Forest Carbon Partnership Facility (FCPF)
Carbon Fund

ER Monitoring Report (ER-MR)

ER Program Name and Country	**Costa Rica**
Period covered in this report	**01-01-2018 to 31-12-2024[1]**
Number of FCPF ERs	**8,906,047 t CO_2**
Quantity of ERs allocated to the Uncertainty Buffer	**412,314 t CO_2**
Quantity of ERs allocated to the Pooled Reversal Buffer	**989,558 t CO_2**
Number of FCPF ERs from enhanced Removals through afforestation/reforestation (A/R)	**NA**
Date of Submission	**23-6-2026**
Version	**1**

[1] This ER-MR covers the third reporting period 2022-2024 of the Costa Rica ERPA. Due to a Methodological Deviation affecting prior periods, Costa Rica was permitted to report the full crediting period 2018-2024. The ERs for the 3rd ERMR total 6,888,128 tCO_2, down from 8.906,047 tCO_2 reported for 2018-2024.

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LIST OF ACRONYMS

AC: Conservation Areas
ACC: Central Conservation Area
AD: Activity data
ADII: Asociaciones de Desarrollo Integral Indígena (Associations for Integral Indigenous Development)
AFOLU: Agriculture, Forests, and Other Land Use
ASP: Protected Wilderness Areas
ASVO: Volunteers Association
CATIE: Tropical Agricultural Research and Higher Education Center
CENIGA: National Geo-environmental Information Center
CIAgro: Colegio de Ingenieros Agrónomos (College of Agricultural Engineers)
CIRAD: Center for International Cooperation in Agricultural Research for Development
CONAC: The National Council of Conservation Areas
COVIRENA: Natural Resources Surveillance Committees
CREF: Contract for the Reduction of Forest Emissions
DCC: Climate Change Directorate
EF: Emission Factors
ER: Emission Reduction
ER-MR: Emission Reduction-Monitoring Report
ERPA: The Emissions Reduction Purchase Agreements
ER-PD: Emission Reduction Program Document
FCPF: Forest Carbon Partnership Facility
FONAFIFO: National Fund for Forest Financing
FREL/FRL: Forest reference emission level/forest reference level
IGN: National Geographic Institute
IMN: National Meteorology Institute
INEC: Institute of Statistics and Census
INF-CR: Costa Rica's Nacional Forest Inventory
INGEI: National GHG Inventory
IPCC: Intergovernmental Panel on Climate Change
LULCC: Land Use Land Cover Change
LULUCF: Land Use, Land-Use Change and Forestry
MAG: Ministry of Agriculture and Livestock
MCS: Land Cover Maps
MINAE: Ministry of Environment and Energy
MRV: Monitoring, Reporting, and Verification
NFMS: National Forest Monitoring System
ONF: Oficina Nacional Forestal (National Forest Office)
PES: Payment for Environmental Services
PGM: General Management Plans
PNCB: National Biological Corridors Program
PNE: State Natural Heritage Lands

PPC: Prevention, Protection, and Control Plans
PRE: Emission Reduction Program
PSA: Environmental Services Payment Program
RMSE: Root Mean Square Error
SAF: Agroforestry Systems
SATIF: Forest Fire Early Warning System
SEPLASA: Secretariat for Sector Planning for the Environment, Energy, Seas and Territorial Planning
SICAF: System for the Control of Forest Harvesting
SIMOCUTE: National Monitoring System for Land Use, Land Use Cover, and Ecosystems
SINAC: Sistema Nacional de Areas de Conservación (National System of Conservation Areas)
SINAMECC: National System of Climate Change Metrics of Costa Rica
SIPLAMA: System of Management Plans
SITADA: Integrated Environmental Complaint Processing System
SLMP: Satellite Land Monitoring Protocol
SLMS: Satellite Land Monitoring System
SPMH-ACLAC: Strategy and Action Plan for the Participatory Strengthening of the World Heritage Site of La Amistad Caribe
TREES: The REDD+ Environmental Excellency Standard
UMP: Primary Sampling Unit
UNFCCC: United Nations Framework Convention on Climate Change
USGS: United States Geological Survey

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

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

Progress on the actions and interventions under the ER Program: There are no changes or deviations in the ER Program's design and critical assumptions compared to the description of the ER Program in the ER-PD. This section refers to FONAFIFO and SINAC's REDD+ actions implemented during the 2018-2024 period[2] (for further detail, see Annex 1).

ACTION 1.1. Strengthen the operation and financing of SINAC's Forest Fires Management Strategy inside and outside Protected Conservation Areas

During the 2018–2024 period, progress in Action 1.1 focused on strengthening the operational and financial capacity of the National System of Conservation Areas (SINAC) and its National Integrated Fire Management Program (PNMIF). Implementation was guided by the National Fire Management Strategy 2012–2021 and the subsequent design of the V National Fire Management Strategy, which incorporates a pioneering gender focus.

Key elements of progress during this period include:

i. Technical and Technological Advancements

- Early Warning System (SATIF): Developed with FCPF readiness funds and SINAC's budget, SATIF predicts fire behavior and occurrence nationwide. It was officially launched in February 2020 and remains a primary tool for measuring the effectiveness of fire response.
- Response Levels: Monitoring indicates high efficiency, with a vast majority of fires (e.g., 96% in 2021 and 89% in 2023) being successfully managed at Level 1, meaning they were controlled using only local resources from subregional offices or individual protected areas.

ii. Strategic Financing and Institutional Support

- Diversified Funding: Following a 50% reduction in SINAC's institutional budget in 2020 due to the fiscal crisis and the pandemic, the program increasingly relied on external resources.
- Major Investments: Between 2021 and 2024, approximately $6.1 million USD from the Green Climate Fund (via the REDD+ PBR project) was transferred to SINAC for fire management. An additional $2.2 million USD was invested in specialized equipment, including vehicles, protection gear (helmets, boots, uniforms), and tools for 90% of the country's conservation areas.

iii. Capacity Building and Community Participation

- Volunteer Brigades: SINAC coordinates volunteer brigades in high-risk zones. From 2021 to 2024, the program trained 1,740 people through 79 courses on topics like fire behavior and water use in extinction.
- Gender Inclusion: The program has made significant strides in including women in firefighting. This includes the First National Encounter of Women Forest Firefighters in 2019 and a second encounter in 2024 with 66 participants. A specialized course titled "Gender, Forests and Fire" was also developed to empower women and improve relations within brigades.

iv. Public Awareness and Prevention

- National Campaigns: SINAC organizes annual prevention campaigns. During the pandemic, these shifted from in-person events to digital media, television, and radio broadcasts.
- Operational Protection: Resources were consistently allocated for hiring reinforcement brigades and maintaining firewalls in high-incidence zones.

Despite challenges such as the severe 2024 fire season in Guanacaste, which saw a record number of incidents due to adverse weather, the program's integration of community surveillance, volunteer brigades, and modernized monitoring systems has been essential to protecting Costa Rica's forest carbon stocks.

ACTION 1.2: Strengthen the operation and financing of SINAC's Illegal Logging Control Strategy:

[2] See Policies, actions, and activities included in the ER-P and the National REDD+ Strategy, in Table 4.3.1 of the Emission Reduction Program Document.

During the 2018–2024 period, progress in Action 1.2 focused on modernizing logging permit systems, enhancing field surveillance through technology, and strengthening community-led oversight.

i. Digitization and System Improvements

SINAC focused on automating the issuance of logging permits to improve oversight and reduce illegal harvesting on private lands. This was achieved through two primary online systems:

- SICAF (Information System for the Control of Forest Harvesting): Used for permits on pasture and agricultural lands. During this period, SICAF was updated based on user feedback to include performance adjustments and new modules, such as those for harvesting fallen wood.
- SIPLAMA (System of Management Plans): Utilized for wood harvesting on forest lands.
- SITADA (Integrated Environmental Complaint Processing System): This platform was used to manage and track environmental complaints. Training on SITADA was provided to both SINAC officers and local volunteers to expedite the reporting process.

ii. Surveillance and Operational Control

Operational efforts combined traditional patrols with high-tech monitoring:

- Control Operations: Regular patrols were intensified during high-risk periods like Easter and Christmas to deter forest burning and illegal logging.
- Overflights: In 2022, SINAC conducted 35 overflights using ultralight aircraft to detect illegal activities in inaccessible areas. These missions identified 406 environmental offenses, including 232 cases of illegal logging and 54 cases of land-use change. However, these flights were suspended in 2023 and 2024 due to budget constraints.
- Activity Volume: Between 2020 and 2024, SINAC performed 15,019 control and protection activities and submitted 391 reports to the prosecutor's office for suspected environmental crimes.

iii. Community Participation and Governance

The program prioritized the reactivation of COVIRENAS (Natural Resources Surveillance Committees), which are volunteer groups that assist government agencies in monitoring compliance with environmental laws.

- Accreditation and Training: During this period, SINAC trained and accredited 24 COVIRENA groups in the use of the SITADA reporting system to ensure local communities could effectively document and report illegal activities.

iv. Traceability and Enforcement

To prevent the laundering of illegal timber, SINAC maintained a traceability system using physical identifiers:

- Log Tagging: Timber products are tracked using plastic plates/tags that identify logs from authorized harvests, alongside printed transport guides.
- Enforcement Data: Statistics from SITADA show that logging and harvesting remain the most frequent environmental infractions, followed by timber transport violations.

v. Key Challenges

Despite progress, SINAC identified several persistent hurdles in its illegal logging strategy, including a lack of standardized procedures nationwide, insufficient personnel and economic resources for field interventions, and growing complexity as environmental crimes become increasingly linked to organized crime.

ACTION 1.5: Contribute to the consolidation of SINAC's Protected Areas System

During the 2018–2024 period, progress in Action 1.5 focused on strengthening the management and governance of Costa Rica's Protected Wilderness Areas (ASP) through new planning instruments, effectiveness assessments, and legislative updates.

i. Management Planning and Officialization

SINAC produced comprehensive guidelines for the establishment, expansion, and administration of ASPs, which now serve as the mandatory reference for creating General Management Plans (PGM).

- Approval Volume: A total of 12 PGMs were initially approved for key areas, including Braulio Carrillo, Los Quetzales, and Tapantí National Parks.
- Recent Acceleration: Between 2022 and 2024, the process accelerated, with 23 additional PGMs officialized nationwide (5 in 2022, 4 in 2023, and 14 in 2024).

- Specific Plans: Methodological guidance was also developed for specific sub-plans, such as Prevention, Protection, and Control (PPC), sustainable tourism, and ecological integrity.

ii. Management Effectiveness and Adaptive Tools

A specialized tool for evaluating the effectiveness of ASP management, initially launched in 2015, was consolidated as a standard institutional practice.

- Purpose: This tool uses data to support adaptive management, promote more efficient resource allocation, and ensure transparency and accountability to stakeholders.
- Results: Periodic workshops held in each ASP produced management results reports and identified specific improvement plans. By 2024, evaluation results were categorized by management quality, ranging from "Satisfactory" to "Not Acceptable" for different categories of protected areas.

iii. Participatory Governance and Indigenous Inclusion

Progress included a shift toward "Landscape Management," integrating protected areas with their surrounding buffer zones and biological corridors.

- SPMH-ACLAC: Starting in 2020, SINAC implemented the "Strategy and Action Plan for the Participatory Strengthening of the World Heritage Site of La Amistad Caribe." This initiative diagnosed coexistence models in seven indigenous territories to establish a formal governance structure for the site.
- Biological Corridors: SINAC supported the National Biological Corridors Program (PNCB), which reached a milestone in 2024 with 38 corridors having completed their own local management plans.
- Concessions for Local Organizations: The passage of Ley N° 10,332 in 2022 promoted efficient management by allowing local organizations to obtain concessions for non-essential services within ASPs, fostering community participation in conservation.

iv. Consolidation of State Natural Heritage (PNE)

Efforts were made to formally define and protect state-owned lands not previously categorized.

- New PNE Chapter: In 2021, the National Council of Conservation Areas (CONAC) approved a specific chapter for the Natural State Heritage (ASP-PNE) to be included in the updated National Forestry Development Plan.
- Indigenous "Areas of Care": Work progressed on incorporating the recognition of ancestral uses and traditional "areas of care" for indigenous peoples into ASP management plans, aligning with national biodiversity targets.

ACTION 1.4: Develop a strategy to integrate public lands into the State Natural Heritage

During the 2018–2024 period, progress in Action 1.4 focused on creating digital and legal infrastructure to manage and secure the State Natural Heritage (PNE), specifically by developing a centralized Land Tenure Management System.

i. 1. Development of the Land Tenure Management System

- Creation (2019): Using REDD+ readiness funds, the National System of Conservation Areas (SINAC) created the System of Land Tenure Management specifically for Natural State Heritage lands.
- Platform Adjustments (2020): While the system was created in 2019, its computer structure and technical work guides were finalized and fully adjusted in 2020.
- Pilot Implementation (2021): The operational rollout of the tool began with a pilot project in the Central Conservation Area (ACC).

ii. 2. System Features and Capabilities

- Secure Administration: The platform is a high-security web system designed for SINAC officers to manage certifications, visas, land purchases, donations, and the registration of vacant lands.
- Geospatial Modules: The system includes distinct geospatial modules for SINAC officials and the general public. These modules feature detailed layers representing:
    - State Natural Heritage Lands (PNE).
    - Protected Wilderness Areas (ASP) and Conservation Areas (AC).
    - Forest types and wetlands.
- Technical Utility: The data generated is used for ASP monitoring, research, education, and improved institutional decision-making regarding forest management.

iii. 3. Strategic Integration and Regularization

- Territorial Regularization Plan: Parallel to the digital platform, a Plan for Territorial Regularization has been in execution to consolidate and expand the PNE through the purchase, donation, and formal inscription of lands.
- Institutional Officialization (2021): In July 2021, the National Council of Conservation Areas (CONAC) approved a specific chapter for the Natural State Heritage (ASP-PNE).
- Forestry Development Integration: This approved chapter was integrated into the updated National Forestry Development Plan to guide the execution of state land management for the current period.

iv. 4. Impact on Emission Reductions

- Ownership Certainty: These management efforts ensure that carbon rights to emission reductions generated on state lands remain clear and uncontested, a prerequisite for credit issuance under the FCPF and TREES standards.
- Consolidated Coverage: By 2021, the documented forest area within the State Natural Heritage (including SINAC and other state institutions) totaled over 671,000 hectares of verified ownership.

ACTION 5.2: Improve competitiveness of forestry and agroforestry financing mechanisms, also in relation to other land uses.

During the 2018–2024 period, progress in Action 5.2 focused on increasing the financial attractiveness of forest conservation and restoration, modernizing the Payment for Environmental Services (PSA) program, and creating specialized funds to reach previously underserved groups.

i. Increasing Financial Attractiveness

To improve the competitiveness of the program compared to other land uses (such as cattle ranching or agriculture), the government significantly increased payment rates:

- CREF Payment Increase: The payment for Forest Emissions Reduction Agreements (CREF) was raised from an initial US$7 to US$18 per hectare per year. This adjustment was funded by US$38.8 million in results-based payments from the Green Climate Fund (GCF) and aimed to make the program more attractive to private landowners and indigenous territories.
- PSA 2020 Manual: FONAFIFO published an updated procedures manual in 2020 that modernized financial mechanisms, adjusted technical and legal procedures, and integrated new technological tools to improve management efficiency.

ii. Program Modernization (PSA 2.0)

A landmark reform known as PSA 2.0 was established via Decree N° 44607-MINAE in 2024:

- Scaling Up: The goal of PSA 2.0 is to increase the area under new contracts from 40,000 hectares annually to 182,000 hectares per year.
- Integrated Funding: This expansion is achieved by integrating national fuel tax and water fee revenues with international climate finance from the World Bank and the GCF.

iii. Specialized Modalities and Funds

Costa Rica developed new financial instruments to lower barriers to entry and diversify its impact:

- Mixed Systems Modality (2020): Designed for micro-producers on farms smaller than 15 hectares, this modality supports activities such as natural regeneration and agroforestry while reducing transaction costs for owners.
- Inclusive Sustainable Development Fund (FOINDES): Formally established in 2024, this fund uses 10% of the Emission Reduction Program's resources to finance small climate-positive enterprises, with a specific focus on supporting rural women.
- "Fonafifo a tu lado": A credit program launched in 2020 that offers specialized financing for women-led forestry activities with 10-year terms and a fixed 4% interest rate.

iv. Sector-Specific Competitiveness

The program worked to integrate forest sector goals into broader agricultural value chains:

- Deforestation-Free Coffee: In 2024, a pilot project with the coffee sector enabled the first export of verified deforestation-free coffee to Europe. This initiative provided technical guides for over 800 farming families to meet new international market requirements.

- Incentives for Mixed Land Use: Evaluation matrices for PSA were adjusted to provide additional points for women landowners and for projects located in cantons with a low Social Development Index, ensuring that financial benefits are distributed where they are most needed to prevent land-use change.

ACTION 6. Effectiveness of the organizational arrangements and involvement of partner agencies:
Progress in Action 6 during the 2018–2024 period focused on the officialization and operationalization of national monitoring platforms, the strengthening of the REDD+ governance structure, and the enhancement of feedback and grievance mechanisms.

i. Officialization and Consolidation of SIMOCUTE

A major milestone was the officialization of the National Monitoring System for Land Use, Land Use Cover, and Ecosystems (SIMOCUTE) in May 2021.

- Legal Framework: Established via Executive Decree No. 42886-MINAE-MAG-JP, the platform is managed by the Ministry of Environment and Energy (MINAE) in coordination with the Ministry of Agriculture and Livestock (MAG) and the Ministry of Justice and Peace (MJP).
- Implementation: The system transitioned from its design phase to full implementation, marked by the approval of its internal regulations and the establishment of specialized technical tables in January 2023 to harmonize methodologies and data dissemination.
- Role: SIMOCUTE serves as the official platform for institutional and sectoral integration, facilitating knowledge management and monitoring for the AFOLU sector (agriculture, forestry, and other land uses).

ii. Governance and Institutional Strengthening

The governance of the National REDD+ Strategy (EN-REDD+) was formalized and expanded to manage growing international commitments.

- REDD+ Secretariat: Led by FONAFIFO and SINAC, the Secretariat significantly increased its operational capacity to execute the REDD+ PBR Project (GCF) and the Emission Reduction Program (FCPF).
- Monitoring Committee: Tasked with ensuring compliance and social dialogue, this multi-stakeholder body was renewed and integrated in 2022. It meets at least twice annually for formal accountability sessions.
- Board of Directors: Composed of the directors of SINAC and FONAFIFO, along with the Vice Minister of Environment, the Board continued to provide political oversight and strategic direction.

iii. Strengthening the MIRI Mechanism

Significant progress was made in operationalizing the Information, Feedback, and Non-conformities Mechanism (MIRI) to ensure transparency and accountability.

- Capacity Building: In 2022, a dedicated plan was finalized to strengthen the Service Comptrollers of SINAC and FONAFIFO, which serve as the foundation for the MIRI.
- Financial Investment: Approximately $142,000 USD from the REDD+ PBR project was invested through 2024 to support this plan, including the hiring of specialized consultants to unifiy information management and reporting procedures.
- Operational Integration: Efforts focused on standardizing the resolution of inquiries and complaints from private landowners, indigenous territories, and the general public.

iv. Inter-Institutional and Partner Agency Involvement

The effectiveness of organizational arrangements was enhanced through collaborative projects with international partners.

- **MINAE, MAG and COMEX**: The Sustainable Landscape Initiative, developed by MINAE, MAG, and COMEX, strengthens coordination between environmental, agricultural, and trade authorities. It links forest conservation and land-use monitoring with agricultural competitiveness and market access, supporting deforestation-free and sustainable production.
- **GCF REDD+ results-based payments project:** complemented national financing by transferring approximately US$6.1 million to SINAC for forest fire management between 2021 and 2024 and by supporting additional investments in vehicles, personal protection equipment, tools, monitoring, safeguards, and institutional strengthening.

- **MAG and the Ministry of Justice and Peace:** contributed to the officialization of SIMOCUTE under Executive Decree No. 42886-MINAE-MAG-JP, enabling the integration of agriculture, forestry, land-use, land-cover, and ecosystem information for AFOLU-sector monitoring.
- **SIMOCUTE technical tables:** supported the harmonization of methodologies, validation of information flows, improvement of data management, and dissemination of land-use and ecosystem monitoring information following their establishment in 2023.
- **COVIRENA groups and local organizations:** strengthened field-level surveillance and reporting by supporting control and protection activities, participating in local monitoring, and using SITADA to report suspected illegal logging, forest fires, and unauthorized land-use change.
- **Indigenous territories and community stakeholders:** contributed through consultation, participation in benefit-sharing processes, local monitoring, and engagement in governance arrangements that helped align ER Program implementation with territorial priorities and safeguards requirements.
- **SINAC and FONAFIFO Service Comptrollers:** supported the operationalization of MIRI by standardizing the receipt, processing, and resolution of inquiries, complaints, and non-conformities from private landowners, indigenous territories, and the public.

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

Costa Rica considers the risk of displacement low and mitigates it through its national accounting framework, strengthened forest governance and enforcement, improved economic incentives for conservation and restoration, the inclusion of vulnerable groups in benefit-sharing, and national monitoring systems for shifts in land-use pressure.

Costa Rica's approach to mitigating potential displacement is based on the ER Program's national scale, a national accounting area, and measures that address the main drivers of deforestation and forest degradation nationwide. The national scope reduces the risk of land-use pressure transfer between areas within the accounting area, as consistent policy instruments, incentives, enforcement, and monitoring are applied at the country level. This is supported by monitoring results in Section 1.2, including Figure 1-1 and Table 1-1, which show sustained reductions in deforestation-related emissions relative to the Reference Period and continued net forest regeneration during the Monitoring Period.

The mitigation strategy integrates incentive-based instruments with regulatory, institutional, and territorial measures. FONAFIFO's PES and CREF mechanisms, including revised payment levels and expanded modalities for private landowners, indigenous territories, smallholders, women, and mixed production systems, enhance the competitiveness of forest conservation, restoration, natural regeneration, and agroforestry compared to alternative land uses. The CREF payment increased from US$7 to US$18 per hectare per year. PSA 2.0 aims to scale up new contracts from 40,000 hectares annually to 182,000 hectares annually, and 724,011 hectares of PES contracts were signed during 2012–2024 for protection, reforestation, regeneration, and forest management activities. These instruments diminish economic incentives for forest conversion while fostering sustainable land-use practices and enhanced removals.

In tandem with complementary control and enforcement measures, SINAC mitigates the risk of displacement by addressing forest fires, illegal logging, and unauthorized land-use change. These measures encompass enhancements to the Forest Fire Management Strategy and SATIF; the modernization of timber control and forest management systems through SICAF, SIPLAMA, and SITADA; field patrols; targeted control operations; timber traceability procedures; and the reactivation and training of COVIRENA groups for local surveillance and reporting. Notably, SINAC has trained 1,740 individuals through 79 fire-management courses (2021–2024), allocated US$6.1 million from the GCF REDD+ PBR project for fire management, conducted 35 overflights in 2022 that identified 406 environmental offenses, engaged in 15,019 control and protection activities (2020–2024), submitted 391 reports to the prosecutor's office, and accredited and trained 24 COVIRENA groups in SITADA reporting.

The ER Program minimizes displacement to other regions inside the jurisdiction through territorial planning, land-tenure regularization, and long-term forest protection. Strengthening Protected Wilderness Areas, biological corridors, State Natural Heritage lands, and management plans ensure forest cover permanence and clarifies institutional responsibilities and carbon rights. Officialization of 23 General Management Plans (2022–2024), completion of local management plans for 38 biological corridors (2024), and documentation of over 671,000

hectares of verified forest area in State Natural Heritage (2021) are supported by participatory governance, including the REDD+ Secretariat, Monitoring Committee, MIRI mechanism, and consultation with indigenous territories and local stakeholders.

Costa Rica's national MRV framework, including SIMOCUTE, the NFMS, periodic land-use and land-cover mapping, updated activity data, and institutional complaint and control systems, monitors potential displacement to other regions inside the jurisdiction. National-scale monitoring detects changes in deforestation, forest regeneration, degradation, and underlying drivers, enabling adaptive management for emerging land-use pressures. During the Reference Period, average annual deforestation emissions decreased from 7,269,407 tCO2e in 2012–2014 to 673,084 tCO2e in 2022–2024. Mature forest loss was 35,661 hectares between 2012 and 2024, while 198,686 hectares of forest were regenerated, mainly from pasture lands (see Table 1-1).

Effectiveness of the organizational arrangements and involvement of partner agencies

The organizational setup for the ER Program effectively supports governance, oversight, and coordination. Responsibilities are clearly assigned to MINAE, with FONAFIFO and SINAC as main implementers for forest financing, protected areas, fire management, illegal logging, land tenure, safeguards, benefit-sharing, and monitoring. The REDD+ Secretariat, Board, and Monitoring Committee facilitate decision-making, technical coordination, social dialogue, and tracking progress. This structure offers a solid foundation for accountability by connecting policy oversight to operational duties and documented reports.

Partner agencies' involvement supports the effective implementation arrangements. The formalization of SIMOCUTE via Executive Decree No. 42886-MINAE-MAG-JP established coordination among MINAE, MAG, and the Ministry of Justice and Peace for monitoring land use, ecosystems, and the AFOLU sector. Creating SIMOCUTE technical tables in 2023 added control points for harmonization, data management, validation, and dissemination. These arrangements improve data traceability and reliability for adaptive management and ER Program reporting, reducing risks by sharing responsibilities among institutions.

These organizational arrangements were further complemented by the Sustainable Landscape Initiative developed jointly by MINAE, MAG, and COMEX. The initiative strengthened coordination between environmental, agricultural, and trade authorities by linking forest conservation and land-use monitoring with agricultural competitiveness, traceability, due diligence, and access to international markets. Through this collaboration, MINAE contributed environmental policy, biodiversity, climate, and forest-monitoring functions; MAG connected the initiative with agricultural producers, production systems, and farm-level information; and COMEX helped align the initiative with trade policy and evolving market requirements for deforestation-free products. The initiative therefore complements SIMOCUTE and the ER Program by improving cross-sector information flows, supporting deforestation-free and sustainable production, and reducing the risk that agricultural expansion or market pressures undermine emission reduction results.

Partner agency contributions supported implementation through financing, technical assistance, field participation, and grievance functions. International climate finance, like the GCF REDD+ project, supplemented domestic resources and ensured continuity despite fiscal and COVID-19 challenges. Contributions from local groups, indigenous territories, COVIRENA, SINAC, FONAFIFO, and others improved surveillance, consultation, feedback, and grievance systems, including SITADA and MIRI. Overall, arrangements and partner involvement were effective in supporting the ER Program, with accountability and operational controls in place.

Financial plan implementation

Financial plan implementation remained consistent with the ER Program design. However, Annex 2 identifies two main implementation constraints: delays in financing the SINAC Strengthening Plan and operational adjustments required for CREF implementation. In both cases, Annex 3, section 2.5 shows that additional results-based climate finance helped address these constraints without requiring changes to the ER Program design.

For SINAC, the principal constraint was the timing and execution of funding for activities that depended on recurrent operational resources, procurement processes, specialized technical assistance, and coordination across conservation areas. As a result, actions related to forest fire management, illegal logging control, protected-area

management, land-tenure regularization, monitoring systems, COVIRENA support, SITADA reporting, equipment maintenance, and field operations progressed more slowly than expected.

Several measures were taken to accelerate implementation of the SINAC Strengthening Plan after these funding constraints were identified. The ER Program used a diversified financing mix—national resources, ER Program resources, and additional results-based climate finance—to maintain priority operations despite fiscal and COVID-19-related budget reductions. Annex 3, section 2.5 reports that GCF REDD+ results-based payments provided US$38.8 million in additional financing, complementing ER Program and domestic resources.

Part of this financing supported SINAC directly, including approximately US$6.1 million transferred between 2021 and 2024 for forest fire management and a further US$2.2 million for specialized equipment, vehicles, personal protection equipment, tools, monitoring, safeguards, and institutional strengthening across conservation areas. Implementation was further supported by prioritizing activities linked directly to ER Program results, improving coordination between FONAFIFO and SINAC, advancing procurement and contracting processes, and directing resources toward equipment, forest fire management, monitoring, safeguards, and institutional strengthening. These measures helped compensate for domestic budget limitations and allowed SINAC to continue priority actions, although some operational activities, such as overflights, remained affected by budget availability in 2023–2024.

Annex 2 also identifies implementation issues associated with CREF funding. Although the CREF payment increased from US$7 to US$18 per hectare per year to improve the competitiveness of forest conservation and restoration, implementation still required operational adjustments to ensure that the mechanism could reach eligible beneficiaries and remain aligned with ER Program objectives. These adjustments included updating procedures, coordinating financing sources, aligning CREF with PSA modernization and benefit-sharing arrangements, and addressing transaction and administrative requirements for private landowners, indigenous territories, smallholders, and other participants.

Corrective actions for CREF included using the additional GCF results-based finance identified in Annex 3, section 2.5 to support the higher incentive level. These resources made CREF more competitive with alternative land uses and helped expand incentives for private landowners, indigenous territories, smallholders, women, and mixed production systems. Additional financing also supported PSA modernization, including the updated 2020 PSA procedures manual and the establishment of PSA 2.0 through Decree No. 44607-MINAE in 2024, which aims to scale up new contracts from 40,000 hectares annually to 182,000 hectares annually by combining domestic revenues from the fuel tax and water fee with international climate finance from the World Bank and GCF.

Complementary instruments reinforced this approach. FOINDES was established in 2024 using 10% of ER Program resources to finance inclusive climate-positive initiatives, while the “Fonafifo a tu lado” credit line, launched in 2020, supported women-led forestry activities with 10-year terms and a fixed 4% interest rate. Overall, the issues identified in Annex 2 did not require changes to the ER Program design. Instead, Annex 3, section 2.5 shows that additional financing was critical to accelerating implementation, strengthening CREF and PSA incentives, supporting SINAC operations, and improving the competitiveness of conservation, restoration, natural regeneration, agroforestry, and sustainable forest management compared with alternative land uses.

1.2 Update on major drivers and lessons learned

Costa Rica decoupled agricultural production from deforestation by implementing robust legal frameworks, innovative agricultural and environmental policies, and Payment for Environmental Services schemes (REDD+ financial mechanisms), which together drove agricultural and livestock intensification and the growing development of Ecotourism. AFOLU emissions have decreased from 14.1 in 1998 to 0.9 million tCO2-e yr-1 in 2021 (see Figure 1-1).

- ***The Investment in REDD financial mechanisms promoted forest use over marginal agriculture***. By addressing drivers of forest loss, Costa Rica has demonstrated that emissions can be reduced effectively, as planned in the ER Program. During 2012-2024, the government of Costa Rica signed 724,011 ha[3] of PES

[3] PES Contracts by Project Size https://www.fonafifo.go.cr/es/servicios/estadisticas-de-psa/

contracts with private forest owners under the activities of Protection, Reforestation, Regeneration, and Forest Management. Deforestation in Costa Rica has historically been driven by **the undervaluation of ecosystem services,** which incentivizes converting forest land to agriculture and pasture. The **lack of property rights** prevented small landowners and indigenous people from participating in existing payment for environmental services (PES) programs[4]. No new deforestation drivers have been identified beyond those listed in ER-PD. Deforestation drivers are also being addressed through the recently released (2020) Benefit Sharing Plan in the National REDD+ Strategy[5]. Costa Rica has established, expanded, and improved the financial mechanisms to strengthen natural reforestation and foster forest management. Costa Rica expanded the PES scheme to include indigenous territories, allowing indigenous peoples to influence and benefit from REDD+ activities in the country. These activities do not pose a risk of leakage, as they improve financial incentives for all landowners. Stakeholders in these lands were part of a consultative process that led to the implementation of a comprehensive government plan on socioeconomic and environmental safeguards[6] and benefit-sharing mechanisms[7].

