gender, civil society organizations (CSOs), Indigenous Peoples, and local communities, and any specific agreements signed with the beneficiaries for them to receive the benefits, and the key terms of such agreements will be provided in the ER Monitoring Report for the subsequent Reporting Period as prescribed by the FCPF MRV report template. Status of benefit distribution as of December 2023 is as follows.

| | Number of people | | |
|---|---|---|---|
| | **Monetary** | **Non-monetary** | **TOTAL** |
| **Men** | 0 | 0 | 0 |
| **Women** | 0 | 0 | 0 |
| **TOTAL** | 0 | 0 | 0 |

| | % of monetary benefits shared |
|---|---|
| **Men** | 0 |

| | |
|---|---|
| **Women** | 0 |
| **TOTAL** | 0 |
| | **% of monetary benefits shared** |
| **CSOs** | 0 |
| **IPs** | 0 |
| **Local Communities** | 0 |
| **TOTAL** | 0 |

**3.3** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Information on whether the beneficiaries receive adequate implementation support to assist in the management and use of benefits distributed to them will be included in the ER Monitoring Report for the subsequent Reporting Period

**3.4** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Assessment and Information on the effectiveness of the mechanisms for ensuring transparency and accountability during the implementation of the BSP, such as participatory monitoring by beneficiaries will be included in the ER Monitoring Report for the subsequent Reporting Period.

**3.5** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Assessment on whether Benefit Sharing distributions continue to be relevant to core objectives and legitimacy of the ER Program objectives (e.g., benefit sharing is considered equitable and effective; seeks active participation of recipients; is respectful of customary land rights; enjoys broad community support of Indigenous People; benefit distributions incentivize adoption of emission reduction measures, among others) will be conducted and the information will be included in the ER Monitoring Report for the subsequent Reporting Period.

**3.6** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Description on the mechanisms that are in place to verify how benefits are used and whether those payments provide sufficient incentive or compensation to participate in program activities to change land use or reduce carbon emissions and to what extent are distribution mechanisms viewed as credible and trusted by beneficiaries will be included in the ER Monitoring Report for the subsequent Reporting Period.

**3.7** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries. Information on whether the beneficiaries understand their continued obligations once benefit distribution has taken place and any evidence that there is a mismatch of expectations among beneficiaries regarding the nature and value of benefits accruing to them will be included in the ER Monitoring Report for the subsequent Reporting Period.

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

**4.1** As this ER Monitoring Report covers the first Reporting Period, no ER payments have been made or benefits distributed to beneficiaries and assessment of the measures for managing the environmental and social aspects of BSP activities have not been done yet. Information on Environmental and Social Assessment of the BSP and measures for managing the environmental and social aspects of BSP activities will be included in the ER Monitoring Report for the subsequent Reporting Period.

The environmental and social management measures are implemented according to the provisions of laws and policies identified in Table 5 of Annex 1, "Nepal's laws, policies and plans related social and environmental safeguards", and more specifically according to Environmental and Social Management Framework 2019.[89]

[89] REDD IC. 2019. Environmental and Social Management Framework for the Proposed Emission Reduction Program Interventions in the Terai Arc Landscape. Kathmandu: REDD IC (REDD Implementation Center). Available at https://www.forestcarbonpartnership.org/system/files/documents/NEPAL%20ER%20Program%20ESMF%20October%202019%20for%20FCPF%20website.pdf

## 5. Recommendations for BSP Improvement or Modifications.

The BSP was revised, and updated in July 2023 to address some concerns of some of the stakeholders regarding the allocation of the benefits and fund flow mechanism. Revision and updates were done as per the suggestions, feedback and inputs received from the participants of the national level consultation workshop organized on 10 March 2023. It was again revised incorporating suggestions of the Ministry of Finance on benefit sharing arrangements and fund-flow mechanism and to make clear and specify the allocation of benefits among the broad category of the benefits and within the sub-groups of the beneficiaries under the broad beneficiary category in August 2024. Representatives of major stakeholders, including FECOFUN, ACOFUN, NEFIN participated in the workshop organized by the REDD Implementation Centre on August 21 and 22 at Dhulikhel and agreed the allocation of benefits among broader categories of the beneficiaries and sub-groups within the broader category of beneficiary groups. The stakeholders query about the distribution of benefits to local communities, which was addressed by describing the distribution system (43% to community forests and collaborative forests, 42% to government-managed forests, and 15% buffer zone community forests, which is based on area of forest conservation). Similarly, stakeholders expressed concerns about fund spending areas, which were discussed and a consensus was reached on four spending areas: forest protection, biodiversity conservation, forest restoration/afforestation/carbon stock enhancement, sustainable forest management, and capacity building/livelihood improvement. In addition, a task force will be constituted at the district level, coordinated by the REDD focal person in each district, with participation from indigenous people and local communities (FECOFUN, ACOFUN, and NEFIN).

List of participants and organizations represented by them is provided in the following Table. List of participants of the BSP workshop organized by the REDD IC at Dhulikhel (Aug 21 and 22, 2024)

| S No | Name | Designation | Organization |
|---|---|---|---|
| 1 | Nabaraj Pudasaini | Joint Secretary and Chief | REDD IC |
| 2 | Prakash Thapa | Under Secretary | REDD IC |
| 3 | Prakash Nepal | Under Secretary | REDD IC |
| 4 | Shanta Kafle | Forest Officer | REDD IC |
| 5 | Sujas P Phuyal | Forest Officer | REDD IC |
| 6 | Bishnu Kumari Adhikari | Soil Conservation Officer | REDD IC |
| 7 | Rema Dhungana | Account Officer | REDD IC |
| 8 | Leeza K C | Information Officer, | REDD IC |
| 9 | Yubraj Jirel | Vice-President | NEFIN |
| 10 | Bhadra Kumari Baram | Secretary | NEFIN |
| 11 | Bikas Surel, | Secretary, | NEFIN |
| 12 | Yamuna Chhantyal | Secretary, | NEFIN |
| 13 | Riyar Nosang Bhote | Joint Treasurer | NEFIN |
| 14 | Mangkesh Gupta | Indigenous Peoples Coordinator | CIPRED |
| 15 | Brikha Bahadur Shahi | Senior Vice President | FECOFUN |
| 16 | Sita Aryal | Executive Director | FECOFUN |
| 17 | Shanta Neupane | Treasurer | FECOFUN |
| 18 | Nira Devi Dhakal | Treasurer | ACOFUN |
| 19 | Rajani Kanta Jha | Central Member | ACOFUN |
| 20 | Jograj Giri | President | AFFON |
| 21 | Indra Prasad Koirala | Vice President | Leasehold Forest Association |
| 22 | Aarati Shrestha | senior Vice-President | HIMAWANTI |
| 23 | Madhab Mani Humagani, | General Secretary | FENFIT, Nepal |
| 24 | Mohan Poudyal | National Coordinator | UN-REDD |
| 25 | Pradeep Budhathoki | Deputy Director | RECOFTC Nepal |
| 26 | Shreesha Chhatkuli | Information Officer | RECOFTC Nepal |
| 27 | Yadav Prasad Kandel | National Safeguard Consultant | UNEP |

After getting concurrence from the Ministry of Finance, the revised BSP has been approved by the government of Nepal (Minister level decision of Ministry of Forests and Environment) on the 17th of October 2024.

As per the revised and approved BSP, fund flow of the benefit distribution will be as follows:
Total benefits received as the results-based payments from the Carbon Fund of the FCPC will be first deposited in the Federal Consolidated Fund of the government of Nepal. Forest Development Fund (FDF) will then propose programs for distribution and allocation of the benefits to the identified beneficiaries as per this BSP considering the agreement with the WB following the annual budgetary system and procedures for the Appropriation Bill (Biniyojan Bidhayak) through the Ministry of Forests and Environment. The Ministry of Finance will then transfer the money to the FDF as per the approved Appropriation Act (Biniyojan Aain) for the fiscal year for management of forests. When the money is received at the bank account of FDF, FDF then will transfer the money to the accounts of the identified beneficiaries as per this BSP and the approved investment plans (of the benefits) submitted by the beneficiaries. Minimum 80% of the total ER payments received at the Federal Reserve Fund will be transferred to the FDF through the Ministry of Finance (Rule 107 (8) of Forest Rules, 2022). Allocation of benefits for distribution among different beneficiary groups and sub-groups is provided in Annex 16 of the approved BSP.

**5.1** Based on experience of benefit distribution during the current reporting period after the results-based payment is received as well as feedback from recipients, any specific recommendations for modifying the procedural or substantive content of the BSP will be identified and the plan will be revised and procedures will be modified as necessary. The substantive changes may include modifications to eligible beneficiaries; rationale or justification for benefits sharing; form or modality of benefit distribution; structure of dedicated funds established to distribute benefits; as well as obligations of recipients.

**5.2** Once the benefits are distributed as per the approved BSP, any procedural or administrative obstacles to timely distribution of benefits (e.g., adequacy of financial channels, ability to use funds) will be identified and corrective measures will be applied immediately.

**5.4** Once the benefits are distributed as per the approved BSP, any other emerging risks that may affect the sustainability or effectiveness of the BSP will be identified and corrective measures will be applied as required.

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

## Priority Non-Carbon benefits

### 1. Identified set of priority Non-Carbon benefits

**1.** Nepal perceived REDD+ as an opportunity to further leverage investment in good forest management for improving sustainable supply of forest commodities, ecosystem services, biodiversity, and livelihood opportunities. Nepal's submission to the UNFCCC on methodological guidance for non-market-based approaches and methodological issues related to noncarbon benefits resulting from the implementation of REDD+ identified five major non-carbon benefits. These are: 1. Enhancement of local livelihoods; 2. increased value of biodiversity; 3. Better ecosystem services to people and environment; 4. More resilient ecosystems for climate change adaptation improved governance, institutional setup, and policies for natural resource management at local to national levels; and 5. Contributions to multinational environmental agreements[90].

Nepal's ER program under the Carbon Fund of the FCPF is focused on REDD+ and expected to achieve the emissions reduction targets as the carbon benefits. In addition, several non-carbon benefits of the ER program were also identified and listed in the ER-PD as forest resources of Nepal are integral parts of local livelihoods, culture, agriculture, industry, and human wellbeing. Priority Non-Carbon Benefits of ER program interventions listed in the ER-PD and BSP of the program and details on activities for generation and enhancement of these benefits are provided in the following Table:

| Priority Non-Carbon Benefit | • Details on activities for generation and enhancement<br>○ Approach (as defined in ERPD including relevant indicators) |
|---|---|
| Enhancement of local livelihoods | • The improved CBFM system through the SFM practices has generated employment opportunities and enhanced livelihoods at the local level.<br>• Promotion of private forestry/agroforestry has enhanced livelihoods of local farmers through multiple cropping, and from selling forest products.<br>• The Pro-Poor Leasehold Forestry program has enhanced the livelihoods of ultra poor families through providing income generation opportunities. |
| Biodiversity conservation | • Strengthened Protected Area Management system contributed to the biodiversity conservation.<br>• Land use planning has reduced unplanned and ad hoc infrastructure development resulting in a decrease in biodiversity loss at local level.<br>• Implementation of the ESMF and Cancun Safeguards principles has contributed to biodiversity conservation in the ER program area.<br>• Promotion of biogas and improved cookstoves has reduced pressure on national forests resulting biodiversity conservation. |
| Better ecosystem services to people and environment | • All the ER program interventions are focused on reducing deforestation, forest degradation and restoration of degraded ecosystem which have supported better ecosystem services to the people and the environment. |

[90] 2_78_redd_20140326_nepal_nmbas_ncb.pdf (unfccc.int)

| | |
|---|---|
| | • Implementation of the ESMF of the ER program and Cancun Safeguards have ensured that environmental and social risks of the ER program interventions are reduced and mitigated. |
| Improved Governance, Policy, and Institutional arrangement | • Establishment of REDD+ institutions have promoted transparency & accountability.<br>• Implementation of Cancun Safeguards principles ensures good governance.<br>• ER program has contributed to development/revision of different policies, which are aligned with different international agreements and principles of Environmental and Social Safeguards. Some of these include:<br>- Climate change policy, 2019<br>- National REDD+ Strategy, 2018<br>- Agroforestry Policy, 2019<br>- Environment Policy, 2019<br>- National Forest Policy, 2019<br>- National Adaptation Plan (NAP),), 2021<br>- Nationally Determined Contribution (NDC),), 2020<br>- Nepal Long Term Strategy for Net Zero Emission, 2021<br>- GESI Strategy for Climate Change, 2021<br>- Forest Act, 2019<br>- Environment Protection Act, 2019<br>- Environment Protection Regulation, 2020 |
| Improved and Enhanced Social Benefits. | Through the implementation of ER program including ESMF and Cancun Safeguards, different social benefits have improved and enhanced. Some of these include:<br>• Recognition of rights and importance of Indigenous Peoples in REDD+ process and Biodiversity conservation.<br>• Women empowerment.<br>• Enhanced Gender Equality and Social Inclusion<br>• Enhanced health and safety of workers.<br>• Empowerment of Dalit and other marginalized groups |

**Other Non-Carbon benefits and additional information as linked to Monitoring and Evaluation Framework**
Monitoring and Safeguard Consistency and Gap Assessment Report of Implementation of Interventions under the Nepal Emissions Reductions Program (2021) revealed that Community Forest User Group and Collaborative Forest User Groups of the ER program area, which were implementing Scientific Forest Management Plans until 2021 were able to provide and enhance more non-carbon benefits. Different CBFM user groups were practicing different approaches to enhance the non-carbon benefits. These are included in the relevant sections below.

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

Livelihood enhancement and sustainability

2.1. Is your CF program testing ways to sustain and enhance livelihoods (e.g. one of your program objective/s is explicitly targeted at livelihoods; your approach to non-carbon benefits explicitly incorporates livelihoods)?
Yes. Community Forest User Group and Collaborative Forest User Groups of the ER program area, which were implementing Scientific Forest Management Plans until 2021 were able to provide different kinds of support to the local communities for livelihood enhancement. Some of these include:

- Specific sites that were important for edible forest products and other NTFP were identified and protected as far as possible while implementing SFM.
- Timber was provided free of cost for the families who were below the poverty line.
- Families who installed the biogas plants were provided some financial support.
- Timber was provided at a subsidized rate for Dalits.

- Financial support (interest free loans) was provided for poor families for different kinds of income generating activities.
- Scholarships were provided for poor students.
- Fuelwood was provided free of cost for cremation.
- All forest management activities were done from FUG members to provide employment opportunities for the members.
- After regeneration harvesting, members were allowed to collect debris and other branches for fuelwood free of cost.
- Timber was provided free of cost to the farmers involved in the bee keeping for making beehives.
- Farmers involved in goat farming and pig farming were provided financial support.
- Tractors were provided at a subsidized rate within the FUGs.

Biodiversity

2.2. Is your CF program testing ways to conserve biodiversity (e.g. one of your program objective/s is explicitly targeted at biodiversity conservation; your approach to non-carbon benefits explicitly incorporates biodiversity conservation)?

Yes. CF program mainly supported biodiversity conservation in the protection areas of the ER program area through its intervention 7- Strengthening Protected Area Management system. Furthermore, ER program supported biodiversity conservation outside the protected areas during the implementation of the ER program interventions through implementation of the Environmental and Social policies of the World Bank as specified in the Environmental and Social Management Framework of the program.

Protected/conserved areas

2.3. What amount (in ha) of protected or conserved areas are included in your CF program area?

` Has this amount increased or decreased in the last year? If so, by how much?

Carbon Fund (CF) supported ER program area covers six protected areas – National Parks and Conservation Areas, which have a total area of 341341,997 hectares. These PAs have an additional total buffer zone area of 210210,601 hectares (see details in Table 4, Chapter 1). The total combined area of protected areas and buffer zone areas is 552,614 ha and there has been no change in this area since the ER program commenced.

Re/afforestation and restoration

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

During this monitoring period, Nepal established new plantations in 2,127 hectares of land in the program area. Additionally, natural forest sites involving the corridors such as *Kamdi, Mohana- Laljhadi, Karnali - Chisapani, Basanta, Brahmadev* and *Khata* have been restored to some extent, leading to habitat improvement in the CF program area.

Finance and Private Sector partnerships

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

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

| **Amount** (US$) | **Source** (e.g. FCPF, FIP, name of gov't department) | **Date committed** (MM/YY) | **Public or private finance?** (Delete as appropriate) | **ERP, grant, loan, equity or other?** (Delete as appropriate) |
|---|---|---|---|---|
| $ 2.5 million | Government of Nepal | For Fiscal year 2019-2023 | Public | Other- Government regular budget |

| | | | | |
|---|---|---|---|---|
| $ 24 million | World Bank- Forests for Prosperity Project | 2021 – 2025 (for 5 years) | Public | Grant / Loan / |
| + | Regular budget of Provincial governments | | Public | Other- government regular budget |

ER-PD (Annex 1) provides the anticipated funding from different sources for implementation of the ER program. However, external funding has not been received for implementation of the program and activities are being implemented from the regular budget of the government (2.5 million USD was allocated/spent for REDD Forestry and Climate Change Program from 2019 -2023). Only one external funding received that partially supporting to implement the ER-PD is 24 million USD for Forests for Prosperity Project under the Forest Investment Plan of the Climate Investment Fund through the World Bank.

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

| | **Total REDD+ ER payments received to date ($US)** |
|---|---|
| **Carbon Fund project/s** (i.e. ER payments from sources other than the Carbon Fund) | $0 |
| **All other national REDD+ projects** | $0 |

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

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

| | **Established in the last year** (Jul-Jun) | **Total to date** |
|---|---|---|
| **Number of private sector partnerships involving financial exchange** | 0 | 0 |
| **Number of private sector partnerships involving non-financial exchange** | 0 | 0 |

**3. Other Non-Carbon benefits and additional information**

There are no other Non-Carbon benefits and additional information to be included in this reporting period.

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

Policy development

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

Development of the National REDD+ Strategy 2018 was initiated in 2014 during the implementation of the FCPF REDD+ readiness project. The ER program is involved mainly in implementation of the National REDD+ strategy, 2018 and the new Forest Policy, 2019; National Environment Policy, 2019 and Climate change policy, 2019.

Capacity building

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

Yes, CF program involved in number of capacity building activities to the different stakeholders including government staff, Indigenous Peoples and Local Communities (IPLCs). Capacity developing activities were conducted mainly under the FCPF's readiness project. Some of the capacity building training on various aspects of the REDD+ were also supported by the UN-REDD and ICIMOD's Himalaya REDD+ project as well as DGM under the FIP. Capacity development activities conducted at different levels from fiscal year 2017/18 to 2022/23 are provided in Annex Table 2.

Other

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

Yes, there are many other non-carbon benefits as **Social Safeguards** generated from the implementation of SFM practices in the ER program area. These include:

- Culturally sensitive and important sites and species were identified and recorded in the Management Plans. They were protected from harvesting and other activities.
- Forest Users Groups were using local and customary practices as far as practicable during implementation of the Scientific Forest Management Plans.
- Timber was provided free of cost for educational institutions (up to 200 Cu ft).
- Women empowerment and leadership training were organized regularly.
- Schools were supported in classroom construction and furniture.
- Financial support was provided for different local cultural activities.
- CFUG was providing computer training regularly for local youths.
- Football training was provided for local and indigenous youth.
- Religious site with Durga Temple was protected.
- Financial support was provided for Indigenous Community (Tharu) in celebrating their festival– Maghi.
- Support was provided for local road construction and pitch (black top) as well as in drinking water program.
- Local schools were supported financially in hiring teachers.

# ANNEX 4: CARBON ACCOUNTING - ADDENDUM TO THE ERPD

## Technical corrections

The technical corrections applied to the original Reference Level have been made. All the technical modifications are in line with paragraphs 2 and 3 of the "Guideline on the application of the methodological framework Number 2: Technical corrections to GHG emissions and removals reported in the Reference Period". Technical corrections do not compromise the consistency of GHG emissions and removal estimates between the Reference Period and monitoring periods, as both calculations apply the improvements. None of the improvements relate to a change in policy and design decisions affecting the Reference Level. Carbon pools and gases, GHG sources, Reference Period, forest definition, REDD+ activities and Accounting Area remain unchanged. Changes in data sources, methods, and the re-estimation of Activity Data and Emission Factors have been made in calculating the FREL/FRL of Nepal ER-P. The changes made are detailed below.

i. **Reference Period**: There is an error in the ER-PD's Reference Period (RP); the number of years was mistakenly defined as 10 years, which should have been 11 years, considering the start and end of the RP (Start 1/1/2004, End 31/12/2014). Therefore, the Forest Reference Emission Level was calculated considering a Reference Period of 11 years.

ii. **Reported Accounting Area for the ER-Program.** Differences were found in the reported ER Program Boundary between the ER-P boundary shapefile and the pixel count stratification map (Agreement map) used for estimating activity data. This discrepancy arose because the strata areas in the Agreement map were projected in degrees (EPSG 4326-WGS 84) based on pixel count areas, incorrectly assuming a pixel size of 30m x 30m. To address this, the Agreement map file was reprojected to the local projection EVEREST 1830_LCC_NEPAL to determine the pixel size in meters [1]. After reprojection, the pixel size measured 27.0814 m x 27.0814 m, resulting in slight adjustments to the pixel count values (see table below). The changes in pixel count values are a result of the reprojection. Consequently, the activity data has been recalculated using the map projected with EVEREST 1830_LCC_NEPAL for strata area calculations.

**Agreement map pixel count area used to estimate activity data calculated with two different map projections.**

| Map value | Pixel count | | Area (ha) | | Strata |
|---|---|---|---|---|---|
| | EPSG:4326 - WGS 84 | EVEREST 1830_LCC | EPSG:4326 - WGS 84 | EVEREST 1830_LCC | |
| 1 | 1,787,371 | 1,927,955 | 160,863 | 141,397 | DEG |
| 2 | 543,523 | 586,327 | 48,917 | 43,001 | LOSS |
| 3 | 2,068,731 | 2,230,870 | 186,186 | 163,613 | GAIN |
| 5 | 11,453,138 | 12,353,207 | 1,030,782 | 905,989 | Forest |
| 4 | 13,037,220 | 14,089,421 | 1,173,350 | 1,033,324 | Nonforest |
| Total | 28,889,983 | 31,187,780 | 2,600,098 | 2,287,325 | |

[1] FCPF_2004_2021_TAL_clipped_Agreement_Everest1830_LCC_NEPAL accessible at the following link https://drive.google.com/drive/folders/1ehLiof_pj4JpsXtRk-CioWi2cPEQOJgP?usp=sharing

i.

ii. **Activity Data:** The ER-PD Activity Data assessment is a yearly analysis of tree canopy cover estimations, done in collaboration with the University of Maryland and supported by the USGS SilvaCarbon program. The assessment involves removing bias and making area estimates based on stratified random sampling. This method is used to establish changes observed between 2004 and 2014 and to determine the extent of deforestation and forest degradation. The emissions estimates for deforestation and forest degradation are based on the changes observed in the tree canopy cover.

Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation for the current monitoring report. This approach ensures unbiased estimates of the area and the error associated with the map. The forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO. To differentiate between secondary and permanent forests to avoid overestimating emissions from deforestation, as well as to identify the age of forest gain cohorts for applying accurate emission factors and estimating removals, the sampling points are visually interpreted for the same period that the forest change map was created. This period is divided into four subperiods: 1984-2003, 2004-2014. 2015-2017, and 2018-2021. The canopy cover is visually evaluated in the permanent forest only for 2003/2004, 2014/2015, 2017/2018, and 2021.

iii. **Forest carbon densities**: In the ER-PD, the NFI provided average estimates for each independent physiographic region by combining all sampled forest types based on the stratification used. For the ERPD, a single average was proposed for CORE and EDGE classes based on MSPA analysis results. The existing total biomass stocks calculated for each NFI plot were reclassified into an overall CORE and EDGE class using the MSPA analysis. The mean biomass and variance were calculated following Birigazzi et al. (2018) [91].

The carbon density estimates have been updated using data from the NFI biomass plots for forest and non-forest areas. The NFI conducted two biomass measurements, one between 2011 and 2013 and the other in 2022. It's important to note that the first measurement was taken during the ER-Program Reference Period 2004-2014, while the second was taken after the signing of the ERPA in February 2021.

As a result, the carbon densities of natural forests were recalculated using only the first measurement (2011-2013) based on 388 biomass NFI plots. The determination of average carbon densities for non-forest lands is based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were also obtained during the NFI's first measurement phase.

To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland.

iv. **Removal Factor**: The ERPD biomass removal factors were estimated using LiDAR data. Average removal factors were calculated based on areas reported as gain under the reference level submitted to the UNFCCC, which used LiDAR to estimate biomass and compared it with IPCC default values. A Monte Carlo analysis was applied to all biomass and Activity Data estimates to produce reference level estimates, resulting in 10,000 randomized iterations.

For this monitoring report, NFI plots were evaluated and categorized based on their land use type, including non-forestland use, Permanent Forest, or Secondary Forests. This ensures consistency between the Emission Factors and land-use transition areas. The same time series analysis was used for NFI permanent plot locations to replicate the CEO's data collection methods.

The forest regrowth removal rate calculation is based on 16 NFI plots established in secondary forests. The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between

[91] Birigazzi, L, JGP Gamarra, TG Gregoire. 2018. Unbiased emission factor estimators for large-area forest inventories: domain assessment techniques. Environmental and Ecological Statistics. https://doi.org/10.1007/s10651-018-0397-3

measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.
A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (8.97 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1].

[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following
lhttps://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

v. **Forest degradation**: Nepal initially did not include increased forest biomass observed in forests remaining as forests. For this monitoring report, a net emission from forest degradation was calculated, including biomass recovery.

### Start Date of the Crediting Period

The start date of the crediting period is June 22, 2018. This date corresponds to the definition of the start date of the crediting period provided in the FCPF Glossary, i.e., follows:
-
- The ER Program measures, and the activities have been implemented since July 2018. The activities are listed in Table 2 of the ER-MR.
- The Crediting Period Start date is from June 22, 2018.
- The Crediting Period Start Date does not fall under the reference period 2004-2014.
- In terms of compliance with safeguards, Nepal had to demonstrate that the ER Program measures met the WB safeguards requirements from the start date (June 22, 2018). To do so, Nepal submitted environmental and safeguards consistency and gap assessment report. This report was cleared by the WB on June 15th, 2022. The clearance covers the retroactive period as well (June 22, 2018, to June 25, 2022).

## 7. CARBON POOLS, SOURCES AND SINKS

### 7.1 Description of Sources and Sinks selected

| Sources/Sinks | Included? | Justification/Explanation |
|---|---|---|
| *Emissions from deforestation* | *Yes* | Emissions from deforestation are significant sources of GHG emissions in TAL and therefore are included in the Reference Level (RL).<br>The RL analysis shows that during the 11-year period between 2004 and 2014, a total of **3,008,934** $tCO_2e$ was emitted from deforestation in the TAL, an average annual emission of 273 539 $tCO_2e$/yr. |
| *Emissions from forest degradation* | *Yes* | Emissions from degradation are significant sources of GHG emissions in TAL and therefore are included in the Reference Level (RL).<br>The RL analysis shows that during the 11-year period between 2004 and 2014, a total of **2,004,005** $tCO_2e$ was emitted from degradation in the TAL, an average annual emission of 182,182 $tCO_2e$/yr. |
| *Enhancement of forest carbon stocks* | *Yes* | Enhancement of forest carbon stocks by forest cover gain is included in the Reference Level (RL). The RL analysis shows that during the 11-year |

| Sources/Sinks | Included? | Justification/Explanation |
|---|---|---|
| | | period between 2004 and 2014, a total of **-6 873 406** $tCO_2e$ was removed via forest gain and canopy cover recovery in permanent forest in the TAL, an average annual emission of -624,855 $tCO_2e$/yr. |
| *Conservation of forest* | *No* | Any emissions or removals that occur in protected areas or managed forests are included in three, aforementioned, REDD+ activities. The impact of the emissions and removals related to sustainable forest management, especially in community forests, are included in the overall carbon balance calculation of afforestation and forest lands that remain as forests. |
| *Sustainable management of forests* | *No* | |

## 7.2 Description of carbon pools and greenhouse gases selected

| Carbon Pools | Selected? | Justification/Explanation |
|---|---|---|
| *Above Ground Biomass (AGB)* | *Yes* | The ERPD follows suit with the Nepal submission of its FRL to the UNFCCC. The NFI data indicates a carbon accounting area average of 100.93 t dm/ha, constituting the largest pool. |
| *Below Ground Biomass (BGB)* | Yes | Below-ground biomass for forest lands was estimated using a root-to-shoot ratio of 0.44 (2019 refinement to the 2006 IPCC guidelines for national GHG inventory, Table 4.4 -Subtropical dry Asia, . B > 125 tons/ha). BGB for non-forest lands was estimated using R::S 1.887 (Mokany et al., 2006; Table 2). |
| *Dead Wood* | *No* | Based on NFI analysis, it is estimated that dead organic matter, litter, and debris contribute 1.18 tdm/ha (State of Nepal Forest[92]) against an average aboveground forest biomass of 100.93 tC/ha (113.01 t C/ha [Gurung and Koch, 2011] [93]). As such, both pools do not seem to constitute a significant pool and are initially excluded (**see below analysis for non-$CO_2$ gasses**).<br>Since primary activities are related to avoiding deforestation and degradation and do not include significant ground disturbance, exclusion of soil carbon is likely conservative even though available estimates indicate high values representing about 29% of total biomass (Gurung and Koch, 2011).<br>Moreover, community forestry practices in Nepal are globally recognized for their participatory environmental governance, which includes well-defined policies, institutions, and practices. Key management activities involve seedling plantations, wildlife hunting control, forest fire prevention, grazing management, and erosion protection measures, all aimed at ensuring sustainable forest management and ecosystem resilience. Meaning that human interventions may enhance carbon sink functionality, balancing carbon accumulation between biomass and soil organic carbon (Bhandari and Lamichhane, 2020)[94].<br>Additionally, the calculations, using the Carbon Densities tool, of annual soil organic carbon (SOC) emissions from deforestation (27,628 tCO2/yr) |
| *Litter* | *No* | |
| *Soil Organic Carbon (SOC)* | *No* | |

[92] https://drive.google.com/file/d/1Ppsa-SNM1dEfwmAtH-aTv8L9H5wpePpT/view

[93] Gurung, M B., and Kokh, M. 2011. Forest Carbon Accounting Study Report: Baseline, Optimum Sequestration Potential and Economics of REDD+ in the Terai Arc Landscape of Nepal. Narrative Report submitted to WWF. Winrock International, Nepal. https://drive.google.com/file/d/16mQXAbJkri5_L9a3I0pxLIbTgwFWNeiC/view

[94] Bhandari, A.R., and Lamichhane, S. 2020. Sustainable Forest Management Resource Book. WWF Nepal. Baluwatar, Kathmandu, Nepal. https://www.wwfnepal.org/?364515/SFM-Manual

| | | |
|---|---|---|
| | | represent only 2,56**%** of the absolute annual emissions/removals during the reference period (**1,080,577** tCO2/yr). The SOC emissions from deforestation estimates are considered overestimated. This is due to the assumption of immediate SOC release instead of considering a 20-year period and neglecting the SOC content of the final land use.<br>Since SOC emissions from deforestation are below the 10% threshold, and an increase in SOC stock is anticipated due to the implementation of sustainable forest management (SFM) practices in permanent forests, SOC was not included in the carbon accounting of the ER program. |

| GHG | Selected? | Justification/Explanation |
|---|---|---|
| *CO2* | Yes | The ER Program accounts for $CO_2$ emissions and removals. |
| *CH4* | No | Nepal has no coastline or mangroves; thus, there are no $CH_4$ or $N_2O$ emissions associated with organic and mineral soils for the management activities of extraction (including construction of aquaculture and salt production ponds), drainage and rewetting and revegetation as provided in the 2013 Wetlands Supplement to the 2006 IPCC Guidelines. Experience under the Kyoto Protocol's CDM also suggests that emissions from using fertilizer and planting leguminous plants and trees will not be significant (FCPF Decision Support Tool Part 1). A significant proportion of $CH_4$ emissions in Nepal come from enteric fermentation, solid waste disposal and wastewater treatment as well as from the rice fields as reported by the Initial National Communication (2004). These are not directly associated with forestry, though, so they are not relevant for the FRL calculation. Additionally, some of the implementation's actions proposed by this ERPD, like the use of biogas units, will indirectly target emissions from enteric fermentation resulting from grazing inside forest areas, minimizing even further the relevance of this gas.<br>The excluded GHGs therefore are CO, $CH_4$ and $N_2O$ because:<br>● There are no mangroves in Nepal.<br>● There are no seasonal or permanently flooded forest areas in Nepal. |
| *N2O* | No | In the case of the national Reference Level (RL), to understand whether non-$CO_2$ emissions associated with forest fires provide a significant contribution to total emissions from forests, we considered the Global Forest Resources Assessment 2015 (FAO 2015) report for Nepal. In the report, Nepal provides a burned forest area estimate of on average 9,738 ha/yr for the period 2003–2010. They indicate this number concerns mainly fire events in remaining forestland, a sub-category which is currently not fully covered by the FRL. For the FRL, Nepal performed an estimation of annual non-$CO_2$ emissions from fire using equation 2.27 (IPCC 2006, Volume 4, Chapter 2). Input data in the equation was derived from the Global Forest Resources Assessment 2015's burned forest area estimate for Nepal (the average for the years 2003–2010), the average above-ground biomass (mass of fuel available for combustion) as obtained from Nepal's National Forest Inventory (2010) and IPCC default values for fuel biomass consumption, the combustion factor, and Emission Factor of dry matter burnt per mass. According to the calculation, $N_2O$, CO, and $CH_4$ account for 0.24% (2,568 tCO2e/yr), 1.27% (13,742 tCO2e/yr), and 0.85% (9,225 tCO2e/yr) respectively of the absolute annual emissions/removals during the reference period |

(**1,080,577** tCO2/yr). Because of this, Nepal has determined that non-CO2 emissions are below the 10% threshold to be considered significant sources, and considering the country doesn't dispense reliable fire data, it was decided to omit non-CO2 gasses associated with fire.