- ***The Intensification of agriculture and livestock*** production helped produce a positive balance between mature forest loss and forest regeneration, improving the agriculture sector's value added and exports (see Figure 1-1). Between 2012 and 2024, the loss of mature forest was 35,661 hectares (77% of permanent cropland), while 77,675 hectares of forest were regenerated, mainly from permanent cropland (31%)[8].
- ***Ecotourism facilitated the Internalization of the benefits of biodiversity conservation*.** Ecotourism in Costa Rica has become an effective forest conservation strategy. Explicit conservation mechanisms, local economic benefits, and strict monitoring and enforcement of environmental regulations have accompanied ecotourism[9].

Regarding degradation, it is necessary to implement adjustments to reduce its emissions. Emissions due to forest degradation increased during THE monitoring periods (see Table 1-1). Forest degradation from illegal logging has been addressed since 2002. MINAE established strategies to control illegal logging and grant wood harvesting permits in agricultural lands, shifting the sources of Costa Rica's wood supply entirely. It is estimated that 49% of wood products come from forest plantations, 34% are imported, 12% are from agricultural lands, and 5% are from natural forests[10]. Costa Rica is addressing degradation through the financing mechanisms of PES and sustainable timber production initiatives. No other degradation drivers have been identified.

[4] Plan de Implementación de la Estrategia Nacional REDD+ Costa Rica. Secretaria Ejecutiva REDD+ Costa Rica. 2017. Available at https://reddcr.go.cr/publicacion/plan-de-implementacion-de-la-estrategia-nacional-redd-costa-rica/

[5] Benefit Sharing Plan, National REDD+ Strategy. June 2020. Ministry of Environment and Energy (MINAE), Costa Rica. Retrieved from http://documents1.worldbank.org/curated/en/785151594625278269/pdf/Benefit-Sharing-Plan.pdf

[6] First Safeguards repot is accessible at https://reddcr.go.cr/publicacion/primer-informe-sobre-abordaje-y-respeto-de-las-salvaguardas-de-cancun-en-la-estrategia-nacional-redd/

[7] ibid 5.

[8] Forest transition cross tabulation is included in the worksheet "Forest Transition" of the Reference Period excel file, accessible at the following link: https://docs.google.com/spreadsheets/d/1nwgFFeN5qWZ8sZhxF2XFvvqOuQZO7BeY/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[9] Brandt, J. S., & Buckley, R. C. (2018). A global systematic review of empirical evidence of ecotourism impacts on forests in biodiversity hotspots. *Current Opinion in Environmental Sustainability*, *32*, 112–118. https://doi.org/10.1016/j.cosust.2018.04.004

[10] Santamaria et al. 2015. Mercado de la madera y derivados en Costa Rica. 216pp. https://onfcr.org/wp-content/uploads/media/uploads/documents/mercado-de-la-madera-y-derivados-en-cr-final.pdf

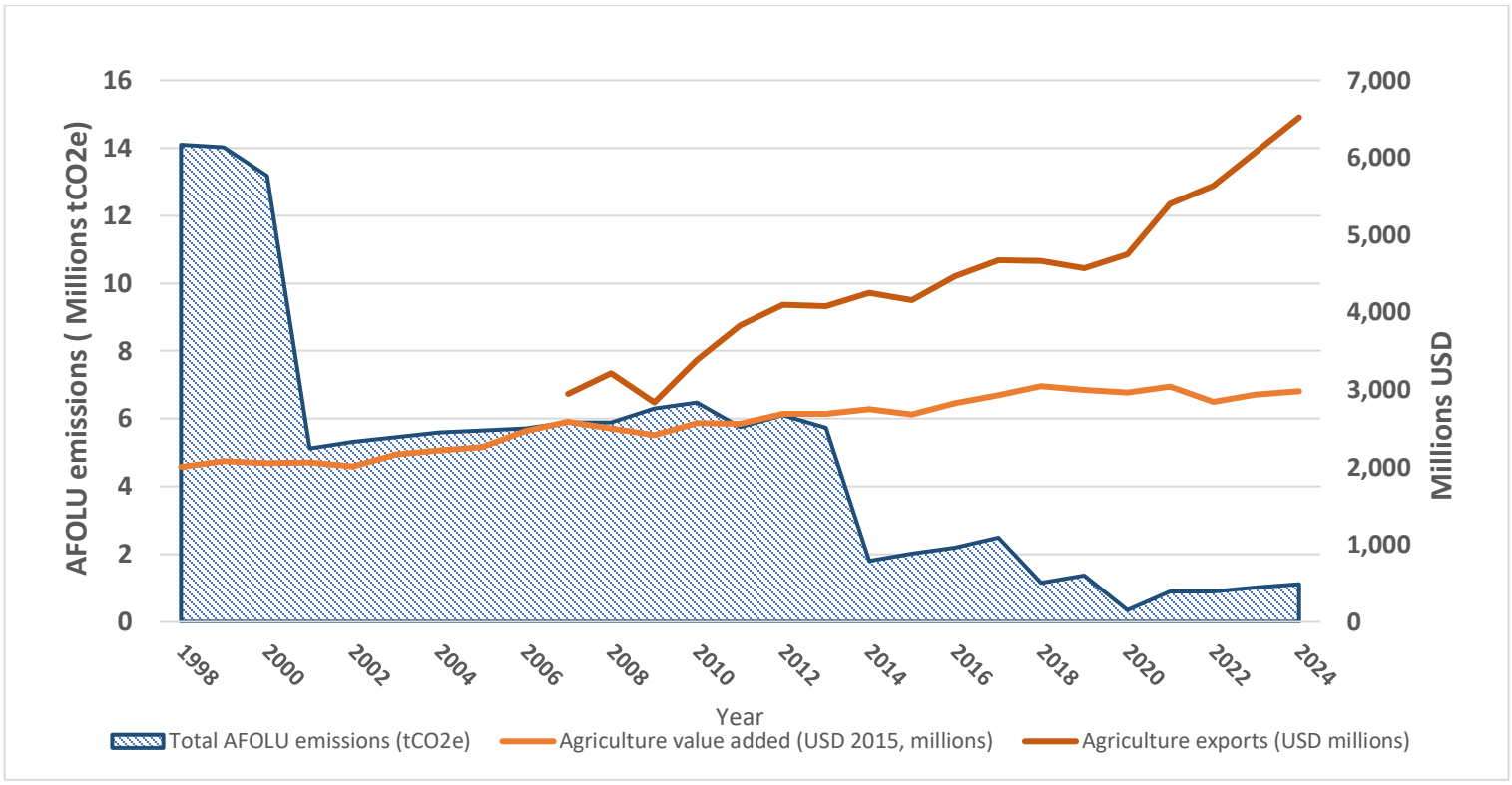

Figure 1-1*:* AFOLU emissions are decreasing while the agricultural sector's value-added and exports during 2012-2024 increased, showing that Costa Rica decouples deforestation from commodities production. Sources: World Bank (https://datos.bancomundial.org/indicador/NV.AGR.TOTL.KD), COMEX (https://www.comex.go.cr/estadísticas-y-estudios/comercio-bienes/exportaciones/), UNFCCC (Agriculture - Costa Rica. 2024 Common Reporting Table (CRT) - https://unfccc.int/documents/650148) and the National Forest Monitoring System.

Table 1-1: Comparison of the emissions in the reference period (1998-2011) and the ERPA monitoring periods 2018-2019, 2020-2021 and 2022-2024.

Period	Average emissions from deforestation, tCO_2e*yr^{-1}	Average removals from reforestation (Secondary forests), tCO_2e*yr^{-1}	Average emissions from degradation, tCO_2e*yr^{-1}	Average emissions from enhancements (forest remaining forests), tCO_2e*yr^{-1}	Net forest land cover change emissions, tCO_2e*yr^{-1}	Net forest remaining forests emissions, tCO_2e*yr^{-1}	Total net emissions, tCO_2e*yr^{-1}
Reference period (1998-2011)	7,269,407	-4,067,278	1,363,824	-413,971	3,202,129	949,853	4,151,982
Monitoring period 2018-2019	995,653	-5,363,786	2,538,390	-408,797	-4,368,134	2,129,593	-2,238,541
Monitoring period 2020-2021	575,977	-4,972,188	2,077,173	-403,674	-4,396,211	1,673,499	-2,722,712
Monitoring period 2022-2024	673,084	-4,723,299	2,077,173	-403,674	-4,050,215	1,673,499	-2,376,716

Note: Costa Rica revised its total forest emissions after identifying errors in its ER Program calculation tools, including incorrect carbon stock data and revised activity data due to cloud cover. These errors caused a 60.57% increase in the Reference Level and a 30.44% increase in Emission Reductions, exceeding the 1% error threshold. Further details on this revision can be found in Section 1.3, Methodological Deviations. For further details, check Section 1.3.

1.3 Methodological deviations

Under Criterion 10 (Indicator 10.1) and Criterion 22 of the Methodological Framework, the Participant may propose methodological deviations to correct material errors in the estimation of the validated Reference Level and verified Emission Reductions. Accordingly, the Costa Rica ER Program has identified a material error in both the validated Reference Level and verified Emission Reductions, which must be corrected due to:

- **Revision of Carbon Stock values**: Carbon stock data for various land uses in Costa Rica were not correctly compiled or standardized to a 0.47 carbon fraction. Updates were necessary to the carbon stocks database to ensure literature data were correctly assigned and standardized to the 0.47 carbon fraction, including adjustments to values from Andrade et al. (2008), Somarriba et al. (2013), Nájera-Gómez (2011), and SINAC's NFI biomass data. These revisions resulted in changes to total biomass values, particularly for primary forests, and improved the traceability of the calculation methodology. Table 1-5 shows the original and revised carbon stock values by land use, used to calculate emissions from deforestation in the Costa Rica Emission Reduction Program.

Table 1-2. Original and revised carbon stock values by land use, used to calculate emissions from deforestation in the Costa Rica Emission Reduction Program.

Land use	AGB tCO2*ha-1-Original	AGB tCO2*ha-1-Revised	BGB tCO2*ha-1-Original	BGB tCO2*ha-1-Revised	DW tCO2*ha-1-Original	DW tCO2*ha-1-Revised	L tCO2*ha-1-Original	L tCO2*ha-1-Revised	Total Biomass-Original	Total Biomass-Revised
Wet and rain-Primary Forest	313.69	459.42	71.97	102.45	49.50	49.50	10.05	10.05	445.21	621.43
Wet and rain-Secondary Forest (400 yrs)	480.82	459.15	106.86	102.40	52.18	58.23	4.96	5.12	644.82	624.90
Moist-Primary Forest	203.99	312.14	48.32	71.64	48.27	48.27	8.01	8.01	308.59	440.05
Moist-Secondary Forest (400 yrs)	339.71	312.14	77.48	71.64	39.25	48.34	6.56	7.14	462.99	439.26
Dry-Primary Forest	199.19	227.37	47.27	53.43	56.47	56.47	22.73	22.73	325.66	360.00
Dry-Secondary Forest (400 yrs)	225.58	227.37	53.04	53.43	27.06	27.27	21.79	21.96	327.46	330.03
Mangroves-Primary Forest	253.74	270.02	59.14	62.64	6.95	6.95	0.97	0.97	320.80	340.59
Mangroves-Secondary Forest (400 yrs)	253.74	270.02	59.14	62.64	6.49	6.85	0.68	0.73	320.05	340.24
Palm-Primary Forest	229.81	213.06	53.96	50.31	5.97	5.97	0.96	0.96	290.69	270.30
Palm-Secondary Forest (400 yrs)	229.81	213.06	53.96	50.31	7.23	5.97	1.17	0.96	292.16	270.30
Cropland-Annual	83.57	83.57	21.16	21.16	-	-	-	-	104.72	104.72
Cropland -Permanent (400 yrs)	83.84	83.79	22.23	22.22	1.22	1.20	7.59	7.59	114.89	114.80
Grassland	42.71	44.54	11.92	12.38	8.28	8.28	-	-	62.92	65.21
Settlements	-	-	-	-	-	-	-	-	-	-
Wetlands-Natural	-	-	-	-	-	-	-	-	-	-
Wetlands-Artificial	-	-	-	-	-	-	-	-	-	-
Paramo	126.87	126.87	31.13	31.13	-	-	-	-	158.00	158.00
Bare soil-Natural	-	-	-	-	-	-	-	-	-	-
Bare soil-Artificial	-	-	-	-	-	-	-	-	-	-

Revised FREL Tool: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
Original FREL Tool: https://docs.google.com/spreadsheets/d/1HQzfM2qSoHu2KECgw_dwI2WdaZT269Gx/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

- **Revision of the annualization of activity data for the REDD+ time series**: Costa Rica has revised the annualization of activity data due to cloud cover that affected the Landsat sampling windows used to prepare the land-use maps. The revision involved adjusting monitoring periods to the midpoint of the spectral sampling window and interpolating data for years in which the midpoint did not align with the calendar year. This resulted in minor variations in secondary forest areas and more substantial discrepancies in deforested areas, thereby impacting emissions calculations. Initially, the spectral sampling window was defined as a 12-month Landsat acquisition period from June of year 1 to June of the following year, assuming its midpoint corresponds to January 1st of the target calendar year. However, the actual midpoints of the spectral sampling windows for land-use maps of 1991, 1987, 2000, 2007, 2010, 2021, and 2024 do not correspond to January 1st of the target calendar year (see Table 1-8). The corrected annualization uses the actual midpoint of the spectral sampling window for each map and aligns the resulting activity data with the corresponding calendar year through interpolation where the midpoint does not coincide with 1 January. This correction addresses an error in the temporal assignment and annualization of activity data, rather than a change in the underlying monitoring methodology. The same remote-sensing data source, LULC mapping approach, REDD+ time series, carbon pools, activities, and accounting framework continue to be applied; only the timing of how the already generated activity data are attributed to reporting years has been corrected to ensure temporal consistency between the Landsat mosaics and the annual emissions calculations. Table 1-3 presents the original and revised annual secondary forest and deforested areas derived from Costa Rica's REDD+ land use change maps, using spectral sampling midpoints determined by satellite image dates.

Table 1-3: Original and revised annual secondary forest and deforested areas, from the land use change matrices of Costa Rica's REDD+ time series, based on the spectral sampling mid-points determined by satellite image acquisition dates.

Year	Secondary Forest – Revised (A) - Ha	Secondary Forest – Original (B) - Ha	Difference % = (B/A)-1	Annual Deforestation -Revised (C) - Ha	Annual Deforestation -Original (D) - Ha	Difference % = (D/C)-1
1992	575,507.27	576,120.09	0.1%	30,723.78	29,016.90	-5.6%
1993	590,254.59	590,048.11	0.0%	30,723.78	29,016.90	-5.6%
1994	605,001.91	603,976.14	-0.2%	30,723.78	29,016.90	-5.6%
1995	619,749.23	617,904.16	-0.3%	30,723.78	29,016.90	-5.6%
1996	634,496.55	631,832.19	-0.4%	30,723.78	29,016.90	-5.6%
1997	643,804.60	645,760.21	0.3%	38,628.85	29,016.90	-24.9%
1998	646,021.17	643,345.05	-0.4%	49,695.96	55,217.73	11.1%
1999	665,749.04	665,264.91	-0.1%	49,695.96	55,217.73	11.1%
2000	686,399.92	687,184.77	0.1%	47,427.20	55,217.73	16.4%
2001	722,856.72	722,082.37	-0.1%	22,470.90	23,808.46	6.0%
2002	727,512.35	727,015.11	-0.1%	22,470.90	23,808.46	6.0%
2003	732,167.97	731,947.86	0.0%	22,470.90	23,808.46	6.0%
2004	736,823.60	736,880.61	0.0%	22,470.90	23,808.46	6.0%
2005	741,479.22	741,813.35	0.0%	22,470.90	23,808.46	6.0%
2006	746,134.85	746,746.10	0.1%	22,470.90	23,808.46	6.0%
2007	750,790.47	751,678.84	0.1%	22,470.90	23,808.46	6.0%
2008	749,213.28	752,743.57	0.5%	28,774.05	25,729.25	-10.6%

Year	Secondary Forest – Revised (A) - Ha	Secondary Forest – Original (B) - Ha	Difference % = (B/A)-1	Annual Deforestation -Revised (C) - Ha	Annual Deforestation -Original (D) - Ha	Difference % = (D/C)-1
2009	758,043.85	766,168.96	1.1%	30,875.09	25,729.25	-16.7%
2010	774,154.32	779,594.35	0.7%	30,875.09	25,729.25	-16.7%
2011	790,264.79	793,019.74	0.3%	29,977.77	25,729.25	-14.2%
2012	802,647.77	798,179.26	-0.6%	28,721.52	34,705.17	20.8%
2013	841,704.37	845,372.65	0.4%	28,721.52	34,705.17	20.8%
2014	908,094.37	908,094.37	0.0%	14,665.07	14,665.07	0.0%
2015	914,247.74	914,247.74	0.0%	14,665.07	14,665.07	0.0%
2016	926,089.64	926,089.64	0.0%	8,873.53	8,873.53	0.0%
2017	925,261.94	925,261.94	0.0%	8,873.53	8,873.53	0.0%
2018	924,520.95	924,520.95	0.0%	6,405.05	6,405.05	0.0%
2019	922,024.21	922,024.21	0.0%	6,405.05	6,405.05	0.0%
2020	918,976.79	918,762.85	0.0%	5,563.50	5,795.32	4.2%
2021	916,677.76	916,368.03	0.0%	5,563.50	5,795.32	4.2%
2022	914,510.37	914,672.59	0.0%	5,294.19	5,123.32	-3.2%
2023	918,251.53	919,063.12	0.1%	5,269.70	5,123.32	-2.8%
2024	922,767.51	923,453.66	0.1%	5,269.70	5,123.32	-2.8%

Note: Years marked in red indicate where the interpolation process was applied during the annualization of activity data.

- **Revision of reference data and emission factors used to estimate emissions from degradation and removals during canopy cover recovery:** Canopy cover and aboveground biomass ratios (RC) were estimated for Palm, Dry Forest, Wet Forest, and Rainforest types using data from 100 temporal plots. Discrepancies in canopy cover data across 10 plots were corrected (5648, 23477, 24003, 1557, 6375, 21587, 21766, 16749, 17599, 17646), resulting in the recalculation of degradation emission factors. While the corrected values fall within the confidence limits of the original factors, updated emissions are now available. Table 1-4 shows the original and corrected values of degradation emission factors.

Table 1-4.Original and corrected values of Degradation emission factors

Forest type	Original Degradation Emission Factor	Confidence Interval	Lower Limit	Upper limit	Corrected Degradation Emission Factor
Palm	4.26	1.59	2.67	5.85	3.85
Dry Forest	3.47	1.98	1.49	5.45	3.00
Wet and Rain Forest	5.03	0.81	4.22	5.84	4.94

Table 1-5 presents a comparison of the validated and revised Reference Levels, with the revised values recalculated using updated tools and parameters. In the revised Reference Level, average deforestation-related emissions and

carbon enhancement in remaining forests increased by 21.44% and 0.5%, respectively. In contrast, average emissions from degradation and average removals from natural regeneration decreased by 1.46% and 6.97%, respectively. Overall, the validated Reference Level increased from 2,585,717 tCO_2 to 4,151,982 tCO_2 (a 60.57% rise), mainly due to updated carbon stock estimates for wet, rain, and moist primary forests.

Table 1-6 compares the verified and revised net emissions for the Costa Rica ER Program for the 2018–2019 and 2020–2021 reporting periods. In the revised totals, deforestation-related emissions increased by 12.34%, while average emissions from degradation and average removals from natural regeneration decreased by 13.37% and 4.36%, respectively. Overall, verified net emissions decreased from -9,996,108 tCO_2 to -9,922,505 tCO_2 (a 0.74% change).

Finally, Table 1-7 presents a comparison of original emission reductions under Costa Rica's ER Program for the 2018–2019 and 2020–2021 reporting periods. Over this interval, total ERs rose by 30.44%, from 20,339,056 tCO_2 to 26,530,433 tCO_2.

Since the difference between revised and original ERs (30.44%) exceeded the material error threshold of 1%, the Participant is submitting a methodological deviation to correct the inaccuracies in the validated Reference Level and verified Emission Reductions[11].

Table 1-5: Revised and validated Reference Levels for the Costa Rica ER Program

	FREL - Revised	FRL - Original	% Change
Average annual historical Emissions from deforestation over the Reference Period ($tCO_{2\text{-}e}$/yr)	7,269,408	5,985,795	21.44%
If applicable, average annual historical Emissions from forest degradation over the Reference Period ($tCO_{2\text{-}e}$/yr)	1,363,825	1,383,974	-1.46%
If applicable, average annual historical enhanced Removals from afforestation/reforestation (AR) ($tCO_{2\text{-}e}$/yr)	-4,067,279	-4,372,155	-6.97%
If applicable, average annual historical enhanced Removals from other activities besides A/R ($tCO_{2\text{-}e}$/yr)	-413,972	-411,896	0.50%
Adjustment, if applicable ($tCO_{2\text{-}e}$/yr)	NA	NA	NA
Reference Level (tCO2-e/yr)	4,151,982	2,585,717	60.57%

[11] Previous and updated calculation tools can be accessed at the following links:
Previous tool – degradation:
https://docs.google.com/spreadsheets/d/1X4TrUOLufRXHfzngdbmY7PwJxg3EDhGp/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
Previous tool – deforestation:
https://docs.google.com/spreadsheets/d/1HQzfM2qSoHu2KECgw_dwI2WdaZT269Gx/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
Update tool – degradation:
https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
Update tool – deforestation: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Table 1-6: Revised and original total net emissions for the Costa Rica ER Program during the 2018–2019 and 2020–2021 reporting periods

	Reporting Years 2018-2019			Reporting Years 2020-2021			Total 2018-2021		
	Revised	Original	% Change	Revised	Original	% Change	Revised	Original	% Change
Emissions from deforestation (tCO2-e/yr)	1,991,305	1,680,333	18.51%	1,151,954	1,117,653	3.07%	3,143,259	2,797,986	12.34%
If applicable, Emissions from forest degradation (tCO2-e/yr)	5,076,780	5,126,484	-0.97%	4,154,346	5,529,642	-24.87%	9,231,126	10,656,126	-13.37%
If applicable, enhanced Removals from afforestation/reforestation (AR) (tCO2-e/yr)	-10,727,572	-11,214,734	-4.34%	-9,944,376	-10,399,530	-4.38%	-20,671,948	-21,614,264	-4.36%
If applicable, enhanced Removals from other activities besides A/R (tCO2-e/yr)	-817,594	-817,594	0.00%	-807,348	-1,018,442	-20.73%	-1,624,942	-1,836,036	-11.50%
Net Emissions and Removals (tCO2-e/yr)	**-4,477,081**	**-5,225,511**	**-14.32%**	**-5,445,424**	**-4,770,677**	**14.14%**	**-9,922,505**	**-9,996,188**	**-0.74%**

Note: revised and original total net emissions are provided only for the previous reporting periods: 2018-2019 and 2020-2021. Net emissions for the third reporting period were calculated exclusively using the revised activity data and emission factor; consequently, this period is not included in the comparison table.

Table 1-7: Revised and verified Emission Reductions for the Costa Rica ER Program during the 2018–2019 and 2020–2021 reporting periods

Emission Reductions during the Reporting period (tCO_2-e)	Revised ERs	Original ERs	Difference (Revised-Original)	% Change
2018	6,487,597	5,300,209	1,187,388	22.40%
2019	6,293,448	5,096,736	1,196,712	23.48%
2020	6,970,165	5,071,590	1,898,575	37.44%
2021	6,779,223	4,870,521	1,908,702	39.19%
Total ERs	**26,530,433**	**20,339,056**	**6,191,377**	**30.44%**

***Notes**:*

i. The values of the Revised and Original ERs are before discounts.

ii. Please note that values in Original ERs differ from the figures reported in the first and second ER-MR. The difference is due to a calculation error identified during the preparation of the Second Monitoring Report (ER-MR) for Costa Rica. This stemmed from human error during the import of canopy cover data from Collect Earth Desktop (CED) files into the Excel-based "Degradation Tool". The problem, detailed in Table 7 of Section 3.1 of the Second ER-MR, involved incorrectly entering Plot number 7948—an extra plot not part of the original 4,377—while omitting Plot 14764, which was successfully collected in CED. This caused a shift in the order of plots across databases during subsequent monitoring periods. The remedial measure agreed with the FMT was to keep the number of ERs obtained in the first Monitoring Report (Value A in the table of section 8 of the First Monitoring Report) and adjust the ER estimate for the second MR to match the corrected accumulated ERs for 2018-2021, as follows

- ***First Monitoring Period (2018–2019)**: The reported emission reductions, including the material error, were originally calculated at 10,486,289 tCO2e. The corrected value was determined to be 10,396,947 tCO2e, which matches the sum of 5,300,209 + 5,096,736 = 10,396,945 in the Original ERs column. Note that a small difference of 2 tCO2 is due to rounding.*
- ***Second Monitoring Period (2020–2021)**: The value of ERs reported in Table 8 of the Second ER-MR was 9,852,768 tCO2e, used to deduce the ERs in excess reported in the First ER-MR. The unadjusted reported emission reductions for the second period were 9,942,111 tCO2e, which corresponds to the sum of 5,071,590 and 4,870,521 tCO2e.*

Updates to the Costa Rica Emission Reduction calculation:

The activity data, emission factors, and calculation tools used to report the Carbon Fund's performance of the Costa Rica ER Program during the crediting period 2018-2024 were also used to report under the TREES standard for the same crediting period 2017-2021. The activity data, emission factors, and calculations were reviewed during the validation and verification of the emission reductions monitoring reports (ERMR) for the Carbon Fund and were submitted to the auditors for an additional assessment during the validation and verification of the TREES standard. The following changes to the calculation process resulted from the multiple assessments:

I. Revision of carbon stocks:

Carbon stocks for relevant land uses were compiled from published data and the National Forest Inventory. All estimates were converted to tons of carbon per hectare (tC ha-1), applying the IPCC's default carbon fraction of 0.47 when the original values were reported in tons of dry matter (t d.m. ha-1). This compilation also includes details on the C stock estimates, including land-use type, the number of sampling units, plot sizes, the allometric equations used, and other relevant information. were also recorded. For full details, please check BaseDeDatos_v5[12] and the C-STOCKS sheet of the FREL TOOL[13]. The literature review employed the following criteria for compiling the reported values: The publication reported data from direct measurements carried out in Costa Rica; measurements were

[12] BaseDeDatos_v5(18.02.2025).xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/14xIYQbtETN0x_kpI3Qci8OVGiIRsWKV7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[13] The updated FREL Tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

carried out after the year 2005; data were sufficiently disaggregated by reporting values of carbon stocks per land use categories and per carbon pool sampled, and the publications included information on uncertainties related to the carbon stock estimates.

Each carbon stock value was verified against its published source to confirm the correct value for each land use, and all data were standardized to a carbon fraction of 0.47. The C-STOCK Word file document[14] summarizing the revision of published carbon stock values included in the dataset was prepared. This document compiles carbon stock values for estimating emission factors in Costa Rica, focusing on above-ground biomass, dead wood, and litter in forest and non-forest land uses. It aims to support transparency and consistency in carbon stock values, providing a documented basis for reviewing and updating emission factor estimates.

The revision process led to the following updates to the carbon stocks database:

- The value of 3.0 tC/ha for non-tree aboveground biomass carbon stocks in grasslands was not reported in Andrade et al. (2008)b. It may have been erroneously assigned in the emission factor database. Therefore, this value was excluded from the average calculated in cell N430, which derives from values in cells G430:G434 in the '3.DensidadesCarbono' worksheet of BaseDeDatos_V5 (18.02.2025). Updated value for non-tree aboveground biomass carbon stocks in grasslands is *3.81 t C/ha*.
- To ensure consistency in carbon accounting, Somarriba et al. (2013) values have been adjusted to a carbon fraction of 0.47. The values from Somarriba et al. (2013) have been adjusted to a carbon fraction of 0.47 by multiplying them by 0.47/0.5. This adjustment is recorded in the "2.BaseDeDatos" worksheet of the BaseDeDatos_V5 (18.02.2025) Excel file, in cells AH415:AH419.
- Nájera-Gómez (2011) reports on accumulated carbon in above-ground biomass in pasture lands in section 5.2. Table 17 on page 62 provides individual values from 14 locations. The average carbon remaining after cattle consume grass is included in the 'BaseDeDatos' worksheet of the BaseDeDatos_V5 (18.02.2025) Excel file. Since AGB measurements account for grass consumption, this reference value has been reassigned to above-ground biomass in non-trees (BNAA/AGB.n) in the "2.BaseDeDatos" worksheet, in cell AH399. Consequently, the average values for BARA/AGB.t and BNAA/AGB.n were recalculated.
- In the NFI calculation, a carbon fraction of 0.5 was initially used. However, carbon stock values were recalculated using a 0.47 carbon fraction (see column 'Recalculated Carbono (ton/ha) '[arb>2 cm] in NFI correspondence file.xlsx [15]). The updated carbon stocks by cover type are reflected in the revised version of the "Winrock analysis" ("BD_EstimacionIFNCostaRica_CoordXY_Feb18-2025"[16]). The average values can be found in the "Pivot table" worksheet, rows 13-21. It is crucial to note that these values are derived directly from the tree-list file using a carbon fraction of 0.47. Consequently, carbon stocks have been updated in the Costa Rica database (BaseDeDatos_V5 (18.02.2025), worksheet "2.BaseDeDatos," cells AH363..AI367 [1]).

Updates to the carbon stock database are reflected in the "C-STOCKS" worksheet of FREL TOOL version 6. C-STOCKS worksheet is linked to the Parameters Table ("4.Tabla de Parametros") of the updated carbon stocks database. An Excel file comparing the C-STOCKS worksheets from the previous (FREL TOOL version 4) and updated (FREL TOOL version 6) versions was prepared to facilitate identification of values affected by the revision of the carbon stock database. In the C-STOCKS V6 Review worksheet of the comparison Excel file, cells highlighted in yellow with red text indicate values recalculated based on the updated carbon stock revision listed under "Parameters and assumptions" in that worksheet.

[14] The C-STOCK Word file document can be accessed at the following link https://docs.google.com/document/d/1ORrAy2L65phuzwPnyc7JVt_jmh_wAfZ7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[15] The correspondence file "NFI_correspondence_file.xlsx can be accessed at the following link https://docs.google.com/spreadsheets/d/1SNKOWM5QUCTLmzO2hDGNRadDQsoIhAXh/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[16] "Winrock analysis" file "BD_EstimacionIFNCostaRica_CoordXY_Feb18-2025" can be accessed at the following link https://docs.google.com/spreadsheets/d/1Uwx8yyS5f2LelNfkaRIRgfWvDEeYl9-s/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Table 1-2 presents the original and revised carbon stock by land use and carbon pool used to calculate deforestation-related emissions in the Costa Rica Emission Reduction Program. Figure 1 compares total biomass across land uses. As a result of this revision, total biomass values changed by −7% to 6%, except for Wet and Rain Primary Forest (40%), Moist Primary Forest (43%), and Dry Primary Forest (11%). This process has strengthened the traceability of the calculation methodology for natural forest carbon stocks, enabling tracking from the individual-tree level[17] to per-hectare biomass for each forest type within the National Forest Inventory.