Additional analyses were carried out for the TAL area for 2004–2013. MODIS Area Burnt data were used to assess patterns of fire occurrence between 2004 and 2013. Results indicate fires occur mostly within forest areas that are also within protected areas (see figures below). Discussing the results with the relevant agencies such as the DFRS and NRC as well as with FAO, it was indicated these are prescribed burnings for the most part that do not affect the main biomass content of the forests and are targeted at the litter and deadwood pools (less than 2% of the available biomass). When assessing NFI plot data from areas within MODIS derived burnt area estimates vs areas with no fire, following Birigazzi et al (2018), areas with fire presence appeared as having higher biomass than areas without fire.

| DOMAIN | domain mean (t/ha) | $\frac{1}{\hat{N}_d^2}$ | $V(\tilde{y}_{sd})$ | Confidence interval at 95% | % CI (95%) | Confidence Interval at 90% | % CI (90%) |
|---|---|---|---|---|---|---|---|
| **FIRE** | **219.11** | 6.46168E-14 | 189.9 | **27.0** | 12.3% | **22.7** | 10.3% |
| **NO FIRE** | **180.25** | 1.65974E-15 | 44.1 | **13.0** | 7.2% | **10.9** | 6.1% |

Currently, definitive forest fire emission estimates are not possible because Nepal lacks reliable data. Therefore there is insufficient information to accurately assess the impact of fires in the Terai region on forests or emissions. A preliminary estimate was obtained derived from low-resolution satellite imagery, MODIS, and IPCC 2006 default emission factors for the TAL (2004–2013) calculated using the Equation 2.27 from IPCC 2006, Volume 4, Chapter 2. Note that the MODIS Forest fire data used detects thermal anomalies (above 300 degrees Fahrenheit) within 500x500m (25ha) pixels, but it does not specifically indicate the area burned or the impact. So, the estimate was obtained assuming all 25 ha MODIS pixel-1 litter, and deadwood pool were fully burnt (1.18 t biomass/ha; as per NFI data) and fully recovered year after year (some pixels are flagged as burnt in all years), which is unlikely. Based on this preliminary calculation, forest fire emissions represent 8.70% (94,052 tCO2e/yr) of the absolute annual emissions/removals during the reference period (**1,080,577** tCO2/yr).

| Year | # MODIS pixels Flagged | Emissions from Litter Burning |
|---|---|---|
| 2004 | 7140 | 161,921 |
| 2005 | 6957 | 157,770 |
| 2006 | 6468 | 146,681 |
| 2007 | 5675 | 128,697 |
| 2008 | 5136 | 116,474 |
| 2009 | 4403 | 99,851 |
| 2010 | 3544 | 80,371 |
| 2011 | 3249 | 73,681 |
| 2012 | 2080 | 47,170 |
| 2013 | 968 | 21,952 |

| | | |
|---|---|---|
| | | Average emission \| 94,052<br><br>Nepal considers these numbers to be a large overestimation of emissions, as it is clear that not all the area of a given MODIS pixel highlighted as having fire presence (25 ha) is necessarily burnt; which is highly unlikely (the fact some of these pixels were highlighted every single year without apparent tree canopy damage and related burn scars supports this fact) plus a full recovery of the biomass burnt is also unlikely.<br>**Based on this, Nepal considers the percentage of emissions resulting from these fires to be very well below the 10% threshold for their inclusion as significant sources in a conservative manner and therefore left them out of this version of the Reference Level in addition to derived N2O, CH4 and CO (non-CO2) gasses**.<br>However, Nepal is aware of the need for better informing the estimated emissions from these fires and is currently defining the terms of reference to carry out, with the support of FAO, an area burnt characterization that will deliver the necessary quality data required for the sound assessment of emissions resulting from these fires. |

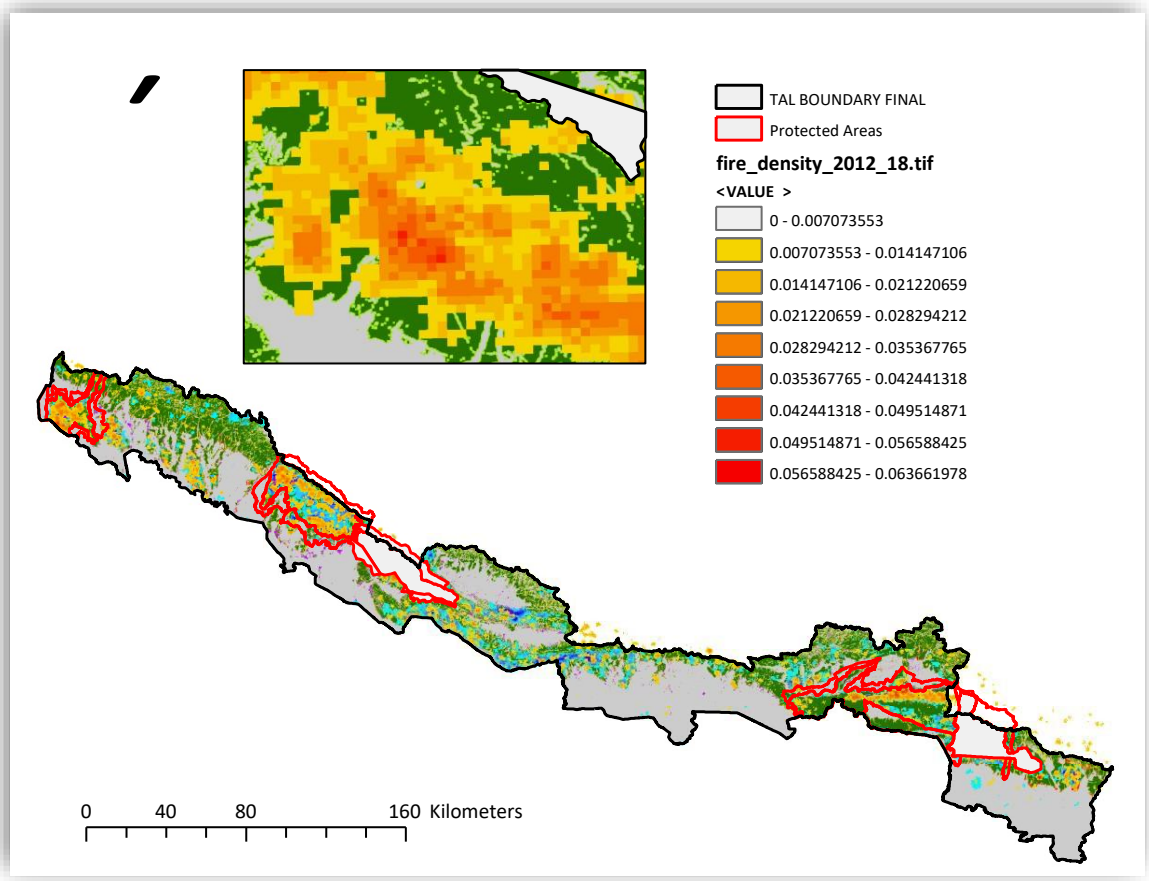



**Figure 11:** MODIS-derived fires frequency data with protected areas in the TAL; occurrence density 2012–2018. The data show how most of the fires occur within protected areas boundaries.

# 8 REFERENCE LEVEL

## 8.1 Reference Period

The Reference Period starts on January 1st, 2004, and ends on December 31st, 2014, making it a duration of 11 years. These dates are consistent with the available data used to inform the stratification used for unbiased estimation of Activity Data and elements of permanence in Nepal's definition of deforestation and forest degradation—particularly those involved with their permanence. We used 2002–2004 forest conditions to define a benchmark or forest stratum area and used changes observed as of 2014 and that remained as such as of 2015 and 2016 as a means to assess permanence of relevant accounting strata: stable forest, stable non-forest (all non-forest classes), forest gain, and forest loss.

## 8.2 Forest definition used in the construction of the Reference Level

### Official definition of forest in Nepal:

The official definition of forest in Nepal is, "Land spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10%, or trees able to reach these thresholds in situ." It does not include land that is predominantly under agricultural or urban land use.

(chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://frtc.gov.np/uploads/files/Study%20Report%20Inner-final.pdf)

For the construction of the Reference Level, the following definition of the forest is used: "forest as an area of land of at least 0.5 ha and a minimum width/length of 20 m with a tree crown cover of more than 10% and tree heights of 5 m at maturity."

The National Forest Reference Level of Nepal (2000-2010) uses the following definition of forest: Land with tree crown cover of more that 10 percent and area covering more than 0.5 ha, with minimum height of the trees to be 5 m at maturity and in-situ conditions. The land may consist either of closed forest formations where trees of various storied and undergrowth cover a high proportion of the ground, or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest, as are areas normally forming part of the forest area which are temporarily un-stocked as a result of human intervention or natural causes but which are expected to revert to forest. This includes forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas within the forest; forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and a width of more than 20 m. Land predominantly used for agricultural practices are excluded.

In essence there are no differences in the forest definition between RL and FREL. The only difference is that in the case of the latter, additional descriptions that came from the extended definition from the FAO document were copied. However, in terms of biophysical implications as applicable to the assessment, they do not contribute to differences. For example, the key variables are related to canopy cover, minimum mapping unit and stand height. Due to Landsat pixel size, the closest approximation that the ER-MR could achieve while keeping whole pixel units is 0.49 ha.

The definitions of all classes of forest and non-forest is provided below:

| **Forest Type (pre-period)** | **Definition** |
|---|---|
| Permanent Forest | Ideally, a permanent forest is a natural forest having an age of more than 20 years (1991-2011/12) and crown cover is greater than 10%. |
| Secondary Forest | Plantation forest or the regrowth in the non-forest land. The age of the secondary forest is always less than 20 years. If this is more than 20 years it will automatically be converted into a permanent forest. |

| **Forest Type** | **Definition** |
|---|---|
| natural forest or planted native mixed | Natural forest are those forest which evolved over time without direct human intervention where as Planted native mixed forest are those forest planted intentionally of native tree species. |
| plantation or planted commercial forest | plantation or planted commercial forest are those forest planted intentionally for commercial purpose. |
| tree-shaded-cropland / silvopasture | The term "tree-shaded cropland" refers to agricultural fields or farmland that have trees that may or may not have been deliberately placed or that are interspersed throughout the agricultural fields or farmland to offer shade and other advantages to the crops cultivated there. This practice combines elements of traditional farming with agroforestry, which is the intentional integration of trees and shrubs into agricultural systems. |

| **Non-Forest LULC Type** | **Definition** |
|---|---|
| Unshaded Cropland (TCC 10% or less) | This is agricultural areas or fields in which little trees are scattered, and the area has less than and equal to 10 percent canopy cover of trees. |

| | |
|---|---|
| Grasslands | Areas covered by herbaceous vegetation with cover ranging from Closed to Open (15–100%). This category includes rangeland and pasture that is not considered cropland.NLCMS,2022 |
| Settlements | Built-up areas refer to artificial structures such as towns, villages, industrial areas, airports, etc.NLCMS,2022 |
| Other Land | This category includes bare soil, rock, ice, river bed, waterbodies, snow and all unmanaged land areas that do not fall into any of the above categories. |

**Forest definition operationalization:**
The ER-PD uses Landsat data (30m resolution) for mapping of tree canopy cover estimated data following Hansen et al (2012) from 2002 to 2016, to derive corresponding Activity Data. Given the fact Nepal's area component of its forest definition refers to 0.5 ha and 10% tree cover, Nepal considers that 30m resolution TCC estimates inform its forest definition, as any given pixel represents an area of 0.09 ha or 18% of 0.5 ha.

Use of TCC data for unbiased estimation of AD via stratified random sampling following Tyukavina et al. 2013,65 2015,66 Global Forest Observation Initiative's Methods and Guidance (MGD) update *in process* as well as pixel level sample assessment of tree canopy cover permanence, loss and gain complies with the operationalization of the forest definition as well as of its definition of deforestation (permanent forest loss: TCC below 10% threshold) and forest degradation (partial loss while still above 10%).

Forest Degradation

Broadly, forest degradation is a decrease in forest tree cover that is short lived. Overall, the land cover type remains as a forest over time, often regenerating to intact forest canopy. Contrast this pattern with deforestation, where forest area is permanently lost.

The definition of forest degradation is "a decrease in the amount of canopy cover of a forest, whether partial or complete, that does not result in a change in land use." This means if a forest is completely cut down but is immediately allowed to regrow and the land is not used for any other purpose, it will be considered a severely degraded forest. If the forest is completely cut down and the land is used for another purpose, so that a new land use / land cover should be assigned such as for agriculture, then this would be considered deforestation rather than forest degradation.

## 8.3 Average annual historical emissions over the Reference Period

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

**Annual change in total biomass carbon stocks forest land converted to another land-use category ($\Delta C_{B_{defo,t}}$)**
Emissions from deforestation were estimated based on the Deforestation Sheet of Activity Data tool following the 2006 IPCC Guidelines, the annual change in total biomass carbon stocks forest land converted to other land-use category ($\Delta C_{B_{defo,t}}$) would be estimated through the following equation:

$$\Delta C_{B_{defo,t}} = \Delta C_G + \Delta C_{CONVERSION} - \Delta C_L \qquad \textbf{Equation 3}$$

Where:

| | |
|---|---|
| $\Delta C_{B_{defo,t}}$ | Annual change in carbon stocks in biomass on land converted to other land-use category, in tones C $yr^{-1}$; |
| $\Delta C_G$ | Annual increase in carbon stocks in biomass due to growth on land converted to another land-use category, in tones C $yr^{-1}$; |
| $\Delta C_{CONVERSION}$ | Initial change in carbon stocks in biomass on land converted to other land-use category, in tones C $yr^{-1}$; and |
| $\Delta C_L$ | Annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use categories, in tones C $yr^{-1}$. |

Following the recommendations set in chapter 2.2.1 of the GFOI Methods Guidance Document[95] for applying IPCC Guidelines and guidance in the context of REDD+, the above equation will be simplified and it will be assumed that: a) the annual change in carbon stocks in biomass ($\Delta C_B$) is equal to the initial change in carbon stocks ($\Delta C_{CONVERSION}$); b) it is assumed that the biomass stocks immediately after conversion are the biomass stocks of the resulting land-use. Therefore, the annual change in carbon stocks would be estimated as follows:

$$\Delta C_B = \Delta C_{CONVERSION}$$

$$\Delta C_{B_t} = \sum_{j,i} \left(B_{Before,j} - B_{After,i}\right) x\, CF\, x \frac{44}{12} \times A(j,i)_{RP} \qquad \textbf{Equation 4}$$

Where:

| | |
|---|---|
| $A(j,i)_{RP}$ | Area converted/transited from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, sixteen forest land conversions are possible:<br><br>1 Intact Forest to Grasslands<br>2 Intact Forest to Other Land<br>3 Intact Forest to Settlements<br>4 Intact Forest to Unshaded Cropland (TCC 10% or less)<br>5 Degraded Forest to Grasslands<br>6 Degraded Forest to Other Land<br>7 Degraded Forest to Settlements<br>8 Degraded Forest to Unshaded Cropland (TCC 10% or less)<br>9 Very Degraded Forest to Grasslands<br>10 Very Degraded Forest to Other Land<br>11 Very Degraded Forest to Settlements<br>12 Very Degraded Forest to Unshaded Cropland (TCC 10% or less)<br>13 Secondary natural forest to Grasslands<br>14 Secondary natural forest to Other Land<br>15 Secondary natural forest to Settlements<br>16 Secondary natural forest to Unshaded Cropland (TCC 10% or less) |
| $B_{Before,j}$ | Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground ($AGB_{Before,j}$) and belowground biomass ($BGB_{Before,j}$) and it is defined for each forest type. |

[95]Page 44, GFOI (2013) Integrating remote-sensing and ground-based observations to estimate emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative: Pub: Group on Earth Observations, Geneva, Switzerland, 2014.

$B_{After,i}$ Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest Land Use categories.

$CF$ Carbon fraction of dry matter in tC per ton dry matter. The value used is:
- **0.47** is the default for (sub)tropical forest as per IPCC AFOLU guidelines 2006, Table 4.3.

$44/12$ Conversion of C to $CO_2$

R: :S Root-to-shoot ratio (0.44).

**Annual change in carbon stocks in biomass on forestland remaining forestland** ($\Delta C_{B_{deg,t}}$)

Following the 2006 IPCC Guidelines the annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{DEG}}$) could be estimated through the Gain-Loss Method or the Stock-Difference Method as described in Chapter 2.3.1.1 of Volume 4 of the 2006 IPCC Guidelines.

$$\Delta C_B = \Delta C_G - \Delta C_L$$ **Equation 5** (Equation 2.7, 2006 IPCC GL)

$$\Delta C_B = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$ **Equation 6** (Equation 2.8 (a), 2006 IPCC GL)

$\Delta C_B$ Annual change in carbon stocks in biomass for each land sub-category, in tones C $yr^{-1}$

$\Delta C_G$ annual increase in carbon stocks due to biomass growth for each land sub-category, considering the total area, tones C yr-

$\Delta C_L$ annual decrease in carbon stocks due to biomass loss for each land sub-category, considering the total area, tones C yr-1

$C_{t_2}$ total carbon in biomass for each land sub-category at time $t_2$, tonnes C

$C_{t_1}$ total carbon in biomass for each land sub-category at time $t_1$, tonnes C

Following the recommendations set in chapter 2.2.2 of the GFOI Methods Guidance Document[96] for applying IPCC Guidelines and guidance in the context of REDD+, the above equation will be simplified, and it will be assumed that: a) the annual change in carbon stocks in biomass ($\Delta C_B$) due to degradation is equal to the annual decrease in carbon stocks (b) the decrease in carbon stocks occurs the year of conversion. The long-term decrease in carbon stocks indicated in equation (1) of the GFOI MGD is assumed here to be zero. Therefore, considering the GFOI MGD the IPCC equation for forest degradation could be expressed as an Emission Factor time Activity Data as follows:

$$\Delta C_{B_{DEG}} = \sum_j \{EF_j \times A(a,b)_{RP}\}$$ **Equation 7**

Where:

$EF_j$ Emission factor for degradation of forest type a to forest type b, tones CO2 $ha^{-1}$.

$A(a,b)_{RP}$ Area of forest type a converted to forest type b (transition denoted by a,b) during the Reference Period, ha $yr^{-1}$.

**Annual change in carbon stocks in biomass on non-forestland converted in forestland** ($\Delta C_{B_{reg}}$)

[96]Page 48, GFOI (2013) Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests: Methods and Guidance from the Global Forest Observations Initiative: Pub: Group on Earth Observations, Geneva, Switzerland, 2014.

Land converted to forest land $CO_2$ removals has been estimated following the recommendations set in the Guidance Note for accounting of legacy emissions/removals of the FCPF (version 1). When non-forest land is converted to forest land, the removal of $CO_2$ has been estimated based on the assumption that the conversion from non-forest to forest occurs over a conservative default period of 20 years.

The removal estimate takes into account changes in carbon stocks in aboveground and belowground biomass. The changes in total carbon stocks in biomass (removals) during the Reference Period were determined as the sum of the total carbon stocks in biomass of all land units with forest cohorts with ages no longer than 20 years.

The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by their land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.

A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (8.97 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1].

| Statistics | Biomass increment Opt 1 tdm/ha/yr | MAI Opt 2 tdm/ha/yr |
|---|---|---|
| **Average** | **7.27** | **9.69** |
| **Standard deviation** | **5.82** | **8.97** |
| **n** | **3** | **8** |
| **CI** | **10.09** | **6.01** |
| **ERROR%** | **135%** | **62%** |

[1]The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link: https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[2]Joshi, V. C., Negi, V. S., Bisht, D., Sundriyal, R., & Arya, D. (2021). Tree biomass and carbon stock assessment of subtropical and temperate forests in the Central Himalayas, India. Trees, Forests and People, 6, 100147. https://doi.org/10.1016/j.tfp.2021.

The net annual $CO_2$ removals are calculated using equation 8. It was determined the changes in the total carbon stocks in biomass (removals) during the Reference Period as the sum of the total carbon stocks in biomass of all land units.

$$\Delta C_{B_{reg}} = \sum_{LU=1}^{n} \left\{ RF_{reg} \times A(i,j)_{RP} \right\} \qquad \textbf{Equation 8}$$

Where:

| | |
|---|---|
| $RF_{reg}$ | Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$]. |
| $A(j,i)_{RP}$ | Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Reference Period, ha yr$^{-1}$. |
| **LU** | Land unit. |

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

**Activity Data**

*Provide an overview of the **activity data** that are available and of those that were used in calculating the average annual historical emissions over the Reference Period in a way that is sufficiently detailed to enable the reconstruction of the average annual historical emissions over the Reference Period. Use the table provided (copy table for each parameter). Attach any spreadsheets, spatial information, maps and/or synthesized data.*

*If different data sources exist for the same parameter, please list these under the 'Sources of data'. In this case, discuss the differences and provide justification why one specific dataset has been selected over the others.*

*Refer to **criterion 6, 7, 8 and 9** of the Methodological Framework*

| | |
|---|---|
| **Parameter:** | Activity Data: $A(j,i)_{RP}$ Equation 4; $A(a,b)_{RP}$ Equation 7; $A(j,i)_{RP}$ Equation 8. |
| **Description:** | ● Deforestation: Area converted/transited from forest type j to non-forest type i during the Reference Period<br>● Degradation: Area of forest type a converted to forest type b (transition denoted by a,b) during the Reference Period, ha $yr^{-1}$<br>● Forest gain: Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Reference Period, ha $yr^{-1}$. |
| **Data unit:** | hectare |
| **Source of data and description of measurement /calculation methods and procedures applied:** | Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation. This approach ensures unbiased estimates of the area and the error associated with the map. A forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO.<br>**Forest change mapping**: The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis was used to map areas experiencing forest loss, degradation, and/or regrowth.<br>ix. **CCDC-SMA**: Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation.<br>x. **CODED**: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).<br>xi. **LandTrendr**: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.<br>xii. **MTDD**: Multi-variate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., |

NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification.

**Sample design**: A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and the error associated with your map. An agreement map generated from the results of all four methods is used for sample design. The goal is to ensure that no strata is under-sampled. The resulting strata is anywhere 1-4 algorithms agreed there was a certain kind of change event or stable forest/non-forest, anywhere the different algorithms labeled different types of change events, anywhere all 4 algorithms labeled non-forest, and anywhere all 4 algorithms labeled forest. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest. The number of points randomly selected depend on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. A total of **1,522** points were randomly selected, with a specified number from each strata, to be used for the sample-based area estimation.

**Reference data collection (completed in CEO):** To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were collected through a time series analysis of 1,522 sampling plots in CEO. To identify the age of forest gain cohorts and differentiate between secondary and permanent forests, the sampling points were visually interpreted for the same period that the forest change map was created (1983 to 2021). This period was divided into four subperiods: 1984-2003, 2004-2014, 2015-2017, and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.

ix. *Generating a CEO project from a template:* Nepal created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[97]) for the following periods: Pre-reference period (t0) - 1983-2003, Reference period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.

x. *Sampling unit*: The Sampling Unit (SU) is a 70 x 70meter plot. Inside SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit.

xi. *Number of Sampling Units*: A total of 1,522 sampling points, selected via stratified random sampling, were visually assessed.

xii. *Interpretation key*: Nepal produced an interpretation key that should be reused and updated as needed. The land use categories considered are the following:

| **Forest lands**: | **Non-forest lands** |
|---|---|
| 1 Intact Forest<br>2 Degraded Forest<br>3 Very Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands | 7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less) |

[97] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).

- Note, the first three types of forest land (intact, degraded, and very degraded) were indirectly labeled in post-processing using the number of tree-covered points out of a 9-point grid over each plot

**Area and uncertainty estimation:** Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522 samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[98]. Estimates are made for each of the land use categories considered (10 classes) and in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9).

**Value applied**

**Deforestation**

| | | 2004-2014 | | |
|---|---|---|---|---|
| **Initial** | **Final** | **Area (ha)** | **±90% CI** | **Area (ha*yr-1)** |
| Intact Forest | Grasslands | 391 | 639 | 35.55 |
| Intact Forest | Other Land | 1,564 | 1,261 | 142.18 |
| Intact Forest | Settlements | 1,676 | 2,199 | 152.36 |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | 4,818 | 3,983 | 438.00 |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | 3,506 | 3,672 | 318.73 |
| Degraded Forest | Settlements | 2,017 | 2,748 | 183.36 |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | 3,897 | 3,726 | 354.27 |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Secondary Natural Forest | Other Land | - | - | - |

**Forest gain**

| **Forest Type** | **2004-2014** | | |
|---|---|---|---|
| | **Area (ha)** | **±90% CI** | **Area (ha*yr-1)** |
| natural secondary forest gain | 17,136 | 8,467 | 1,557.82 |
| plantation forest gain | - | - | - |
| shaded cropland gain | - | - | - |

**Degradation**

| | | 2004-2014 | | |
|---|---|---|---|---|
| **Initial** | **Final** | **Area (ha)** | **±90% CI** | **Area (ha*yr-1)** |
| Intact forest | Intact forest | 1,125,747 | 22,515 | 102 340.64 |
| Degraded forest | Degraded forest | 56,347 | 14,799 | 5 122.45 |
| Very degraded forest | Very degraded forest | 10,546 | 6,585 | 958.73 |
| Intact forest | Degraded forest | 5,991 | 4,120 | 544.64 |
| Intact forest | Very degraded forest | 391 | 639 | 35.55 |
| Degraded forest | Very degraded forest | 1,627 | 2,672 | 147.91 |
| Degraded forest | Intact forest | 7,904 | 5,553 | 718.55 |
| Very degraded forest | Intact forest | - | - | - |
| Very degraded forest | Degraded forest | 3,254 | 3,780 | 295.82 |

[98] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

**QA/QC procedures applied:**

**QA QC Manual Reference data collection:**

**Reference data compilation:** To ensure accuracy, the data collected from the CEO was compiled in R for each period of the time series analysis (t0, t1, t2, and t3). The compilation process identifies land-use interpreted points with impossible transitions, and these points are sent back to the interpreted for review, until the compilation process detects no inconsistencies.

**Area estimate**: To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheet (**Activity Data Tool**). This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok".

**Uncertainty for this parameter:**

The determination of the uncertainty Activity Data was not done using the standard deviation (SD) given that the formulas (Cochran (1977)) used to estimate the Activity Data do not allow for the calculation of SD. To determine the uncertainty for Activity Data, initially the country used the calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions and the normal probability density function (PDF). This calculation only takes sampling errors into account and does not consider the interpreter error. Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available.

**Deforestation**

| Initial | Final | 2004-2014 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | %E |
| Intact Forest | Grasslands | 391 | 639 | 164% |
| Intact Forest | Other Land | 1,564 | 1261 | 81% |
| Intact Forest | Settlements | 1,676 | 2199 | 131% |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | 4,818 | 3983 | 83% |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | 3,506 | 3672 | 105% |
| Degraded Forest | Settlements | 2,017 | 2748 | 136% |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | 3,897 | 3726 | 96% |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| secondary natural forest | other land | - | - | - |
| secondary natural forest | other land | - | - | - |

**Forest gain**

| Forest Type | 2004-2014 | | |
|---|---|---|---|
| | Area (ha) | ±90% CI | %E |
| natural secondary forest gain | 17,136 | 8,467 | 49% |
| plantation forest gain | - | - | - |
| shaded cropland gain | - | - | - |

**Degradation**

| Initial | Final | 2004-2014 |
|---|---|---|

| | | | | Area (ha) | ±90% CI | %E | |
|---|---|---|---|---|---|---|---|
| | | Intact forest | Intact forest | 1,125,747 | 22,515 | 2% | |
| | | Degraded forest | Degraded forest | 56,347 | 14,799 | 26% | |
| | | Very degraded forest | Very degraded forest | 10,546 | 6,585 | 62% | |
| | | Intact forest | Degraded forest | 5,991 | 4,120 | 69% | |
| | | Intact forest | Very degraded forest | 391 | 639 | 164% | |
| | | Degraded forest | Very degraded forest | 1,627 | 2,672 | 164% | |
| | | Degraded forest | Intact forest | 7,904 | 5,553 | 70% | |
| | | Very degraded forest | Intact forest | - | - | - | |
| | | Very degraded forest | Degraded forest | 3,254 | 3,780 | 116% | |
| **Any comment:** | | | | | | | |

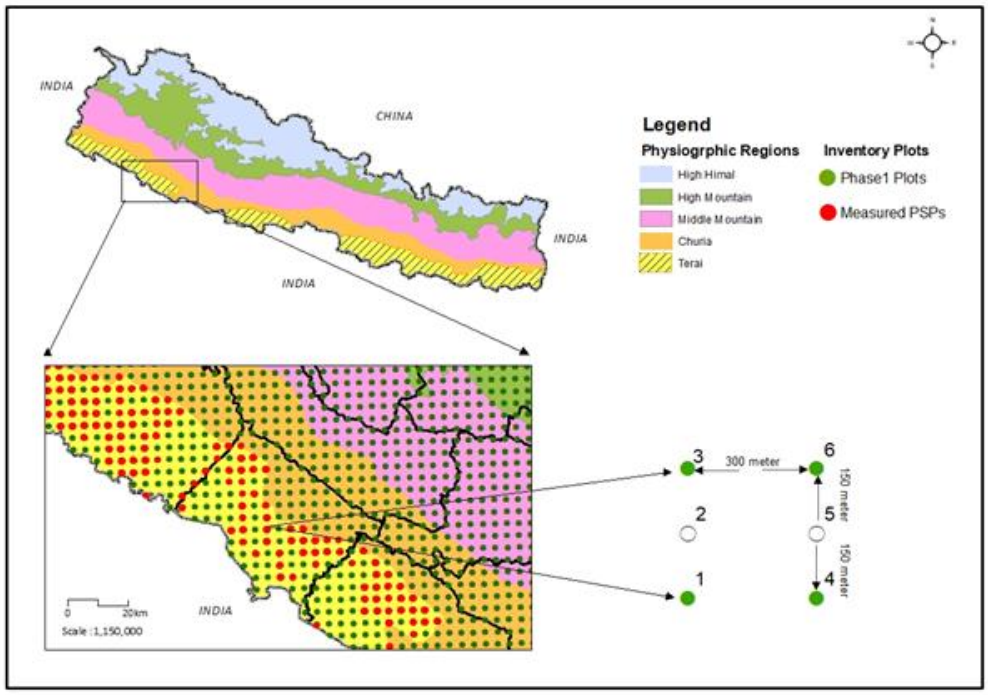
**Emission Factors**

| | |
|---|---|
| **Parameter:** | $B_{Before,j}$ **Equation 4;** $B_{After,i}$ **Equation 4;** $RF_{reg}$ **Equation 8** |
| **Description:** | **B Before**: Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground (AGB_(Before,j)) and belowground biomass (BGB_(Before,j)) and it is defined for each forest type.<br>**B after**: Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest Land Use categories.<br>**Removal rate**: Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$]. |
| **Data unit:** | Tonne/ha (dry matter), |
| **Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):** | The carbon densities and removal rates used for the ER monitoring report are Tier 2 (country specific data) and has been derived from the latest NFI (FRA) except the removal rates for forest plantation and shaded crops. The NFI (FRA) involved remeasurement in 2022 of the permanent sample plots established by the FRA Nepal Project (2010-2014) including an additional number of plots established and measured using the same methodology. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years.<br>**NFI (FRA) inventory design**: The inventory design adopted was based largely on methods developed by Kleinn (1994)[99] and finalized by the DFRS/FRA 2010-2014 (see Figure below). The detailed methodology adopted for sample selection is presented in DFRS, 2014[100]. NFI data from 622 permanent sample plots located within the ER accounting area were derived (see NFI_dataset sheet in Carbon density calculation tool[101]). |

[99] Kleinn, C. 1994. Forest Resources Inventories in Nepal Status, Qou, Needs, Recommendations. FRISP, HMGN/FINNIDA

[100] https://drive.google.com/file/d/1EFpJXYa7GZRiGfP0WJIWwu-zljs9C65v/view?usp=drive_link

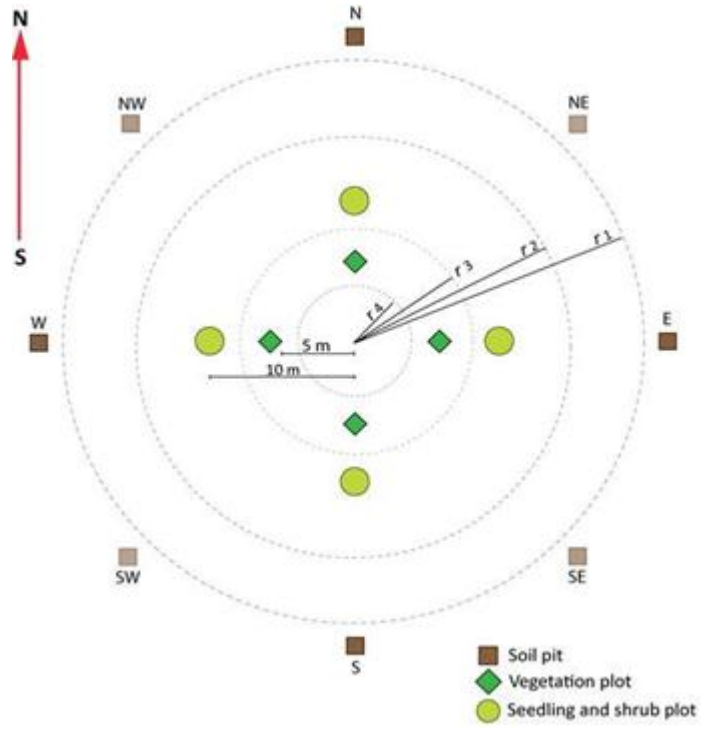
[101] https://docs.google.com/spreadsheets/d/1ibHCmjnV16J4UD9GT7eqTx8Yr2k0_z4-/edit?usp=drive_link&ouid=101304895378504185754&rtpof=true&sd=true




**Inventory Sample plot design and data collection**: The Concentric Circular Sample Plot (CCSP) design was adopted as used by the FRA Nepal Project (2010-2014). Each sample plot had four concentric circles of different radii (see Figure below), which were used to measure trees with different DBH as follows:

- trees having 30 cm DBH or more enumerated within a 20 m radius plot (area: 1256.6 $m^2$)
- trees having 20-29.9 cm DBH enumerated within a 15 m radius plot (area:706.9 $m^2$)
- trees having 10-19.9 cm DBH enumerated within an 8 m radius plot (area:201.0 $m^2$)
- trees having 5-9.9 cm DBH enumerated within a 4 m radius plot (area: 50.3 $m^2$)

Other subplots were established to assess forest attributes other than trees, such as dead woods and disturbances, seedlings, saplings, shrubs, and herbs, etc.




Layout of the concentric circular plot with other sub-plots

The plots were used for data collection of standing trees (diameter at breast height (dbh) ≥5 cm), which were used in the estimation of the biomass and carbon stocks. Data collected included tree information (bearing, distance from plot center, species code, local name, scientific name, DBH, quality class, crown class and total and crown heights. In addition, data on other important variables like dead woods, disturbances, shrub and small trees, soil characteristics and soil samples, leaf litter and debris, non-wood forest products, epiphytes, parasites, herbaceous plants, bamboo, invasive and alien plant species, forest diseases and pests, etc. have been collected in regular NFI/FRA. One of the important characteristics of NFI in Nepal is hidden permanent sample plots leaving "no marks" above ground. Instead, the plots are georeferenced and plot centers consist of metal pegs inserted a few inches below the ground level. The reason behind hidden plots in NFI is to maintain consistency in anthropogenic activities and forest products use by local people both inside and outside the plots. This characteristics of NFI plots of Nepal might even aid to control leakage of GHG emission.

**Volume and Biomass estimation**: Tree stem volumes and biomass were estimated using standard methodology with national allometric equations adopted since NFI / FRA 2010-2014[102]. To ensure consistency between the Emission Factors and land-use transitions area, the NFI plots were evaluated and categorized according to their land use type, such as non-Forest land use, Permanent Forest, or Secondary Forests, for the current monitoring report. The same time series analysis and data collection methods used in CEO were replicated for the NFI permanent plot locations. Additionally, the canopy cover of Permanent Forest plots was

[102] https://drive.google.com/file/d/1Z1h0Q2JiXlEXCHW1qDNcBrj1B38GEhi7/view?usp=drive_link

| | |
|---|---|
| | evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points).<br>**Carbon density estimates:** The carbon density estimates for forest and non-forest areas are calculated using data from the NFI biomass plots. The NFI gives two measurements of biomass: the first was taken between 2011 and 2013, and the second in 2022. It's important to note that the first measurement was made during the ER-Program Reference Period 2004-2014.<br>The determination of average carbon densities for non-forest lands is based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the NFI's initial measurement phase, which was measured between 2011 and 2013.<br>The initial carbon density estimates for natural forests were based on the second measurement. However, these estimates were made after the signing of the ERPA in February 2021. Therefore, the carbon densities of natural forests were recalculated using only the first measurement (2011-2013) [1]. The carbon densities of intact, degraded, and very degraded natural forests were recalculated using the first measurement from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were also obtained during the initial measurement phase of the NFI. The plots are classified as unshaded cropland based on experts' knowledge, experiences, the extent of the forest patch, and analysis of near-temporal images and changes in the land cover. In a conservative approach, Nepal has decided to use the country-specific average value for unshaded crops instead of the IPCC default factor. This is because the country-specific value is larger than the IPCC default value, resulting in a smaller emission factor for the transition from forest to unshaded crops.<br>[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link:<br>https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true<br>**Removal Factor Calculation:** The calculation for the rate of regrowth removal in the forest is based on a sample of sixteen NFI plots set up in secondary forests. Three plots have biomass measurements for both 2022 and 2011-2014, five have measurements only for 2022, and eight have measurements only for 2011-2013.<br>The removal rate was calculated using two methods: Opt1) Calculating the biomass increment between measurements taken in NFI plots located in secondary forest, and Opt2) Estimating the Mean Annual Increment (MAI) in biomass. To apply these calculation methods, the NFI plots were evaluated and categorized by their land use type, including non-forestland use, Permanent Forest, or Secondary Forests, along with the date the forest was regenerated.<br>A total of 16 NFI plots were established in Secondary Forests. However, only 8 had biomass measurements after regeneration to calculate the MAI (Option 2), and only 3 plots had two measurements to obtain the biomass increment (Option 1). The worksheet "Natural Forest reg removal rate" in the Carbon Densities Tool contains the calculations to obtain the two estimates of the removal factor [1]. The MAI removal (9.69 tdm/ha/yr) was ultimately used for the removal calculation because it had a lower estimation error and was consistent with the peer review estimate made by Joshi et al. in 2021 [1]. |

| Statistics | Biomass increment Opt 1 tdm/ha/yr | MAI Opt 2 tdm/ha/yr |
|---|---|---|
| Average | 7.27 | 9.69 |
| Standard deviation | 5.82 | 8.97 |
| n | 3 | 8 |
| CI | 9.82 | 6.01 |
| ERROR% | 135% | 62% |

[1] The updated version of Carbon densities tool (CarbonDensitiesToolV6.xlsx) can be accessed at the following link: https://docs.google.com/spreadsheets/d/1TkQ_dLmGF9Iz_h0Jx4zGRpiNJZN3UIoC/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

**Value applied:**

Due to the homogeneity of the forest in the Emission Reduction Program accounting area, the whole forest was considered as the same unit for the calculation.