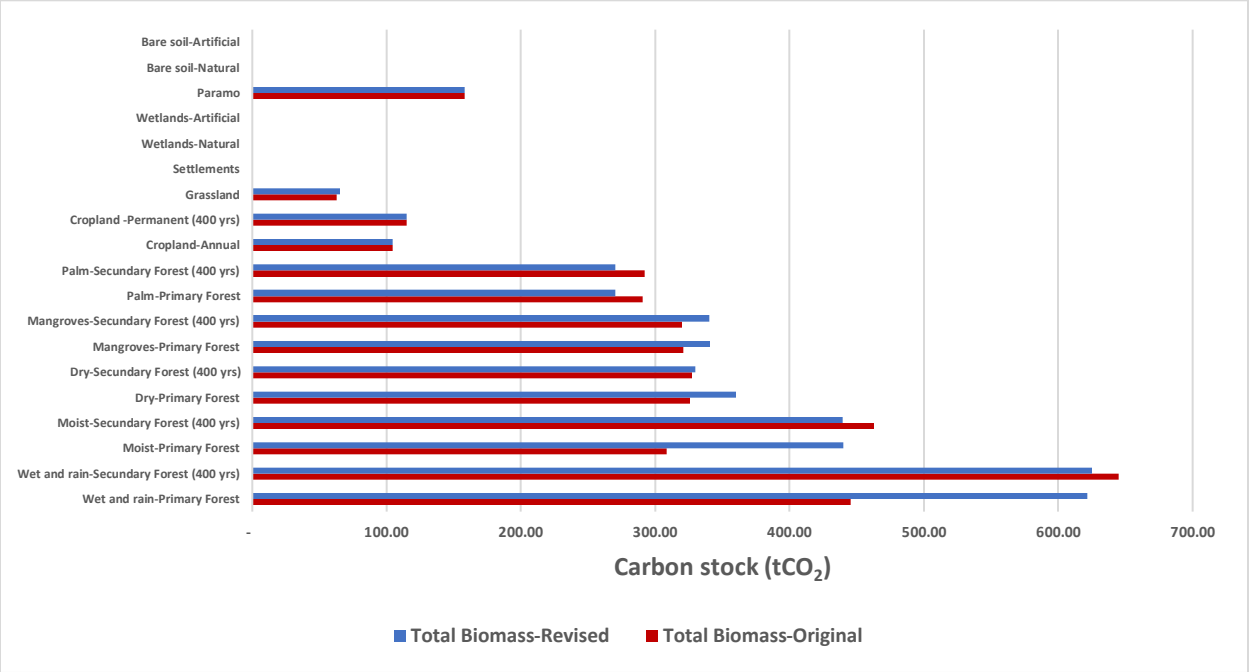

Figure 1-2: Comparison of original and revised total biomass for each land use included in the emissions calculation in the Costa Rica Emission Reduction Program

II. Revision of the annualization of activity data of the REDD+ time series.

While a completely cloud-free period is rare in a tropical country as ecologically diverse as Costa Rica, creating a LULC map for a specific year based on remote sensing imagery requires mosaicking the available cloud-free images from that period. It is essential to clarify that using Landsat mosaics spanning calendar years is acceptable and supported by other REDD+ jurisdictional standards, peer-reviewed studies, and international guidelines.

Costa Rica selected Landsat imagery to develop land-use and land-cover (LULC) maps due to the availability of images from the historic reference period of the ER-Program. A primary challenge in using remote sensing imagery in Costa Rica is the frequent cloud cover. This persistent cloud cover results from Costa Rica's geographic position between the Caribbean and Pacific Oceans, which provides moisture, and its mountainous terrain, which induces orographic lift. Additionally, the Intertropical Convergence Zone (ITCZ) and convection significantly contribute to cloud formation, leading to diverse microclimates and influencing the country's ecosystems (https://www.noaa.gov/jetstream/tropical/convergence-zone). The sunniest and least cloudy period in Costa Rica is during the dry season. It's essential to note that this dry-season pattern is not uniform across the entire country. The Pacific Coast experiences the most intense and prolonged dry season. The dry season in the Central Valley of Costa

[17] NFI Tree-level datasets can be accessed at the following links:
base datos final a 2015-ifn corregida Julio2023Jfallas.xlsx
https://docs.google.com/spreadsheets/d/1wReh79Y1Hp0g4IMbv-EqEtF13AEQ5YxV/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
base_de_datos_final_inventario_na cional_forestal_AbnerJiménez_table_treelevel.xlsx
https://docs.google.com/spreadsheets/d/1B5QRAogzXreymWz4Hp4L7SMu34uJFiS-/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Rica generally runs from December to the end of April. The Caribbean Coast (Tortuguero, Puerto Viejo) follows a different climate pattern. It doesn't have a truly defined dry season like the Pacific and Central Valley. Its driest periods are typically September and October, which coincide with the rainiest time of the year in the rest of the country.

To create a cloud-free image mosaic, a time window was chosen to align with the start of the calendar year at the beginning of the monitoring period. Therefore, the Landsat image acquisition period was set from June of year 1 to June of the following year. This timeframe was selected to ensure the midpoint falls on January 1st, the start of the calendar year.

The "LULC_SpectralSampling_FCPF.xlsx"[18] Excel file delineates the imagery dataset used to construct the LULC maps for 1992, 1998, 2001, 2007, 2011, 2013, 2015, 2017, 2019, 2021, and 2024. The "Period Start Date" worksheet provides the monthly image count for each LULC map. Table 1.3-5 summarizes the imagery sampling window, its midpoint, and the number of images selected for each LULC map in the REDD+ time series of Costa Rica ER-Program. Note that the midpoint for each LULC map was determined based on the median position, defined as the month when 50% of the cumulative frequency is reached.

Because of the limited availability of Landsat cloud-free images, the time frame for acquiring imagery to prepare the Land Use and Land Cover (LULC) maps for the years 1992, 1998, 2001, 2008, 2011, and 2013 has been extended from 12 months (June to June) to 18 months. Although more than 51% of the Landsat images used during these years were still within the June-to-June timeframe, extending the period results in a misalignment of the sampling window's midpoint with the calendar year's commencement, except in 2013.

The initial annualization of activity data, based on a January 1st start date for all monitoring periods, was incorrect. Therefore, the annualization process was revised. Monitoring periods were adjusted using the midpoint of the spectral sampling window, and interpolation was applied to the years 1997, 2000, 2008, 2011, and 2022, because the midpoints of the sampling windows do not coincide with the calendar start year.

For example, the interpolation used to calculate the activity data (deforestation/forest gain) for the calendar year 2008 *(AD_{2008})* was performed using the equations below (see Figure 1-2). It is important to note that the Activity Data calculation tool FREL & MRV TOOL CR[19] was updated with this interpolation process for the years 1997, 2000, 2008, 2011, and 2022. Therefore, the subsequent calculation of emissions from deforestation and degradation, as well as removals, was also updated.

$$AD_{2008} = A + B \quad \textbf{\textit{Equation 1,}}\ \textit{where}\ AD_{2008}\ \textit{units are hectares}$$

$$AD_{annual\ 01-07} = \frac{AD_{Period\ 01-07}}{\Delta T_{Period\ 01-07}}\ ;\ AD_{annual\ 07-11} = \frac{AD_{Period\ 07-11}}{\Delta T_{Period\ 07-11}}\ ;\ \textbf{\textit{Equations 2 and 3}}$$

$$\Delta T_{Period\ 01-07} = t_{07} - t_{01}\ ,\ \textbf{\textit{Equation 4}},\ \textit{where}\ t_{07} = (1/4/2008),\ t_{01} = (1/11/2000),\ \textit{and}\ \Delta T_{Period\ 01-07}\ \textit{units are years}$$

$$\Delta T_{Period\ 07-11} = t_{11} - t_{07}\ ,\ \textbf{\textit{Equation 5}},\ \textit{where}\ t_{11} = (1/8/2011),\ t_{07} = (1/4/2008),\ \textit{and}\ \Delta T_{Period\ 07-11}\ \textit{units are years}$$

$$A = AD_{annual\ 01-07} \times YF_A\ \textbf{\textit{Equation 6}},\ \textit{where}\ YF_A = (1/1/2008) - t_{07}\ \textit{in years}$$

[18] LULC_SpectralSampling_FCPF.xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/1FCXafLDt4bNo6OJClwz4l08ha2Cm03-p/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[19] Updated FREL & MRV TOOL CR can be accessed at the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

$$B = AD_{annual\ 07-11} \times YF_B \qquad \textit{Equation 7, where } YF_A = t_{07} - (31/12/2008) \textit{ in years}$$

Table 1.3 presents the original and revised annualized activity data used to calculate emissions from deforestation and removals. These calculations consider the years within the monitoring periods, using the midpoints of spectral sampling windows determined by the acquisition dates of the satellite images used to create land-use maps for each year in Costa Rica's REDD+ time series

Table 1-8 displays the imagery sampling window, its midpoint, and the number of images chosen for each LULC map in Costa Rica's REDD+ time series. The original spectral sampling window was set as a 12-month Landsat acquisition from June of Year 1 to June of the following year, with its midpoint coincide to January 1st of the target year. However, the actual midpoints for land-use maps from 1991, 1987, 2000, 2007, 2010, 2021, and 2024 do not align with January 1st of the respective year. The updated annualization now uses the actual midpoint of each spectral sampling window, aligning activity data with the corresponding calendar year through interpolation when the midpoint isn't January 1st. This adjustment corrects the timing and annualization of activity data without altering the underlying monitoring approach.

The revision of the annualization process for activity data in the REDD+ time series resulted in minor variations in the annualized secondary forest areas, ranging from -0.6% to 1.1%. Conversely, the discrepancies in annual deforested areas are more pronounced, extending from -24.9% to 20.8%. It is important to emphasize that the revision of the activity data's annualization led to the consideration of a total of 424,617 hectares of deforested areas for the reference period, compared with the 435,229 hectares accounted for in the original analysis' annualization.

Table 1-8: Imagery sampling window, midpoint of the window, and number of images selected for each LULC map in the REDD+ time series of Costa Rica ER-Program.

LULC map	Sampling window	Months	Midpoint of the sampling window	Number of images selected	% of images within the June-to-June window
MCS 1991/1992	March 15, 1991 – April 3, 1992	12	December 1st, 1991	28	68%
MCS 1987/1998	November 16, 1996 – April 19, 1998	17	August 1st, 1997	61	51%
MCS 2000/2001	December 31, 1999 - June 15, 2001	18	November 1st, 2000	41	61%
MCS 2007/2008	December 9, 2007 – April 27, 2009	17	April 1st, 2008	47	51%
MCS 2010/2011	November 6, 2010 – March 25, 2012	17	August 1st, 2011	49	51%
MCS 2012/2013	January 7, 2013 – April 8, 2014	15	January 1st, 2014	78	85%
MCS 2014/2015	August 1st, 2015 – June 16, 2016	11	January 1st, 2016	56	100%
MCS 2017/2018	June 19, 2017 – June 13, 2018	12	January 1st, 2018	70	100%
MCS 2019/2020	June 2, 2019 – June 11, 2020	12	January 1st, 2020	69	100%
MCS 2021/2022	June 5, 2021 – June 10, 2022	12	February 1st, 2022	79	100%
MCS 2024/2025	January 24, 2024 – December 17, 2025	22	February 1st, 2024	91	98%

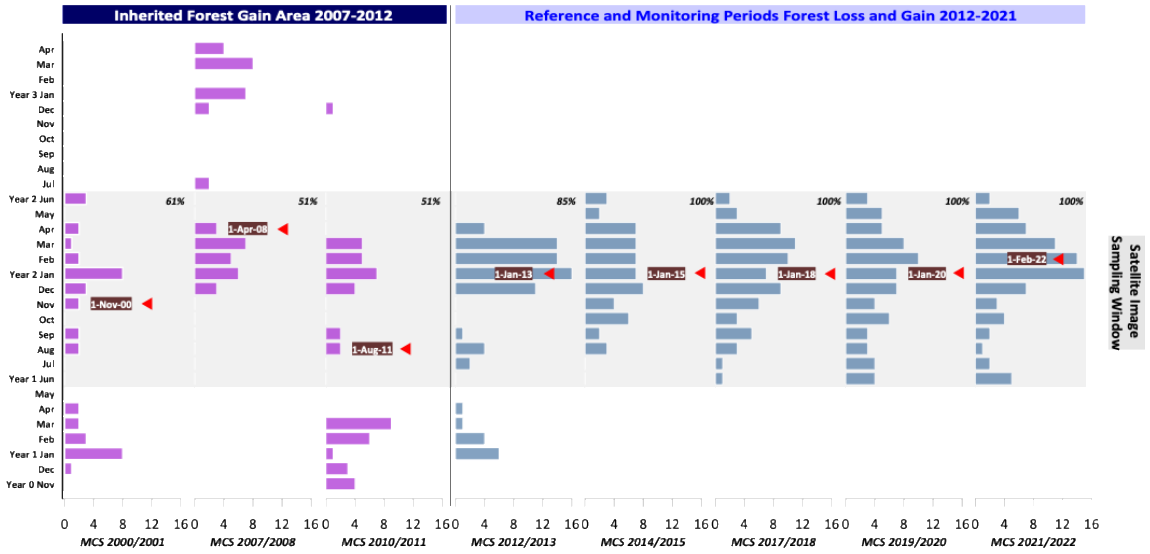

Figure 1-3: Number of images per month for each Land Use Land Cover (LULC) map used to calculate activity data for the reference and monitoring periods

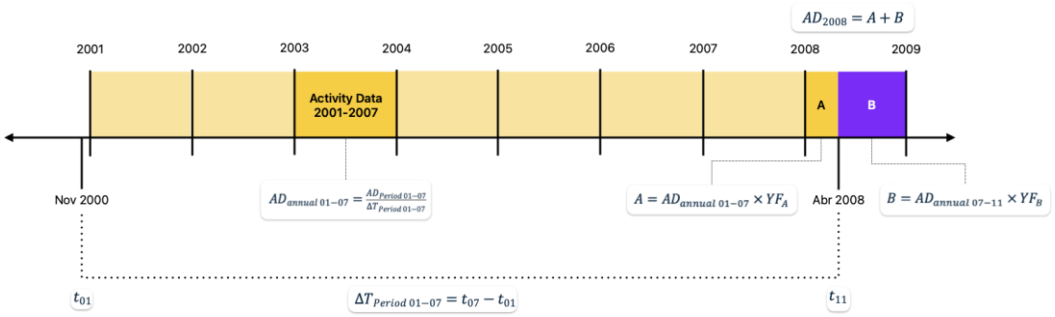

Figure 1-4: Interpolation process applied to activity data for the year 2008.

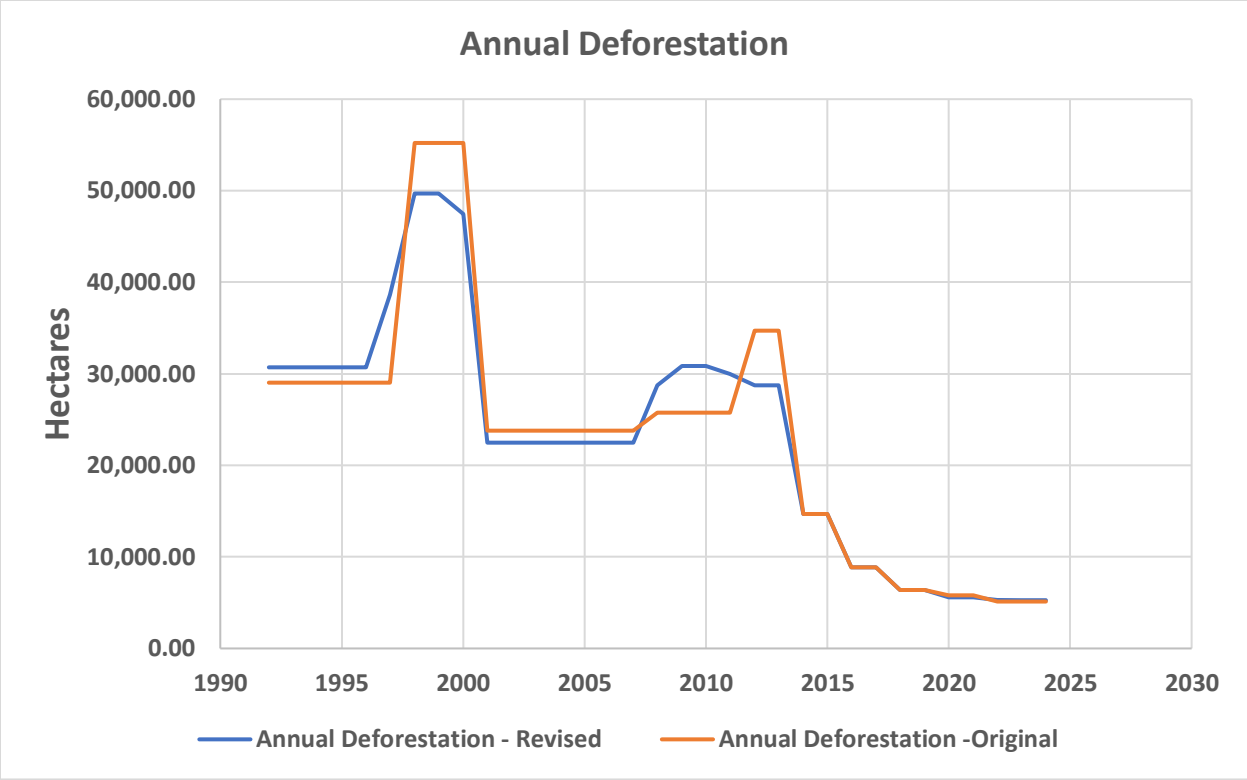

Figure 1-5: Original and revised annual deforestation of the Costa Rica REDD+ time series.

III. Revision of reference data used for estimating degradation activity data and the degradation calculation tool

The canopy cover value (Arbol+Palma_2016) for plot 16749 was previously reported as 88%, which was incorrect. This value has been corrected in the DegradationTool_without_Simulations_DB-Model_Fixed_2020-2024_FREL2 Excel file. The revised canopy cover value is now 100%.

Additionally, the formula in the "Deg_ems_antro_MP_16-19" tab previously referenced the incorrect cell in the "Base_de_Datos" tab. Specifically, it was retrieving values from "ClaseDegrad_2018" instead of "ClaseDegrad_2016" in the cell ranges "D27:D69" and "F27:F69," and selecting data from "Con_datos_2018" rather than "Con_datos_2020" within the same ranges. Additionally, the actual emissions data from degradation in Cell K72 of the "Deg_ems_antro_MP_11-16" tab had not been correctly updated. The formula in the "Deg_ems_antro_MP_16-19" sheet of the DegradationTool_without_Simulations_DB-Model_Fixed_2020-2024 Excel file was subsequently corrected[20]. It now properly retrieves data from "ClaseDegrad_2016" within cell ranges "D27:D69" and "F27:F69," and from "Con_datos_2020" in the corresponding range. Furthermore, the actual emissions from degradation in Cell K72 of the "Deg_ems_antro_MP_11-16" tab have been revised accordingly.

IV. Revision of degradation emission factors for the Palm, Dry Forest, Wet Forest, and Rainforest types

For each forest type, a **Canopy cover and aboveground biomass ratio (R_C)** was estimated based on direct measurements in 100 temporal plots located in permanent forest lands. These ratios were used to estimate degradation in remaining forests. Temporal sampling plots were measured using the NFI methodology to determine aboveground biomass covering all forest types (i.e., wet and rain forests, moist forests, dry forests, mangroves, and

[20] DegradationTool_without_Simulations_DB-Model_Fixed_2020-2024_FREL2 excel file can be accessed at the following link: https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

palm forests). These data were integrated into the aboveground biomass-canopy cover models to develop degradation emission factors.

The canopy cover for the 100 plots used to determine the ratio (R_c) was assessed by visual interpretation of high-resolution imagery collected in the SIMOCUTE systematic grid, for plots located in "forest remaining forest" according to the MCS 2012/2013 land-use map. Based on the MCS 2012/2013 map, 4,377 points were classified as permanent forest land. These points were extracted from the systematic grid used in SIMOCUTE.

An Excel sheet was prepared with the database and the estimated AGB/canopy cover ratio for forest type. The AGB / canopy ratio was estimated, excluding outliers. Cook's Distance statistical approach (calculated in R) was used to identify the outliers. Two observations were eliminated in BMHP and BS, whereas only one outlier was identified in BH, M, and P.

However, it was identified that discrepancies exist between the canopy cover assessment for the year 2016 ("Arbol+Palma_2016") values reported in "Calculo FE Nov 041220" and those found in the reference data plots: 5648, 23477, 24003, 1557, 6375, 21587, 21766, 16749, 17599, 17646. The discrepancies in the "Arbol+Palma_2016" values for these ten plots, as noted in the Excel file "Calculo FE Nov 041220,"[21] were due to an error in the version of the degradation tool used at the time of the field survey for these plots.

The degradation estimate is based on 4,377 sampling plots, as shown in column B of the "Base_de_Datos" worksheet in the "Degradation tool." Canopy cover data is collected using Collect Earth Desktop (CED) and is imported into the Degradation tool for emission calculations. The information collected from CED and the quality control processes applied have been well maintained. However, an inconsistency was found in the canopy cover data loaded into the tool for monitoring periods after 2016.

This inconsistency was identified during an additional review prompted by a significant increase in the degradation results. The statistics on illegal logging events did not account for this rise in emissions from degradation, and there were no changes in SINAC's budget for illegal logging control.

The error occurred during the import of canopy cover data from CED-generated files into the "Degradation Tool." A human error involved entering plot number 7948, which is not part of the original 4,377 plots to be evaluated. Additionally, plot 14764 was omitted, even though it had been collected in the CED form. This error caused a change in the order of plots for monitoring periods after the 2016 assessment.

To rectify this issue, we entered the data for the omitted plot (14764), eliminated plot number 7948, and reordered the information for all plots according to the plot numbers in column B of the "Degradation Tool" for the two previous periods. We also confirmed that the data collected from CED for the year 2021 was imported into the "Degradation Tool" in the correct order.

The QA/QC procedures for collecting canopy cover changes in CED have been updated. To prevent similar errors in the future, the Collect Earth Desktop form now includes the entire time series of canopy cover data, and dataset imports will encompass the complete time series rather than just the most recent period. Furthermore, when a degradation point is identified, it will be discussed in a group and documented appropriately.

Table 4 shows both the original and corrected canopy cover values for the ten affected plots. This error influenced the degradation emission factors for the Palm, Dry Forest, Wet Forest, and Rainforest types. However, the degradation emission factors for Wet Forests and Mangroves remained unaffected.

Degradation emission factors were recalculated[22], replacing the original values with the corrected ones. Table 5 presents the updated degradation emission factor. Note that there is no significant difference between the original

[21]Previous Excel file with the database and the estimated AGB/canopy cover ratio by forest type (Calculo FE Nov 041220.xlsx) can be accessed at the following link:
https://docs.google.com/spreadsheets/d/1sVP8PgBzVM3UdPcWwKeuPU5Fq7BOE6O1/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[22] The corrected Excel file with the database and estimated AGB/canopy cover ratio by forest type is available at the following link:
https://docs.google.com/spreadsheets/d/1aWA12ukXs8yQKlZa4PzKcrxKRieqokS1/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

and corrected values; the corrected value falls within the confidence limits of the original degradation emission factor. However, the degradation emission was recalculated using the corrected database and degradation emission factors. Updated emissions from degradation can be accessed at the following links:

Degradation tool without simulations:
https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Degradation tool with simulations:
https://docs.google.com/spreadsheets/d/1EnFxRnYRUzL8UW8jy1mKMwMIg78Aai0B/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Table 1-9. Original and revised canopy cover values of the ten affected plots

Forest type	Plot number	Original Value	Corrected Value
Palm	5648	88	100
Palm	23477	25	100
Palm	24003	82	100
Wet and Rain Forest	1557	49	72
Wet and Rain Forest	6375	69	100
Wet and Rain Forest	21587	49	90
Wet and Rain Forest	21766	78	100
Dry Forest	16749	84	100
Dry Forest	17599	47	100
Dry Forest	17646	45	100

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

2.1 Forest Monitoring System

2.1.1 Organizational structure

Costa Rica's National Forest Monitoring System (NFMS), which provides data for REDD+ Monitoring, Reporting, and Verification (MRV), was established in accordance with the Warsaw Framework to enable result-based payments. The country submitted its NFMS for REDD+ to the UNFCCC in November 2019[23]. The development process began in 2015 when the National Center for Geospatial Information (CENIGA) started designing the NFMS to encompass all land uses and land-use changes at the national level, following the IPCC's 2003 Good Practice Guidelines[24].

The NFMS is integrated into the SIMOCUTE platform, which stands for the National Monitoring System for Land Use, Land Cover, and Ecosystems (see Figure 2). SIMOCUTE functions as the official platform for coordinating, connecting, and integrating institutional and sectoral efforts in Costa Rica's land management and disseminating knowledge and data on land-use change and ecosystem monitoring (see Figure 3). It offers technical guidance for the monitoring, reporting, and verification (MRV) of land-use changes within the AFOLU sector, encompassing agriculture, forests, and other land uses. Now fully operational, SIMOCUTE will incorporate the MRV systems for GHG emissions from the AFOLU sector, including the national REDD+ program, the NAMA initiatives, the national carbon trading system, and the progress of NDC implementation[25].

The NFMS is composed of two data collection mechanisms:

- **The Satellite Land Monitoring System (SLMS)** gathers data on land use and land use changes. Responsible agencies include the National Meteorology Institute (IMN) and the REDD+ Secretariat, which is formed by FONAFIFO and SINAC. The IMN also manages Costa Rica's National GHG Inventory (INGEI) and prepares Biennial Transparency Reports (BTRs). Collaboration between IMN and FONAFIFO is essential to ensure consistency between REDD+ reports and the national GHG inventory. Additionally, IMN develops indicators aligned with IPCC's Good Practice Guidelines and the structure of SIMOCUTE.
- **The National Forest Inventory (NFI)** collects forest field data to estimate and update the country's emission factors. This component of the NFMS is managed by SINAC, which is also responsible for promoting sustainable forest management, issuing logging permits, and controlling illegal logging.

Other government entities participating in the REDD+ Program include: the Ministry of Environment and Energy (MINAE), which provides political backing; the College of Agricultural Engineers (CIAgro), overseeing forestry professionals involved in program implementation; the National Forestry Office (ONF), acting as the liaison between these government bodies and the private sector; and the Associations for Integral Indigenous Development (ADII), supporting indigenous communities. The inter-institutional REDD+ Board of Directors is tasked with setting policies, making decisions, and addressing conflicts or grievances related to REDD+.

The REDD+ Secretariat, supported by the Costa Rica REDD+ Result-Based Payments Project (RPB Project), successfully achieved the Costa Rica REDD+ Program's accreditation with the "REDD+ Environmental Excellence Standard" (TREES) under the 'Architecture for REDD+ Transactions' (ART) Program for the crediting period 2017-2021. The RBP project aligns market standards with the Warsaw Framework for REDD+ results-based payments, aiming to maximize REDD+ funding for Costa Rica. These standards can be harmonized with UNFCCC decisions, including additional rules to minimize uncertainties and reduce risks of leakage and reversals.

Additionally, the REDD+ Secretariat has submitted to the UNFCCC the Costa Rica FREL 2010-2019 and the Technical Annex on REDD+ results 2020-2023 for Costa Rica's first BTR for technical review, to qualify for participation in the

[23] https://redd.unfccc.int/files/4863_2_sistema_nacional_monitoreo_forestal_costa_rica.pdf
[24] Available at: https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html
[11] Accessible at https://simocute.go.cr/
[25] https://simocute.go.cr/acerca/

REDD+ Program of the Green Climate Fund. Currently, Costa Rica is preparing the Technical Proposal to claim REDD+ results for 2020-2022.

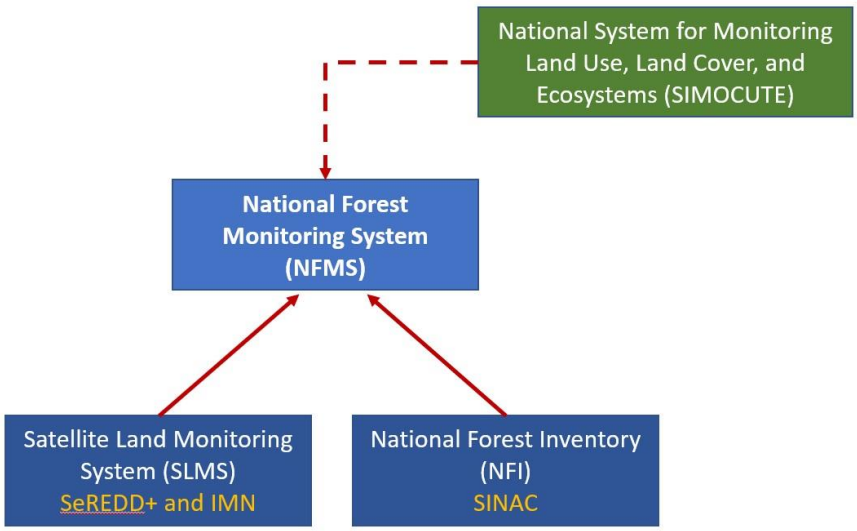

Figure 2-1: Organizational structure of the National Forest Monitoring System in Costa Rica.



Figure 2-2*:* Conceptual Framework of Costa Rica's SIMOCUTE (National Monitoring System for Land Use, Land Use Cover, and Ecosystems). Source: MINAE 2017.

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

The procedures and methods for gathering, processing, consolidating, and reporting GHG data during monitoring are identical to those used when establishing the reference level. Costa Rica monitors the same activities and carbon pools, applying these procedures during all monitoring events. The entities responsible for handling GHG data collection, processing, consolidation, and reporting are as follows:

- **Obtaining activity data (AD):** The National Meteorological Institute (IMN) has produced, to date, all land-use cover maps and national GHG inventories in Costa Rica. The REDD+ Secretariat has been responsible for developing the land-use cover maps for the historical series used to prepare the FRL/FREL submitted to the UNFCCC.
- **Obtaining emission factors (EFs):** SINAC manages Costa Rica's National Forest Inventory (NFI), which consistently monitors the country's forest stocks. The results from the NFI are crucial for creating emission factors for Costa Rica's REDD+ MRV system. Costa Rica's first National Forest Inventory (NFI) was finished in 2015, under the supervision of SINAC. The NFI plots have been found to pose challenges for SINAC in conducting forest change assessments over time due to uneven plot distribution among forest strata[26]; thus, SINAC is currently evaluating changes to the NFI structure by redistributing plots to enhance compatibility with SIMOCUTE. SINAC is actively updating the NFI to allow for future resampling, involving 441 plots over five years to track changes in biomass.
- **Estimating emissions and sinks:** IMN, responsible for Costa Rica's national GHG inventories, estimates emissions from AFOLU (agriculture, forestry, and other land use) and LULUCF (land use, land use change, and forestry).
- **Reporting:** The REDD+ Secretariat prepares technical reports in collaboration with IMN experts. These reports cover the FCPF ERPA Carbon Fund (FC), the Emergent ERPA - ART TREES, safeguards assessments, and BTRs for REDD+ performance payments. External reviewers evaluate these reports and recommend adjustments when needed.

Costa Rica determined the average annual emissions over the reference period through an activity-based method (See Table 2.12-1). This approach estimates emissions and removals using spatially explicit activity data and net emission factors. The activity data were incorporated into land-use matrices (see below) to precisely track land-use changes and avoid double-counting or omissions. External experts evaluate the uncertainty of these estimates as necessary. After deriving activity data and emission factors for remaining forests and forest cover changes, the REDD+ Secretariat estimates the associated GHG fluxes using Excel calculators.

To develop NFMS methods and protocols, SIMOCUTE aligned with IPCC guidelines, focusing on AFOLU requirements for monitoring land use change emissions. It formed technical working groups of experts from institutions involved in ecosystem and land-use/land-cover monitoring to define procedures for implementing and updating methodologies and protocols as needed.

The essential components of the SLMS and NFI—such as methods, protocols, data sources, and monitoring frequency—are detailed in Section 3 of this report. QA/QC procedures for AD and FE calculations are outlined as follows:

[26] Recomendaciones para la Medición, Reporte, y Verificación (MRV) de REDD+. 2016. Report from the CDI, US Forest Service, and FAO UNREDD. 33 pp.

- **Activity Data:** The QA/QC procedures applied during the calculation of AD for the reference and monitoring period are summarized in Tables 2, 3, 6, and 7. Further information may be found in Agresta (2005)[27], Ortiz-Malavassi (2017)[28], and Aguilar (2020)[29].
- **Emission Factors:** The QA/QC procedures applied in calculating EF for deforestation and degradation are summarized in Tables 4 and 5. Further information may be found in Ministerio de Ambiente y Energía (2015)[30], Rodriguez (2018)[31], Coto (2018)[32], and Obando (2019)[33].

Table 2.1.2-2-1. Activity based approach to estimate emissions and removals using spatially explicit activity data and net emission factors in Costa Rica.

	FL	LCFL	CL	GL	SL	WL	OL
FL	*CO*	*NA*	*DF.1*	*DF.1*	*DF.1*	*DF.1*	*DF.1*
LCFL	*EC.3*	*EC.2*	*DF.2*	*DF.2*	*DF.2*	*DF.2*	*DF.2*
CL	*NA*	*EC.1*	*NA*	*NA*	*NA*	*NA*	*NA*
GL	*NA*	*EC.1*	*NA*	*NA*	*NA*	*NA*	*NA*
SL	*NA*	*EC.1*	*NA*	*NA*	*NA*	*NA*	*NA*
WL	*NA*	*EC.1*	*NA*	*NA*	*NA*	*NA*	*NA*
OL	*NA*	*EC.1*	*NA*	*NA*	*NA*	*NA*	*NA*

__FL__, Forest Land; __LCFL__, Land Converted to Forest Land; __CL__, Cropland, GL, Grassland; __SL__, Settlements; __WL__, Wetlands; __OL__, Other Land; __CO__, Conservation of forest C stocks; __EC__, Enhancements of forest C stocks (.1, EC in conversions of non-forest land to forest land; .2, EC in LCFL remaining LCFL; .3, EC in LCFL converting to FL); __DF__, Deforestation (.1, DF of old-growth forests; .2, DF of secondary forests); __NA__, Not Applicable in the REDD+ context.

2.1.3 Role of communities in the forest monitoring system

The NFMS, designed as an official information system, must comply with current standards for producing official data, which are regulated by various entities such as the National Geographic Institute (IGN) and its territorial information systems, as well as the National Institute of Statistics and Census (INEC) regarding data use. Therefore, community participation is generally not expected in these systems, unless it becomes necessary to address data gaps that require such involvement.

The ER-Program supported initiatives that promote active participation by communities and organizations in forest resource management. For instance, SINAC enhanced community involvement in firefighting through "Forest fire brigades," primarily made up of volunteers in high-risk zones (see section 1.1).

[27] Agresta, Dimap, Universidad de Costa Rica, Universidad Politécnica de Madrid. 2015. Final Report: Generating a consistent historical time series of activity data from land use change for the development of Costa Rica's REDD plus reference level: Methodological Protocol. Report prepared for the Government of Costa Rica under the Carbon Fund of the Forest Carbon Partnership (FCPF). 44 pp. https://www.dropbox.com/s/ygjw6zq00a1qtbm/Informe_tecnico_feb_2015.pdf?dl=0

[28] Ortiz-Malavassi, E. (2017). Evaluación Visual Multitemporal (EVM) del Uso de la tierra, Cambio en el Uso de la Tierra y Cobertura en Costa Rica Zonas A y B Tarea 1: Estimación del área de cambio de uso de la tierra durante el periodo 2014-2015. Retrieved from https://drive.google.com/file/d/1GXdN43f-DNKelkM8y7gBLrKou-f7LI-G/view?usp=sharing

[29] Aguilar, L. (2020). Evaluación Visual Multitemporal para la determinación de la degradación forestal para los periodos 2014-2015-2017-2019 y determinación de datos de referencia para periodo 2017-2019. Tercer Informe. Retrieved from https://drive.google.com/file/d/1ERutZo6vNI6MXUCmlrky7wiaeOqOLMqh/view?usp=sharing

[30] Ministerio de Ambiente y Energía. (2015). Volumen 4 Marco conceptual y metodológico para la Inventario forestal nacional de Costa Rica. Retrieved from https://www.sirefor.go.cr/pdfs/Volumen4-MarcoC-Imprenta.pdf

[31] Rodríguez, J. (2018). INFORME FINAL DE CONSULTORÍA Estudio de parcelas temporales para estimar el stock de carbono en bosques intactos, degradados y altamente degradados en zona A. (Contrato N°020-2018-REDD). Retrieved from https://drive.google.com/file/d/1dSyL8Dldwym5VN1jXpnAbmPovUW3AiTu/view?usp=sharing

[32] Coto, O. (2018). INFORME FINAL DE CONSULTORÍA. Estudio de parcelas temporales para estimar el stock de carbono en bosques intactos, degradados y altamente degradados en zona B. (Contrato N°019-2018-REDD). Retrieved from https://drive.google.com/file/d/1svYPJGEoBHpLn72sg4ejpf6uZkp6lllM/view?usp=sharing

[33] Obando, G. (2019). COORDINACIÓN GENERAL DE LA IMPLEMENTACIÓN DEL PLAN DE MEJORA DEL NIVEL DE REFERENCIA. Tercer Informe de Consultoría N ° 016-2018-REDD. Retrieved from https://drive.google.com/file/d/1MEHZ6dvQKY52X58UtlG02o4Uw9x1HV6v/view?usp=sharing

Additionally, SINAC is strengthening the “Natural Resources Monitoring Committees” (COVIRENAS) and the Volunteers Association (ASVO), non-governmental groups that coordinate various activities with government agencies—monitoring compliance with legislation and aiding in the management of protected areas.

SINAC involved various national actors to encourage participation in conserving natural resources. It functions as a mechanism enabling responsible state institutions to coordinate surveillance activities with communities according to national laws. In 2019, SINAC conducted multiple training workshops to reestablish COVIRENAS, targeting local participants interested in their organization and training in the use of the integrated environmental reporting system, SITADA, among other topics.

During the period 2002-2024, COVIRENAS continues to participate through several key actions and activities on the ground to support the implementation of the ER Program, including:

- **Enforcement of Environmental Regulations**: They actively assist public servants at both the regional and local levels in the direct application, monitoring, and compliance of national environmental laws.
- **Protection of Natural Resources**: They participate in localized surveillance and protection activities to safeguard forests, ecosystems, and other vital natural resources.
- **Information Sharing and Community Outreach**: As recognized community leaders, they serve as crucial ground-level communication channels. They are responsible for sharing and explaining information to local stakeholders to encourage and assist them in participating in the various Payment for Environmental Services (PES) modalities funded by the program.

Additionally, the College of Agricultural Engineers (Agronomists’ Association), which oversees the “Certified Foresters" responsible for developing and monitoring management plans for various payment modalities under environmental services agreements, has a key role in ensuring beneficiaries meet their commitments related to conservation, restoration, reforestation, or management. Similarly, numerous local and regional forestry producer organizations offer regulatory services to interested parties, enhancing their capabilities through PES. The goal is to strengthen these organizations' capacities through various policies, actions, and tasks integrated into the PRE.

2.2 Updates to the monitoring approach

No updates have been made to the monitoring approach for the reporting period 2022-2024.

2.3 Measurement, monitoring and reporting approach

2.3.1 Line Diagram

The diagrams below show a 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 (Figure 2-3).

Costa Rica has developed a tool to estimate emissions and removals from deforestation and reforestation - FREL & MRV TOOL CR.xlsx[34], and another for the estimate of emission and removals from degradation in permanent forest lands – DegradationTool.xlsx[35].

FREL tool: Details of the FREL tool can be found in the START spreadsheet and its manual (Manual de la Herramienta FREL & MRV Tool – UNFCCC.pdf in Spanish[36]). The tool is organized in the following sections:

Setting sections that users must not modify:

i. START: This spreadsheet explains the general information of the Tool: i. name and contact information of the person who made the last modification of the Tool, ii. date of the changes, and iii. keyword used to lock spreadsheets.

ii. FREL&FRL: In this spreadsheet, the user can recalculate the FREL/FRL by selecting i. carbon gases and reservoirs to be included in the FREL/FRL; ii. REDD + activities to be included in the FREL/FRL; iii. the years of the historical reference period of the FREL/FRL.

iii. C-STOCKS: This spreadsheet aims to calculate the carbon stocks (in tCO_2-e ha^{-1}) of the land use categories represented in the Land Cover Maps (MCS) of Costa Rica. The calculation is done separately for each gas and carbon pool, whether it is included in the FREL/FRL. The spreadsheet also reports uncertainty values, at 90% or 95%, associated with estimates of average carbon existence. The calculations of these uncertainty values are made in a separate Excel file ("Carbon Database> 4. Carbon Densities"[37]) using the IPCC uncertainty propagation method (Equation 3.1 and 3.2 of IPCC-GL, 2006 - Volume 2). At the end of the spreadsheet, all the data, parameters, and default values used in calculating carbon stock estimates and their respective sources are listed.

iv. REDD+ ACT: This spreadsheet defines REDD + activities in such a way that it is not possible to count the same source or the same GHG sink in more than one REDD + activity and ensure, at the same time, that all GHG sources and sinks are considered in the analysis. The approach taken to meet this objective is to represent in a matrix of land use changes all possible transitions between land use categories and then assign each cell in the matrix to a single REDD + activity.

v. LIST: This spreadsheet contains the drop-down lists that appear in the rest of the Tool's pages and additional information related to the stratification of Costa Rica's forests. No calculation is made on this sheet.

Input section:

vi. LCM AAAA-AA: In this spreadsheet, the activity data of the "AAAA-AA" period are reported, where "AAAA and AA" are the beginning ("AAAA") and end ("AA") years of the period.

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[34] The FREL Tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[35] Degradation tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[36] A copy of the FREL Tool Manual can be download at the following link: https://drive.google.com/file/d/14CsE_rpBBrEJgyUTplziKKsGGVm_YtL_/view?usp=sharing

[37] A copy of Carbon Stocks database can be download at the following link: https://docs.google.com/spreadsheets/d/14xlYQbtETN0x_kpI3Qci8OVGiIRsWKV7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

This is done by filling in a matrix of land use changes with all possible transitions. The matrix structure is identical to the matrix presented in the "REDD + ACT" spreadsheet, which allows the activity data to be related to REDD + Activities. The "LCM AAAA-AA" spreadsheets are the only ones that must be filled in for REDD + monitoring. When activity data is entered in the matrices of the "LCM AAAA-AA" sheets, the Tool will automatically calculate the annual activity data ("AD AAAA" sheets) and annual emissions and removals ("ER AAAA" sheets) up to the "AA" year (= last year of the "AAAA-AA" period). The "FREL & FRL" sheet will be updated with the data calculated up to the "AA" year and the results of the mitigation actions (or emission reduction program) on the "RESULTS" sheet.

Calculation section:

vii. AD AAAA: In this sheet, the annual activity data are calculated from the values entered in the "LCM AAAAAA" sheets. The calculation is made in matrices of land use changes and assumes that in the "AAAA-AA" period, the areas converted annually are equal.

viii. ER AAAA: These spreadsheets calculate GHG emissions and removals related to the land use change summarized by forest type and REDD + activities. The calculation is performed automatically in each of the cells of the land use change matrices by multiplying the activity data by their corresponding emission factors. The activity data are the values calculated in the matrices of the "AD AAAA" spreadsheets. The emission factors are calculated as the difference between the carbon contents existing at the beginning and end of the year, taking the carbon stock values of the "C-STOCKS" spreadsheet.

Results sections:

ix. RESULTS: This spreadsheet calculates and shows the results of the mitigation action. Results are calculated considering the same gases, carbon reservoirs, emission factors and REDD + activities that were included in the FREL / FRL. The calculation of the results is simply the difference between the actual emissions / removals and the emissions / removals of the FREL/FRL.

x. CHARTS: This spreadsheet contains graphs and tables that were included in the FREL / FRL description documents of Costa Rica that were submitted to the UNFCCC (MINAE, 2016). The content of this sheet is informative and there are no parameters that the user can change (except the working language) or calculations that are not performed on other spreadsheets.

Uncertainty analyses are performed in a separate tool using Monte Carlo simulation as described in section 5.

Degradation tool: Costa Rica used a methodology of visual interpretation of high-resolution images to detect changes in the canopy of permanent forest areas to estimate emissions and removals from degradation. This analysis resulted in a database of canopy cover percentages in 4,377 points in forest lands of Costa Rica for several years. Details of the Degradation tool can be found in Winrock International, (2018)[38]. The tool facilitates the following calculations:

- Segregation of interpretation points between anthropic and natural carbon flux areas to eliminate natural changes from emissions accounting since the ER program cannot control them.
- Calculation of the number of points in each forest state transition. In this step, the canopy interpretation assessment of the three forest status classes of the initial year and the final year of the monitoring period are classified. The three classes of forest status are: a. Intact: forest areas with canopy percentage between 85-100%; b. Slightly degraded: forest areas

[38] Winrock International. (2018). Ejercicio : estimación de emisiones por actividades en bosques que permanecen como tales. Retrieved from https://drive.google.com/file/d/1Mk8MACXEKDROXQg2UP7t4FDqQmc8Q5S9/view?usp=sharing

with canopy percentage between 60-85%; c. Very degraded: forest areas with canopy percentage less than 60%.

- Extrapolate the area of each transition of forest states. This step is necessary to extrapolate the carbon flows detected at the interpretation points to the entire permanent forest area for the monitoring period.
- Calculation of the average canopy percentage for each forest state. In this step, the tool calculates the average canopy percentage of each forest state for the beginning and the end of the monitoring period.
- Estimation of carbon fluxes (emissions and removals) of each type of transition is the final step. The tool uses the relationship between the percentage of canopy cover and biomass to estimate carbon fluxes in each transition from forest state.

The Degradation tool is organized as follows:

i. **Descripcion_Variables**: This sheet contains descriptions of the High-Resolution Image Visual Interpretation Analysis database attributes. Take note of the attributes *Arbol+Palma_AAAA* variables. These attributes show the percentage of canopy cover in the initial and final year of the monitoring period.

ii. **Base_de_Datos**: This sheet contains the database for the visual interpretation of high-resolution images.

iii. **Resumen_de_puntos**: This sheet calculates the number of points and extrapolates the area for each transition from the forest state.

iv. **Deg_ems_antro_RP_AA-AA**: This sheet calculates the average canopy percentage of each forest state and the anthropic carbon fluxes (emissions and removals) of each type of transition for the Reference Period.

v. **Deg_ems_nat_RP_AA-AA**: This sheet calculates the average canopy percentage of each forest state and the natural carbon fluxes (emissions and removals) of each type of transition for the Reference Period.

vi. **Deg_ems_antro_MP_AA-AA**: This sheet calculates the average canopy percentage of each forest state and the anthropic carbon fluxes (emissions and removals) of each type of transition for the Monitoring Period. vii. Deg_ems_nat_MP_AA-AA: This sheet calculates the average canopy percentage of each forest state and the natural carbon fluxes (emissions and removals) of each type of transition for the Monitoring Period.

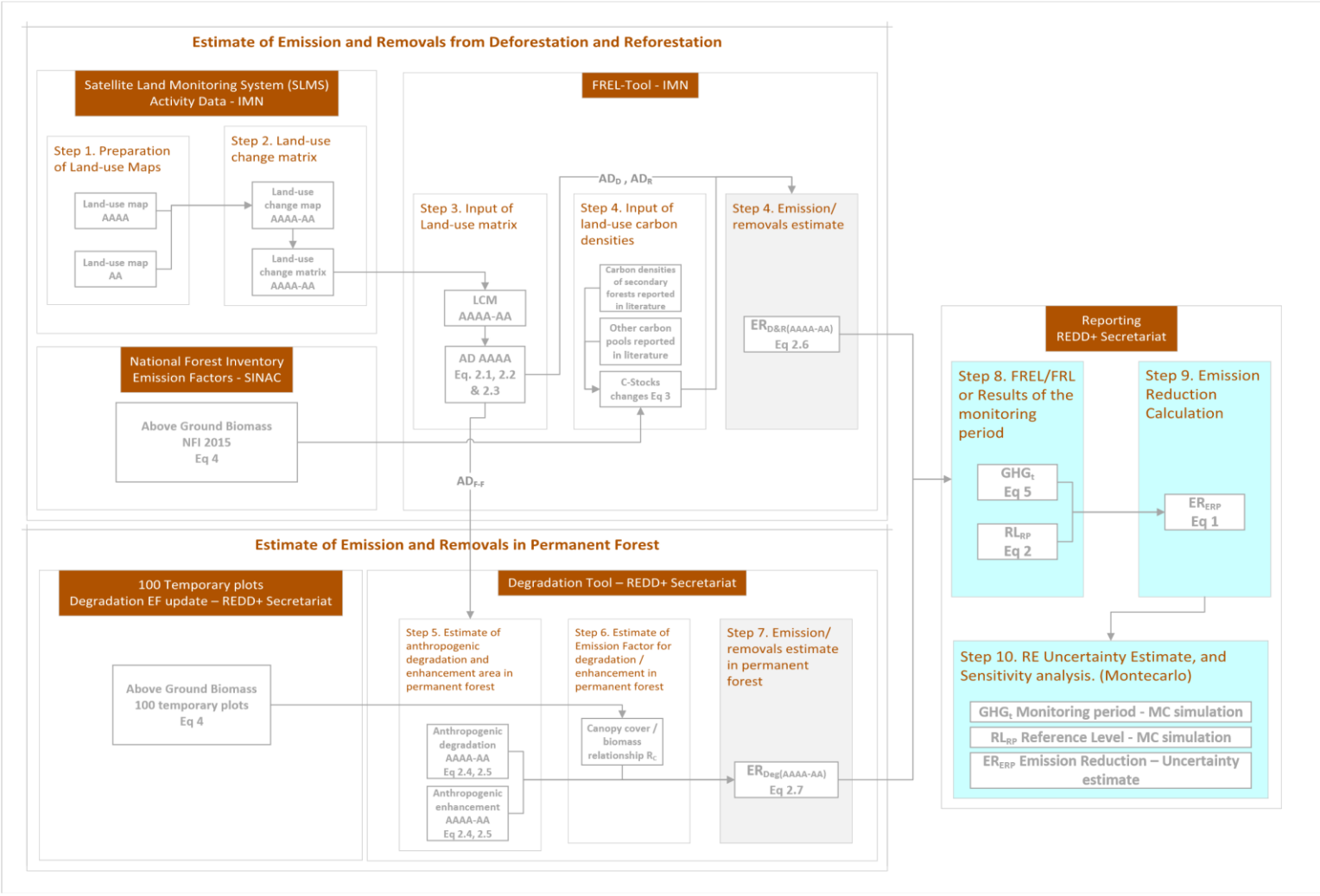

Figure 2-3: A detailed, step-by-step overview of the measurement and monitoring method used to establish the Reference Level and estimate emissions and reductions during the Monitoring / Reporting Period. This approach applies to the emissions and removals from Sources/Sinks, Carbon Pools, and greenhouse gases listed in Annex 4 of Costa Rica's first ER-MR.

2.3.2 Calculation

2.3.2.1 EMISSION REDUCTION CALCULATION

$$ER_{ERP,t} = RL_{RP} - GHG_t \qquad \textbf{Equation 8}$$

Where:

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

RL_{RP} = Gross emissions of the RL from deforestation and degradation over the Reference Period; $tCO_2e*year^{-1}$. This is sourced from Annex 4 to the first ER Monitoring Report and equations are provided below.

GHG_t = Monitored gross emissions from deforestation at year t; $tCO_2e*year^{-1}$;

t = Number of years during the monitoring period; dimensionless.

2.3.2.1.1 Reference Level ($\mathbf{RL_t}$)

The RL estimation may be found in Annex 4 of the first ER-MR, yet a description of the equations is provided below. RL was defined as the net annual average historical emissions. Annual emissions or absorptions were estimated for all land transitions i by REDD+ activity, and then adding the results for all selected REDD+ activities for each year:

$$\mathrm{RL_{RP}} = \frac{\sum_{t=1}^{RP} \mathrm{ER_{RA_t}}}{\mathrm{RP}} = \frac{\sum_{t=1}^{RP} \sum_{i=1}^{I} \left(\mathrm{AD_{RA\,i,t}} * \mathrm{EF_{RA_{i,t}}}\right)}{\mathrm{RP}}$$

Equation 9

Where:

ERRAt	=	Emissions or removals associated to REDD+ activity *RA* in year *t*; tCO_2-e yr^{-1}
ADRAi,t	=	AD associated to REDD+ activity *RA* for the land use transition *i* in year *t*; ha yr^{-1}
EFRAi,t	=	EF associated to REDD+ activity *RA* applicable to the land use transition *i* in year *t*; tCO_2-e ha^{-1}
RP	=	Reference Period in years
i	=	A land use transition represented in a cell of the land use change matrix; dimensionless
I	=	Total number of land use transitions related to REDD+ activity *RA*; dimensionless
t	=	A year of the historical period analyzed; dimensionless

Deforestation and Reforestation Activity Data ($\mathbf{AD_D}$ and $\mathbf{AD_R}$) are calculated differently from Degradation and Enhancement Activity Data ($\mathbf{AD_{Deg}}$ and $\mathbf{AD_E}$). Deforestation and Reforestation ADs result from the cartographic comparison of land-use maps from the beginning and end of the monitoring period. The Degradation and Enhancement DAs result from the sample-based estimation of canopy change area in permanent forest lands. Below are the equations used to calculate these parameters:

Activity Data of Deforestation ($\mathbf{AD_D}$)

$$AD_{D_{i,t}} = \left|D_{i,t}\right| * 0.81,$$ **Equation 9.1**

Where $\left|D_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Activity Data of Reforestation ($\mathbf{AD_R}$)

$$AD_{R_{i,t}} = \left|R_{i,t}\right| * 0.81,$$ **Equation 9.2**

Where $\left|R_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Forest remaining forests ($\mathbf{AD_{F\text{-}F}}$)

$$AD_{F-F_{i,t}} = \left|F - F_{i,t}\right| * 0.81,$$ **Equation 9.3**

Where $\left|F - F_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Activity Data of Degradation ($\mathbf{AD_{Deg}}$)

$$AD_{Deg_k} = \frac{|Deg_k|}{N} * AD_{F-F_t}$$ **Equation 9.4**

Where $\left|Deg_{i,t}\right|$ is the count of sampling points where canopy change decrease (dimensionless) in forest type *k*, *N* is the total of sampling points (dimensionless), and AD_{F-F_t} is the total area of permanent forest (in hectares – ha) in the monitoring period.

Activity Data of Permanent Forest Regeneration ($\mathbf{AD_E}$)

$$AD_{E_k} = \frac{|E_k|}{N} * \sum_{i=1}^{I} AD_{F-F_{i,t}}$$

Equation 9.5

Where $\left|E_{k,}\right|$ is the count of sampling points where canopy change increase (dimensionless) in forest type *k*, *N* is

Emissions from Deforestation & Removals $E_{D\&R(AAAA-AA)}$	$E_{D\&R(AAAA-AA)} = \sum_{k=1}^{I} AD_{D_{i,t}} * EF_{D_i} + \sum_{k=1}^{I} AD_{R_{i,t}} * EF_{R_i}$ **Equation 9.6**	the total of sampling points (dimensionless), and AD_{F-F_t} is the total area of permanent forest (in hectares – ha) in the monitoring period. Where *i* is a land-use transition represented in a cell of the land-use change matrix (dimensionless), EF_{D_i} is the deforestation emission factor for land-use transition *i*, EF_{R_i} is the removal factor for land-use transition *i* (when land-use transition *i* is forest loss, activity data and emission factor for forest recovery are cero and vice versa).
Emission & Removals from Degradation $E_{Deg(AAAA-AA)}$	$E_{Deg(AAAA-AA)} = \sum_{i=1}^{I} AD_{Deg_k} * EF_{Deg_k} + \sum_{i=1}^{I} AD_{E_k} * EF_{E_k}$ **Equation 9.7**	Where *k* is a forest type, EF_{Deg_k} is the degradation emission factor for forest type *k*, EF_{E_k} is the removal factor for forest type *k.*

Deforestation EFs were determined from C stocks. C stock changes (ΔC) were estimated using the Stock-Difference Method by applying IPCC (2006) equation 2.5 (cf. Volume 2, Chapter 2, Section 2.2.1.). All results were multiplied by the stoichiometric ratio 44/12, as follows:

$$\Delta C = \frac{(C_{t2} - C_{t1})}{(t2 - t1)} * 44/12$$ **Equation 10**

Where:

ΔC	=	C stock changes associated to the land use transition *i* in year *t*; tCO_2-e ha^{-1}
C_{t1}	=	C stock at time *t1*, t CO_2 ha^{-1} *t1* in all cases was the 1st of January of each year *t*, *i.e.* C_{t1} is the C stock per hectare existing at the beginning of the year, before the conversion occurs. The estimated values are reported in the column K of the sheets "ER AAAA" (where "AAAA" stands for the year *t*) in the FREL TOOL.
C_{t2}	=	C stock at time *t2*, t CO_2 ha^{-1} *t2* in all cases was the 31st of December of each year *t*, *i.e.* C_{t2} is the C stock per hectare existing at the end of the year, after the conversion occurred. The estimated values are reported in the lines 19[39] and 20[40] of the sheets "ER AAAA" (where "AAAA" stands for the year *t*) in the FREL TOOL.
t2-t1	=	In all cases the C stock changes were estimated annually, *i.e. t2-t1* = 1 year.
44/12	=	Conversion of C to CO_2

[39] The C stock values reported in line 19 represent total C stocks existing in secondary forest and tree plantation at the end of the first year at which they meet the definition of "Forest", i.e., 4 years for all forest strata and 8 years for dry forests. These values are used to estimate ΔC in conversions of non-Forest land use categories to Forest land and conversions of other land use categories to permanent crops.

[40] The C stock values reported in line 20 represent total C stocks existing in the land use categories at the end of the year. They are used to estimate ΔC in all land use transitions, except conversions of non-Forest land use categories to Forest land and conversion of other land use categories to permanent crops.

Forest C is determined from the NFI biomass data, converted to carbon as follows:

$$C_t = \sum_{j,i} (B_{tot}) \times CF \qquad \textbf{Equation 11}$$

Where:

B_{tot} = Total biomass stock for the land use category *LU*; tCO_2-e ha^{-1}.
Total biomass is equivalent to the sum of all biomass pools: $B_{tot} = B_{AGB} + B_{BGB} + B_{DW} + B_L$
Where:
AGB is above-ground biomass for land use category *LU*; tCO_2-e ha^{-1}
BGB is below-ground biomass for land use category *LU*; tCO_2-e ha^{-1}
DW is dead wood biomass for land use category *LU*; tCO_2-e ha^{-1}
L is litter biomass for land use category *LU*; tCO_2-e ha^{-1}

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.

Carbon stocks of non-Forest land uses are estimated as the average values reported by the selected studies:

- *Cropland:* carbon stock values reported in selected studies showed high variability, depending on crop type (sugar cane, coffee, banana, cocoa, etc.). For this reason, the carbon stock data compiled were weighted by the surface area of the respective crops in Costa Rica to produce a single estimate of carbon stocks from cropland.
- *Grassland:* carbon stocks were estimated as the average values reported in different carbon pools in the selected studies.
- *Settlements and (non-forested) Wetlands:* no studies could be found reporting biomass values for these categories. It was assumed that their carbon stock is zero.
- *Other Land:* studies were found reporting carbon stocks for *Paramo.* In the case of *Bare Soil* it was assumed carbon stocks are zero.

Additional details on AD, EF, and calculations in the reference level and monitoring period are available in Section 3 and Annex 4 of this monitoring report.

2.3.2.1.2 Monitored emissions ($\mathbf{GHG_t}$)

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 (ΔC_{Bt}).

$$GHG_t = \frac{\sum_t^{MP} ER_{RA_t}}{MP} = \frac{\sum_{t=1}^{MP} \sum_{i=1}^{I} \left(AD_{RA_{i,t}} * EF_{RA_{i,t}} \right)}{MP} \qquad \textbf{Equation 12}$$

Where:

ER_{RAt} = Emissions or removals associated to REDD+ activity RA in year t; tCO2-e yr-1
$AD_{RAi,t}$ = AD associated to REDD+ activity RA for the land use transition i in year t; ha yr-1
$EF_{RAi,t}$ = EF associated to REDD+ activity RA applicable to the land use transition i in year t; tCO2-e ha-1
MP = Monitoring Period in years

i	=	A land use transition represented in a cell of the land use change matrix; dimensionless
I	=	Total number of land use transitions related to REDD+ activity RA; dimensionless
t	=	A year of the historical period analyzed; dimensionless

Deforestation and Reforestation Activity Data (**AD_D** and **AD_R**) are calculated differently from Degradation and Enhancement Activity Data (**AD_{Deg}** and **AD_E**). Deforestation and Reforestation ADs result from the cartographic comparison of land-use maps from the beginning and end of the monitoring period. The Degradation and Enhancement DAs result from the sample-based estimation of canopy change area in permanent forest lands. Below are the equations used to calculate these parameters:

Activity Data of Deforestation (AD_D)

$$AD_{D_{i,t}} = \left|D_{i,t}\right| * 0.81,$$ **Equation 12.1**

Where $\left|D_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Activity Data of Reforestation (AD_R)

$$AD_{R_{i,t}} = \left|R_{i,t}\right| * 0.81,$$ **Equation 12.2**

Where $\left|R_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Forest remaining forests (AD_{F-F})

$$AD_{F-F_{i,t}} = \left|F - F_{i,t}\right| * 0.81,$$ **Equation 12.3**

Where $\left|F - F_{i,t}\right|$ is the count of pixels of the land-use transition *i* in year *t*, dimensionless; and 0.81 is the pixel size in Hectares (ha).

Activity Data of Degradation (AD_{Deg})

$$AD_{Deg_k} = \frac{|Deg_k|}{N} * AD_{F-F_t}$$ **Equation 12.4**

Where $\left|Deg_{i,t}\right|$ is the count of sampling points where canopy change decrease (dimensionless) in forest type *k*, *N* is the total of sampling points (dimensionless), and AD_{F-F_t} is the total area of permanent forest (in hectares – ha) in the monitoring period.

Activity Data of Permanent Forest Regeneration (AD_E)

$$AD_{E_k} = \frac{|E_k|}{N} * \sum_{i=1}^{I} AD_{F-F_{i,t}}$$ **Equation 12.5**

Where $\left|E_{k,}\right|$ is the count of sampling points where canopy change increase (dimensionless) in forest type *k*, *N* is the total of sampling points (dimensionless), and AD_{F-F_t} is the total area of permanent forest (in hectares – ha) in the monitoring period.

Emissions & Removals from Deforestation $E_{D\&R(AAAA-AA)}$

$$E_{D\&R(AAAA-AA)} = \sum_{k=1}^{I} AD_{D_{i,t}} * EF_{D_i} + \sum_{k=1}^{I} AD_{R_{i,t}} * EF_{R_i}$$ **Equation 12.6**

Where *i* is a land-use transition represented in a cell of the land-use change matrix (dimensionless), EF_{D_i} is the deforestation emission factor for land-use transition *i*, EF_{R_i} is the removal factor for land-use transition *i* (when land-use transition *i* is forest loss, activity data and emission factor for forest recovery are cero and vice versa).