| Forest type | Average | CI | Unit |
|---|---|---|---|
| Natural intact forest | 203.08 | 9.78 | tdm/ha |
| Natural degraded forest | 101.93 | 37.93 | tdm/ha |
| Natural very degraded forest | 18.49 | 10.68 | tdm/ha |

| Non- Forest Lands | Average | CI | Unit |
|---|---|---|---|
| Grassland | 20.95 | 17.96 | tdm/ha |
| Other land | 27.37 | 32.32 | tdm/ha |
| Unshaded cropland | 57.54 | 28.67 | tdm/ha |

Note: It was assumed the carbon density of grasslands for Settlements.

| Land Cover | AGB (tCO2e/ha) | BGB (tCO2e/ha) | Total Biomass (AGB+BGB) |
|---|---|---|---|
| Intact Forest | 348.26 | 153.23 | 501.49 |
| Degraded Forest | 175.65 | 77.29 | 252.94 |
| Very Deg Forest | 31.86 | 14.02 | 45.88 |
| grassland | 36.10 | 68.12 | 104.22 |
| other land | 47.17 | 89.01 | 136.18 |
| unshaded cropland | 99.16 | 187.11 | 286.27 |

Below-ground biomass for forest lands was estimated using a root-to-shoot ratio of 0.44 (2019 refinement to the 2006 IPCC guidelines for national GHG inventory, Table 4.4 -Subtropical dry Asia, . B > 125 tons/ha). BGB for non-forest lands was estimated using R::S 1.887 (Mokany et al., 2006; Table 2).

| | |
|---|---|
| | In order to calculate the Emission Reductions, the entire forest was treated as a single unit due to its uniformity. The removal rate in new forests is country specific data and has been derived from the NFI (FRA). For Plantation forests and Shaded croplands, removal factors established by the IPCC were utilized.<br><br>**Forest type** / **Average** / **CI** / **Unit**<br>**Natural secondary forest gain** / -9.69 / 6.01 / tdm/ha/yr<br>**Plantation forest gain** [1] / -13.79 / 4.40 / $tCO_2$/ha/yr<br>**Shaded cropland gain** [2] / -10.23 / 2.46 / $tCO_2$/ha/yr<br><br>[1] Table 4.10 (Updated) ABOVE-GROUND NET BIOMASS GROWTH IN TROPICAL AND SUB-TROPICAL PLANTATION FORESTS (TONNES D.M. HA-1 YR-1). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 4: Forest Land.<br>[2] Table 5.2 (Updated) DEFAULT COEFFICIENTS FOR ABOVE- AND BELOW-GROUND BIOMASS IN AGROFORESTRY SYSTEMS CONTAINING PERENNIAL SPECIES. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 5: Cropland. |
| **QA/QC procedures applied** | **Quality assurance of forest inventory data:** Use of periodically revised field manual, training to field members and regular monitoring and feedbacks were some of the measures applied to maintain the quality of the inventory results. For the statistical analysis to check the quality of the results, over 10% of the total Permanent Sampling Plots measured were systematically selected (with a random start) and re-measured[103]. Furthermore, standard protocols and manuals on modeling of required parameters e.g., diameter-height modeling & taper function curve, calculation of volume and biomass using the allometric models, and error estimation were developed under supervision of the experts from Finnish Forest Research Institute (METLA, now LUKE Finland) during the FRA 2010-2014. Also, documentation on the assemble of the QAQC protocol is available, as well as QAQC report of 2021[104]. |
| **Uncertainty associated with this parameter:** | To determine the uncertainty in carbon density, we calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions. This calculation only takes sampling errors into account and does not consider model or allometric errors. The Country used a local volume tree equation to estimate biomass. The volume of the tree, which is further converted into biomass and carbon, is calculated using the allometric equation developed by Sharma and Pukala in 1990. There are more than 21 species of trees with specific parameters, along with two additional groups of species found in lower and higher altitudes, each with their respective parameters. The maximum and minimum standard error percentages of the regression model are 9.9% and 5.8%, respectively. The R2 of the model for every species is higher than 95% (Sharma and Pukala, 1990). The country has not determined whether the uncertainty from this source is lower than the uncertainty from sampling error. Since the country is unable to include this error source in the Monte Carlo simulation due to a lack of covariance table, the sampling uncertainty of carbon density in different land uses based on the NFI dataset has been increased by 10% at a 90% confidence level using the quadrature approach (see %E adj in tables below). The combined error was then included in the Monte Carlo simulation. |

[103] https://drive.google.com/file/d/1YmbHZSOIxfsnfotBbb3elCBSemh4cA8h/view?usp=drive_link
[104] https://drive.google.com/file/d/1Xhboag3rtykW2p0oiIYuz9Rj0H6VQsg8/view?usp=drive_link

| Forest type | Average | CI | %E | %E adj | n | Std Dev | Unit |
|---|---|---|---|---|---|---|---|
| **Natural intact forest** | 202.08 | 9.78 | 5% | 11% | 367 | 113.57 | tdm/ha |
| **Natural degraded forest** | 101.93 | 37.93 | 37% | 39% | 14 | 80.15 | tdm/ha |
| **Natural very degraded forest** | 18.49 | 10.68 | 58% | 59 | 7 | 14.54 | tdm/ha |

| Non- Forest Lands | Average | CI | % E | %E adj | n | Std Dev | Unit |
|---|---|---|---|---|---|---|---|
| **Grassland** | 20.95 | 17.96 | 86% | 148% | 10 | 30.99 | tdm/ha |
| **Other land** | 27.37 | 32.32 | 118% | 133% | 6 | 39.28 | tdm/ha |
| **Unshaded cropland** | 57.54 | 28.67 | 50% | 76% | 5 | 30.07 | tdm/ha |

The table below displays the results of the normality test conducted on carbon densities and removal rate estimations for various land uses in Nepal's ER-Program. The test was based on NFI biomass plots and utilized the Shapiro-Wilk Test calculated with the Real Statistics Resource Pack [1]. All parameters demonstrate a normal distribution, with the exception of Intact Forest and Grasslands.

It's worth noting that four out of the seven parameters are calculated using less than eight data points, which makes it challenging to fit a probability density function (PDF) distribution to these parameters. As a result, following the FCPF Guidance note on estimating the uncertainty of Emission Reductions (ERs) using Monte Carlo simulation, the country has opted to use the bootstrapping approach instead of a specific non-normal distribution to sample the values of Carbon Densities for use in the simulation. According to the FCPF guidance, sampling from a dataset has the advantage that no assumptions are needed about the nature of the distribution. If the distribution is not normal, then bootstrapping would be more accurate, unless the data are not representative.

The Monte Carlo simulation has been updated [2] and now includes the bootstrapping sampling method for all carbon density parameters except for the Natural Forest Removal Rate. Since the removal rate follows a normal distribution, we used a normal probability density function (PDF) in the Monte Carlo simulation. The bootstrapping sampling was done using Infostat software with the Resampling method (Randomly with replacement). The resampling results for the different carbon density parameters can be found in [4], [5], [6], [7], [8], and [9].

| Parameter | n | Shapiro-Wilk Normality test results | | | |
|---|---|---|---|---|---|
| | | W-stat | p-value | alpha | Normal |
| Natural Forest Removal rate | 8 | 0.836001505 | 0.068507908 | 0.05 | Yes |
| Intact Forest Carbon Density [4] | 367 | 0.965272874 | 1.18349E-07 | 0.05 | No |
| Degraded Forest Carbon Density [5] | 14 | 0.942524 | 0.451617 | 0.05 | Yes |

| | | | | | |
|---|---|---|---|---|---|
| Very Degraded Forest Carbon Density [6] | 7 | 0.952499 | 0.752377 | 0.05 | Yes |
| Grassland Carbon Density [7] | 5 | 0.728652 | 0.001962 | 0.05 | No |
| Other Land Carbon Density [8] | 4 | 0.722904 | 0.010679 | 0.05 | No |
| Unshaded Crops Carbon Density [9] | 5 | 0.90192 | 0.420587 | 0.05 | Yes |

[1] Real Statistics Resource Pack is available at the following link: https://real-statistics.com/free-download/

[2] The updated Monte Carlo simulation tool can be accessed at the following link: https://docs.google.com/spreadsheets/d/11mM9bnqVLZ6hiFvupfaviTksvHlfpF3u/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[3] Infostat software is available at the following link: https://www.infostat.com.ar/

[4] Intact Forest bootstrapping https://docs.google.com/spreadsheets/d/1tD49N6OB-5qAPEIeH8y4oPeTRwTQQ0nD/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[5] Degraded Forest bootstrapping https://docs.google.com/spreadsheets/d/1IWhWH_KQsWlrh3qz_-X-Ur5AH3OliN5e/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[6] Very Degraded Forest bootstrapping https://docs.google.com/spreadsheets/d/14rMgD0_PZeYLwBO9PXBIWjt_98NtUo1a/edit?usp=drive_link

[7] Grassland bootstrapping https://docs.google.com/spreadsheets/d/1AaSR6NDF86Xqn3G67axs2xAAWTfjBhiX/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

[8] Other Land bootstrapping https://docs.google.com/spreadsheets/d/1zNyRyyK-vNAZGeQ5GFJwtvFwQYePdVDq/edit?usp=drive_link

[9] Unshaded Crops bootstrapping https://docs.google.com/spreadsheets/d/192L-jqRohxAZiX3R_KLWvPoks4TbGYCJ/edit?usp=sharing&ouid=100991295489415488908&rtpof=true&sd=true

To determine the uncertainty in removal rates, we calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions. However, for Natural Secondary Forest gain, this calculation only considers sampling errors and does not consider model or allometric errors. In the case of forest plantations, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4 - Forest Land, Table 4.10 does not provide any reference to uncertainty. Therefore, it was assumed that the uncertainty of Natural Secondary Forests gain applies to Plantation Forests as well. When it comes to shaded cropland gain, we used the 2006 IPCC reference to uncertainty in Table 5.2.

| Forest type | Average | CI | % Error | n | DevStd | Unit |
|---|---|---|---|---|---|---|
| **Natural secondary forest gain** | -9.69 | 6.01 | 62% | 8 | 8.97 | tdm/ha/yr |
| **Plantation forest gain** | -13.79 | 4.40[1] | 32% | - | - | $tCO_2$/ha/yr |
| **Shaded cropland gain** | -10.23 | 2.46[2] | 24% | - | - | $tCO_2$/ha/yr |

[1] In the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4 - Forest Land, the Table 4.10 does not have any reference to uncertainty. As a result, it was assumed that the uncertainty of Natural secondary forest for Plantation Forest.

[2] Uncertainty indicated in Table 5.2 (Updated) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 5: Cropland.

| Any comment: | |
|---|---|

## 8.4 Estimated Reference Level

***ER Program Reference level***

| Crediting Period year *t* | 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, average annual historical removals by sinks over the Reference Period ($tCO_{2-e}$/yr) | Adjustment, if applicable ($tCO_{2-e}$/yr) | Reference level ($tCO_{2-e}$/yr) |
|---|---|---|---|---|---|
| 2015 | 273 539 | 182 182 | -491 090 | 0 | -35 368 |
| 2016 | 273 539 | 182 182 | -517 843 | 0 | -62 121 |
| 2017 | 273 539 | 182 182 | -544 596 | 0 | -88 874 |
| 2018 | 273 539 | 182 182 | -571 348 | 0 | -115 627 |
| 2019 | 273 539 | 182 182 | -598 102 | 0 | -142 381 |
| 2020 | 273 539 | 182 182 | -624 855 | 0 | -169 134 |
| 2021 | 273 539 | 182 182 | -651 608 | 0 | -195 887 |
| 2022 | 273 539 | 182 182 | -678 361 | 0 | -222 640 |
| 2023 | 273 539 | 182 182 | -705 114 | 0 | -249 393 |
| 2024 | 273 539 | 182 182 | -731 867 | 0 | -276 146 |
| 2025 | 273 539 | 182 182 | -758 621 | 0 | -302 899 |
| ***Total*** | **3 008 929** | **2 004 002** | **-6 873 401** | **0** | **-1 860 462** |

### Calculation of the average annual historical emissions over the Reference Period

**Reference Level ($RL_{RP}$)**

Net emissions of over Reference Period ($RL_{RP}$) are estimated as the sum of annual change in total biomass carbon stocks (deforestation and degradation), and annual removals ($\Delta C_{B_t}$).

$$RL_{RP} = \frac{\sum_t^{RP} \Delta C_{LU_{RP,i,t}}}{RP} \qquad \textbf{Equation 2}$$

Where:

$\Delta C_{LU_{RP,i,t}}$ = Balance of emissions during the Reference Period in the Accounting Area of the ER Program that corresponds to the sum of annual change in carbon stocks and removals for each REDD+ activity *i* at year t; $tCO_2*year^{-1}$.

RP = Reference Period; years.

## 8.5 Upward or downward adjustments to the average annual historical emissions over the Reference Period (if applicable)

### *Explanation and justification of proposed upward or downward adjustment to the average annual historical emissions over the Reference Period*

***Intentionally left blank.***

The section has been intentionally left blank because there has not been upward or downward adjustment to the average annual historical emission over the Reference Period.

### *Quantification of the proposed upward or downward adjustment to the average annual historical emissions over the Reference Period*

***Intentionally left blank.***

The section has been intentionally left blank because there has not been upward or downward adjustment to the average annual historical emission over the Reference Period.

## 8.6 Relation between the Reference Level, the development of a FREL/FRL for the UNFCCC and the country's existing or emerging greenhouse gas inventory

***Intentionally left blank.***

The Forest Reference Level (FRL) for Nepal, aligning with UNFCCC standards, focuses on the historical period of 2000-2010 and primarily considers deforestation, degradation due to fuelwood extraction, and forest enhancement activities. The FRL, constructed following IPCC guidelines, relies on national forest inventory (NFI) data, remote sensing information from Landsat TM, and proxy methodologies for the period 2000-2010. The current greenhouse gas inventory during the preparation of the first ER monitoring report follows a similar process and the application of remote sensing techniques for the period 2018 to 2021.

During the development of FREL three activities i.e., Degradation, Deforestation, and Enhancement were included which is replicated during the current greenhouse gas inventory process. In FREL, the definition of degradation was based on the short-term and long-term disturbance while the current method adopts the concept of canopy cover. Deforestation has a static definition i.e., permanent conversion of forest land to other land-use classes in both FREL and current GHG inventory procedures. For enhancement, there are two categories in FREL: the afforestation or reforestation, i.e., permanent conversion or other land use classes into the forest, and the restoration, i.e., permanent improvement of carbon stock in forest land that remains as forest land. But currently, only conversion of other land to forest is being considered as regarded as both terms i.e., restoration or gain.

In terms of methodology, during FREL simple landcover change assessment and change assessment were used but the current method follows the ensemble method i.e., agreement map among four algorithms (1. CCDCSMA, 2. LandTrendR, 3. MTDD, and 4. CODED) was used to calculate the area under each activity.
In both methods, only one greenhouse gas was considered i.e., $CO_2$.

Moreover, the ERPA Reference level employed a significantly better methodology compared to the FREL. The Reference Level has adopted a robust method and QA/QC protocols for the activity data preparation. In addition, the limitations of the FREL and the learnings informed the ER program's Reference Level, in particular, advancements in technology and methodology and the availability of data have improved the ER program's reference level. Therefore, the Government of Nepal (GoN) is considering submitting the updated FREL to the UNFCCC.

Regarding the GHG inventory, information on a national scale needs to be developed. However, the efforts from varying scales of subnational projects—such as the current REDD+ program—that require a more robust approach

of emission factors and forest degradation monitoring would serve as valuable references for national GHG inventory and reporting, especially in meeting requirements like the Biennial Transparency Report (BTR). Nepal's first Biennial Transparency Report/Biennial Update Report is being prepared and this will take into account and report REDD+ programs, including this one. For example, in the ongoing BTR preparation task for Nepal, the base datasets and other information used for the Forest Reference Level (FRL) will be used as a reference at the national scale. Specifically, emissions from the forest sector will be based on the input time series of forest cover maps and emission rates. Institutionally, the Forest Research and Training Centre (FRTC), the agency undertaking the MRV part of REDD+, will be the key agency contributing inputs to the GHG emission estimates from the forest sector. Once an operational MRV system for multi-sectoral GHG is established, we expect that the interlinkage between the FRL and the national GHG inventory will be strengthened. In this regard, the Ministry of Forests and Environment is initiating the GEF-funded Capacity Building Initiative for Transparency (CBIT), which aims to strengthen institutional capacity and establish an operational national MRV and GHG reporting system.

# 9 APPROACH FOR MEASUREMENT, MONITORING AND REPORTING

## 9.1 Measurement, monitoring and reporting approach for estimating emissions occurring under the ER Program within the Accounting Area

Table 8 provides a systematic and step-by-step description of the measurement and monitoring approach applied for the establishment of the Reference Level and estimating Emissions and Emissions reductions during the Monitoring / Reporting Period for estimating the emissions and removals from the Sources/Sinks, Carbon Pools, and greenhouse gases selected in the ER-PD.