Emission & Removals from Degradation $E_{Deg(AAAA-AA)}$

$$E_{Deg(AAAA-AA)} = \sum_{i=1}^{I} AD_{Deg_k} * EF_{Deg_k} + \sum_{i=1}^{I} AD_{E_k} * EF_{E_k}$$ **Equation 12.7**

Where *k* is a forest type, EF_{Deg_k} is the degradation emission factor for forest type *k*, EF_{E_k} is the removal factor for forest type *k*.

Changes in total biomass carbon stocks are calculated following Equation 10 above.

3 DATA AND PARAMETERS

3.1 Fixed Data and Parameters

Table 3-1: Source of Activity Data and description of the methods for developing the data for estimate emissions from deforestation during the reference period[41].

Parameter:	**Activity Data of Deforestation (AD_D) Eq. 9.1** **Activity Data of Reforestation (AD_R) Eq. 9.2** **Forest remaining forests (AD_{F-F}) Eq. 9.3**
Description:	**Deforestation**: Hectares of forest that changed to non-forest land in a year summed each year (i) of the reference period. **Reforestation**: Hectares of non-forest that changed to forest land in a year, summed for each year (i) of the reference period. **Forest remaining forests**: Hectares of Forest remaining forests in a year, summed for each year (i) of the reference period
Data unit:	**Hectares**
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	**Introduction** AD for land-use change activities was derived from map-algebra by analyzing all land cover maps created for 1998-2011 and estimating multi-temporal data for the areas that remained in the same category or converted to other land cover categories. Annual AD was interpolated for years in which maps were not produced. A time-series of land use maps was created for 1985/86-2012/13 in a Geographical Information System (GIS)[42] and then extracting the values of the areas that remained in the same category or converted to other land use categories from the combined set of multi-temporal data. The area covered by the land-use maps includes the country's continental territory (5,133,939.50 ha) but excludes Coco Island (238,500 ha). The land use maps were created using the methodology summarized here; further information may be found in separate reports [43, 44, 45]. **Data sources for estimating activity data.** The construction of the AD time series required the following sources of data: i. Remotely sensed data from four generations of the Landsat family (Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM and Landsat 8 OLI/TIRS). ii. A "Life Zones" map according to the classification system of Holdridge (1966). This map was used to stratify "Forests" into the three sub-categories: "Wet and Rain Forests", "Moist Forests" and "Dry Forests". iii. Ancillary data to edit the results of the spectral classification of remotely sensed data and to further stratify the five forest categories "Wet and Rain Forests", "Moist Forests", "Dry Forests", "Mangroves" and "Palm Forests" into the sub-categories "primary forests" and "secondary forest. iv. The Global Forest Change project (Hansen et al., 2013) has been used to fill in pixels without information in the mosaic of classifications for each year of the series between 2000 and 2012. **Methods for mapping land-use and land-use change.** • **Selection of images:** Creating a LULC map for a specific year in Costa Rica requires mosaicking cloud-free images. Costa Rica uses Landsat imagery for LULC maps, but frequent cloud cover due to its geography and climate poses a challenge.

[41] All AD parameters listed in table 3.1-1 sourced from the same survey.
[42] The geodatabase with the time-series of land use maps created for the reference period 1985/86-2012/13 can be accessed at the following link: https://drive.google.com/drive/folders/1kMgTzOwbKD0VnpTsHoag5zjgEXgd4yB9?usp=sharing
[43] Agresta, Dimap, Universidad de Costa Rica, Universidad Politécnica de Madrid. 2015. Final Report: Generating a consistent historical time series of activity data from land use change for the development of Costa Rica's REDD plus reference level: Methodological Protocol. Report prepared for the Government of Costa Rica under the Carbon Fund of the Forest Carbon Partnership (FCPF). 44 pp.
[44] Ministry of the Environment and Natural Resources of Costa Rica. (2016). Modified REDD+ Forest reference emission level/forest reference level (FREL/FRL). COSTA RICA. SUBMISSION TO THE UNFCCC SECRETARIAT FOR TECHNICAL REVIEW ACCORDING TO DECISION 13/CP.19. Retrieved from https://redd.unfccc.int/files/2016_submission_frel_costa_rica.pdf
[45] Ministry of the Environment and Natural Resources of Costa Rica. (2018). Costa Rica Emission Reductions Program to the FCPF Carbon Fund. Retrieved from https://www.forestcarbonpartnership.org/system/files/documents/Costa Rica ERPD EN_Oct24-2018_clean.pdf

	The dry season, ideal for remote sensing, varies regionally, with the Pacific Coast experiencing the most intense and prolonged dry season. Costa Rica selected Landsat sensor imagery to develop land-use and land-cover (LULC) maps because of the availability of images from the ER-Program reference period. A primary challenge in using remote sensing imagery in Costa Rica is the frequent cloud cover. Costa Rica's constant cloud cover results from its location between the Caribbean and Pacific Oceans, which provides moisture, and its mountainous terrain, which causes orographic lift. The Intertropical Convergence Zone (ITCZ) and convection also play a significant role in cloud formation, leading to diverse microclimates and shaping the country's ecosystems[46]. The sunniest and least cloudy period in Costa Rica occurs during the dry season. However, this pattern is not uniform across the country. The Pacific Coast experiences the most intense and prolonged dry season. In the Central Valley of Costa Rica, the dry season generally runs from December to the end of April. The Caribbean Coast (Tortuguero, Puerto Viejo) follows a different climate pattern. It doesn't have a clearly defined dry season like the Pacific and Central Valley. Its driest periods are typically September and October, coinciding with the rainiest time of year for the rest of the country. To create a cloud-free image mosaic, a time window was chosen to align with the start of the calendar year at the beginning of the monitoring period. Therefore, the Landsat image acquisition period was set from June of year 1 to June of the following year. This timeframe was selected to ensure the midpoint falls on January 1st, the start of the calendar year. Costa Rica prepared the FREL/FRL using a time series of satellite images from 1987 to 2013. The time series includes images from four generations of Landsat satellites: Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI/TIRS. The analyst downloaded the satellite data through the USGS Earth Explorer server. To cover the continental territory of Costa Rica for each year in the series, seven Landsat scenes were used: two scenes from path 14, rows 53 and 54; three from path 15, rows 52, 53, and 54 (see Figure 3-1); and two from path 16 (rows 52 and 53). Low-cloud-coverage Landsat images were combined to minimize the area covered by clouds and cloud shadows. In most cases, scenes were selected from the same year and season, but in some cases, scenes from different years within a 13-18-month timeframe were necessary.

[46] https://www.noaa.gov/jetstream/tropical/convergence-zone .

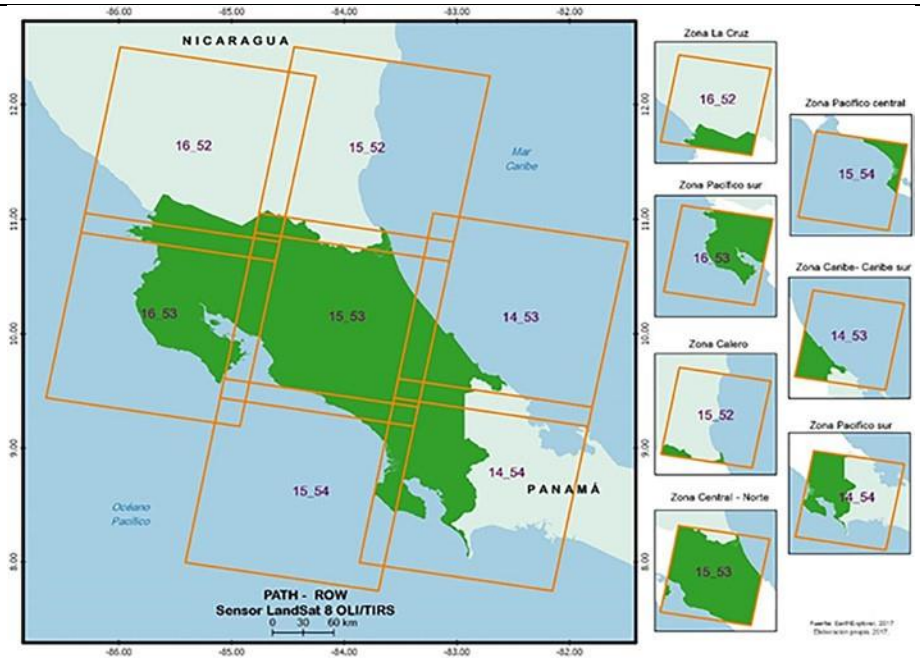

Figure 3-1: LANDSAT paths and rows needed to create the LULC maps for Costa Rica's mainland territory.

- **Pre-processing and Geometric validation:** All images were registered to a standard coordinate system (CRTM05). The mean quadratic error in control points was less than one pixel (30 m). The maximum registration error was estimated at 2 pixels (60 m). The 2005 orthophotography generated with the IDB-Cadastral project's CARTA mission has been used to collect control points for the geometric validation of the reference runs. A mosaic of scenes is prepared for each path's available dates, with the geometrically corrected images.
- **Radiometric normalization:** All images were radiometrically normalized. This process is applied to reduce radiometric differences between images due to atmospheric conditions and the sensors' calibration at image acquisition dates. The radiometric normalization was done using the "Iteratively Reweighted Multivariate Alteration Detection" (IR-MAD), as described by Canty and Nielsen (2008)[47]. The normalization of the time series used as a reference the zenith angle 36.90° corresponding to February 17, 2013.
- **Random Forest Classification:** The images are classified using the Random Forest (RF) method. This methodology has 2 phases: (1) training or adjustment of the RF and (2) classification of the images using the generated RF classifier. Homogeneous regions of interest have been digitized according to the land cover classes between 2011 and 2014 (see Table 3 of Agresta, 2015) for the models' adjustment. The base information used for the digitization and photointerpretation of these regions has been i) the systematic grid of cover points taken on the RapidEye images by SINAC for the elaboration of the map of forest types of Costa Rica 2013 (10,000 points distributed in the national territory), ii) the RapidEye high spatial resolution images themselves, and iii) both current and historical images available on Google Earth. Control points for RF training have been randomly generated from these regions of interest. In total, 20 predictor variables (also called covariates or auxiliary variables) were used for the adjustment of the RF models, divided into four groups: (1) Spectral information of the bands, (2) Indices of vegetation, (3) Variables related to the texture of the image, and (4) Variables derived from the Digital Elevation Model. The analyst applied the classifiers to all the images according to their path and sensor. The result is a classification file for each classified image.

Postprocessing.

Final maps are provided at a resolution of 30 meters. The process of preparing these final maps from the classified images involved the following tasks:

i. **Union of the mosaic** for each date from the classified images using a pixel prioritization algorithm. The analyst merged all the different images' classifications for each of the dates and paths, eliminating the extreme strip of the paths overlapping. If the classifier predicts several classes for the same pixel, the most common category was selected, according to band 2 of the results.

ii. **Filling gaps with global products**: The Global Forest Change project (Hansen et al., 2013) has been used to fill in pixels without information in the mosaic of classifications for each year of the series between 2000 and 2012.

iii. **Multi-temporal analysis**: the multi-temporal analysis of the series allowed assigning the age class to each of the forest pixels, analyzing the years that have elapsed from the date of appearance of a new forest. The forest from 1987 has been considered a primary forest. Also, the multi-temporal analysis improved land-uses classification, especially when the land cover has similar spectral information. The classifier confused native forests with forest plantations. For this reason, the forest plantations were reclassified as forest.

iv. **Minimum mapping unit**: The analyst replaced Forest Class groups of pixels smaller than 11 pixels with the LULC class of the largest neighboring group to comply with the minimum area threshold of the definition of "forest (1.00 ha) and setting the minimum mapping unit. Due to the pixels' dimensions in the Landsat images (30.00 m x 30.00 m), the minimum mapping area is 0.99 ha, equivalent to 11 pixels (11 x 30.00 m x 30.00 m).

v. **Manual editions**: To improve land use mapping, several editions were made, largely aimed at decreasing high classification errors (for more detail please see section 4.3.3 in Ministry of the Environment and Natural Resources of Costa Rica, 2016[48]):

a. "Forest Plantations" were merged with the "Forest land" category. This means that although initially classified as a separate class, @Forest Plantations@ presented a very high classification error and, for purpose of GHG estimation, it was treated as Forest land".

b. For estimating the area of "Coffee Plantations", the analyst used ancillary maps from the Ministry of Agriculture (MAG), the Costa Rican Coffee Institute (ICAFE), and the Costa Rican Meteorological Institute (IMN). These maps were used to correct the classified areas for the years 2000/01, 2007/08, 2011/12, and 2013/14. For previous maps, a mask representing potential "Coffee Plantation" areas was created using the location and elevation of all areas mapped as "Coffee Plantations" considering all available sources of information (MAG, ICAFE, and IMN).

c. Paramo, Mangroves and Palm forests are ecosystems restricted to particular elevation, edaphic, inundation, and salinity conditions; it is challenging for such ecosystems to exist in other locations. Therefore, these forests were re-classified using the map of Forest types (MTB), prepared by Agresta (2015). All masks representing "Mangroves", "Palm Forests" and "Paramo" have been compiled in a map of masks that will be kept in order to enable consistent map editions in future measurement and reporting.

d. Areas classified as "Urban Areas" in 2013/14 were manually edited through visual interpretation of 2013 high resolution RapidEye images and creation of a mask representing "Urban Areas" in 2013/14. Pixels originally classified as "Urban Areas" outside the mask were reclassified as "Bare Soil" and conversely, pixels classified as "Bare Soil" inside this mask were reclassified as "Urban Areas". Additionally, under the assumption that "Urban Areas" never convert to other land use categories, all pixels

e. A map of potential forest types was created to assign secondary forests to a forest type (Wet and Rain Forests, Moist Forests, Dry Forests, Mangroves, Palm Forests). This map will also be used in future measurements for determining the forest type of secondary forests. The map of potential forest types was created by combining the life-zones and then overlapping the map of the masks of potential areas of "Mangroves", "Palm Forests", and "Paramo".

[47] Canty, M. J. y A. A. Nielsen, 2008. Automatic radiometric normalization of multitemporal satellite imagery with the iteratively re-weighted MAD transformation. Remote Sensing of Environment 112 (2008):1025-1036.

[48] Ministry of the Environment and Natural Resources of Costa Rica. (2016). Modified REDD+ Forest reference emission level/forest reference level (FREL/FRL). COSTA RICA. SUBMISSION TO THE UNFCCC SECRETARIAT FOR TECHNICAL REVIEW ACCORDING TO DECISION 13/CP.19. Retrieved from https://redd.unfccc.int/files/2016_submission_frel_costa_rica.pdf

Activity Data (AD) Calculation.

AD for land use change activities, such as deforestation and reforestation, were estimated by combining all land use maps created for 1998-2011 in a Geographical Information System (GIS) and then extracting, from the combined set of multi-temporal data, the values of the areas that remained in the same category or converted to other land use categories. The results of this operation are reported in land use change matrices prepared for each measurement period in the sheets "LCM 1986-91", "LCM 1992-97", "LCM 1998-00", "LCM 2001-07", "LCM 2008-11", and "LCM 2012-13" of the spreadsheets tool "FREL TOOL CR[49]". It is essential to clarify that areas in the land-use change matrices are calculated using a rounded pixel size of 30 × 30 m. Note that the full digit resolution of pixels in the 1998-2011 LCM maps is 29.99951156658000428 meters by 29.99951156657999718 meters, and the difference between raster resolution and final resolution used in the land use change matrices is 0.49 mm in X and 0.49 mm in Y.

- **Annualization of activity data:** For monitoring periods where the midpoint of the imagery selection window for both the initial and final land-use maps aligns with either the start or end of the calendar year, the activity data is annualized by dividing the area that was deforested or regenerated during that period by the total number of years in the monitoring period (see Eq 2 and 3).

  The LULC_SpectralSampling_FCPF.xlsx[50] file details the imagery dataset used for LULC maps from 1992 to 2024. Table 1.3-1 summarizes the imagery sampling window, midpoint, and image count for each LULC map. Limited Landsat imagery availability in 1992, 1998, 2001, 2008, 2011, and 2013 caused the LULC map time window to expand from 13 to 18 months in several years, leading to misalignment with the calendar year's start.

  Consequently, monitoring periods were shifted to the midpoints of the spectral sampling windows, and interpolation adjustments were made for 1997, 2000, 2008, 2011, and 2022, since these midpoints do not align with the calendar year start or end.

  For example, the interpolation used to calculate the activity data (deforestation/forest gain) for the calendar year 2008 (AD_{2008}) was performed using the equations below. It is important to note that the Activity Data calculation tool FREL & MRV TOOL CR was updated with this interpolation process for the years 1997, 2000, 2008, 2011, and 2022. Therefore, the subsequent calculation of emissions from deforestation and degradation, as well as removals, was also updated.

$$AD_{2008} = A + B \quad \textbf{Equation 1,} \text{ where } AD_{2008} \text{ units are hectares}$$

$$AD_{annual\ 01-07} = \frac{AD_{Period\ 01-07}}{\Delta T_{Period\ 01-07}} \; ; AD_{annual\ 07-11} = \frac{AD_{Period\ 07-11}}{\Delta T_{Period\ 07-11}} \; ; \textbf{Equations 2 and 3}$$

$$\Delta T_{Period\ 01-07} = t_{07} - t_{01} \text{ , } \textbf{Equation 4}, \text{ where } t_{07} = (1/4/2008),\ t_{01} = (1/11/2000), \text{ and } \Delta T_{Period\ 01-07} \text{ units are years}$$

$$\Delta T_{Period\ 07-11} = t_{11} - t_{07} \text{ , } \textbf{Equation 5}, \text{ where } t_{11} = (1/8/2011),\ t_{07} = (1/4/2008), \text{ and } \Delta T_{Period\ 07-11} \text{ units are years}$$

$$A = AD_{annual\ 01-07} \times YF_A \quad \textbf{Equation 6}, \text{ where } YF_A = (1/1/2008) - t_{07} \text{ in years}$$

$$B = AD_{annual\ 07-11} \times YF_B \quad \textbf{Equation 7}, \text{ where } YF_A = t_{07} - (31/12/2008) \text{ in years}$$

[49] FREL & MRV TOOL CR can be accessed at the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[50] LULC_SpectralSampling_FCPF.xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/1FCXafLDt4bNo6OJCIwz4l08ha2Cm03-p/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Table 1.3-5: Imagery sampling window, midpoint of the window, and number of images selected for each LULC map in the REDD+ time series of Costa Rica ER-Program.

LULC map	Sampling window	Months	Midpoint of the sampling window	Number of images selected	% of images within the June-to-June window
MCS 1991/1992	March 15, 1991 – April 3, 1992	12	December 1st, 1991	28	68%
MCS 1987/1998	November 16, 1996 – April 19, 1998	17	August 1st, 1997	61	51%
MCS 2000/2001	December 31, 1999 - June 15, 2001	18	November 1st, 2000	41	61%
MCS 2007/2008	December 9, 2007 – April 27, 2009	17	April 1st, 2008	47	51%
MCS 2010/2011	November 6, 2010 – March 25, 2012	17	August 1st, 2011	49	51%
MCS 2012/2013	January 7, 2013 – April 8, 2014	15	January 1st, 2014	78	85%
MCS 2014/2015	August 1st, 2015 – June 16, 2016	11	January 1st, 2016	56	100%
MCS 2017/2018	June 19, 2017 – June 13, 2018	12	January 1st, 2018	70	100%
MCS 2019/2020	June 2, 2019 – June 11, 2020	12	January 1st, 2020	69	100%
MCS 2021/2022	June 5, 2021 – June 10, 2022	12	February 1st, 2022	79	100%
MCS 2024/2025	January 24, 2024 – December 17, 2025	22	February 1st, 2024	91	98%

Value applied:

1998-2011:

- **Deforestation**
  - Total anthropogenic deforestation: 29,887 ha yr-1
  - Primary forest anthropogenic deforestation: 12,617 ha yr-1
  - Secondary forest and tree plantation anthropogenic deforestation: 17,270 ha yr-1
- **Reforestation**
  - Non-forest converted to forest: 28,615 ha yr-1
- **Forest remaining forest at the end of the reference period (2011)**
  - Primary Forest: 2,226,715 ha
  - Secondary Forest: 790,265 ha

QA/QC procedures applied

The QA/QC procedures used in preparing the land-use maps for calculating AD during the reference period are summarized here. Additional details are available in Agresta (2005), Sections 3, 4, and 7.

Download and satelite image preparation:

1. Verification of file storage errors in digital media that could affect reading the data by the analyst responsible for download support images.
2. Previewing and verification of the satellite image quality and metadata by the analyst responsible for downloading support images.
3. Previewing and verification of the satellite image quality and metadata by the supervisor.

Image orthorectification:

4. The analyst conducts a thorough visual inspection to detect errors in the orthorectification process, including duplicated regions, pixel stretching, or geometric inaccuracies associated with the digital terrain model (DTM).
5. Geometric control of orthorectified images by taking checkpoints in each scene in a regularly distributed grid.
6. The analyst responsible for orthorectification verifies the root-mean-square error (RMSE) of the control points. In all cases, the RMSE remains below the image's pixel size. After debugging, there should be at least 20 accurate ground control points per reference path. The RMSE at checkpoints is under 1 pixel (30 meters), and the largest error at any point does not exceed 2 pixels (60 meters).
7. Preparation of a "georeferencing validation datasheet" involves creating a general image view with marked checkpoints, along with a list of the coordinates and RMS values for each point. Annex 5 of Agresta (2015) provides the lists of checkpoints and the RMSE for the processed dates.

Radiometric normalization*:*

8. Radiometric normalization to minimize differences across time-series images

Generation of cloud and shadow masks

	9. The cloud and shadow mask is validated through visual inspection of a systematic random grid of checkpoints labeled as cloud (n), shadow (s), or clear (d). The analyst reviews the original image in RGB or false color to confirm that the classification aligns with the mask. Particular attention is required for cloud masks over urban areas and coastlines, which often have high reflectance. During this process, the analyst may adjust certain parameters related to cloud and shadow mask degeneration to improve accuracy. 10. The validation process involves selecting a random sample from each image path within each time series (3 paths x 6 series = 18 images). Table 2 in Agresta (2015) provides a summary of the validation results for both the cloud and shadow maps **Land use classification** 11. Analysts perform an iterative process of classification, verification of results, error detection, and review of areas and training points. 12. Progressive improvement of the areas and training points of the RF classifier before the final classification of the images. Review of the Random Forest classifiers' errors, identify classes that need improvement, and training points. 13. Visual verification and validation of classified images by comparing them with the available high-resolution image. **Preparation of land-use maps**: 14. Visual inspection of mosaics to identify information gaps and sensor failures in each time-series image. 15. Visual inspection of the maps produced after filling gaps with global data.. 16. Analysts perform an independent validation of the land-use change maps by using ground validation points supplied by the country's institutions, which were not involved in the classification process. 17. Manual editing of the time-series classification to enhance land use mapping, mainly targeting the reduction of significant classification errors. **Visual verification and validation of land-use change map:** 18. Visual verification of the country's main deforestation and reforestation areas across consecutive years in the series to detect classification errors. 19. Validation of land-use changes from 2001 to 2011 was conducted through photointerpretation of changes on a systematically sampled random grid of points, utilizing Landsat data, aerial orthophotography from 2005, and RapidEye images from 2011 and 2012.
Uncertainty associated with this parameter:	Uncertainties associated to AD are due to the production process of land use maps. The uncertainties of the AD for land use change activities (deforestation and reforestation) and forest remaining forest activities (degradation and enhancements in forest lands) come from the uncertainties (i.e. the margin of error for a 90% confidence level divided by the estimate) associated with the process creating land use change maps from which the activity data are obtained. The uncertainty associated with the activity data used to calculate the FREL 1998-2011 is based on the accuracy assessment of the land-use change map 2001/02 – 2011/12, conducted in accordance with Olofsson et al.'s (2014) [51] guidelines. Due to a large number of land-use change transitions, they were aggregated into four categories: Deforestation (forest to non-forest), new forests (non-forest to forest), stable forest (forest remaining forest), and stable non-forest (nonforest to non-forest). The validation of land-use changes during the period 2000/2001 2010/2011 is based on the photointerpretation of orthophotography from 2005, Rapid eye imagery, and Landsat images, since they have higher quality and spatial resolution than the maps and are independent of the sample of land-use data used to produce the maps. For further detail please see section 12.2 in ERPD document (Ministry of the Environment and Natural Resources of Costa Rica, 2018)[52]. A total of 639 reference points were assessed in this study. Out of these, 328 were in stable forest areas (areas classified as forest in 2000/01 remaining forest in 2010/11), 221 were in stable non-forest areas (areas classified as non-forest in 2000/01 remaining non-forest in 2010/11), 42 were in afforestation/reforestation areas (areas classified as non-forest in 2000/01 classified as forest in 2010/11), and 48 were in deforested areas (areas classified as forest in 2000/01 classified as non-forest in 2010/11)[53]. The activity data's

[51] Olofsson et al. (2014) Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment 148, 42-57.
[52] Ministry of the Environment and Natural Resources of Costa Rica. (2018). Costa Rica Emission Reductions Program to the FCPF Carbon Fund (Second Revision). Retrieved from https://www.forestcarbonpartnership.org/system/files/documents/Costa Rica ERPD EN_Oct24-2018_clean.pdf
[53] Accuracy Assessment 2001-2011 analysis can be accessed in the following link (CDI_CostaRicaREL_AnalisisExactitud_MCS2000-2001 vs MCS2010-2011.xlsm excel file): https://drive.google.com/file/d/1vhLK_i2Y0EFm_-yPQ8RkpgjQBejHHbBr/view?usp=sharing

	uncertainty is the bias between the adjusted (reference data) and estimated (land use maps) areas. The uncertainty values are as follows (see cells F56-F59 of spreadsheet "2.4E Datos Actividad 2001-2011 in excel file CDI_CostaRicaREL_AnalisisExactitud_MCS2000-2001 vs MCS2010-2011): Uncertainty of hectares of deforestation from 1998-2011: 26% Uncertainty of hectares of non-forest that changed to forest land: 51% Uncertainty of hectares of forests remaining forests in 1998-2011: 7% Note that the annualized activity data (AD) changed, but the total area of change during the monitoring period did not. Since uncertainty is calculated based on the total area of change during the monitoring period, rather than the annual area of change, the uncertainty remains the same.
Any comment:	Costa Rica revised the annualization of activity data for its REDD+ time series because cloud cover affected Landsat imagery. The revision adjusted monitoring periods to the midpoint of the spectral sampling window and interpolated data for years when the midpoint didn't align with the calendar year. This led to minor variations in secondary forest areas and more significant discrepancies in deforested areas, affecting emissions calculations. For further details, consult section 1.3, **Methodological deviations**.

Table 3-2: Source of Activity Data and description of the methods used to develop the data for estimating emissions from degradation during the reference period.

Parameter:	**Activity Data of Degradation (AD_{Deg}) Eq. 9.4** **Activity Data of Permanent Forest Regeneration (AD_E) Eq. 9.5**
Description:	**Degradation**: Hectares of forest with a reduction of canopy cover during the reference period. **Forest Enhancement**: Hectares of forest with an increase of canopy cover during the reference period
Data unit:	**Hectares**
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	The forest degradation assessment was made on forest lands that remain as forest lands. The analysis of degradation was only performed on the area of forest remaining forest according to the land-use MCS 2012/13 map to avoid double-counting of baseline emissions between deforestation and forest degradation. This procedure avoided any measurements of degradation that were also accounted for under deforestation. Reference data to estimate Degradation AD were collected by Ortiz-Malavassi, (2017)54. • **Type of sampling**: A Systematic Sampling (SYS) over the Level 1 Systematic Grid of 10,242 points of the Monitoring system of land-use change and ecosystems (SIMOCUTE) was used. The original systematic grid is in the CRTM05 coordinate system of Costa Rica. However, it was re-projected to geographic coordinates in WGS84 to evaluate the sampling point with the Collect Earth Desktop tool. The SIMOCUTE sampling units are permanent, which facilitates reinterpretation through time and easy temporal tracking of LULC changes. • **Sampling Unit**: The Sampling Unit (SU) is a 90x90 meter plot whose central point coincides with the SIMOCUTE sampling points. The SU corresponds to 3x3 Landsat pixels and covers 0.98 ha. Inside SU, a 7x7 points sub-grid was created to estimate land cover percentage within each sampling unit. • **Number of Sampling Units**: The forest degradation assessment was made on forest lands that remain as forest lands during 1998-2016. A total of 4377 points were classified as permanent forest land according to the MCS 2012/13 map. These points are an extract from the Systematic Grid adopted in SIMOCUTE. • **Classification scheme**: Three classes of canopy cover were considered to estimate degradation/enhancement in permanent forest land: i. Intact Forest (85-100% forest cover), ii. Degraded forest (60-85% forest cover), and iii. Very degraded forest (<60% forest cover). The following forest cover change classes were assessed by forest type and type of carbon fluxes (anthropogenic and natural): Degradation: a. Intact to Degraded Forest. b. Intact to Very degraded forest. c. Degraded to Very degraded forest. Forest enhancement: d. Very degraded to intact forest. e. Very degraded to degraded forest. f. Degraded to Intact Forest. No Condition changes: g. Stable intact forest h. Stable degraded forest i. Stable very degraded forest • **Imagery Sources:** The range of dates of the images presented in the table below was used. Priority was given to operating with the ortho-rectified photographs of the TERRA 1997 project to evaluate the canopy cover in 1998. Still, since TERRA 1997 covered less than 40% of the national territory, the second priority was to use high-resolution images in Google Earth before 2006. If these did not exist, the next priority was to use the ortho-rectified

[54] Ortiz-Malavassi, E. (2017). Evaluación Visual Multitemporal (EVM) del Uso de la tierra, Cambio en el Uso de la Tierra y Cobertura en Costa Rica Zonas A y B Tarea 1: Estimación del área de cambio de uso de la tierra durante el periodo 2014-2015. Retrieved from https://drive.google.com/file/d/1GXdN43f-DNKelkM8y7gBLrKou-f7LI-G/view?usp=sharing

photos of the project Carta-2005 available on the SNIT server. For the other years, the repository of high-resolution images available in Google Earth and Earth Engine was used as a data source, giving priority to images from the years to be evaluated (2011 or 2016). However, in case of absence, the use was recorded in the year closest to monitoring dates. Data sources and imagery date range used in the canopy cover evaluation on permanent forest for the reference period 1998-2011 are the following:

Monitoring Year	Imagery date range	Data sources
1998	January 1997 – December 2005	• Orthophotos TERRA 1997. • Google Earth imagery repository • Mission CARTA 2005
2011	July 2011 – June 2012	• Google Earth imagery repository
2016	July 2015 – June 2016	• Google Earth imagery repository

- **Interpretation Key:** The land cover class keys used to determine canopy cover for the years 1998, 2011, and 2016 are the following:

Code	Land cover class
1100	Trees
1200	Shrubs
1300	Herbaceous
1400	Palm
1500	Bromeliads
1600	Greenhouse
1700	Other vegetation
2000	No vegetation
3000	Water
4000	Clouds and shadows
5000	Not classifiable

- **Data analysis:** The country developed a tool for calculating emissions and removals on permanent forest lands (¨Herramienta_degradación.xlsx¨ [55]). The database for the visual interpretation of canopy cover for the reference period 1998-2011 and period 2012-2016 are included in the sheet "Base_de_datos". The area of degraded and enhanced forest areas was extrapolated to the forest area in the entire country through proportional representation within the respective degradation classes (intact, degraded and very degraded) and forestry type. Degradation classes were determined based on the reduction of the forest canopy cover, by which intact forests have a cover of 85-100%, degraded forests have a cover of 60-85%, and very degraded forests a cover between 30% and 59%. Forest areas that went from intact to degraded, intact to very degraded, or degraded to very degraded (in terms of their canopy cover) during the assessment period (1998-2011) were classified as degraded. Forest areas that went from very degraded to degraded, very degraded to intact, or degraded to intact were identified as forest enhancement areas. Carbon fluxes were estimated for anthropogenic and natural conditions. Fluxes from sampling points inside protected areas and farther than 500 meters from a road[56] were considered natural fluxes and removed from reference level accounting. The estimation of the areas of change of degradation and canopy enhancement, for both anthropic and natural carbon

[55] Degradation tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[56] The latest and highest-resolution official roads map for Costa Rica was used for this exercise, which was completed in 2007. It is accessible via the National System of Territorial Information (SNIT) website: http://www.snitcr.go.cr/Metadatos/full_metadata?k=Y2FwYW1ldGFkYXRvczo6Y2FwYTo6SUdOXzU6OnZpYXNfNTAwMA

	fluxes, can be found in the sheet ¨Resumen_de_puntos¨ of the Degradation tool, for the reference period 1998-2011 and period 2012-2016.
Value applied:	• **2,226,715** hectares of forests remaining forests in the reference period (1998-2011) • **145,139** hectares of anthropogenic degradation (1998-2011) • **157,287** hectares of anthropogenic forest enhancement (1998-2011)
QA/QC procedures applied	Ortiz-Malavassi (2017) prepared a land cover evaluation protocol to reduce the uncertainty of the land cover classification due to: a) the bias associated with the spatial registration of the reference image, b) the interpreter bias in the assignment of the land cover class; and c) interpreter variability. The protocol includes the operational definition of the canopy coverage with examples taken from high-resolution images and registration templates for Collect Earth Desktop. The following procedures were applied during the collection of reference data: • **Data registry forms**: The canopy cover change information was recorded in standard Collect Earth Desktop forms. • **Variability between interpreters:** The analysts recorded screenshots, plot numbers, and a brief description of the problem in case of doubts with the interpretation (land cover and land-use). Every two days, they sent the log to other analysts for feedback. This feedback was available to all team members. Meetings will be held at the end of the week to discuss complex cases to reduce interpreters' variability. • **Validation of the coverage classification:** The supervisor validated land cover classification with National Forest Inventory land cover data. This information was available only for the supervisors. Imagery co-registration: Google Earth images can show displacements, which became evident when the interpreter compares the same area for different years. Potere (2008)[57] found that the average displacement in developing countries is 44.4 meters. When this problem occurred, the analyst noted the maximum displacement detected in meters in Collect Earth form. • **Data consistency:** The supervisor reviewed the existence of discrepancies between cover class and land use.
Uncertainty associated with this parameter:	In the assessment of degradation in remaining forests, it was assumed that there was no uncertainty associated with the visual interpretation of sample areas because this procedure employed visual classification of canopy cover using high-resolution imagery. Uncertainty of changes in canopy cover to identify areas of degradation and forest enhancement from 1998 to 2011 varies depending on the forest type and the conversion class. It is based on sampling error.
Any comment:	The reference data for estimating degradation activity and the calculation tool was updated. The canopy cover for plot 16749 was changed to 100%, and the formula in the “Deg_ems_antro_MP_16-19” tab was corrected to fetch data from the appropriate cells in the “Base_de_Datos” tab. For further details, consult section 1.3, **Methodological deviations**.