**Table 8:** ***Step-by-step description of the monitoring parameter and data integration tools to establish the Reference Level and estimate Emissions and Emissions reductions during the Monitoring Period for the Carbon Pools and greenhouse gases selected in the ER-PD.***

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| **1** | **Activity Data estimate and associated uncertainty.** | **CCDC-SMA**[105]:<br>1_CCDC_SMA_UI_C2<br>2_ViewExportDegDefMapp<br>3_LTMakeLossGainPostprocessed<br>4_AssembleMap<br>**CODED**[106]<br>Forest Disturbance Mapping GUI<br>**LandTrendr**[107]<br>1_UI-ImageScreener (optional)<br>2_LT-Data-Visualization-NepalTool<br>**MTDD**[108]<br>1MTDD_app_trainingpoints | **Nepal Forest change area estimation tool**: Documentation on how to use this tool and a compiled set of links to user interfaces of all the tools needed to complete the forest change area estimation for Nepal can be accessed at the following link: https://training.sig-gis.com/NEPALworkshopAE/<br>8. **Forest change mapping**: To estimate the area, Nepal employs a sample-based approach. For the sample design, a forest change map spanning from 1983 to 2021 was prepared. The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis was used to map areas experiencing forest loss, degradation, and/or regrowth.<br>v. **CCDC-SMA**: Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation. |

[105] Procedure document of CCDCSMA can be accessed at the following link https://github.com/shijuanchen/forest_degradation_georgia

[106] Tools CODED of the GEE repository can be accessed at the following link https://code.earthengine.google.com/?accept_repo=users/bullocke/coded

[107] Procedure document of LandTrendr can be accessed at the following link https://docs.google.com/document/d/1GfdMSSaU4tiDv1Sf2L8S4k2144ptpU9seB1UkPURDCA/edit

[108] Procedure document of MTDD can be accessed at the following link https://docs.google.com/document/d/1TukNQOuEqw9OoeZgcHWUrv-ER-87TkhU9HVuV_x6HZA/edit

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | 2MTDD_app_changemap<br><br>**Forest change maps** | vi. **CODED**: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).<br>vii. **LandTrendr**: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.<br>viii. **MTDD**: Multivariate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification. |
| | | **Map Visualization tool 1_VisualizationApp_Nepal** (in Visualization App folder of GEE repository) | 9. **Map visualization and comparison:** Each of the mapping algorithms is useful for detecting changes in a slightly different manner. However, all maps are susceptible to bias, which is why the area of map classes from the resulting maps should not be directly used for Activity Data reporting. Each map is visually assessed so any concerning results can be addressed with parameter adjustment as needed. |
| | | **Agreement map preparation 1_MakeAgreementMap_Nepal**[109] (Agreement Map in Google Drive folder)<br><br>**Forest Change Agreement Map**[110]<br><br>**Area available in each stratum**[111]<br><br>**Spreadsheet for Sample Size/Distribution Design**[112] | 10. **Sample design:** A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and allows calculation of the uncertainty of each estimate. An agreement map generated from the results of all four methods is used for sample design. The goal is to ensure that no strata is under-sampled. The 1_MakeAgreementMap_Nepal tool (in Map Agreement App folder of GEE repository) is used to combine the maps of the four forest change detection algorithms. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest.<br><br>When combining the results of the four algorithms into one map, the following logic rules are applied for each pixel:<br>● A GAIN supersedes all other labels<br>● If an equal number of DEG and LOSS labels occur across the four algorithms, LOSS supersedes<br>● If the number of DEG labels is more than the number of LOSS labels or DEG is the only type of change detected, a DEG label is given<br>● If the number of LOSS labels is more than the number of DEG labels or LOSS is the only type of change detected, a LOSS label is given<br>● A Non-forest label is given only if all four algorithms label it as Non-forest<br>● A Forest label is given only if all four algorithms label it as Forest<br><br>Final strata definitions: |

[109] https://drive.google.com/drive/folders/1SJq6ZGzVTM4g1IB5ALSq6z2JHJdyFX7d?usp=sharing

[110] https://drive.google.com/file/d/1VtYM-xCunuRpjfOgeAO9aLDMMGwj_H71/view?usp=drive_link

[111] https://docs.google.com/spreadsheets/d/1Wp0lxDpqKMFlro7OdeTuaLwAQSVb2VgJ/edit?usp=sharing&ouid=101304895378504185754&rtpof=true&sd=true

[112] https://docs.google.com/spreadsheets/d/1AfZTmd-KQHMy_amBkz03ZepFhrUlcqCG/edit?usp=sharing&ouid=101304895378504185754&rtpof=true&sd=true

<table>
<tr><th>Step</th><th>Monitoring parameters and Data Integration tools</th><th>Tools and datasets</th><th>Description of the measurement and monitoring approach</th></tr>
<tr><td></td><td></td><td></td><td>DEG (1) = more algorithms detected degradation than loss, and GAIN is not detected<br>LOSS (2) = more algorithms detected LOSS than DEG or an equal number of algorithms detected LOSS and DEG, and GAIN is not detected<br>GAIN (3) = one or two algorithms labeled the pixel as GAIN, even if others detected LOSS or DEG<br>Nonforest (4) = all algorithms labeled pixel as stable nonforest<br>Forest (5) = all algorithms labeled pixel as stable forest<br>11. The number of points randomly selected depends on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. The linked spreadsheet in tools columns contains equations needed to calculate the ideal sample size to hopefully achieve the target standard error. A total of 1,522 points were selected via stratified random sampling to be used for sample-based area estimation. For the smaller strata a minimum of 110 points was required.</td></tr>
<tr><td></td><td></td><td><u>Nepal's CEO institution</u><br><u>Interpretation key</u><br><u>SOP for QA/QC Procedures</u><br><u>Activity Data CEO Survey Questions</u><br><u>NFI CEO Survey Questions</u></td><td>12. Reference data collection (completed in CEO): To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were collected through visual imagery interpretation and time series analysis of 1,522 sampling plots in CEO. The sampling points were visually interpreted for the same period that the forest change map was created (2004 to 2021. However, to identify the age of forests in order to differentiate between secondary and permanent forests, an additional pre-period was examined. The time period of examination was divided into four subperiods with distinct sets of survey questions: 1984-2003, 2004-2014. 2015-2017 and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.<br>vi. <u>Generating a CEO project from a template</u>: FRTC created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[113]) for the following periods: Pre-reference period (t0) - 1983-2003, Reference Period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.<br>vii. <u>Sampling unit</u>: The Sampling Unit (SU) is a 70 x 70 meter plot. Inside the SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit. Negative changes in this value were used to indicate whether a degradation event had occurred.<br>viii. <u>Number of Sampling Units</u>: A total of 1,522 sampling points, selected via stratified random sampling, were visually assessed.<br>ix. <u>Interpretation key</u>: Nepal produced an interpretation key that should be reused and updated as needed. The key was used to increase consistency across the team of interpreters. The land use categories considered are the following:
<table>
<tr><th>Forest lands:</th><th>Non-forest lands</th></tr>
<tr><td>1 Intact Forest<br>2 Degraded Forest<br>3 Very Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands</td><td>7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less)</td></tr>
</table></td></tr>
</table>

[113] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | | ● Note, the first three types of forest land (intact, degraded, and very degraded) were indirectly labeled in post-processing using the number of tree-covered points out of a 9-point grid over each plot.<br><br>**SOP for QA/QC Procedures** |
| | | **Reference data compilation R-script CompiledData_CEO** | 13. **Reference data compilation:** The data collected in the CEO was compiled in R for each period (t0, t1, t2, and t3) to obtain necessary information that was then used to estimate the Activity Data:<br>**i. Deforestation Activity Data**<br>● tx_disturbance_type_subcat: type of forest loss and gain, stable forest, and stable non-forest.<br>● Non.forest.land.use.type.in.[year of interest]. Non forest land use type in the period.<br>● Number.of.tree.covered.samples.[year of interest]. Number from 9-point grid of sample points within plot that are covered by tree canopies. sampling points with canopy cover.<br>● GEEcombo_strata_readable: Agreement map strata.<br>● tx_type_final: Land use / land cover type<br>● tx_yr_secondaryforest_establ: year of secondary forest establishment<br>**ii. Forest gain Activity Data**<br>● tx_disturbance_type_subcat: type of forest loss and gain, stable forest, and stable non-forest.<br>● GEEcombo_strata_readable: Agreement map strata.<br>**iii. Degradation Activity Data**<br>● tx_type_final: Land use / land cover type<br>● tx_numbretrees: canopy cover<br>● GEEcombo_strata_readable: Agreement map strata |
| | | **Activity Data Tool**<br>(Please read this file "READ" before accessing it) | 14. **Area and uncertainty estimation:** Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522 samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[114]. Estimates are made for each of the land use categories considered (10 classes) and in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9).<br>With Cochran (1977) formulas it is not possibles to calculate a standard deviation (SD) for the activity data estimate. Instead, the sampling error calculation is based on the standard error (SE), which quantifies the precision of the estimates based on the sample data. In Monte Carlo simulations de SD is used to represent the variability of input parameters. Initially, because no SD was available for the activity data, the country used the 90th percentile confidence interval and the normal probability density function (PDF). Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available.<br>Estimates and associated uncertainties are produced in the Activity Data Tool (**Nepal_TAL_AD_tool.xlsx**) for each combination considering the stratification applied. The Activity Data tool comprises various spreadsheets that estimate different types of Activity Data. These include the Dataset that is used to estimate sample-based Activity Data (CompiledData_CEO_GEE(7) sheet), as well as spreadsheets for estimating Activity Data for deforestation (Deforestation sheet), forest restoration (Forest_gain sheet), and area of change in canopy cover (loss and gain) in permanent forest lands (Degradation sheet).<br>To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheets. This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30- |

[114] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | | V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok". |
| **2** | **Forest regrowth removal rates and forest carbon densities calculation, including the uncertainty estimate.** | **NFI dataset** | 1. **National Forest Inventory**:<br>The biomass estimates used for the ER monitoring report are Tier 2 (country specific data) and have been derived from the National Forest Inventory-Forest Resource Assessment (NFI-FRA). The NFI-FRA involved remeasurement of the permanent sample plots established by the FRA Nepal Project (2010-2014) in addition to an additional number of plots established and measured using the same methodology. The inventory design adopted was based largely on methods developed by Kleinn (1994) and finalized by the DFRS/FRA 2010-2014. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years. One of the important characteristics of NFI in Nepal is hidden permanent sample plots leaving "no marks" above ground. Instead, the plots are georeferenced and plot centers consist of metal pegs inserted a few inches below the ground level. The reason behind hidden plots in NFI is to maintain consistency in anthropogenic activities and forest products used by local people both inside and outside the plots. These characteristics of NFI plots of Nepal might even aid to control leakage of GHG emission.<br>The detailed methodology adopted for sample selection is presented in DFRS, 2014, link: https://frtc.gov.np/downloadfile/The-TeraiForestsofNepal_1579845265.pdf . NFI data from 622 permanent sample plots located within the Emission Reduction Program area were derived.<br>**i. Inventory / Sample plot design and data collection**: The Concentric Circular Sample Plot (CCSP) design was adopted as used by the FRA Nepal Project (2010-2014). Each sample plot had four concentric circles of different radii (Figure), which were used to measure trees with different DBH as follows:<br>▪ trees having 30 cm DBH or more enumerated within a 20 m radius plot (area: 1256.6 m2)<br>▪ trees having 20-29.9 cm DBH enumerated within a 15 m radius plot (area:706.9 m2)<br>▪ trees having 10-19.9 cm DBH enumerated within an 8 m radius plot (area:201.0 m2)<br>▪ trees having 5-9.9 cm DBH enumerated within a 4 m radius plot (area: 50.3 m2)<br>Other subplots were established to assess forest attributes other than trees, such as dead woods and disturbances, seedlings, saplings, shrubs, and herbs, etc.<br>**ii. Volume and Biomass estimation**: Tree stem volumes and biomass were estimated using standard methodology with national allometric equations adopted since NFI / FRA 2010-2014. Details provided in link: Final FRA data analysis manual 2021.pdf (frtc.gov.np)<br>**iii. Quality assurance of forest inventory data:** Use of periodically revised field manual, training to field crews and regular monitoring and feedback were some of the measures applied to maintain the quality of the inventory results. For the statistical analysis to check for the quality of the results, over 10% of the total PSPs measured were systematically selected (with a random start) and re-measured, link: 1_QAQC_manual.pdf (frtc.gov.np). Furthermore, standard protocols and manuals on modeling of required parameters e.g. diameter-height modeling & taper function curve, calculation of volume and biomass using the allometric models, and error estimation were developed under supervision of the experts from Finnish Forest Research Institute (METLA, now LUKE Finland) during the FRA 2010-2014. |
| | | **Nepal's CEO institution** | 2. **Land use change analysis of the NFI permanent plots stratification for carbon densities, and removal rate estimate**. To ensure consistency, the Emission Factors (EF) have been aligned with the estimates of land-use transitions area (AD). To achieve this, the same time series analysis and data collection methods that were used in CEO were replicated for the NFI permanent plot's locations. The NFI plots have been classified as Non-forest land use (grassland, other land, unshaded cropland), Permanent Forest, or Secondary Forests. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). |
| | | **CarbonDensitiesTools.xlsx**<br>(Please read this file "READ" before accessing it) | 3. **Carbon densities and removal rates calculation**: Nepal developed a calculation tool (CarbonDensitiesTools.xlsx), to estimate carbon densities for both forest and non-forest areas based on the NFI plots dataset. This tool also facilitates the determination of forest regrowth removal rates. Confidence intervals and errors are computed based on the number of sampling plots and standard deviation within each respective land use type or removal rate: |

| Step | Monitoring parameters and Data Integration tools | Tools and datasets | Description of the measurement and monitoring approach |
|---|---|---|---|
| | | | i. *Natural Forest carbon densities calculation*: The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from NFI's 388 plots (pl_total_bio_mrv).<br>ii. *Non-Forest carbon densities calculation*: The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the initial measurement phase of the NFI (pl_total_bio_mspa).<br>iii. *Forest regrowth removal rates estimate*: The forest regrowth removal rate calculation is based on a sample of sixteen NFI plots established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years between measurements (pl_yr) was used to estimate the average removal rate. |
| **3** | **Emission and removals calculation** | **Nepal_TAL_Integration_tool.xlsx**<br>(Please read this file "READ" before accessing it) | To calculate the Emission Reductions of the Nepal Emission Reduction Program, an Excel tool named Nepal_TAL_Integration_tool.xlsx is used. This tool generates estimates for emissions and removals, along with their associated uncertainties, for both the reference and reporting periods. The estimates are generated for Deforestation, Carbon Enhancement, and Degradation - the three REDD+ activities involved in the carbon accounting of the program.<br>iv. *Calculation of emissions and removals*: **The Parameters and Model sheet** generate estimates for Emissions and Removals. These estimates are calculated using Activity Data and Carbon Density tools.<br>v. *Emission Reductions calculation*: **Results sheet** generates estimates of Emission Reductions for the Reporting Period (June 22, 2018 – December 31, 2021). These estimates are calculated using the Parameters and Model sheet calculations.<br>vi. *Emission Reductions available for transfer to the Carbon Fund*: The **Table-8-ER-MR sheet** computes the available ER for transfer in accordance with Section 8 of the ER monitoring report. |
| **4** | **Emission reduction uncertainty estimate and sensitivity analysis.** | **NEPAL_TAL_Integration_tool_MC.xlsx**<br>**NEPAL_TAL_Integration_tool_SensitivityAnalysis.xlsx**<br>(Please read this file "READ" before accessing it) | Nepal has developed two distinct Excel tools utilizing the ER calculation tool (NEPAL_TAL_Integration_tool.xlsx). The first one, NEPAL_TAL_Integration_tool_MC.xlsx, is designed to carry out Monte Carlo simulations and estimate the uncertainty of the ER calculation. The second tool, NEPAL_TAL_Integration_tool_SensitivityAnalysis.xlsx, is utilized for sensitivity analysis purposes. |

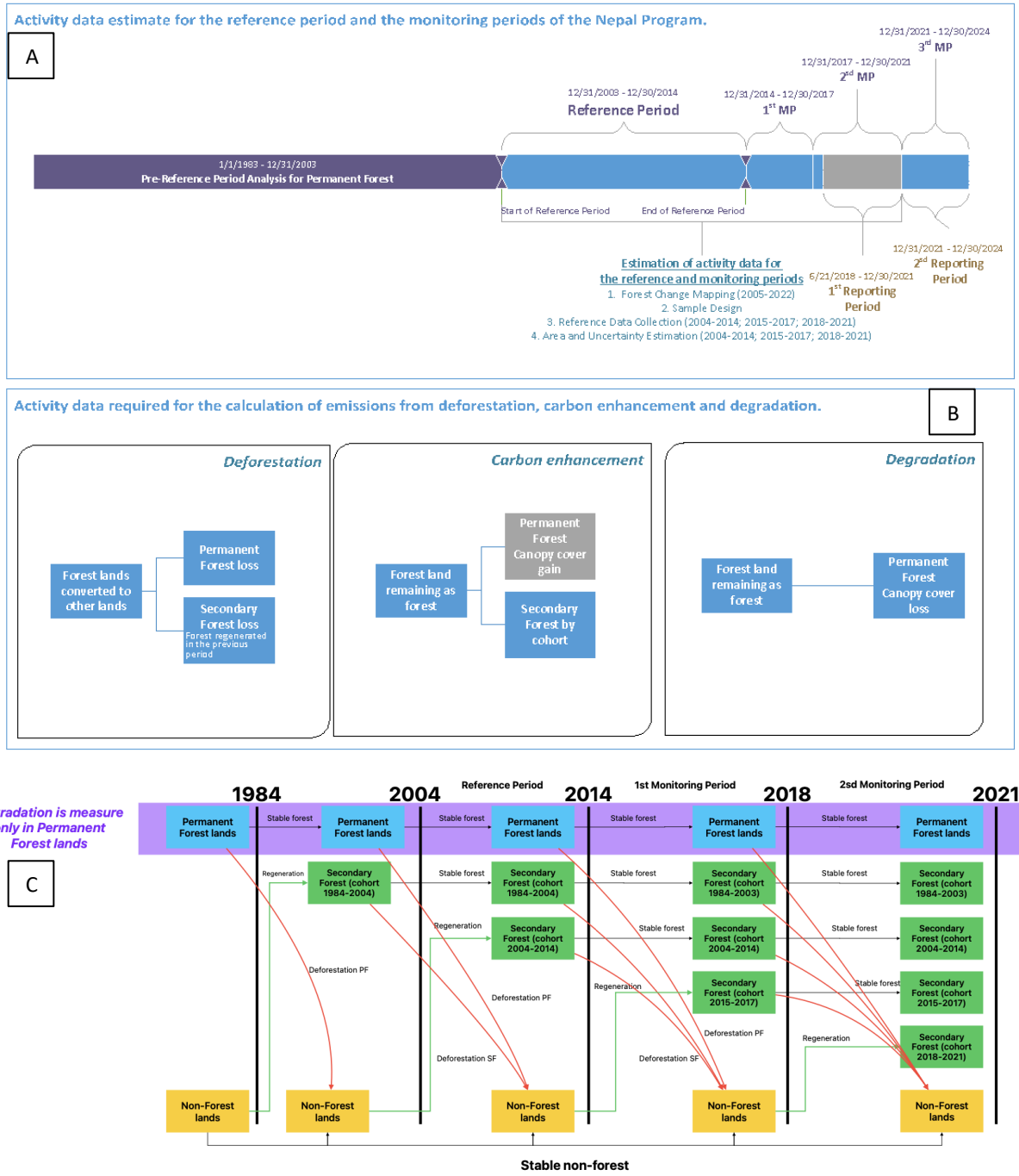
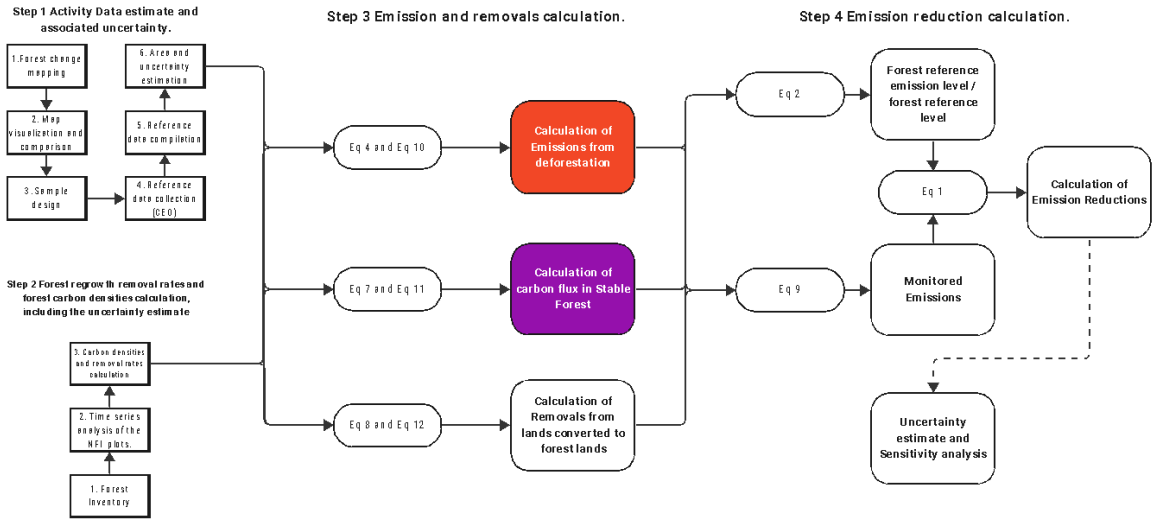



Figure 12: A. Reference Period and monitoring periods considered in collecting reference data for AD estimate. B. Activity Data that required for the estimate of emissions from deforestation, carbon enhancement removals, and emissions from degradation. C. Forest cover type definition (permanent and secondary) based on time-series analysis.