[57] Potere, D. (2008). Horizontal positional accuracy of Google Earth`s high-resolution imagery archive. In: Sensors, 8,12: 7973-7981 p. Retrieved from: http://www.mdpi.com/1424-8220/8/12/7973/htm

Table 3-3: Source of Emission Factors and description of the methods for developing the emission factors for deforestation.

Parameter:	**Above-ground biomass in trees (AGB.t) in Forest and Non-forest land uses ($C_{AGB.t}$) Eq. 11** **Above-ground biomass in non-trees (AGB.n) Non-forest land uses ($C_{AGB.n}$) Eq. 11** **Below-ground biomass in Forest and Non-forest land uses (C_{BGB}). Eq. 11** **Carbon stock of dead wood biomass in Forest and Non-forest land uses (C_{DWB}). Eq. 11** **Carbon stock of litter in Forest and Non-forest land uses (C_L). Eq. 11**
Description:	• **C_{AGB}**: Amount of carbon (C) contained in aboveground biomass per forest hectare, converted to CO_2e multiplying by a factor of 44/12 (i.e., the molecular weight of a CO_2 molecule over the molecular weight of a C molecule). • **C_{BGB}**: Amount of C contained in belowground forest biomass per forest hectare, converted to CO_2e multiplying by a factor of 3.67 (i.e., the molecular weight of a CO_2 molecule over the molecular weight of a C molecule). • **C_{DWB}**: Amount of C contained in dead wood forest biomass (standing and lying) per forest hectare, converted to CO_2e multiplying by a factor of 3.67 (i.e., the molecular weight of a CO_2 molecule over the molecular weight of a C molecule). • **C_L**: Amount of CO_2e contained in litter biomass per forest hectare.
Data unit:	Tonnes of CO_2 per hectare
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	**Introduction** The emission factor for deforestation of primary forest is derived from data collected during Costa Rica's first National Forest Inventory (INF-CR for its acronym in Spanish), and models or average values of direct measurements reported in literature. • **Carbon pool of aboveground tree or woody biomass (C_{AGB}):** Carbon pool of aboveground tree or woody biomass for each Primary Forest type (C_{AGB}) is the area-weighted average of C_{AGB} stock value from 2015 field campaign performed for the National Forest Inventory. The values assigned to non-forest lands are derived from a literature review. • **Carbon pool of belowground biomass (C_{BGB})**: Derived directly from C_{AGB} data following the Cairns et al., (1997) formula for forest lands uses. The values assigned to non-forest lands are derived from a literature review. • **Carbon pool of dead wood biomass (C_{DWB})**: Average values of direct measurements reported in literature. The value was used to develop a ratio of C_{DWB} over C_{AGB} used for AD_D, $AD_{F\text{-}F}$, and AD_R. The values obtained from the literature were used to develop an area-weighted average of DW:AGB ratios, assumed to be the same in primary and secondary forests. • **Carbon pool of litter (C_L):** Average values of direct measurements reported in literature. The value was used to develop a ratio of C_L over C_{AGB} used for AD_D, $AD_{F\text{-}F}$, and AD_R. The values obtained from the literature were used to develop an area-weighted average of L:AGB ratios, assumed to be the same in primary and secondary forests All C stock estimates from the consulted sources were compiled in tons of carbon per hectare (tC ha-1), using IPCC's default carbon fraction (0.47) when the values were reported in tons of dry matter (t d.m. ha^{-1}). All information related to C stock estimates, such as information on land use, number of sampling units, plot size, the allometric equation used, etc., were also recorded. For full detail please check BaseDeDatos_v5[58] and C-STOCKS sheet of FREL TOOL[59]. The literature review employed the following criteria for compiling the reported value: • The publication reported data from direct measurements carried out in Costa Rica • Measurements were carried out after the year 2005 • Data were sufficiently disaggregated by reporting values of carbon stocks per land use categories and per carbon pool sampled • The publications included information on uncertainties related to the carbon stock estimates

[58] BaseDeDatos_v5.xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/14xIYQbtETN0x_kpI3Qci8OVGiIRsWKV7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[59] The FREL Tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

The document C-STOCKS[60] compiles and documents carbon stock values used to estimate emission factors for forest and non-forest land uses in Costa Rica. This document supports transparency in carbon stock value selection and adjustment, drawing from various sources. It is organized by carbon pool and land-use category, providing a documented basis for reviewing and updating carbon stock assumptions in land-use and forest carbon accounting.
It focuses on the main above-ground carbon pools represented in the emission factor database, including above-ground biomass in trees, above-ground biomass in non-trees, dead wood, and litter. The tables summarize reported values in tonnes of carbon per hectare, identify the corresponding land-use or forest category, and provide the original source or supporting documentation for each value.

Source of Data of Above Ground Biomass for Primary Forest

Type of sampling: The INF-CR is a multipurpose inventory seeking to enhance the understating of Costa Rica´s forest resources and generate data to monitor and quantify their provision of ecosystem services, such as climate change mitigation. The INF-CR was led by the National Conservation Area System (SINAC) with measurements taken between 2013 and 2015. The INF-CR employed a stratified-systematic sampling approach covering the entirety of Costa Rica's continental territory. The stratification was based on a forest type map derived from Rapid Eye imagery (REDD/CCAD-GIZ-SINAC, 2015)[61] and plots were equidistantly allocated within each stratum.

Sampling Unit: Rectangularly shaped plots with an area of 0.1 ha (20m x 50m) distributed on fixed sample intensities by forest class. The sampling unit design allows the measurements of the following (Ministerio de Ambiente y Energía, 2015)[62]:

- Primary Sampling Unit (UMP for its acronym in Spanish) for measurement of live tree DBH and height of trees with DBH ≥ 10cm (light green area)
- Secondary Sampling Unit (UMS for its acronym in Spanish) for measurement of saplings with 2cm ≤DBH<10cm, and height >1.5m.
- Third-order Sampling Unit (UMT for its acronym in Spanish) for measurement of live non-tree vegetation, including seedlings (DBH<2cm and height<1.5m), were taken (light grey circles)
- Fourth-order Sampling Unit (UMC for its acronym in Spanish) to measure the abundance of species.
- Fifth-order Sampling Unit (UMH) to measure litter.
- Lying deadwood sampling (UMM) to measure the lying deadwood's diameter in the 20m transects.
- Soil sampling of the first 30cm with cylinder method.

Number of Sampling Units: The INF-CR installed a total of 286 single plots. Out of the 286 sampling units (SU), litter was sampled only in 54 and lying deadwood in 61 SUs. Because of inconsistent sampling of all carbon pools across all plots and lack of confidence in data where litter and deadwood, a decision to consider only aboveground biomass from INF-CR was made. Some SU presented zero as a result of litter and deadwood pools. It was not verified whether the SU represented the absence of litter and deadwood in the plots, or these carbon pools weren't sampled.

Source of Data of Above Ground Biomass for Secondary Forest

The AGB for secondary forest was estimated assuming the forest stand accumulated biomass since its restoration. The AGB of Wet and Rain Forests, Moist Forests and Dry Forests were estimated using the equations developed by Cifuentes (2008)[63] based on direct measurements in 54 plots located in age classes between 0 and 82 years. For Mangroves and Palm Forests, a linear function was assumed for estimating carbon stocks as a function of age.

Wet and Rain Forests (Cifuentes, 2008, Table 2.5, p. 42, equation for "*Tropical Wet*"):

[60] C-STOCKS document can be accessed at the following link: https://docs.google.com/document/d/1ORrAy2L65phuzwPnyc7JVt_jmh_wAfZ7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[61] Sistema Nacional de Áreas de Conservación (SINAC) - Programa REDD-CCAD-GIZ. (2015). Cartografía base para el Inventario Forestal Nacional de Costa Rica 2013-2014. Retrieved from https://www.sirefor.go.cr/pdfs/Documento-cartografia-Imprenta.pdf

[62] Ministerio de Ambiente y Energía. (2015). Volumen 4 Marco conceptual y metodológico para la Inventario forestal nacional de Costa Rica. Retrieved from https://www.sirefor.go.cr/pdfs/Volumen4-MarcoC-Imprenta.pdf

[63] Cifuentes, M. (2008). Aboveground Biomass and Ecosystem Carbon stocks in Tropical Secondary Forests Growing in Six Life Zones of Costa Rica (Oregon State University). Retrieved from https://drive.google.com/file/d/1FsiTVc78EHcU0gQ4JfFJFSlPqesm3JFW/view?usp=sharing

$$TAGB_t = B_{max} * \left[1 - e^{(-0.0186*t)}\right]^1$$

Moist Forests (Cifuentes, 2008, Table 2.5, p. 42, equation for "*Tropical Moist*"):

$$TAGB_t = B_{max} * \left[1 - e^{(-0.0348*t)}\right]^1$$

Dry Forests (Cifuentes, 2008, Table 2.5, p. 42, equation for "*Tropical Dry*"):

$$TAGB_t = B_{max} * \left[1 - e^{(-0.113*t)}\right]^{5.1411}$$

Mangroves and Palm Forest the following linear equation was applied:

$TAGB_t = \frac{B_{max}}{100} * t$, when t <= 100
$TAGB_t = B_{max}$, when t > 100

It was assumed that the maximum biomass in secondary forests (B_{max}) equals the biomass estimated for primary forests.

Source of data of Litter and Deadwood in primary and secondary forest

The carbon stocks of litter and deadwood were estimated based on a compilation of values from published literature.

Source of data of carbon stocks of non-Forest land uses

C stocks in these non-forest land uses were estimated as the average values reported by the selected studies. For full detail please check BaseDeDatos_v5 and C-STOCKS sheet of FREL TOOL.

- **Cropland:** carbon stock values reported in selected studies showed high variability, depending on crop type (sugar cane, coffee, banana, cocoa, etc.). For this reason, the carbon stock data compiled were weighted by the surface area of the respective crops in Costa Rica to produce a single estimate of carbon stocks from cropland.
- **Grassland**: carbon stocks were estimated as the average values reported in different carbon pools in the selected studies.
- **Settlements and (non-forested) Wetlands:** no studies could be found reporting biomass values for these categories. It was assumed that their carbon stock is zero.
- **Other Land:** studies were found reporting carbon stocks for Paramo. In the case of Bare Soil, it was assumed carbon stocks are zero.

Methods for estimating C stocks and Emission Factors

• **Above ground biomass (AGB)**: Above ground of forest biomass is calculated as 47% of the biomass dry weight of standing trees in the forest, which is calculated using allometric equations. Aboveground biomass of each measured tree was estimated using Chave et al., (2005)[64] moist forests allometric equation as follows:

$$AGB = \exp(-2.977 + \ln(\rho * DBH^2 * HT))$$

Where:

AGB: aboveground biomass (kg) ρ: wood specific gravity (g/cm³). Obtained from literature.

DBH: Diameter at breast height (cm)

HT: Tree height (cm)

AGB estimates at the tree level are then summed per plot, and extrapolated to a per hectare basis by applying a scaling factor of 10, which represents the proportion of a hectare (10,000 m²) that is occupied by the plot as follows:

$$ScalingFactor = \frac{10{,}000m^2}{1{,}000m^2} = 10$$

Where:

[64] Chave J et al. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145: pp. 87-99.

10,000m²: Area of one hectare (m²)

1,000m²: Area of INF-CR rectangular plot (20m x 50m)

• **Below ground biomass (BGB):** BGB is derived directly from Cairns et al., (1997)[65] equation, to estimate C_{BGB} from C_{AGB} data. This equation was applied to both, primary and secondary forests.

$$\mathrm{BGB} = \exp(-1.085 + 0.9256 * \ln(\mathrm{AGB}))$$

Where:

BGB: belowground biomass (t d.m. ha-1)

AGB: aboveground biomass (t d.m. ha-1)

• **C stocks of forest lands** correspond to the area-weighted average of C stocks by C pool and strata**.**

• **C stock changes** (ΔC) are estimated using the Stock-Difference Method by applying IPCC (2006) equation 2.5 (cf. Volume 2, Chapter 2, Section 2.2.1.).

Value applied:

Carbon stocks in primary forests, secondary forests, and non-forest land uses utilized in the calculation of emission factors

Land use	*AGB tCO2*ha-1*	*BGB tCO2*ha-1*	*DW tCO2*ha-1*	*L tCO2*ha-1*	*Total Biomass tCO2*ha-1*
Wet and rain-Primary Forest	459.42	102.45	49.50	10.05	621.43
Wet and rain-Secundary Forest (400 yrs)	459.15	102.40	58.23	5.12	624.90
Moist-Primary Forest	312.14	71.64	48.27	8.01	440.05
Moist-Secundary Forest (400 yrs)	312.14	71.64	48.34	7.14	439.26
Dry-Primary Forest	227.37	53.43	56.47	22.73	360.00
Dry-Secundary Forest (400 yrs)	227.37	53.43	27.27	21.96	330.03
Mangroves-Primary Forest	270.02	62.64	6.95	0.97	340.59
Mangroves-Secundary Forest (400 yrs)	270.02	62.64	6.85	0.73	340.24
Palm-Primary Forest	213.06	50.31	5.97	0.96	270.30
Palm-Secundary Forest (400 yrs)	213.06	50.31	5.97	0.96	270.30
Cropland-Annual	83.57	21.16	0.00	0.00	104.72
Cropland -Permanent (400 yrs)	83.79	22.22	1.20	7.59	114.80
Grassland	44.54	12.38	8.28	0.00	65.21
Settlements	0.00	0.00	0.00	0.00	0.00
Wetlands-Natural	0.00	0.00	0.00	0.00	0.00
Wetlands-Artificial	0.00	0.00	0.00	0.00	0.00
Paramo	126.87	31.13	0.00	0.00	158.00
Bare soil-Natural	0.00	0.00	0.00	0.00	0.00
Bare soil-Artificial	0.00	0.00	0.00	0.00	0.00

[65] Cairns M.A., Brown S., Helmer E.H., and Baumgardner G.A. (1997). Root biomass allocation in the world's upland forests. Oecologia 111:1-11.

QA/QC procedures applied	SINAC implemented the following QA/QC procedures during the National Forest Inventory of Costa Rica (for further details please see Ministerio de Ambiente y Energía, 2015)[66]: **Fieldwork organization**: SINAC organized the fieldwork by regions: North Pacific and Central Valley (PN-VC), Central Pacific and South Pacific (PS), North-Caribbean North Zone (ZN-CN), Central-South Caribbean (CC-CS), and complex sites (Talamanca mountain range). SINAC prepared terms of reference, describing each member of the field crew's roles and responsibilities. An experienced dendrologist was part of the work team, and a field manual was prepared for identifying, collecting, transport, and processing botanical samples. The Crew was trained before the start of fieldwork, and an Excel template was designed for data typing. **Fieldwork supervision:** During the NFI implementation, the coordinator made field visits to supervise the crews' work. A photographic registry of each plot was made. **Registry of information**: The field crew filed field forms and prepared reports of the activities. The crew chief and fieldwork director reviewed the field forms. The IFN steering committee did the final review. If the supervisor detected errors, omissions, or inconsistencies, the records were returned to the crew leader with observations for their correction or documenting the discrepancies; the dendrological inventory component coordinator reviewed questionable species identifications. Control procedures were applied to evaluate the coherence, integrity, and completeness of dasometric, dendrological, and positioning data. **Independent evaluation of forest inventory data quality:** A separate crew evaluated the quality of forest inventory data. The independent team made field visits and re-measures 10% of the plots established by stratum, both in the pre-sampling and inventory phase.
Uncertainty associated with this parameter:	AGB's uncertainty in primary forests is derived from sampling errors reported in the NFI and the literature. Since belowground biomass is a function of aboveground biomass, the belowground biomass values have the same level of uncertainty as the aboveground biomass. Uncertainty from values DWB and L is derived from values identified in the scientific literature. The statistical uncertainty reported in these documents takes into consideration the sampling error. As information on the uncertainty of the estimates was reported in different ways, it was necessary to standardize the reporting of uncertainties associated to the average C stock values by applying the following equation that assumes normal distribution of the data: $$E_{90\%,i} = 1.645 \times \frac{SD_i}{\sqrt{n_i}} = 1.645 \times SE_i$$ *Where:* $E_{90\%,i}$ *Error estimate at a 90% confidence level of the reference i; $tCO_2\ ha^{-1}$* SD_i *Reported standard deviation of the sample given for the reference i; $tCO_2\ ha^{-1}$* n_i *Sample size for reference I; number* SE_i *Standard error of the sample mean given for reference I; $tCO_2\ ha^{-1}$*

90% uncertainty associated to the estimated average carbon stocks

LAND USE	AGB TCO2*HA^{-1}	BGB TCO2*HA^{-1}	DW TCO2*HA^{-1}	L TCO2*HA^{-1}	TOTAL BIOMASS TCO2*HA^{-1}	TOTAL BIOMASS / STANDARD DEVIATION TCO2*HA^{-1}
WET AND RAIN-PRIMARY FOREST	25.69	5.73	8.75	0.94	27.76	16.87
WET AND RAIN-SECUNDARY FOREST (400 YRS)	25.69	5.73	3.26	1.18	26.54	16.14
MOIST-PRIMARY FOREST	8.55	1.96	23.25	1.04	24.87	15.12
MOIST-SECUNDARY FOREST (400 YRS)	8.55	1.96	37.10	1.74	38.16	23.20
DRY-PRIMARY FOREST	2.55	0.60	21.92	0.61	22.09	13.43
DRY-SECUNDARY FOREST (400 YRS)	2.55	0.60	7.50	0.70	7.98	4.85

66 Ministerio de Ambiente y Energía. (2015). Volumen 4 Marco conceptual y metodológico para la Inventario forestal nacional de Costa Rica. Retrieved from https://www.sirefor.go.cr/pdfs/Volumen4-MarcoC-Imprenta.pdf

MANGROVES-PRIMARY FOREST	23.18	5.38	2.05	0.24	23.88	14.52
MANGROVES-SECUNDARY FOREST (400 YRS)	23.18	5.38	2.47	0.22	23.92	14.54
PALM-PRIMARY FOREST	18.80	4.44	7.02	1.13	20.58	12.51
PALM-SECUNDARY FOREST (400 YRS)	18.80	4.44	7.43	1.14	20.72	12.60
CROPLAND-ANNUAL	9.69	2.45	0.00	0.00	9.99	6.08
CROPLAND -PERMANENT (400 YRS)	58.51	15.51	0.40	3.61	46.12	28.04
GRASSLAND	6.52	1.84	6.29	0.00	7.96	4.84
SETTLEMENTS	0.00	0.00	0.00	0.00	0.00	0.00
WETLANDS-NATURAL	0.00	0.00	0.00	0.00	0.00	0.00
WETLANDS-ARTIFICIAL	0.00	0.00	0.00	0.00	0.00	0.00
PARAMO	2.16	0.53	0.00	0.00	2.23	1.36
BARE SOIL-NATURAL	0.00	0.00	0.00	0.00	0.00	0.00
BARE SOIL-ARTIFICIAL	0.00	0.00	0.00	0.00	0.00	0.00

Any comment:

Carbon stock data for various land uses in Costa Rica were not correctly compiled or standardized to a 0.47 carbon fraction. Updates were necessary to the carbon stocks database to ensure literature data were correctly assigned and standardized to the 0.47 carbon fraction, including adjustments to values from Andrade et al. (2008), Somarriba et al. (2013), Nájera-Gómez (2011), and SINAC's NFI biomass data. These revisions resulted in changes to total biomass values, particularly for primary forests, and improved the traceability of the calculation methodology. For further details, consult section 1.3, **Methodological deviations**.

Table 3-4: Source of Emission Factors and description of the methods for developing the emission factors for forest degradation.

Parameter:	**Ratio AGB:Percent of canopy cover per forest type (R_C)**
Description:	**Canopy cover and biomass relationship (R_C)**: For each forest type, a ratio was estimated of aboveground biomass (in t CO_2e) to percent canopy cover based on direct measurements in 100 permanent forest plots. These ratios were used to estimate degradation and forest regeneration in forests remaining forests.
Data unit:	**Tonnes CO_2e ha^{-1} / % canopy cover**
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	**Introduction** Costa Rica estimated emissions from forest degradation using 100 temporary biomass plots covering all forest types, including wet, rain, moist, dry forests, mangroves, and palm forests. These plots were measured with the same method as the NFI to assess aboveground biomass. Biomass observations helped determine canopy cover and the biomass Ratio (R_c), which served as degradation emission factors. The canopy cover categories used are: intact forests with 85-100% cover, degraded forests with 60-85%, and very degraded forests with 30-59%. Forests transitioning from intact to degraded, intact to very degraded, or degraded to very degraded (based on canopy cover) between 1998-2011 were classified as degraded. Conversely, primary forests moving from very degraded to degraded, very degraded to intact, or degraded to intact were considered forest improvement areas. **Sample unit**: As Sampling Unit, the Primary Sampling Unit (UMP) of the National Forest Inventory was used to collect AGB field observations. The UMP has an area of 1000 m^2 on a rectangular plot of 20 x 50 meters. **Selecction of sampling units**: Rodriguez (2018)[67] and Coto (2018)[68] selected the points to visit for the assembly of the 100 temporary plots, distributed by canopy cover categories and forest type, using the canopy cover assessment over the level 1 systematic grid of SIMOCUTE, generated by Ortiz-Malavassi (2017) as input. It was considered that the changes in the canopy cover can be classified into four types of degradation: 1. Degradation at the edge of the forest, 2. Degradation by elimination of isolated trees, 3. Degradation by the elimination of trees in forest blocks, and 4. Degradation by eliminating trees in protection zones; Rodriguez and Coto avoided selecting sample points at sites with degradation at forest edges (types 1 and 4). Likewise, it was requested that the plot location reflect the corresponding canopy cover category. The following classes were identified in the first plot distribution exercise without sufficient sampling points: Dry Forest 20-40%, Mangrove 20-49% and 50-80%, and Palm forest 20-49% and 50-80%. Rodriguez and Coto used the level 2 systematic grid of SIMOCUTE to complete the plots' sample in these categories **Number of sampling units**: A total of 100 temporary plots were surveyed. Fifteen plots were set up in Palm forests, 36 in Wet and Rain forests, 15 in Moist forests, 19 in Dry forests, and 15 in Mangroves. Overall, 4,340 trees with a DBH greater than 10 cm were measured. The distribution of these plots across different forest types and canopy covers is summarized as follows:

67 Rodríguez, J. (2018). INFORME FINAL DE CONSULTORÍA Estudio de parcelas temporales para estimar el stock de carbono en bosques intactos, degradados y altamente degradados en zona A. (Contrato N°020-2018-REDD). Retrieved from https://drive.google.com/file/d/1dSyL8Dldwym5VN1jXpnAbmPovUW3AiTu/view?usp=sharing

68 Coto, O. (2018). INFORME FINAL DE CONSULTORÍA. Estudio de parcelas temporales para estimar el stock de carbono en bosques intactos, degradados y altamente degradados en zona B. (Contrato N°019-2018-REDD). Retrieved from https://drive.google.com/file/d/1svYPJGEoBHpLn72sg4ejpf6uZkp6lllM/view?usp=sharing

Forest Type	Canopy cover class			Total of SU – forest type
	20-49%	50-79%	80-99%	
Wet and Rain Forests	5	5	5	15
Moist Forests	12	14	10	36
Dry Forests	8	6	5	19
Mangroves	5	5	5	15
Palm Forests	5	5	5	15
Total SU-canopy cover class	35	35	30	100

Data collection: All trees, shrubs, palms, tree ferns, lianas, and vines with a Diameter at Breast Height (DBH) > 10 cm were measured following the protocols of the National Forest Inventory (Ministerio de Ambiente y Recursos Naturales, 2017). The following data were collected:

Scientific Name: registry of the genus and species of each inventoried tree. Lianas and vines were identified at the life-form level, and no samples were collected.

Species Code: National Forest Inventory code of the scientific name (genus and species).

Diameter: registry of diameter in centimeters and at breast height (1.3 m).

Total height: a registry of estimated total height for trees, shrubs, and palms; for vines and lianas, it is not assessed. The crew member who estimated the heights performed periodic calibrations using the clinometer.

Specific Gravity: the GE values were obtained directly from the Biomass estimation tool developed by SINAC and specialized publications (IPCC, 2003[69]; Myers, 2013[70]; Tree Functional Attributes and Ecological Database, 2018[71]).

Data analysis: The biomass and carbon content were calculated using the equation of Chave et al. (2014), with variables DBH, total height, and Specific Gravity (GE) for each individual. An Excel sheet was prepared with the database and the estimated AGB/canopy cover ratio for forest type (Calculo_FE_041220.xlsx[72]). The AGB/canopy cover ratio was estimated after excluding outliers. Cook's Distance (calculated in R) was used to identify outliers. Two points were removed from BMHP and BS, whereas only one outlier was identified in BH, M, and P.

Value applied:

Forest type	**R_c - Ratio Aboveground biomass (t CO_2e ha^{-1})/ % canopy cover**

[69] IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Intergovernmental Panel on Climate Change (IPCC). Edited by Jim Penman, J.; Gytarsky, M.; Hiraishi, T.; Krug, T.; Kruger, D.; Pipatti, R.; Buendia, L.; Miwa, K.; Ngara, T.; Tanabe K.; Wagner, F. IPCC National Greenhouse Gas Inventories Programme. Published by the Institute for Global Environmental Strategies (IGES) for the IPCC. 583 p.

[70] Myers, R. 2013. Fenología y crecimiento de Raphia taedigera (Arecaceae) en humedales del noreste de Costa Rica. En:Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 61 (Suppl. 1): 35-45

[71] Tree Functional Attributes and Ecological Database. (2018). Wood Density. Recuperado el 10 de 12 de 2018, de http://db.worldagroforestry.org/.

[72] Calculo_FE_041220.xlsx can be accessed in the following link: https://docs.google.com/spreadsheets/d/1aWA12ukXs8yQKlZa4PzKcrxKRieqokS1/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Wet and Rain Forests	4.94
Moist Forests	3.86
Dry Forests	3.00
Mangroves	3.19
Palm Forests	3.85

QA/QC procedures applied

The REDD+ Secretariat of Costa Rica implemented the following QA/QC procedures during the measurement of the 100 temporary plots (for further details, please see Rodriguez, 2018, Coto, 2018, and Obando, 2019):
Canopy cover assessments review: To reduce errors in the SU´s impairment category assignment, the image analyst reviewed Ortiz-Malavassi's (2017) database and consulted additional available image repositories, e.g., SAS Planet and Global Mapper.
Review of selected sampling points: the coordinator reviewed the selected sampling points to ensure that SU corresponds to the degradation category.
Review of field information: Once the field measurement work was finished, the field crew chief verified that every tree, shrub, palm, etc., with DBH > 10 cm had been measured and had the paint mark. Also, the crew chief verified that the plot's central point was recorded in the GPS with the required precision and that the access track was recorded for its location.
Registry of information: The field forms were reviewed and digitized daily to minimize errors during field measurements and during the digital recording of data. The collection of all measured trees was managed in an MS Excel template. The data analyst daily reviewed the field forms to identify inconsistencies. If any errors were detected, the data analyst requested clarification from the crew chief.
Independent evaluation of forest inventory data quality: A separate crew evaluated the data's quality. The independent team made field visits and re-measures 5% of the plots (see Annex 1 in Obando, 2019)[73].

Uncertainty associated with this parameter:

The uncertainties were calculated from the standard deviations of the identified relationships.

Forest type	**Uncertainty of R_c (%)**
Wet and Rain Forests	17%
Moist Forests	22%
Dry Forests	17%
Mangroves	32%
Palm Forests	41%

Any comment:

Canopy cover and aboveground biomass ratios (RC) were estimated for Palm, Dry Forest, Wet Forest, and Rainforest types using data from 100 temporal plots. Discrepancies in canopy cover data across 10 plots were corrected, resulting in recalculated degradation emission factors. While the corrected values fall within the confidence limits of the original factors, updated emissions are now available. For further details, consult section 1.3, **Methodological deviations**.

[73] Obando, G. (2019). COORDINACIÓN GENERAL DE LA IMPLEMENTACIÓN DEL PLAN DE MEJORA DEL NIVEL DE REFERENCIA. Tercer Informe de
Consultoría N ° 016-2018-REDD. Retrieved from
https://drive.google.com/file/d/1MEHZ6dvQKY52X58UtlG02o4Uw9x1HV6v/view?usp=sharing

3.2 Monitored Data and Parameters

Table 3-5: Source of Activity Data and description of the methods for developing the data for estimate emissions from deforestation, degradation and carbon removals during the monitoring periods.

<table>
<tr><td>Parameter:</td><td>Activity Data of Deforestation (AD_D) Eq. 12.1
Activity Data of Reforestation (AD_R) Eq. 12.2
Forest remaining forests (AD_{F-F}) Eq. 12.3</td></tr>
<tr><td>Description:</td><td>Deforestation: Hectares of forest that changed to non-forest land in a year summed each year (i) of the monitoring period.
Reforestation: Hectares of non-forest that changed to forest land in a year, summed for each year (i) of the monitoring period.
Forest remaining forests: Hectares of Forest remaining forests in a year, summed for each year (i) of the monitoring period</td></tr>
<tr><td>Data unit:</td><td>Hectares</td></tr>
<tr><td>Value monitored during this Monitoring / Reporting Period:</td><td>Table 3-6: Value monitored during the Monitoring Periods (ha*year^{-1})
<table><tr><th>Period</th><th>2018-2019</th><th>2020-2021</th><th>2022-2024</th></tr><tr><td>Total anthropogenic deforestation (ha*year^{-1}):</td><td>5,387</td><td>4,467</td><td>3,801</td></tr><tr><td>Primary forest anthropogenic deforestation (ha*year^{-1}):</td><td>1,444</td><td>383</td><td>448</td></tr><tr><td>Secondary forest and tree plantation anthropogenic deforestation (ha*year^{-1}):</td><td>3,943</td><td>4,083</td><td>3,354</td></tr><tr><td>Non-forest converted to forest (ha*year^{-1}):</td><td>2,087</td><td>2,836</td><td>9,040</td></tr><tr><td>Primary forest at the end of the period (ha):</td><td>2,194,811</td><td>2,193,953</td><td>2,192,459</td></tr><tr><td>Secondary Forest at the end of the period (ha):</td><td>922,024</td><td>916,678</td><td>922,768</td></tr></table></td></tr>
<tr><td>Source of data and description of Measurement/ca</td><td>Introduction
A consistent and uniform methodology was used both for FREL / FRL and for the monitoring periods forest emission estimate to avoid that deforestaton and regeneration registered in the cartographic comparison of LULC maps were affected by the combination of different techniques and methods. Córdoba-Peraza, (2020b;2023[74]) prepared the LULC Maps 2017, 2019, 2021 and 2024 of Costa Rica (MCS 2017/18[75], MCS 2019/20[76], MCS 2021/22[77], MCS 2024/2025[78]), following the satellite land</td></tr>
</table>

[74] Córdoba-Peraza, J. (2023). INFORME FINAL MAPA DE COBERTURA Y USO DE LA TIERRA 2021 DE LA SERIE HISTÓRICA DE COSTA RICA SECRETARIA REDD +. Retrieved from https://drive.google.com/file/d/14pihK3Lqt622Mziv1qF2qz-IB6Ta-RtG/view?usp=sharing

[75] LULC map 2017 (MCS 2017/2018) can be accessed at the following link: https://drive.google.com/drive/folders/1MxVxcEbBVgjG3yVuDNJlrEFxvX1uTnfy?usp=sharing

[76] LULC map 2019 (MCS 2019/20) can be accessed at the following link: https://drive.google.com/drive/folders/1NRxm3yRV6yT1NgLwhp_z00wxyA0fpMdx?usp=sharing

[77] LULC map 2021 (MCS 2020/21) can be accessed at the following link: https://drive.google.com/drive/folders/19nhF3IXjVpS6EEuGfhCnS-HiQdI4A5RB?usp=sharing

[78] LULC map 2024 (MCS 2024/25) can be accessed at the following link: https://drive.google.com/drive/folders/1mAVYtMKofxMQxHz0pTznS_OxsDhMKP3p?usp=sharing

lculation methods and procedures applied:	monitoring protocol (SLMP) developed by AGRESTA (2015) and the protocol for postprocessing developed by Carbon Decisions International (Ministry of the Environment and Natural Resources of Costa Rica, 2016). The geodatabase's table of uses, types, and ages of the forest was updated in each LULC map. To automate the workflow, AGRESTA (2015) generated the toolkit ***REDD tools Costa Rica package***. This toolbox runs on the geographic information system QGIS for the Microsoft Windows operating system. The programs were compiled in the QGIS Processing framework[79] allowing to run geoprocessing algorithms implemented in software libraries external to QGIS. The following libraries are used: • GRASS GIS (https://grass.osgeo.org/) • Orfeo Toolbox (https://www.orfeo-toolbox.org/) • GDAL (https://gdal.org/) It was necessary to migrate the toolkit to updated versions of QGIS and update the libraries to 64-bit versions to be able to work with recent versions of Windows, QGIS, and IMN equipment. The updated guide for installing the software tools and the necessary programs to prepare Land-use maps can be consulted in Annex 1 of the Córdoba-Peraza (2019) report[80]. It is important to note that none of these updates results in a change in methodology. The land use maps were created using the methodology summarized here; further information may be found in separate reports[81,82,83,8485,86] . **Data sources for estimating activity data:** The construction of the AD time series required the following sources of data: i. Remotely sensed data from Landsat 8 OLI/TIRS. ii. Mask of the country (in raster format) generated from the map MCS 2013/14 iii. The previous LULC map and the Forest type map (MTB), created by AGRESTA (2015), were used to refine the spectral classification results of remotely sensed data. These maps also helped further categorize the five forest types—"Wet and Rain Forests," "Moist Forests," "Dry Forests," "Mangroves," and "Palm Forests"—into sub-categories of "primary" and "secondary forests." iv. Additionally, the Global Forest Change project (Hansen et al., 2013) was utilized to fill gaps in the land-use classification mosaics for all LULC maps. **Methods for mapping land-use and land-use change** • **Selection of images:** Creating a LULC map for a specific year in Costa Rica requires mosaicking cloud-free images. Costa Rica uses Landsat imagery for LULC maps, but frequent cloud cover due to its geography and climate poses a challenge. The dry season, ideal for remote sensing, varies regionally, with the Pacific Coast experiencing the most intense and prolonged dry season.

[79] https://docs.qgis.org/2.8/en/docs/user_manual/processing/

[80] Córdoba-Peraza, J. (2019). Informe final Elaboración del mapa de cobertura y uso de la tierra en Costa Rica 2015. Retrieved from https://drive.google.com/file/d/14rmbzUdfHL9Zw62PQtbVmbY6blbIm79U/view?usp=sharing

[81] Córdoba-Peraza, J. (2020a). Informe final Elaboración del mapa de cobertura y uso de la tierra en Costa Rica 2017. Retrieved from https://drive.google.com/file/d/12u_wsP4Z1ndCDPmSa8RrTpGqZ0NRMveO/view?usp=sharing

[82] Córdoba-Peraza, J. (2020b). Informe final Elaboración del mapa de cobertura y uso de la tierra en Costa Rica 2019. Retrieved from https://drive.google.com/file/d/1WPr46RFOu_1Vr5rAYO_QDUlaL090zWd3/view?usp=sharing

[83] Córdoba-Peraza, J. (2023). Informe final Elaboración del mapa de cobertura y uso de la tierra en Costa Rica 2021. Retrieved from https://drive.google.com/file/d/14pihK3Lqt622Mziv1qF2qz-IB6Ta-RtG/view?usp=sharing

[84] Córdoba-Peraza, J. (2026). Informe final Elaboración del mapa de cobertura y uso de la tierra en Costa Rica 2024. Retrieved from https://drive.google.com/file/d/1ZNAeHtNKDJswMMHu5NeCs_iC3DdHgvkI/view?usp=sharing

[85] Agresta, Dimap, Universidad de Costa Rica, Universidad Politécnica de Madrid. 2015. Final Report: Generating a consistent historical time series of activity data from land use change for the development of Costa Rica's REDD plus reference level: Methodological Protocol. Report prepared for the Government of Costa Rica under the Carbon Fund of the Forest Carbon Partnership (FCPF). 44 pp. https://www.dropbox.com/s/ygjw6zq00a1qtbm/Informe_tecnico_feb_2015.pdf?dl=0

[86] Ministry of the Environment and Natural Resources of Costa Rica. (2016). Modified REDD+ Forest reference emission level/forest reference level (FREL/FRL). COSTA RICA. SUBMISSION TO THE UNFCCC SECRETARIAT FOR TECHNICAL REVIEW ACCORDING TO DECISION 13/CP.19. Retrieved from https://redd.unfccc.int/files/2016_submission_frel_costa_rica.pdf

Costa Rica selected Landsat sensor imagery to develop land-use and land-cover (LULC) maps because of the availability of images from the ER-Program reference period. A primary challenge in using remote sensing imagery in Costa Rica is the frequent cloud cover. Costa Rica's constant cloud cover results from its location between the Caribbean and Pacific Oceans, which provides moisture, and its mountainous terrain, which causes orographic lift. The Intertropical Convergence Zone (ITCZ) and convection also play a significant role in cloud formation, leading to diverse microclimates and shaping the country's ecosystems[87].

The sunniest and least cloudy period in Costa Rica occurs during the dry season. However, this pattern is not uniform across the country. The Pacific Coast experiences the most intense and prolonged dry season. In the Central Valley of Costa Rica, the dry season generally runs from December to the end of April. The Caribbean Coast (Tortuguero, Puerto Viejo) follows a different climate pattern. It doesn't have a clearly defined dry season like the Pacific and Central Valley. Its driest periods are typically September and October, coinciding with the rainiest time of year for the rest of the country.

To create a cloud-free image mosaic, a time window was chosen to align with the start of the calendar year at the beginning of the monitoring period. Therefore, the Landsat image acquisition period was set from June of year 1 to June of the following year. This timeframe was selected to ensure the midpoint falls on January 1st, the start of the calendar year.

Costa Rica prepared the FREL/FRL using a time series of satellite images from 1987 to 2013. To prepare the LULC maps for 2017, 2019, 2021, and 2024, LANDSAT 8 OLI/TIRS images were used. The analyst downloaded the satellite data through the USGS Earth Explorer server. To cover the continental territory of Costa Rica for each year in the series, seven Landsat scenes were used: two scenes from path 14, rows 53 and 54; three from path 15, rows 52, 53, and 54 (see Figure 3-1); and two from path 16 (rows 52 and 53). Low-cloud-coverage Landsat images were combined to minimize the area covered by clouds and cloud shadows. In most cases, scenes were selected from the same year and season, but in some cases, scenes from different years within a 13-18-month timeframe were necessary.

- **Pre-processing and geometric validation**: It was not necessary to rectify the Landsat 8 images supplied by the USGS. These images have a 1T processing level (Terrain corrected), a systematic geometric correction using ground control points for image registration with a WGS84 map projection. These also include correction of relief changes. A mask of the country (in raster format) generated from map MCS 2013/14 of the geodatabase was used to ensure that all LULC maps are consistent in area, pixel resolution, and dimensions (same number of columns and rows X, Y) with the maps of the 1997-2013 time series. All LULC maps have the same number of columns and rows (c 14554, r 14089) and a spatial resolution of pixels in XY (29.99951157, 29.9995115) to compare them geographically and to obtain the land-use change matrix. Also, a mask of clouds and shadows was prepared to improve the classification. According to the SLMP protocol in Agresta (2015), GRASS "r.mapcalculator" in QGIS 2.4 should have been used for cloud and shadow masking, as well as a SAGA majority filter. However, Fmask 4 (https://github.com/gersl/fmask) was used since this tool is an improved software for the generation of cloud and shadow masks in Landsat and Sentinel images. Finally, all those pixels that do not belong to the country's continental territory were included in the mask of clouds and shadows.
- **Radiometric normalization:** All images were radiometrically normalized. This process is applied to reduce radiometric differences between images due to atmospheric conditions and the sensors' calibration at image acquisition dates. The conversion of digital values (6-

[87] https://www.noaa.gov/jetstream/tropical/convergence-zone .

band images) to reflectance was made using "Obtain reflectance" tool included in REDD tools Costa Rica package. The time normalization of the images was performed using the zenithal reference angle with a value of 36.90°, corresponding to February 17, 2013. For this procedure, "time normalization" of REDD tools Costa Rica package was used. Finally, for the radiometric normalization of the images, the tool "Radiometric Normalization" of REDD tools Costa Rica was used.

- **Random Forest Classification**: The images are classified using the Random Forest (RF) method. This methodology has 2 phases: (1) training or adjustment of the RF and (2) classification of the images using the generated RF classifier. Homogeneous regions of interest have been digitized according to the land cover classes between 2011 and 2014 (see Table 3 of Agresta, 2015) for the models' adjustment. The base information used for the digitization and photointerpretation of these regions has been i) the systematic grid of cover points taken on the RapidEye images by SINAC for the elaboration of the map of forest types of Costa Rica 2013 (10,000 points distributed in the national territory), ii) the RapidEye high spatial resolution images themselves, and iii) both current and historical images available on Google Earth. Control points for RF training have been randomly generated from these regions of interest. In total, 20 predictor variables (also called covariates or auxiliary variables) were used for the adjustment of the RF models, divided into four groups: (1) Spectral information of the bands, (2) Indices of vegetation, (3) Variables related to the texture of the image, and (4) Variables derived from the Digital Elevation Model. The analyst applied the classifiers to all the images according to their path and sensor. The result is a classification file for each classified image.

Postprocessing.

Final maps are provided at a resolution of 30 meters. The process of preparing these final maps from the classified images involved the following tasks:

i. **Union of the mosaic** for each date from the classified images using a pixel prioritization algorithm. The analyst merged all the different images' classifications for each of the dates and paths, eliminating the extreme strip of the paths overlapping. If the classifier predicts several classes for the same pixel, the most common category was selected, according to band 2 of the results.

ii. **Filling gaps with global products**: The Global Forest Change project (Hansen et al., 2013) has been used to fill in pixels without information in the mosaic of classifications for each year of the series between 2000 and 2012.

iii. **Multi-temporal analysis**: the multi-temporal analysis of the series allowed assigning the age class to each of the forest pixels, analyzing the years that have elapsed from the date of appearance of a new forest. The forest from 1987 has been considered a primary forest. Also, the multi-temporal analysis improved land-uses classification, especially when the land cover has similar spectral information. The classifier confused native forests with forest plantations. For this reason, the forest plantations were reclassified as forest.

iv. **Minimum mapping unit**: The analyst replaced Forest Class groups of pixels smaller than 11 pixels with the LULC class of the largest neighboring group to comply with the minimum area threshold of the definition of "forest (1.00 ha) and setting the minimum mapping unit. Due to the pixels' dimensions in the Landsat images (30.00 m x 30.00 m), the minimum mapping area is 0.99 ha, equivalent to 11 pixels (11 x 30.00 m x 30.00 m).

v. **Manual editions**: To improve land use mapping, several editions were made, largely aimed at decreasing high classification errors (for more detail please see section 4.3.3 in Ministry of the Environment and Natural Resources of Costa Rica, 2016[88]):

f. "Forest Plantations" were merged with the "Forest land" category. This means that although initially classified as a separate class, @Forest Plantations@ presented a very high classification error and, for purpose of GHG estimation, it was treated as Forest land".

g. For estimating the area of "Coffee Plantations", the analyst used ancillary maps from the Ministry of Agriculture (MAG), the Costa Rican Coffee Institute (ICAFE), and the Costa Rican Meteorological Institute (IMN). These maps were used to correct the classified areas for the years 2000/01, 2007/08, 2011/12, and 2013/14. For previous maps, a mask representing potential "Coffee Plantation" areas was created using the location and elevation of all areas mapped as "Coffee Plantations" considering all available sources of information (MAG, ICAFE, and IMN).

h. Paramo, Mangroves and Palm forests are ecosystems restricted to particular elevation, edaphic, inundation, and salinity conditions; it is challenging for such ecosystems to exist in other locations. Therefore, these forests were re-classified using the map of Forest types (MTB), prepared by Agresta (2015). All masks representing "Mangroves", "Palm Forests" and "Paramo" have been compiled in a map of masks that will be kept in order to enable consistent map editions in future measurement and reporting.

i. Areas classified as "Urban Areas" in 2013/14 were manually edited through visual interpretation of 2013 high resolution RapidEye images and creation of a mask representing "Urban Areas" in 2013/14. Pixels originally classified as "Urban Areas" outside the mask were reclassified as "Bare Soil" and conversely, pixels classified as "Bare Soil" inside this mask were reclassified as "Urban Areas". Additionally, under the assumption that "Urban Areas" never convert to other land use categories, all pixels

j. A map of potential forest types was created to assign secondary forests to a forest type (Wet and Rain Forests, Moist Forests, Dry Forests, Mangroves, Palm Forests). This map will also be used in future measurements for determining the forest type of secondary forests. The map of potential forest types was created by combining the life-zones and then overlapping the map of the masks of potential areas of "Mangroves", "Palm Forests", and "Paramo".

Activity Data (AD) Calculation.

AD for land use change activities, such as deforestation and reforestation, was estimated by geographically comparing LULC maps created for 2017, 2019, 2021, and 2024 in a Geographical Information System (GIS) and then extracting, from the combined set of multi-temporal data, the values of the areas that remained in the same category or converted to other land use categories. The results of this operation are reported in land-use change matrices prepared for each measurement period on the sheets “LCM 2018-19”, “LCM 2020-21”, and “LCM 2022-24” of the “FREL TOOL CR” spreadsheet tool. It is essential to clarify that areas in the land use change matrices are calculated using a rounded pixel size of 30 × 30 m. Note that the 7-digit resolution of LCM maps 2017, 2019, 2021, and 2024 is 29.9995116 meters by 29.9995116 meters, and the difference between the raster resolution and the final resolution used in the land use change matrices is 0.49 mm in X and 0.49 mm in Y..

- **Annualization of activity data:** For monitoring periods where the midpoint of the imagery selection window for both the initial and final land-use maps aligns with either the start or

[88] Ministry of the Environment and Natural Resources of Costa Rica. (2016). Modified REDD+ Forest reference emission level/forest reference level (FREL/FRL). COSTA RICA. SUBMISSION TO THE UNFCCC SECRETARIAT FOR TECHNICAL REVIEW ACCORDING TO DECISION 13/CP.19. Retrieved from https://redd.unfccc.int/files/2016_submission_frel_costa_rica.pdf

end of the calendar year, the activity data is annualized by dividing the area that was deforested or regenerated during that period by the total number of years in the monitoring period (see Eq 2 and 3).

The LULC_SpectralSampling_FCPF.xlsx[89] file details the imagery dataset used for LULC maps from 1992 to 2024. Table 1.3-1 summarizes the imagery sampling window, midpoint, and image count for each LULC map. Monitoring periods were shifted to the midpoints of the spectral sampling windows, and interpolation adjustments were made for 1997, 2000, 2008, 2011, and 2022, since these midpoints do not align with the calendar year start or end. For example, the interpolation used to calculate the activity data (deforestation/forest gain) for the calendar year 2008 (AD_{2008}) was performed using the equations below. It is important to note that the Activity Data calculation tool FREL & MRV TOOL CR was updated with this interpolation process for the years 1997, 2000, 2008, 2011, and 2022. Therefore, the subsequent calculation of emissions from deforestation and degradation, as well as removals, was also updated.

$$AD_{2008} = A + B \quad \textbf{Equation 1,} \text{ where } AD_{2008} \text{ units are hectares}$$

$$AD_{annual\ 01-07} = \frac{AD_{Period\ 01-07}}{\Delta T_{Period\ 01-07}} \; ; AD_{annual\ 07-11} = \frac{AD_{Period\ 07-11}}{\Delta T_{Period\ 07-11}} \; ; \textbf{Equations 2 and 3}$$

$$\Delta T_{Period\ 01-07} = t_{07} - t_{01} \text{ , } \textbf{Equation 4}, \text{ where } t_{07} = (1/4/2008),\ t_{01} = (1/11/2000), \text{ and } \Delta T_{Period\ 01-07} \text{ units are years}$$

$$\Delta T_{Period\ 07-11} = t_{11} - t_{07} \text{ , } \textbf{Equation 5}, \text{ where } t_{11} = (1/8/2011),\ t_{07} = (1/4/2008), \text{ and } \Delta T_{Period\ 07-11} \text{ units are years}$$

$$A = AD_{annual\ 01-07} \times YF_A \quad \textbf{Equation 6}, \text{ where } YF_A = (1/1/2008) - t_{07} \text{ in years}$$

$$B = AD_{annual\ 07-11} \times YF_B \quad \textbf{Equation 7}, \text{ where } YF_A = t_{07} - (31/12/2008) \text{ in years}$$

Table 1.3-5: Imagery sampling window, midpoint of the window, and number of images selected for each LULC map in the REDD+ time series of Costa Rica ER-Program.

LULC map	Sampling window	Months	Midpoint of the sampling window	Number of images selected	% of images within the June-to-June window
MCS 1991/1992	March 15, 1991 – April 3, 1992	12	December 1st, 1991	28	68%
MCS 1987/1998	November 16, 1996 – April 19, 1998	17	August 1st, 1997	61	51%
MCS 2000/2001	December 31, 1999 - June 15, 2001	18	November 1st, 2000	41	61%
MCS 2007/2008	December 9, 2007 – April 27, 2009	17	April 1st, 2008	47	51%
MCS 2010/2011	November 6, 2010 – March 25, 2012	17	August 1st, 2011	49	51%
MCS 2012/2013	January 7, 2013 – April 8, 2014	15	January 1st, 2014	78	85%
MCS 2014/2015	August 1st, 2015 – June 16, 2016	11	January 1st, 2016	56	100%
MCS 2017/2018	June 19, 2017 – June 13, 2018	12	January 1st, 2018	70	100%
MCS 2019/2020	June 2, 2019 – June 11, 2020	12	January 1st, 2020	69	100%
MCS 2021/2022	June 5, 2021 – June 10, 2022	12	February 1st, 2022	79	100%
MCS 2024/2025	January 24, 2024 – December 17, 2025	22	February 1st, 2024	91	98%

[89] LULC_SpectralSampling_FCPF.xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/1FCXafLDt4bNo6OJCIwz4l08ha2Cm03-p/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

QA/QC procedures applied:	The QA/QC procedures used in preparing the land-use maps for calculating AD during the reference period are summarized here. Additional details are available in Agresta (2005), Sections 3, 4, and 7. **Download and satelite image preparation:** 1. Verification of file storage errors in digital media that could affect reading the data by the analyst responsible for download support images. 2. Previewing and verification of the satellite image quality and metadata by the analyst responsible for downloading support images. 3. Previewing and verification of the satellite image quality and metadata by the supervisor. **Image orthorectification:** **4.** Landsat 8 images are already orthorectified, therefore it was not necessary to apply the QA / QC procedure. **Radiometric normalization*:*** 5. Radiometric normalization to minimize differences across time-series images **Generation of cloud and shadow masks** 6. The cloud and shadows mask were not validated with checkpoints. Instead, the analysts performed an exhaustive visual inspection. **Land use classification** 7. Analysts perform an iterative process of classification, verification of results, error detection, and review of areas and training points. 8. Progressive improvement of the areas and training points of the RF classifier before the final classification of the images. Review of the Random Forest classifiers' errors, identify classes that need improvement, and training points. 9. Visual verification and validation of classified images by comparing them with the available high-resolution image. **Preparation of land-use maps**: 10. Visual inspection of mosaics to identify information gaps and sensor failures in each time-series image. 11. Visual inspection of the maps produced after filling gaps with global data.. 12. Analysts perform an independent validation of the land-use change maps by using ground validation points supplied by the country's institutions, which were not involved in the classification process. 13. Manual editing of the time-series classification to enhance land use mapping, mainly targeting the reduction of significant classification errors. **Visual verification and validation of land-use change map:** 14. Visual verification of the country's main deforestation and reforestation areas between consecutive years of the series to detect classification errors. 15. Validation of land-use changes between 2018-2019, 2019-2021, and 2022-2024 is based on photointerpretation of changes on a systematic random grid of points using high-resolution images from 2017, 2019, 2021, and 2024.
Uncertainty for this parameter:	Uncertainties associated to AD are due to the production process of land-use maps. The uncertainties of the AD for land-use change activities (deforestation and reforestation) and forest remaining forest activities (degradation and enhancements in forest lands) come from the uncertainties associated with the process creating land use change maps from which the activity data are obtained. The accuracy assessment of the land-use change maps 2018-2019, 2020-2021 and 2022-2024 was done following Olofsson et al.'s (2014)[90] guidelines. Reference data were collected by Ortiz-Malavassi (2020)[91],

[90] Olofsson et al. (2014) Good practices for estimating area and assessing accuracy of land change. Remote Sensing of Environment 148, 42-57.
[91] Ortiz-Malavassi, E. (2020). Apoyo técnico para el registro de datos de cambio de uso del suelo mediante el método de Evaluación Visual Multitemporal (EVM) para el periodo 2018-2019. Retrieved from https://drive.google.com/file/d/1Bcv8qTLH8TGkbvYQpIPIGhAJ2xbzIYk8/view?usp=sharing

Aguilar, L. (2023) [92], and Aguilar, L. (2025)[93]. The following is a summary of the sampling design for the collection of Refence Data:

- **Type of sampling**: Systematic sampling (SYS) over the level 1 systematic grid of 10,325 points of the Monitoring System of Land Use Change and Ecosystems (SIMOCUTE). The SIMOCUTE sampling units are permanent, facilitating reinterpretation through time and easy temporal tracking of LULUC.
- **Sampling Unit (SU):** The SU is a 2-ha square plot with a 5x5-point subgrid (25 points within the sampling plot) for the 2018-2019 land use change map. For the periods 2020-2021 and 2022-2024, the SU is a 1-ha square plot with a 7x7-point subgrid (49 points within the sampling plot). A unique land-use dominance class is recorded at the SU level for t1 and t2. The change class is calculated using the dominance classes at t1 and t2 at the SU level.
- **Number of Sampling Units:** A total of 9,988 (2018-2019), 10,241 (2020-2021) and 10,005 (2022-2024) reference data plots with land-use information were assessed in the country's territory (excluding Cocos's Island).
- **Classification scheme:** Due to the large number of land-use change transitions, they were aggregated into four categories: deforestation (forest to non-forest), new forests (non-forest to forest), stable forest (forest remaining forest), and stable non-forest (non-forest to non-forest).
- **Data sources:** The reference data for validating land-use changes was collected from the visual interpretation of high-resolution images; during the visual interpretation, priority was given to the high-resolution images available on Google Earth. In the absence of images of less than 4 m resolution, the Planet images available in the NICFI Program were used, and in the second instance, Sentinel-2 or Landsat 8 within the priority dates.
- **Data analysis:** The Stratified sampling tool for area estimation, developed by the FAO Open Foris project and available at https://github.com/openforis/accuracy-assessment, was used to calculate land-use change adjusted areas.
- **Monte Carlo Simulation**: In Monte Carlo simulations for uncertainty analysis, it is good practice to use the standard deviation—or, for sample-based estimation areas, the standard error—to define the probability distribution of input variables. To minimize the risk of over-crediting, the Participant therefore chose, in the Monte Carlo simulation for Deforestation and Regeneration, to use as the error metric the higher of the bias (difference between pixel count and adjusted area estimates) or the standard error (see Table below).

Parameter	2018-2019		2020-2021		2022-2024	
Deforestation	20%	%EE	22%	%EE	22%	%Bias
Non-forest land that has been converted to forest land	36%	%EE	29%	%EE	16%	%EE
Forests remaining forests	0.6%	%EE	0.6%	%EE	0.6%	%EE

[92] Aguilar, L. 2023. Evaluación Visual Multitemporal (EVM) para la determinación de la degradación forestal en los puntos de la malla sistemática de puntos del SIMOCUTE N1 correspondiente al bosque permanente para el periodo 2019-2021 y recolección de datos de cambio de uso de suelo con datos de referencia recolectados mediante EVM con la malla sistemática de puntos del SIMOCUTE N1 sobre imágenes de alta resolución. II Informe. Procedimiento Operativo Estándar. Retrieved from https://drive.google.com/drive/folders/1AA7GKA--SpT2hxbGMPCsg3QKYOSxVnYT?usp=sharing

[93] Aguilar, L. 2025. Informe. Procedimiento Operativo Estándar. Evaluación del cambio de la cobertura de la tierra basado en puntos de muestreo para los períodos 2019-2021 y 2021-2024. Retrieved from https://drive.google.com/file/d/1HBiAikAm_4uNmPTOfpyVam8SeSf8C4fa/view?usp=sharing

Any comment:	Costa Rica revised the annualization of activity data for its REDD+ time series because cloud cover affected Landsat imagery. The revision adjusted monitoring periods to the midpoint of the spectral sampling window and interpolated data for years when the midpoint didn't align with the calendar year. This led to minor variations in secondary forest areas and more significant discrepancies in deforested areas, affecting emissions calculations. For further details, consult section 1.3, **Methodological deviations**.

Table 3-7: Sources of Activity Data and descriptions of the methods used to develop the data for estimating emissions from degradation during the monitoring period.

<table>
<tr><td>Parameter:</td><td>Activity Data of Degradation (AD_{Deg}) Eq 12.4
Activity Data of Permanent Forest Regeneration (AD_E) Eq. 12.5</td></tr>
<tr><td>Description:</td><td>Degradation: Hectares of forest with a reduction of canopy cover during the monitoring period.
Forest Enhancement: Hectares of forest with an increase of canopy cover during the monitoring period</td></tr>
<tr><td>Data unit:</td><td>Hectares</td></tr>
<tr><td>Value monitored during this Monitoring / Reporting Period:</td><td>Table 3-8: Value monitored during the Monitoring Periods (ha)
<table><tr><th>Period</th><th>2018-2019</th><th>2020-2024[1]</th></tr><tr><td>Forests remaining forests in the monitoring period</td><td>2,194,811</td><td>2,192,459</td></tr><tr><td>Anthropogenic forest enhancement</td><td>40,141</td><td>89,254</td></tr><tr><td>Anthropogenic forest degradation</td><td>56,308</td><td>96,552</td></tr></table>[1] As implemented for the reference period, the monitoring periods for degradation in the crediting period differ from the deforestation/regeneration activity data. For degradation, the monitoring for the periods 2020-2021 and 2022-2024 was conducted in a single monitoring period from 2020 to 2024.</td></tr>
<tr><td>Source of data and description of Measurement/calculation methods and procedures applied:</td><td>Introduction
The forest degradation assessment was made on forest lands that remain as forest lands. The analysis of degradation was only performed on the area of forest remaining forest at the start of the monitoring periods 2018-2019 and 2020-2024, to avoid double-counting of baseline emissions between deforestation and forest degradation. This procedure avoided any measurements of degradation that were also accounted for under deforestation. Reference data to estimate Degradation AD were collected by Aguilar (2020)[94] and Aguilar (2025)[95].
Type of sampling: A Systematic Sampling (SYS) over the updated version of Level 1 Systematic Grid with 10,241 points of the Monitoring system of land-use change and ecosystems (SIMOCUTE) was used. The original systematic grid is in the CRTM05 coordinate system of Costa Rica. However, it was re-projected to geographic coordinates in WGS84 to evaluate the sampling point with the Collect Earth Desktop tool. The SIMOCUTE sampling units are permanent, which facilitates reinterpretation through time and easy temporal tracking of LULC changes.
Sampling unit: The Sampling Unit (SU) is a 100x100 meter plot whose central point coincides with the SIMOCUTE sampling points. The SU corresponds to 3x3 Landsat pixels and covers 0.98 ha. Inside SU, a 7x7 points sub-grid was created to estimate land cover percentage within each sampling unit.</td></tr>
</table>

[94] Aguilar, L. (2020). Evaluación Visual Multitemporal para la determinación de la degradación forestal para los periodos 2014-2015-2017-2019 y determinación de datos de referencia para periodo 2017-2019. Tercer Informe. Retrieved from https://drive.google.com/file/d/1ERutZo6vNI6MXUCmlrky7wiaeOqOLMqh/view?usp=sharing

[95] Aguilar, L. 2025. Informe. Procedimiento Operativo Estándar. Evaluación del cambio de la cobertura de la tierra basado en puntos de muestreo para los períodos 2019-2021 y 2021-2024. Retrieved from https://drive.google.com/file/d/1HBiAikAm_4uNmPTOfpyVam8SeSf8C4fa/view?usp=sharing

Number of sampling units*:* The forest degradation assessment was made on forest lands that remain as forest lands during the periods 2018-2019 and 2020-2024. The 4377 points classified as permanent forest land according to the MCS 2012/13 map were assessed in this monitoring period. These points are an extract from the Systematic Grid adopted in SIMOCUTE.