### *Line diagrams*




### *Calculation steps*

**Emission reduction calculation** $(ER_{ERP,t})$**:**
To determine GHG emission reductions, the same IPCC methods and equations described in Annex 4 Section 8.3 were used over the monitoring period.

$$ER_{ERP,t} = RL_t - GHG_t \qquad \textbf{Equation 1}$$

Where:

| | | |
|---|---|---|
| $ER_{ERP}$ | = | Emission Reductions under the ER Program in the Reporting Period; $tCO_2$. |
| $RL_{RP}$ | = | Net emissions of the Reference Level over the Reference Period; $tCO_2e$. This is sourced from Annex 4 to the ER Monitoring Report and equations are provided below. |
| $GHG_t$ | = | Monitored gross emissions from deforestation during the Reporting Period; $tCO_2e$; |
| $T$ | = | Number of years during the reporting period; dimensionless. |

***Monitored emissions ($GHG_t$)***

Annual gross GHG emissions over the monitoring period in the Accounting Area ($GHG_t$) are estimated as the sum of annual change in total biomass carbon stocks ($\Delta C_{B_t}$).

$$GHG_t = \frac{\sum_t^T \Delta C_{LU_{MP,i,t}}}{T} \qquad \textbf{Equation 9}$$

Where:

| | | |
|---|---|---|
| $\Delta C_{LU_{MP,i,t}}$ | = | Balance of emissions during the Monitoring Period in the Accounting Area of the ER Program that corresponds to the sum of annual change in carbon stocks and removals for each of i REDD+ activities at year t; $tCO_2*year^{-1}$. |
| $T$ | = | Number of years during the monitoring period; dimensionless. |

**Annual change in total biomass carbon stocks forest land converted to another land-use category ($\Delta C_{B_{defo,t}}$)**
The annual change in total biomass carbon stocks forest land converted to other land-use category ($\Delta C_{B_{defo,t}}$) would be estimated through **Equation 4** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

$$\Delta C_{B_t} = \sum_{j,i} \left(B_{Before,j} - B_{After,i}\right) x\ CF\ x \frac{44}{12} \times A(j,i)_{MP}$$ ***Equation 10*** **(Equation 2.16, 2006 IPCC GL)**

Where:

$A(j,i)_{RP}$ Area converted/transited from forest type j to non-forest type *i* during the Monitoring Period, in hectares per year. In this case, sixteen forest land conversions are possible:

1 Intact Forest to Grasslands
2 Intact Forest to Other Land
3 Intact Forest to Settlements
4 Intact Forest to Unshaded Cropland (TCC 10% or less)
5 Degraded Forest to Grasslands
6 Degraded Forest to Other Land
7 Degraded Forest to Settlements
8 Degraded Forest to Unshaded Cropland (TCC 10% or less)
9 Very Degraded Forest to Grasslands
10 Very Degraded Forest to Other Land
11 Very Degraded Forest to Settlements
12 Very Degraded Forest to Unshaded Cropland (TCC 10% or less)
13 Secondary natural forest to Grasslands
14 Secondary natural forest to Other Land
15 Secondary natural forest to Settlements
16 Secondary natural forest to Unshaded Cropland (TCC 10% or less)

$B_{Before,j}$ Total biomass of forest type j before conversion/transition, in tons of dry matter per ha. This is equal to the sum of aboveground ($AGB_{Before,j}$) and belowground biomass ($BGB_{Before,j}$) and it is defined for each forest type.

$B_{After,i}$ Total biomass of non-forest type i after conversion, in tons dry matter per ha. This is equal to the sum of aboveground ($AGB_{After,i}$) and belowground biomass ($BGB_{After,i}$) and it is defined for each of the non-forest IPCC Land Use categories.

$CF$ Carbon fraction of dry matter in tC per ton dry matter. The value used is:

- **0.47** is the default for (sub)tropical forest as per IPCC AFOLU guidelines 2006, Table 4.3.

$44/12$ Conversion of C to $CO_2$

R: :S Root-to-shoot ratio (0.44).

**Annual change in carbon stocks in biomass on forestland remaining forestland** ($\Delta C_{B_{deg,t}}$)

The Annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{deg,t}}$) would be estimated through **Equation 7** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

$$\Delta C_{B_{DEG}} = \sum_{j} \left\{EF_j \times A(a,b)_{MP}\right\}$$ **Equation 11**

Where:

$EF_j$ Emission Factor for degradation of forest type a to forest type b, tones CO2 $ha^{-1}$.

$A(a,b)_{MP}$ Area of forest type a converted to forest type b (transition denoted by a, b) during the Monitoring Period, ha yr$^{-1}$.

**Annual change in carbon stocks in biomass on non-forest land converted in forestland** ($\Delta C_{B_{reg}}$)

Annual change in carbon stocks in biomass on forestland remaining forestland ($\Delta C_{B_{reg}}$) would be estimated through **Equation 8** above. Making the same assumptions as described above for the RL the change of biomass carbon stocks could be expressed with the following equation:

:

$$\Delta C_{B_{reg}} = \sum_{LU=1}^{n} \{RF_{reg} \times A(i,j)_{MP}\} \qquad \textbf{Equation 12}$$

Where:

$RF_{reg}$ Above and belowground biomass removal rate in new forests [tCO2*ha*year$^{-1}$].

$A(j,i)_{MP}$ Area of non-forestland *i* converted to forestland *j* (transition denoted by *i,j*) in the Monitoring Period, ha yr$^{-1}$.

***LU*** Land unit.

### *Parameters to be monitored*

| **Parameter:** | Activity Data: $A(j,i)_{MP}$ Equation 10; $A(a,b)_{MP}$ Equation 11; $A(j,i)_{MP}$ Equation 12. |
|---|---|
| **Description:** | ● Deforestation: Area converted/transited from forest type j to non-forest type i during the Monitoring Period<br>● Degradation: Area of forest type a converted to forest type b (transition denoted by a,b) during the Monitoring Period, ha yr$^{-1}$<br>● Forest gain: Area of non-forestland i converted to forestland j (transition denoted by i,j) in the Monitoring Period, ha yr$^{-1}$. |
| **Data unit:** | hectare |
| **Value monitored during this Monitoring / Reporting Period:** | **Deforestation** |

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | Area (ha*yr-1) |
| Intact Forest | Grasslands | - | - | - |
| Intact Forest | Other Land | 1,627 | 2,674 | 406.75 |
| Intact Forest | Settlements | - | - | - |
| Intact Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Degraded Forest | Grasslands | - | - | - |
| Degraded Forest | Other Land | - | - | - |
| Degraded Forest | Settlements | - | - | - |
| Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| Very Degraded Forest | Grasslands | - | - | - |
| Very Degraded Forest | Other Land | - | - | - |
| Very Degraded Forest | Settlements | - | - | - |
| Very Degraded Forest | Unshaded Cropland (TCC 10% or less) | - | - | - |
| secondary natural forest | other land | - | - | - |

**Forest gain**

| Forest Type | 2018-2021 | | |
|---|---|---|---|
| | Area (ha) | ±90% CI | Area (ha*yr-1) |

| | | | |
|---|---|---|---|
| natural secondary forest gain | 19,156 | 8,888 | 4789.00 |
| plantation forest gain | - | - | - |
| shaded cropland gain | 1,627 | 2,674 | 406.75 |

**Degradation**

| Initial | Final | 2018-2021 | | |
|---|---|---|---|---|
| | | Area (ha) | ±90% CI | Area (ha*yr-1) |
| Intact forest | Intact forest | 1,128,443 | 22,067 | 282,110.75 |
| Degraded forest | Degraded forest | 64,950 | 15,825 | 16,237.50 |
| Very degraded forest | Very degraded forest | 9,309 | 6,060 | 2,327.25 |
| Intact forest | Degraded forest | 391 | 639 | 97.75 |
| Intact forest | Very degraded forest | - | - | |
| Degraded forest | Very degraded forest | 782 | 900 | 195.50 |
| Degraded forest | Intact forest | 3,505 | 3,671 | 876.25 |
| Very degraded forest | Intact forest | - | - | |
| Very degraded forest | Degraded forest | 1,627 | 2,672 | 406.75 |

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

Nepal uses a sample-based approach to estimate the Activity Data for Deforestation, Forest gain, and Degradation. This approach ensures unbiased estimates of the area and the error associated with the map. A forest change map spanning from 1983 to 2021 is used for the sample design, and four mapping algorithms are used to map areas experiencing forest loss, degradation, and/or regrowth. The agreement map is used for sample design, and reference data are collected through a time series analysis of 1,522 sampling plots in CEO.

**Forest change mapping**: The following four mapping algorithms that utilize remote sensing imagery, training data points, land cover maps, and time series data analysis was used to map areas experiencing forest loss, degradation, and/or regrowth.

xiii. **CCDC-SMA**: Continuous Change Detection and Classification - Spectral Mixture Analysis (CCDC-SMA) monitors abrupt and gradual forest degradation.

xiv. **CODED**: Continuous Degradation Detection (CODED) algorithm detects forest canopy disturbances and classifies them as degradation or deforestation based on land cover. CODED uses linear spectral unmixing to generate subpixel fractions of spectral endmembers, which are used to calculate a time series of the Normalized Degradation Fraction Index (NDFI).

xv. **LandTrendr**: The LandTrendr algorithms use simple statistical techniques to simplify a time-series of spectral values into a sequence of connected straight-line segments that capture the overall shape of that pixel's trajectory while omitting year-to-year noise. The resultant segments can then be examined to select periods where the trajectory displays behaviors of interest such as disturbance or growth.

xvi. **MTDD**: Multi-variate Time-series Disturbance Detection (MTDD) classifies initially forested areas into stable forest, degraded, and deforested by training a random forest classifier with 66 metrics. These metrics are derived from six annual time-series (i.e., NDVI, two SWIR spectral regions, two NDWI indices, and SAVI) which are used to calculate eleven descriptive statistics (i.e., minimum, maximum, range, mean, standard deviation, coefficient of variation, kurtosis, skewness, slope, maximum 5-year slope, and most recent value). Overall MTDD's process includes five main steps: (1) making annual time series, (2) calculating 11 descriptive statistics for the time series, (3) generating training/validation points, (4) training a random forest classifier, and (5) validating the classification.

**Sample design**: A sample-based approach is used to complete area estimation. This approach is preferred over pixel-counting methods because all maps have errors. Sample based approaches create unbiased estimates of area and the error associated with map. An

agreement map generated from the results of all four methodsis used for sample design. The goal is to ensure that no strata is under-sampled. The resulting strata is anywhere 1-4 algorithms agreed there was a certain kind of change event or stable forest/non-forest, anywhere the different algorithms labeled different types of change events, anywhere all 4 algorithms labeled non-forest, and anywhere all 4 algorithms labeled forest. Final strata values for the agreement map and their human-readable labels are 1: DEG, 2: LOSS, 3: GAIN, 4: Non-forest, and 5: Forest. The number of points randomly selected depend on the relative area available in each stratum, the human resources available to do interpretations, and a target standard error. A total of **1,522** points were selected via stratified random sampling to be used for sample-based area estimation.

**Reference data collection (completed in CEO):** To estimate emissions from deforestation, carbon enhancement removals, and forest degradation emissions, reference data were collected through a time series analysis of 1,522 sampling plots in CEO. To identify the age of forest gain cohorts and differentiate between secondary and permanent forests, the sampling points were visually interpreted for the same period that the forest change map was created (1983 to 2021). This period was divided into four subperiods: 1984-2003, 2004-2014. 2015-2017 and 2018-2021 (see Figure 4). The canopy cover was visually evaluated in permanent forest only for the years 2003/2004, 2014/2015, 2017/2018, and 2021.

xiii. *Generating a CEO project from a template:* Nepal created a template to collect land-use change and degradation reference data in Collect Earth Online (CEO[115]) for the following periods: Pre-reference period (t0) - 1983-2003, Reference Period (t1) – 2004-2014, First monitoring period (t2) – 2015-2017 and Second monitoring period (t3) – 2018-2021.

xiv. *Sampling unit*: The Sampling Unit (SU) is a 70 x 70 meter plot. Inside SU, a 3x3 points sub-grid (9 points) was created to estimate forest canopy cover percentage within each sampling unit.

xv. *Number of Sampling Units*: A total of 1,522 randomly selected sampling points were visually assessed.

xvi. *Interpretation key*: Nepal produced an interpretation key that should be reused and updated as needed. The land use categories considered are the following:

| **Forest lands**: | **Non-forest lands** |
|---|---|
| 1 Intact Forest<br>2 Degraded Forest<br>3 Very Degraded Forest<br>4 Secondary natural forest<br>5 Plantation Forest<br>6 Shaded croplands | 7 Grasslands<br>8 Other lands<br>9 Settlements<br>10 Unshaded croplands (tree canopy cover 10% or less) |

**Area and uncertainty estimation:** Nepal employs a sample-based approach to estimate the Activity Data for Deforestation, Forest gain and Degradation. All 1,522 samples were used as the basis for calculating area estimates and their uncertainty. The estimation of Activity Data was done using the stratified random estimator based on the formulas described by Cochran (1977)[116]. Estimates are made for each of the land use categories considered (10 classes) and in terms of changes from one period to another representing a total of more than 26 effective combinations (Deforestation 14, Forest Gain 3, and Degradation 9).

[115] CEO is a custom built, open-source, satellite image viewing and interpretation system. Collect Earth Online promotes consistency in locating, interpreting, and labeling reference data plots for use in classifying and monitoring land cover / land use change (see https://app.collect.earth ).

[116] Cochran, W.G. (1977) Sampling Techniques. 3rd Edition, John Wiley & Sons, New York.

| | |
|---|---|
| **QA/QC procedures applied:** | **Reference data collection:**<br>**Reference data compilation:** To ensure accuracy, the data collected from the CEO was compiled in R for each period of the time series analysis (t0, t1, t2, and t3). The compilation process identifies land-use interpreted points with impossible transitions, and these points are sent back to the interpreted for review, until the compilation process detects no inconsistencies.<br>**Area estimate**: To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheet (**Activity Data Tool**). This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok".<br>QA/QC procedure employed is explained in detail in the link:<br>https://training.sig-gis.com/NEPALworkshopAE/#CEO-Reference-data |
| **Uncertainty for this parameter:** | The determination of the uncertainty Activity Data was not done using the standard deviation (SD) given that the formulas (Cochran (1977)) used to estimate the Activity Data do not allow for the calculation of SD. To determine the uncertainty for Activity Data, initially the country used the calculated the half-width of the 90% confidence interval as a percentage of the estimated emissions and the normal probability density function (PDF). This calculation only takes sampling errors into account and does not consider the interpreter error. Later on, the Monte Carlo simulation was updated to utilize the standard error (SE) in the normal PDF functions when no standard deviation (SD) was available. |
| **Any comment:** | |

### 9.2 Organizational structure for measurement, monitoring and reporting

*>> Chapter 2 provides full details on the organizational structure for measurement, monitoring and reporting, including selection and management of GHG data and information, process, systems, and related matters.*

### 9.3 Relation and consistency with the National Forest Monitoring System

*>>Refer to Section 2.1.4 for the details related to the relation and consistency with the national forest monitoring system.*

# 12 UNCERTAINTIES OF THE CALCULATION OF EMISSION REDUCTIONS

## 12.1 Identification and assessment of sources of uncertainty

>>

| Sources of uncertainty | Analysis of contribution to overall uncertainty |
|---|---|
| **Activity Data** | |
| *Measurement* | Activity Data is based on sampling. Systematic and random errors during the visual interpretation of land-use and land-use change in satellite imagery contribute to the overall uncertainty. Nepal has taken measures to address this issue by implementing QA/QC procedures for collecting reference data. This involves using the best available imagery and providing detailed interpretation keys. The interpreters have been trained to ensure they follow the correct procedures for land-use and land-use change interpretation. To guarantee accuracy, the collected reference data is compiled in R for each period of the time series analysis (t0, t1, t2, and t3). During the compilation process, land-use interpretation points with impossible transitions are identified and sent back to the interpreter for review until the compilation process detects no inconsistencies. |
| *Representativeness* | Sampling was carried out over the entire accounting area and all reference and monitoring periods. It can therefore be concluded that the impact of this source of uncertainty is low. |
| *Sampling* | To determine the number of points needed for the study, we must consider the area of each stratum. Once the total number of samples is calculated, they must be distributed across the strata proportionally. If any of the strata receive too few samples, they should have a minimum sample size requirement, and the remaining points should be proportionally distributed to the larger strata. However, changes in the study area are small, resulting in a high variance in some change categories. To select the estimator, we follow Cochran's (1977) recommendations. |
| *Extrapolation* | The estimates were made on the basis of the samples collected and for which the interpretation of the land cover classes are exhaustive and cover the whole reference and monitoring periods. This source of error is therefore unlikely to be present in the approach adopted. |
| *Approach 3* | This source of uncertainty exists when there is no land monitoring or IPCC Approach 3 of monitoring, which is not valid for the Nepal ER-Program. Four non-independent surveys were conducted covering reference and monitoring periods (t0, t1, t2, and t3), conducting lands tracking. |
| **Emission Factors** | |
| *DBH measurement* | The permanent sample plots were selected from the National Forest Resource Assessment. The sampling design was adopted from Forest Resource Assessment Design 2011. Please refer to the link: https://drive.google.com/file/d/1VRGGNoMOy-_92qg8ktk3xH82YNsEraym/view?usp=sharing.<br><br>In the selected sample plots, all trees that have a diameter of more than 5 cm were measured. For more details, please refer to FRA field manual provided in the following link:<br>Field Manual Inner (1)_1656760691.pdf (frtc.gov.np).<br><br>The height of every fifth tree was measured and for the remaining trees, their height was predicted using the model developed on the basis of the height-diameter relationship of neighbor trees. The model prepared and used during the calculation is presented in Annex 2 of the report provided in the following link:<br>The-TeraiForestsofNepal_1579845265.pdf (frtc.gov.np)<br><br>For all above-mentioned processes, a strong QA/QC was carried out using QA/QC Manual approved by the FRTC [117]. A comprehensive training was conducted for field staff to minimize the field measurement errors. In addition, the continuous monitoring of the field personnels were carried out by the FRTC's officials. As a result of the robust QA/QC process, the error for field measurement is below 5%. |
| *H measurement* | |
| *Plot delineation* | |
| *Wood density estimation* | The species-specific wood density is referenced from Table 1 of Sharma and Pukkala, 1990, Master Plan for the Forestry Sector Nepal[118], and Devagiri et al., 2013[119].<br>[Sharma_and_Pukkala_1990_Volume_equations_and_biomass_prediction_of_forest_trees_of_Nepal.pdf] |
| *Biomass allometric model* | The country used a local volume tree equation to estimate biomass. The volume of the tree, which is further converted into biomass and carbon, is calculated using the allometric equation developed by Sharma and |

[117] https://drive.google.com/file/d/1TcgEb8kDoGp3trxlKIpp-ofZ1QoUxecF/view

[118] https://drive.google.com/file/d/12FGaJnNuMBB1zMJEoqSNexfYvW451uvH/view?usp=drive_link

[119] https://drive.google.com/file/d/1zaQKB5Xl_qIqB8SXPTQ2yf50XgSH4L1n/view?usp=drive_link

| Sources of uncertainty | Analysis of contribution to overall uncertainty |
|---|---|
| **Activity Data** | |
| | Pukkala, 1990. [Table 2 of Sharma_and_Pukkala_1990_Volume_equations_and_biomass_prediction_of_forest_trees_of_Nepal.pdf] Note that for the species not included in Table 2-7 of Sharma and Pukkala 1990, the parameters from the Miscellaneous Categories were used, depending on the sample plots' locations (Terai or Hills).<br><br>There are more than 21 species of trees with specific parameters and, additional two groups of species found in lower altitude and higher altitude with their respective parameters. The maximum and minimum standard error percentage of regression model is 9.9 % and 5.8 % respectively. The $R^2$ of model for every species is higher than 95 % (Sharma and Pukkala 1990). The country has not determined whether the uncertainty from this source is lower than the uncertainty from the sampling error. Since Nepal is unable to include this error source in the Monte Carlo simulation, due to the lack of a covariance table, the sampling uncertainty of carbon density in different land uses based in the NFI dataset has been increased by 10% at a 90% confidence level using the quadrature approach. The combined error was included in the Monte Carlo simulation. |
| *Sampling* | The sampling is done based on the Inventory Design (ID) of National Forest Inventory. The error of the Inventory Design is 7.34% at 95 % confidence interval. [Please refer to page 40 of the report provided in the link below: https://frtc.gov.np/downloadfile/state%20%20forest%20of%20Nepal_1579793749_1579844506.pdf] |
| *Other parameters (e.g. Carbon Fraction, root-to-shoot ratios)* | Other relevant parameters like root-to-shoot ratio and carbon fraction are taken from the 2006 IPCC guideline. The error provided by the IPCC guideline is also factored while carrying out the Monte Carlo simulation for uncertainty estimation. |
| *Representativeness* | The carbon densities and removal rates used for the ER monitoring report are Tier 2 (country specific data) and has been derived from the latest NFI (FRA) except the removal rates for forest plantation and shaded crops. The NFI (FRA) involved remeasurement in 2022 of the permanent sample plots established by the FRA Nepal Project (2010-2014) including an additional number of plots established and measured using the same methodology. Nepal is conducting NFI by re-measuring the permanent sample plots at an interval of every five years. The carbon densities of natural forests categorized as intact, degraded, and very degraded were estimated using the first measurement from NFI's 388 plots. The determination of average carbon densities for non-forest lands was based on 21 NFI plots, which provided biomass estimates for grassland, other land, and unshaded cropland. These estimates were obtained during the initial measurement phase of the NFI. The forest regrowth removal rate calculation is based on a sample of sixteen NFI plots established in secondary forests. Two biomass measurements were taken in these plots, and the difference in biomass over the years between measurements was used to estimate the average removal rate. |
| Integration | |
| *Model* | To ensure accurate Activity Data estimates, material errors are controlled through specific mechanisms in the estimation spreadsheets. This includes matching forest-type sampling points with sample size to prevent double counting in the sample-based Activity Data estimate. The accuracy of deforested, forest gain, and degraded areas are checked in cells Deforestation: I41-N58, Forest_gain: E19-K47, and Degradation: F30-V50 respectively. Before reporting AD values, a quality assurance/quality control procedure is conducted to verify that all these cells are labeled "Ok". |
| *Integration* | Activity Data and Emission Factors are comparable. Carbon densities have been estimated according to the forest types, and non-forest land uses interpreted in the visual assessment. To ensure consistency, the Emission Factors (EF) have been aligned with the estimates of land-use transitions area (AD). To achieve this, the same time series analysis and data collection methods that were used in CEO were replicated for the NFI permanent plot's locations. The NFI plots have been classified as Non-Forest land use (grassland, other land, unshaded cropland), Permanent Forest, or Secondary Forests. Additionally, the canopy cover of Permanent Forest plots was evaluated to determine whether they were intact (7-9 points), degraded (4-6 points), or very degraded forest (1-3 points). |

## 12.2 Quantification of uncertainty in Reference Level Setting

### *12.2.1 Parameters and Assumptions Used in the Monte Carlo Method*

| Parameter included in the model | Parameter values | Range or standard deviations | | Error sources quantified in the model (e.g. measurement error, model error, etc.) | Probability distribution function | Assumptions |
|---|---|---|---|---|---|---|
| | | Range | %Error | | | |
| ratio R::S | 0.44 | 0.30 | 68% | 90% Confidence Interval | Normal Mean 0.44, SD 0.184 | Only values > 0. |
| ratio R::S Grassland | 1.887 | 0.499 | 26% | 90% Confidence Interval | Normal Mean 1.887, SD 0.304 | |
| CF | 0.47 | 0.020 | 4% | 90% Confidence Interval | Normal Mean 0.47, SE 0.0120 | |
| CD-natural intact forest | 203.84 | 9.77 | 5% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-natural degraded forest | 102.77 | 37.79 | 37% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-natural very degraded forest | 19.28 | 11.97 | 62% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-grassland | 4.07 | 6.07 | 149% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-other land | 39.95 | 53.09 | 133% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-settlements | 4.07 | 6.07 | 149% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| CD-unshaded cropland | 48.69 | 36.41 | 75% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| RF-natural secondary forest gain | 16.69 | 9.41 | 56% | 90% Confidence Interval | Bootstrapping | Only values > 0. |
| RF-plantation forest gain | 13.79 | 9.41 | 68% | 90% Confidence Interval | Bootstrapping | Only values > 0. It is assumed the same SD as Nat Sec forest gain removal rate |
| RF-shaded cropland gain | 10.23 | 2.46 | 24% | 90% Confidence Interval | Normal Mean 2.79, %E 24% | Only values > 0. |
| AD-Defo_Intact Forest-Grasslands-2004-2014 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-Defo_Intact Forest-Other Land-2004-2014 | 1,564 | 1,261 | 81% | 90% Confidence Interval | Normal Mean 1564, SE 767 | Only values > 0. |
| AD-Defo_Intact Forest-Settlements-2004-2014 | 1,676 | 2,199 | 131% | 90% Confidence Interval | Normal Mean 1676, SE 1337 | Only values > 0. |
| AD-Defo_Intact Forest-Unshaded Cropland-2004-2014 | 4,818 | 3,983 | 83% | 90% Confidence Interval | Normal Mean 4818, SE 2422 | Only values > 0. |
| AD-Defo_Degraded Forest-Other Land-2004-2014 | 3,506 | 3,672 | 105% | 90% Confidence Interval | Normal Mean 3506, SE 2233 | Only values > 0. |
| AD-Defo_Degraded Forest-Settlements-2004-2014 | 2,017 | 2,748 | 136% | 90% Confidence Interval | Normal Mean 2017, SE 1670 | Only values > 0. |
| AD-Defo_Degraded Forest-Unshaded Cropland-2004-2014 | 3,897 | 3,726 | 96% | 90% Confidence Interval | Normal Mean 3897, SE 2265 | Only values > 0. |

| Parameter included in the model | Parameter values | Range or standard deviations | | Error sources quantified in the model (e.g. measurement error, model error, etc.) | Probability distribution function | Assumptions |
|---|---|---|---|---|---|---|
| | | Range | %Error | | | |
| AD-Defo_Intact Forest-Other Land-2018-2021 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1626 | Only values > 0. |
| AD-Defo_Secondary natural forest 2007-other land-2015-2017 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1626 | Only values > 0. |
| AD-Deg_Inctact forest-Degraded forest -2004-2014 | 5,991 | 4,120 | 69% | 90% Confidence Interval | Normal Mean 5991, SE 2505 | Only values > 0. |
| AD-Deg_Inctact forest-Very degraded forest-2004-2014 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-Deg_Degraded forest -Very degraded forest-2004-2014 | 1,627 | 2,672 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1625 | Only values > 0. |
| AD-Deg_Degraded forest -Inctact forest-2004-2014 | 7,904 | 5,553 | 70% | 90% Confidence Interval | Normal Mean 7904, SE 3376 | Only values > 0. |
| AD-Deg_Very degraded forest-Degraded forest -2004-2014 | 3,254 | 3,780 | 116% | 90% Confidence Interval | Normal Mean 3254, SE 2298 | Only values > 0. |
| AD-Deg_Inctact forest-Degraded forest -2018-2021 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-Deg_Degraded forest -Very degraded forest-2018-2021 | 782 | 900 | 115% | 90% Confidence Interval | Normal Mean 782, SE 547 | Only values > 0. |
| AD-Deg_Degraded forest -Inctact forest-2018-2021 | 3,505 | 3,671 | 105% | 90% Confidence Interval | Normal Mean 3505, SE 2232 | Only values > 0. |
| AD-Deg_Very degraded forest-Degraded forest -2018-2021 | 1,627 | 2,672 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1625 | Only values > 0. |
| AD-ForestGain_Natural Forest_1983-2003 | 7,996 | 5,869 | 73% | 90% Confidence Interval | Normal Mean 7996, SE 3570 | Only values > 0. |
| AD-ForestGain_Natural Forest_2004-2014 | 17,136 | 8,467 | 49% | 90% Confidence Interval | Normal Mean 17136, SE 5150 | Only values > 0. |
| AD-ForestGain_Natural Forest_2015-2017 | 3,114 | 3,615 | 116% | 90% Confidence Interval | Normal Mean 3114, SE 2199 | Only values > 0. |
| AD-ForestGain_Natural Forest_2018-2021 | 19,156 | 8,888 | 46% | 90% Confidence Interval | Normal Mean 19156, SE 5406 | Only values > 0. |
| AD-ForestGain_Plantation Forest_1983-2003 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |
| AD-ForestGain_Plantation Forest_2015-2017 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |
| AD-ForestGain_Shaded cropland_2015-2017 | 391 | 639 | 163% | 90% Confidence Interval | Normal Mean 391, SE 389 | Only values > 0. |
| AD-ForestGain_Shaded cropland_2018-2021 | 1,627 | 2,674 | 164% | 90% Confidence Interval | Normal Mean 1627, SE 1627 | Only values > 0. |

### *12.2.2 Quantification of the Uncertainty of the Estimate of the Reference Level*

| | | Deforestation | Forest degradation | Enhancement of carbon stocks |
|---|---|---|---|---|
| A | **Median** | **291 265** | **176 262** | **-400 538** |
| B | **Upper bound 90% CI** (Percentile 0.95) | **587 344** | **318 069** | **-197 304** |
| C | **Lower bound 90% CI** (Percentile 0.05) | **45 968** | **74 266** | **-682 123** |
| D | **Half Width Confidence Interval at 90% (B – C / 2)** | **270 688** | **121 901** | **242 409** |
| E | **Relative margin (D / A)** | **93%** | **69%** | **-61%** |
| F | **Uncertainty discount** | **12%** | **12%** | **12%** |

### *12.2.3 Sensitivity Analysis and Identification of Areas of Improvement of MRV System*

The following table show each parameter's contribution to the Emissions Reduction's uncertainty. Four parameters represent 64% of total ER's uncertainty: i. Removal Factor of natural secondary forest gain(22.7%), ii. ratio R::S (16.5 %), iii. Degraded forest -Intact forest Area 2018-2021 (15.8%) and iv. Deforested area from Intact Forest to Other Land in 2018-2021 (8.5%).

| Input Variable | Corresponding Input Value | | | Swing | Percent Swing^2 |
|---|---|---|---|---|---|
| | Low Output | Base Case | High Output | | |
| RF-natural secondary forest gain | 7.28 | 16.69 | 26.11 | 1,931,803 | 22.7% |
| ratio R::S | 0.13972875 | 0.44 | 0.74027125 | 1,647,938 | 16.5% |
| AD-Deg_Degraded forest -Inctact forest-2018-2021 | 0 | 3,505 | 7,176 | 1,613,420 | 15.8% |
| AD-Defo_Intact Forest-Other Land-2018-2021 | 4,301 | 1,627 | 0 | 1,179,902 | 8.5% |
| AD-ForestGain_Natural Forest_2018-2021 | 10,268 | 19,156 | 28,044 | 954,491 | 5.5% |
| AD-Deg_Degraded forest -Inctact forest-2004-2014 | 13,457 | 7,904 | 2,351 | 908,028 | 5.0% |
| AD-Defo_Intact Forest-Unshaded Cropland-2004-2014 | 835 | 4,818 | 8,801 | 838,663 | 4.3% |
| AD-Deg_Very degraded forest-Degraded forest -2018-2021 | 0 | 1,627 | 4,299 | 793,174 | 3.8% |
| AD-ForestGain_Natural Forest_2004-2014 | 8,670 | 17,136 | 25,603 | 727,396 | 3.2% |
| AD-Deg_Inctact forest-Degraded forest -2004-2014 | 1,871 | 5,991 | 10,111 | 673,770 | 2.8% |
| AD-Defo_Intact Forest-Settlements-2004-2014 | 0 | 1,676 | 3,875 | 611,963 | 2.3% |
| AD-ForestGain_Natural Forest_2015-2017 | 0 | 3,114 | 6,729 | 578,092 | 2.0% |
| AD-Deg_Very degraded forest-Degraded forest -2004-2014 | 7,034 | 3,254 | 0 | 471,946 | 1.4% |
| AD-Defo_Secondary natural forest 2007-other land-2015-2017 | 4,301 | 1,627 | 0 | 369,506 | 0.8% |
| AD-Defo_Degraded Forest-Settlements-2004-2014 | 0 | 2,017 | 4,765 | 362,898 | 0.8% |
| AD-Deg_Degraded forest -Very degraded forest-2018-2021 | 1,682 | 782 | 0 | 310,303 | 0.6% |
| AD-ForestGain_Plantation Forest_2015-2017 | 0 | 1,627 | 4,301 | 305,212 | 0.6% |
| AD-Deg_Degraded forest -Very degraded forest-2004-2014 | 0 | 1,627 | 4,299 | 288,427 | 0.5% |
| AD-ForestGain_Natural Forest_1983-2003 | 13,865 | 7,996 | 2,127 | 264,118 | 0.4% |
| AD-Defo_Intact Forest-Other Land-2004-2014 | 303 | 1,564 | 2,825 | 251,552 | 0.4% |
| AD-Deg_Inctact forest-Degraded forest -2018-2021 | 1,030 | 391 | 0 | 231,626 | 0.3% |

| | | | | | |
|---|---|---|---|---|---|
| CD-natural degraded forest | 64.63 | 102.41 | 140.19 | 211,134 | 0.3% |
| ratio R::S Grassland | 2.38556 | 1.887 | 1.38844 | 200,097 | 0.2% |
| AD-Defo_Degraded Forest-Unshaded Cropland-2004-2014 | 170 | 3,897 | 7,623 | 175,288 | 0.2% |
| CD-natural inctat forest | 194.02 | 203.80 | 213.57 | 173,682 | 0.2% |
| AD-Defo_Intact Forest-Grasslands-2004-2014 | 0 | 391 | 1,030 | 162,685 | 0.2% |
| AD-Deg_Inctact forest-Very degraded forest-2004-2014 | 0 | 391 | 1,030 | 153,349 | 0.1% |
| AD-ForestGain_Shaded cropland_2018-2021 | 0 | 1,627 | 4,301 | 141,546 | 0.1% |
| AD-Defo_Degraded Forest-Other Land-2004-2014 | 0 | 3,506 | 7,178 | 129,184 | 0.1% |
| CF | 0.450401 | 0.47 | 0.489599 | 125,121 | 0.1% |
| RF-plantation forest gain | 4.37 | 13.79 | 23.20 | 116,402 | 0.1% |
| CD-other land | 93.04 | 39.95 | 0.00 | 89,387 | 0.0% |
| AD-ForestGain_Plantation Forest_1983-2003 | 4,301 | 1,627 | 0 | 79,936 | 0.0% |
| CD-settlements | 9.85 | 3.97 | 0.00 | 58,842 | 0.0% |
| AD-ForestGain_Shaded cropland_2015-2017 | 0 | 391 | 1,030 | 54,246 | 0.0% |
| RF-shaded cropland gain | 7.77 | 10.23 | 12.69 | 35,586 | 0.0% |
| CD-natural very degraded forest | 37.2 | 19.21 | 7.22 | 20,999 | 0.0% |
| CD-grassland | 9.85 | 3.97 | 0.00 | 6,227 | 0.0% |
| CD-unshaded cropland | 11.78 | 48.31 | 84.85 | - | 0.0% |