Classification scheme: Three classes of canopy cover were considered to estimate degradation/enhancement in permanent forest land: i. Intact forest (85-100% forest cover), ii. Degraded forest (60-85% forest cover), and iii. Very degraded forest (<60% forest cover). The following forest cover change classes were assessed by forest type and type of carbon fluxes (anthropogenic and natural):

Degradation:

a. Intact to Degraded forest
b. Intact to Very degraded forest
c. Degraded to Very degraded forest Forest enhancement:
d. Very degraded to intact forest
e. Very degraded to degraded forest
f. Degraded to Intact forest

No Condition changes

g. Stable intact forest
h. Stable degraded forest
i. Stable very degraded forest

Data sources: The date range of the images shown in the table below was used, with a preference for high-resolution, dated imagery from Google Earth. If unavailable, the next choice was dated Planet images from the NICFI Program.

Table 3-9: Data sources and Imagery date range used in the canopy cover evaluation on permanent forest for the monitoring periods.

Monitoring Year	Imagery date range	Data sources
2018	July 2017 – June 2018	• Google Earth dated high-resolution imagery repository (CNES/Airbus, Maxar Technologies) • Planet dated imagery of NICFI Program • Other sources (Bing Map, Copernicus, Landsat 7, US Geological Survey)
2019	July 2019 – June 2020	
2024	July 2024 – June 2025	

Interpretation key: The Version 1.2. 2018. SIMOCUTE land cover class key was used to determine canopy cover

Table 3-10: Land cover key used in the land cover evaluation protocol

Code	Land cover class
1100	Trees
1200	Shrubs
1300	Herbaceous
1400	Palm

Not included	Bromeliads
1500-1600	Greenhouse
1700	Other vegetation
2000-2200	No vegetation
3000	Water
4000	Clouds and shadows
5000	Not classifiable

Data analysis: The country developed a tool for calculating emissions and removals on permanent forest lands (¨Herramienta_degradación.xlsx¨ [96]). The database for the visual interpretation of canopy cover for the periods 2018-2019, 2020-2024 are included in the sheet "Base_de_datos". The area of degraded and enhanced forest areas was extrapolated to the forest area in the entire country through proportional representation within the respective degradation classes (intact, degraded and very degraded) and forestry type. Degradation classes were determined based on the reduction of the forest canopy cover, by which intact forests have a cover of 85-100%, degraded forests have a cover of 60-85%, and very degraded forests a cover between 30% and 59%. Forest areas that went from intact to degraded, intact to very degraded, or degraded to very degraded (in terms of their canopy cover) during the assessment period were classified as degraded. Forest areas that went from very degraded to degraded, very degraded to intact, or degraded to intact were identified as forest enhancement areas. Carbon fluxes were estimated for anthropogenic and natural conditions. Fluxes from sampling points inside protected areas and farther than 500 meters from a road were considered natural fluxes and removed from reference level accounting. The estimation of the areas of change of degradation and canopy enhancement, for both anthropic and natural carbon fluxes, can be found in the sheet ¨Resumen_de_puntos¨ of the Degradation tool, for the monitoring periods 2018-2019 and 2020-2024. It is important to indicate that it was unnecessary to update proximity analysis to roads and protected areas to estimate anthropogenic carbon flux since the 1: 5000 layer of roads and the layer of protected areas have not been updated.

QA/QC procedures applied:

Aguilar (2020) and Aguilar (2025) applyed a land cover evaluation protocol to reduce the uncertainty of the land cover classification due to: a) the bias associated with the spatial registration of the reference image, b) the interpreter bias in the assignment of the land cover class; and c) interpreter variability. The following procedures were applied during the collection of reference data:

Consideration of spatial and temporal context: The protocol includes a procedure for canopy cover change interpretation considering the spatial and temporal context.

Reference order of the repositories of images: The analyst gave priority to high-resolution images in Google Earth. In the second instance, on the Planet images available for the monitoring period. In case there are no high-resolution images for any sampling points, lower-resolution images available in the Collect Earth Desktop tool were used, if the monitoring period images are equal or better quality than the previus assessment.

Data registry forms: The canopy cover change information was recorded in standard Collect Earth Desktop forms.

Training: The supervisor trained the interpreters before starting the interpretation of plots to calibrate and leave clear procedures to collect the most accurate information possible.

[96] Degradation tool can be accessed in the following link: https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

	Supervision of interpreters ("Hot Checks"): The supervisor opened remote sessions between the coordinator and the interpreter; to oversee the evaluation process without intervening. The coordinator presented the results in periodic sessions with all interpreters to improve the group of interpreters' criteria. The supervisor resolved the consultations of the interpreters online. **Checking of interpretations by the supervisor, without interpreters' presence ("Cold Checks"):** During the data collection process, a certain percentage of randomly selected sample units called "cold checks" are reviewed by a coordinator and data collection operator or group of interpreters. If an interpreter's error is found, the interpreter is directly addressed, and the affected sample units are corrected. Typically, at least 5% of surveyed subplots are reviewed, but in this evaluation, the percentage was increased to 11.0% to improve the remote evaluation process. **Checking of interpreters' consistency ("Blind Checks"):** The analysts performed this procedure at the end of interpreting all the sampling plots. Each analyst evaluated at least 5% of the assessed plots by other interpreters, e.g., Interpreter 1 reviewed interpreters 2 and 3. The minimum level of consistency between evaluators was 90%. If not complying with the standard, the interpreter team should review the work until reaching the 90% threshold. **Consistency between reference and monitoring period data**: The analyst reviewed the consistency of 2021 canopy cover data with the 2019 evaluation. **Treatment of plots with forest cover less than 30%:** The analyst made the degradation analysis over the systematic grid points that falls on permanent forest lands during 1998-2011 in REDD time series maps. Thus, the 4,377 points of the original sampling implemented by Ortiz-Malavassi (2017) were re-visited in 2016, 2018, and 2020 evaluations. During the review of these points, some of them passed to non-forest conditions due to the loss of coverage and non-compliance with the minimum forest definition area (30% of canopy cover). Some of these points may have been declared deforestation or being part of the omission error in the land-use change's permanent forests for the period 2018-19.
Uncertainty for this parameter:	In the assessment of degradation level in forests remaining forests, it was assumed that there was no uncertainty associated with the visual interpretation of sample areas because this procedure employed visual classification of canopy cover using high resolution imagery, as described above. Uncertainty of changes in canopy cover to identify areas of degradation and forest enhancement for monitoring periods 2018-2019 and 2020-2024 vary depending on the forest type and the conversion class. It is based on the sampling error.
Any comment:	The reference data for estimating degradation activity and the calculation tool was updated. The canopy cover for plot 16749 was changed to 100%, and the formula in the “Deg_ems_antro_MP_16-19” tab was corrected to fetch data from the appropriate cells in the “Base_de_Datos” tab. For further details, consult section 1.3, **Methodological deviations**.

4 QUANTIFICATION OF EMISSION REDUCTIONS

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

Under Criterion 10 (Indicator 10.1) and Criterion 22 of the Methodological Framework, the Participant may propose methodological deviations to correct material errors in the estimation of the validated Reference Level and verified Emission Reductions. Accordingly, the Costa Rica ER Program has identified a material error in both the validated Reference Level and verified Emission Reductions, which must be corrected due to:

- Carbon stock data for various land uses in Costa Rica were not correctly compiled or standardized to a 0.47 carbon fraction. Updates were necessary to the carbon stocks database to ensure literature data were correctly assigned and standardized to the 0.47 carbon fraction, including adjustments to values from Andrade et al. (2008), Somarriba et al. (2013), Nájera-Gómez (2011), and SINAC's NFI biomass data. These revisions resulted in changes to total biomass values, particularly for primary forests, and improved the traceability of the calculation methodology.
- Costa Rica revised the annualization of activity data for its REDD+ time series due to cloud cover impacting Landsat imagery. The revision involved adjusting monitoring periods to the midpoint of the spectral sampling window and interpolating data for years in which the midpoint didn't align with the calendar year. This resulted in minor variations in secondary forest areas and more significant discrepancies in deforested areas, impacting emissions calculations.
- Canopy cover and aboveground biomass ratios (RC) were estimated for Palm, Dry Forest, Wet Forest, and Rainforest types using data from 100 temporal plots. Discrepancies in canopy cover data across 10 plots were corrected, resulting in recalculated degradation emission factors. While the corrected values fall within the confidence limits of the original factors, updated emissions are now available.

Table 1.3-1 presents a comparison of the validated and revised Reference Levels, with the revised values recalculated using updated tools and parameters. In the revised Reference Level, average deforestation-related emissions and carbon enhancement in remaining forests increased by 21.44% and 0.5%, respectively. In contrast, average emissions from degradation and average removals from natural regeneration decreased by 1.46% and 6.97%, respectively. Overall, the validated Reference Level increased from 2,585,717 tCO_2 to 4,151,982 tCO_2 (a 60.57% rise), mainly due to updated carbon stock estimates for wet, rain, and moist primary forests.

Table 1.3-2 compares the verified and revised net emissions for the Costa Rica ER Program for the 2018–2019 and 2020–2021 reporting periods. In the revised totals, deforestation-related emissions increased by 12.34%, while average emissions from degradation and average removals from natural regeneration decreased by 13.37% and 4.36%, respectively. Overall, verified net emissions decreased from -9,996,108 tCO_2 to -9,922,505 tCO_2 (a 0.74% change).

Finally, Table 1.3-3 presents a comparison of original emission reductions under Costa Rica's ER Program for the 2018–2019 and 2020–2021 reporting periods. Over this interval, total ERs rose by 30.44%, from 20,339,056 tCO_2 to 26,530,433 tCO_2.

Because the difference between the revised and original ERs (30.44%) exceeded the 1% material error threshold, the Participant is submitting a methodological deviation to address inaccuracies in the validated Reference Level and verified Emission Reductions. The table below displays the revised Reference Level for the entire crediting period from 2018 to 2024.[97]

[97] The ER Program Reference Level for the Reporting Period is computed in the worksheet FREL-FRL (cells P11..V32) of the Reference Level Excel file, which can be accessed at https://docs.google.com/spreadsheets/d/1nwgFFeN5qWZ8sZhxF2XFvvqOuQZO7BeY/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

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 enhanced Removals from afforestation/ reforestation (A/R) (tCO_{2-e}/yr)	If applicable, average annual historical enhanced Removals from other activities besides A/R (tCO_{2-e}/yr)	Adjustment, if applicable (tCO_{2-e}/yr)	Reference Level (tCO_{2-e}/yr)
2018	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2019	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2020	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2021	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2022	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2023	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
2024	7,269,407	1,363,824	-4,067,278	-413,971	0	4,151,982
Total	50,885,849	9,546,768	-28,470,946	-2,897,797	0	29,063,874

ER Program Measures other than A/R that are being considered to generate enhanced Removals:

The country report includes removals from permanent forest lands in addition to A/R. Permanent forest removals result from canopy cover recovery. Measures related to canopy cover recovery are as follows:

- **ACTION 1.1. Strengthen the operational and financial implementation of SINAC's Forest Fires Management Strategy within and beyond Protected Conservation Areas:** SINAC is currently focused on implementing the National Fire Management Strategy. The aim is to achieve an integrated fire management approach involving stakeholders such as local and national government institutions, NGOs, the private sector, and civil society.
- **ACTION 1.2: Strengthen the operation and financing of SINAC's Illegal Logging Control Strategy:** SINAC is responsible for preventing illegal logging and overseeing sustainable forest management activities. SINAC implemented two online systems to issue logging permits on private land: the System of Management Plans (SIPLAMA) for forest lands and the Information System for the Control of Forest Harvesting (SICAF) for pasture and agricultural lands. During this reporting period, SINAC improved SICAF based on user feedback. This included maintenance and performance adjustments, as well as the addition of new modules, such as those for harvesting fallen wood.

4.2 Estimation of Emissions by Sources and Removals by Sinks included in the ER Program's scope

The quantification of emissions and removals during the Reporting Period was done following the measurement and monitoring procedures described in section 2.3.1-Figure 2-3, the equations 8 to 12 described in section 2.3.2 of this Monitoring Report and applying the approaches to determine activity data and emission or removal factors included in the data and parameter tables on section 3 above. As in the Reference Level period, the total emissions or removals associated with each of the REDD+ activities were calculated as the Annual emissions or removals were estimated for all land transitions ¨*i*¨ by REDD+ activity, and then adding the results for all selected REDD+ activities for each year:

$$RL_{RP} = \frac{\sum_{t=1}^{RP} ER_{RA_t}}{RP} = \frac{\sum_{t=1}^{RP} \sum_{i=1}^{I} \left(AD_{RA_{i,t}} * EF_{RA_{i,t}} \right)}{RP}$$

Equation 9

Where:

ER_{RAt}	=	Emissions or removals associated to REDD+ activity *RA* in year *t*; tCO_2-e yr^{-1}
$AD_{RAi,t}$	=	AD associated to REDD+ activity *RA* for the land use transition *i* in year *t*; ha yr^{-1}
$EF_{RAi,t}$	=	EF associated to REDD+ activity *RA* applicable to the land use transition *i* in year *t*; tCO_2-e ha^{-1}
RP	=	Reference Period in years
i	=	A land use transition represented in a cell of the land use change matrix; dimensionless
I	=	Total number of land use transitions related to REDD+ activity *RA*; dimensionless
t	=	A year of the historical period analyzed; dimensionless

REDD+ Secretariat of Costa Rica estimated emissions by sources and removals by sinks included in the ER Program with two separate integration tools: deforestation and degradation[98]. The country also calculate Emission Reductions with FCPF ER-MR template tool based on the revised FREL and Degradation tool results[99].

Year of Monitoring/ Reporting Period t	Emissions from deforestation (tCO_{2-e}/yr)	If applicable, Emissions from forest degradation (tCO_{2-e}/yr)	If applicable, enhanced Removals from afforestation/ reforestation (A/R) (tCO_{2-e}/yr)	If applicable, enhanced Removals from other activities besides A/R (tCO_{2-e}/yr)	Net Emissions and Removals (tCO_{2-e}/yr)
2018	982,455	2,538,390	-5,447,663	-408,797	-2,335,615
2019	1,008,850	2,538,390	-5,279,909	-408,797	-2,141,466
2020	561,143	2,077,173	-5,052,825	-403,674	-2,818,183
2021	590,811	2,077,173	-4,891,551	-403,674	-2,627,241
2022	646,459	2,077,173	-4,799,142	-403,674	-2,479,184
2023	674,152	2,077,173	-4,719,804	-403,674	-2,372,153
2024	698,641	2,077,173	-4,650,950	-403,674	-2,278,810
Total	5,162,511	15,462,645	-34,841,844	-2,835,964	-17,052,652

4.3 Calculation of Emission Reductions

***Total Emissions, Removals and Emission Reductions**:*

T.1	**Deforestation**	**If applicable, forest degradation**	**If applicable, enhanced Removals from afforestation/ reforestation (A/R)**	**If applicable, enhanced Removals from other activities besides A/R***	**Adjustment, if applicable**	**Total (tCO_{2-e})**

[98] FREL and Degradation TOOL can be accessed in the following links:
FREL: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true
Degradation:
https://docs.google.com/spreadsheets/d/1NDhPWpbT3TrUAAB9RfojWpS7tNRAlBp7/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[99] Emission Reduction Calculation tool can be accessed in the following link:
https://drive.google.com/file/d/1MVXLrCu4xoIWLTlhFVK_sgGP8Q6aFvKO/view?usp=sharing

Emissions or Removals in the Reference Level (tCO_{2-e})	50,885,849	9,546,768	-28,470,946	-2,897,797	0	29,063,874
Emissions or Removals under the ER Program during the Reporting Period (tCO_{2-e})	5,162,511	15,462,645	-34,841,844	-2,835,964	0	-17,052,652
Emission Reductions during the Reporting Period (tCO_{2-e})	45,723,338	-5,915,877	6,370,898	-61,833	0	46,116,526

Annual Emissions, Removals and Emission Reductions:

T.2 (1) *Only applicable for Option 1 (no pro-rata)*	Year	Emissions or Removals in the Reference Level (tCO2-e)	Emissions or Removals under the ER Program during the Reporting Period (tCO2-e)	Emission Reductions during the Reporting Period (tCO2-e)
Deforestation	2018	7,269,407	982,455	6,286,952
	2019	7,269,407	1,008,850	6,260,557
	2020	7,269,407	561,143	6,708,264
	2021	7,269,407	590,811	6,678,596
	2022	7,269,407	646,459	6,622,948
	2023	7,269,407	674,152	6,595,255
	2024	7,269,407	698,641	6,570,766
If applicable, forest degradation	2018	1,363,824	2,538,390	-1,174,566
	2019	1,363,824	2,538,390	-1,174,566
	2020	1,363,824	2,077,173	-713,349
	2021	1,363,824	2,077,173	-713,349
	2022	1,363,824	2,077,173	-713,349
	2023	1,363,824	2,077,173	-713,349
	2024	1,363,824	2,077,173	-713,349
If applicable, enhanced Removals from afforestation/reforestation (A/R)	2018	-4,067,278	-5,447,663	1,380,385
	2019	-4,067,278	-5,279,909	1,212,631
	2020	-4,067,278	-5,052,825	985,547
	2021	-4,067,278	-4,891,551	824,273
	2022	-4,067,278	-4,799,142	731,864
	2023	-4,067,278	-4,719,804	652,526
	2024	-4,067,278	-4,650,950	583,672
If applicable, enhanced Removals from other activities besides A/R	2018	-413,971	-408,797	-5,174
	2019	-413,971	-408,797	-5,174
	2020	-413,971	-403,674	-10,297
	2021	-413,971	-403,674	-10,297
	2022	-413,971	-403,674	-10,297
	2023	-413,971	-403,674	-10,297
	2024	-413,971	-403,674	-10,297
Adjustment, if applicable	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			

Total (tCO2-e)	2018	4,151,982	-2,335,615	6,487,597
	2019	4,151,982	-2,141,466	6,293,448
	2020	4,151,982	-2,818,183	6,970,165
	2021	4,151,982	-2,627,241	6,779,223
	2022	4,151,982	-2,479,184	6,631,166
	2023	4,151,982	-2,372,153	6,524,135
	2024	4,151,982	-2,278,810	6,430,792

Proportion of Emission Reductions per REDD+ activity:

T.5	Emission Reductions during the Reporting Period (tCO_{2-e})						
Year	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Total	6,487,597	6,293,448	6,970,165	6,779,223	6,631,166	6,524,135	6,430,792
Emission Reductions from enhanced Removals from afforestation/reforestation as a percentage of the total FCPF ERs (%)	21.27729266%	19.26814999%	14.13950746%	12.15881230%	11.03673170%	10.00172437%	9.07620710%
If applicable, enhanced Removals from other activities besides A/R (%)	-0.07975218%	-0.08221249%	-0.14772964%	-0.15189056%	-0.15528189%	-0.15782935%	-0.16012025%
If applicable, forest degradation (%)	-18.10479288%	-18.66331461%	-10.23432013%	-10.52257759%	-10.75751987%	-10.93400121%	-11.09270833%
Deforestation (%)	96.90725241%	99.47737711%	96.24254232%	98.51565585%	99.87607006%	101.09010620%	102.17662148%
Adjustment, if applicable (%)	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%

T.6	Year	2018	2019	2020	2021	2022	2023	2024
Emission Reductions from enhanced Removals from afforestation/reforestation as a percentage of the total FCPF ERs (%)		0%	0%	0%	0%	0%	0%	0%

Year		2018	2019	2020	2021	2022	2023	2024
A	**Total Reference Level Emissions during the Reporting Period (tCO_2-e)**	4,151,982	4,151,982	4,151,982	4,151,982	4,151,982	4,151,982	4,151,982
B	**Net Emissions and Removals under the ER Program during the Reporting Period (tCO_2-e)**	-2,335,615	-2,141,466	-2,818,183	-2,627,241	-2,479,184	-2,372,153	-2,278,810
C	**Cumulative quantity of Total ERs estimated for prior Reporting Periods (tCO_2-e, only use if negative)**	NA	NA	NA	NA	NA	NA	NA
D	**Emission Reductions during the Reporting Period (tCO_2-e) (A-B+C)**	6,487,597	6,293,448	6,970,165	6,779,223	6,631,166	6,524,135	6,430,792

5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

Since no pro-rata adjustment was made to the emission reduction calculations during any monitoring period, its influence is not considered in the uncertainty assessment.

5.1 Identification, assessment and addressing sources of Uncertainty

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Activity Data					
Measurement	Systematic and random	**Land-use change areas,** including deforestation, reforestation, and remaining forest regions, were analyzed using a consistent and standardized methodology for both FREL/FRL and forest emission estimates. This approach helps prevent differences caused by varying methods when comparing LULC maps. Operator errors during map preparation and interpretation can cause discrepancies, but these are minimized through QA/QC procedures (see tables 3-1 and 3-5). Quality control began during image download and preparation by checking for storage errors, analyzing metadata, and visually inspecting the original images. For the reference period scenes, orthorectification involved: i. verifying control points so that the mean square error does not exceed the pixel size; ii. visually inspecting images for defects such as duplicate areas, deformation, or geometry errors from the digital terrain model; and iii. verifying geometric accuracy using a grid-based checkpoint system. For the monitoring period scenes, Landsat 8 images from USGS, which are already terrain-corrected (Level 1T) with systematic geometric correction and relief adjustments, did not require further rectification. A radiometric normalization was performed to minimize differences among the time-series images. All images' cloud and shadow masks were visually checked by comparing them with the original images in RGB or false color. These masks were further validated through visual inspection of 18 sample images, using a systematic grid of checkpoints. Additional quality control steps included an iterative process of land use classification, verifying classifications, detecting errors, and reviewing areas and training points. Errors identified in the Random Forest classifier were examined, and classes or training points needing improvement were pinpointed. Final maps were created after visually inspecting mosaiced images and identifying information gaps and sensor failures on each date in the series. The final maps underwent a quality assurance (QA) process conducted by institutions from the country that were not involved in the classification phase. These reviewers validated the maps on three different dates within the time series.	High	Yes	No

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
		Activity Data (AD) Calculation. AD for land use change activities, such as deforestation and reforestation, was estimated by geographically comparing LULC maps created for 2017, 2019, 2021, and 2024 in a Geographical Information System (GIS) and then extracting, from the combined set of multi-temporal data, the values of the areas that remained in the same category or converted to other land use categories. The results of this operation are reported in land-use change matrices prepared for each measurement period on the sheets "LCM 2018-19", "LCM 2020-21", and "LCM 2022-24" of the "FREL TOOL CR" spreadsheet tool. It is essential to clarify that areas in the land use change matrices are calculated using a rounded pixel size of 30 × 30 m. Note that the 7-digit resolution of LCM maps 2017, 2019, 2021, and 2024 is 29.9995116 meters by 29.9995116 meters, and the difference between the raster resolution and the final resolution used in the land use change matrices is 0.49 mm in X and 0.49 mm in Y.. **Annualization of activity data:** For monitoring periods where the midpoint of the imagery selection window for both the initial and final land-use maps aligns with either the start or end of the calendar year, the activity data is annualized by dividing the area that was deforested or regenerated during that period by the total number of years in the monitoring period (see Eq 2 and 3). The LULC_SpectralSampling_FCPF.xlsx[100] file details the imagery dataset used for LULC maps from 1992 to 2024. Table 1.3-1 summarizes the imagery sampling window, midpoint, and image count for each LULC map. Monitoring periods were shifted to the midpoints of the spectral sampling windows, and interpolation adjustments were made for 1997, 2000, 2008, 2011, and 2022, since these midpoints do not align with the calendar year start or end. For example, the interpolation used to calculate the activity data (deforestation/forest gain) for the calendar year 2008 (AD_{2008}) was performed using the equations below. It is important to note that the Activity Data calculation tool FREL & MRV TOOL CR was updated with this interpolation process for the years 1997, 2000, 2008, 2011, and 2022. Therefore, the subsequent calculation of emissions from deforestation and degradation, as well as removals, was also updated. $AD_{2008} = A + B$ ***Equation 1,*** *where* AD_{2008} *units are hectares*			

[100] LULC_SpectralSampling_FCPF.xlsx can be accessed at the following link: https://docs.google.com/spreadsheets/d/1FCXafLDt4bNo6OJCIwz4l08ha2Cm03-p/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
		$AD_{annual\ 01-07} = \frac{AD_{Period\ 01-07}}{\Delta T_{Period\ 01-07}}$; $AD_{annual\ 07-11} = \frac{AD_{Period\ 07-11}}{\Delta T_{Period\ 07-11}}$; ***Equations 2 and 3***			

$\Delta T_{Period\ 01-07} = t_{07} - t_{01}$, ***Equation 4***, *where* $t_{07} = (1/4/2008)$, $t_{01} = (1/11/2000)$, *and* $\Delta T_{Period\ 01-07}$ *units are years*

$\Delta T_{Period\ 07-11} = t_{11} - t_{07}$, ***Equation 5***, *where* $t_{11} = (1/8/2011)$, $t_{07} = (1/4/2008)$, *and* $\Delta T_{Period\ 07-11}$ *units are years*

$A = AD_{annual\ 01-07} \times YF_A$ ***Equation 6***, *where* $YF_A = (1/1/2008) - t_{07}$ *in years*

$B = AD_{annual\ 07-11} \times YF_B$ ***Equation 7***, *where* $YF_A = t_{07} - (31/12/2008)$ *in years*

Table 1.3-5: Imagery sampling window, midpoint of the window, and number of images selected for each LULC map in the REDD+ time series of Costa Rica ER-Program.

LULC map	Sampling window	Months	Midpoint of the sampling window	Number of images selected	% of images within the June-to-June window
MCS 1991/1992	March 15, 1991 – April 3, 1992	12	December 1st, 1991	28	68%
MCS 1987/1998	November 16, 1996 – April 19, 1998	17	August 1st, 1997	61	51%
MCS 2000/2001	December 31, 1999 - June 15, 2001	18	November 1st, 2000	41	61%
MCS 2007/2008	December 9, 2007 – April 27, 2009	17	April 1st, 2008	47	51%
MCS 2010/2011	November 6, 2010 – March 25, 2012	17	August 1st, 2011	49	51%
MCS 2012/2013	January 7, 2013 – April 8, 2014	15	January 1st, 2014	78	85%
MCS 2014/2015	August 1st, 2015 – June 16, 2016	11	January 1st, 2016	56	100%
MCS 2017/2018	June 19, 2017 – June 13, 2018	12	January 1st, 2018	70	100%
MCS 2019/2020	June 2, 2019 – June 11, 2020	12	January 1st, 2020	69	100%
MCS 2021/2022	June 5, 2021 – June 10, 2022	12	February 1st, 2022	79	100%
MCS 2024/2025	January 24, 2024 – December 17, 2025	22	February 1st, 2024	91	98%

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Measurement	Systematic and random	**Permanent forest degradation and regeneration**: The same approach was used to estimate degradation and canopy cover recovery in permanent forest areas. A Systematic Sampling (SYS) method was applied over the Level 1 Systematic Grid, which consists of 10,242 points from the Monitoring System of Land-Use Change and Ecosystems (SIMOCUTE). Degradation analysis was limited to permanent forest areas, based on the land-use MCS 2012/13 map, to prevent double-counting of baseline emissions from both deforestation and forest degradation. This process ensured that degradation measurements did not overlap with those attributed to deforestation. To assess degradation levels in remaining forests, it was assumed that visual interpretations of sample areas carried no uncertainty, as they involved visual canopy-cover classification using high-resolution imagery, as detailed in Tables 3-2 and 3-7. QA/QC procedures were implemented during the interpretation of these high-resolution images: i **Consideration of spatial and temporal context**: The protocol includes a procedure for canopy cover change interpretation considering the spatial and temporal context. ii **Reference order of the repositories of images**: The analyst gave priority to high-resolution images in Google Earth. In the second instance, on the Planet images available for the monitoring period. In case there are no high-resolution images for any sampling points, lower-resolution images available in the Collect Earth Desktop tool were used, if the monitoring period images are equal or better quality than the previus assessment. iii **Data registry forms**: The canopy cover change information was recorded in standard Collect Earth Desktop forms. iv **Training**: The supervisor trained the interpreters before starting the interpretation of plots to calibrate and leave clear procedures to collect the most accurate information possible. v **Supervision of interpreters ("Hot Checks"):** The supervisor opened remote sessions between the coordinator and the interpreter; to oversee the evaluation process without intervening. The coordinator presented the results in periodic sessions with all interpreters to improve the group of interpreters' criteria. The supervisor resolved the consultations of the interpreters online. vi **Checking of interpretations by the supervisor, without interpreters' presence ("Cold Checks"):** During the data collection process, a certain percentage of randomly selected sample units called "cold checks" are reviewed by a coordinator and data collection operator or group of interpreters. If an interpreter's error is found, the interpreter is directly addressed, and the affected sample units are corrected.	Low	Yes	No

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
		Typically, at least 5% of surveyed subplots are reviewed, but in this evaluation, the percentage was increased to 11.0% to improve the remote evaluation process. vii **Checking of interpreters' consistency ("Blind Checks"):** The analysts performed this procedure at the end of interpreting all the sampling plots. Each analyst evaluated at least 5% of the assessed plots by other interpreters, e.g., Interpreter 1 reviewed interpreters 2 and 3. The minimum level of consistency between evaluators was 90%. If not complying with the standard, the interpreter team should review the work until reaching the 90% threshold. viii **Consistency between reference and monitoring period data**: The analyst reviewed the consistency of 2021 canopy cover data with the 2019 evaluation. ix **Treatment of plots with forest cover less than 30%:** The analyst made the degradation analysis over the systematic grid points that falls on permanent forest lands during 1998-2011 in REDD time series maps. Thus, the 4,377 points of the original sampling implemented by Ortiz-Malavassi (2017) were re-visited in 2016, 2018, and 2020 evaluations. During the review of these points, some of them passed to non-forest conditions due to the loss of coverage and non-compliance with the minimum forest definition area (30% of canopy cover). Some of these points may have been declared deforestation or being part of the omission error in the land-use change's permanent forests for the period 2018-19.Finally, uncertainty of changes in canopy cover to identify areas of degradation and forest enhancement from reference and monitoring periods vary depending on the forest type and the conversion class. It is based on the sampling error. Finally, uncertainty of changes in canopy cover to identify areas of degradation and forest enhancement from reference and monitoring periods vary depending on the forest type and the conversion class. It is based on the sampling error			
Representative ness	Systematic	**Land-use change areas (deforestation, reforestation, and forest remaining forest areas)**: To prepare the LULCC maps for the reference and monitoring periods, four generations of LANDSAT satellites were used: Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI/TIRS. Scenes were selected from June (Year 1) to June (Year 2) for the monitoring period. Monitoring occurs every two years, and the territorial forest area covered includes the country's continental territory but excludes the Coco Island due to its exclusion from anthropogenic intervention. To ensure the representativeness of the LULCC maps, the Random Forest methodology is used for the reference and monitoring periods to train a forest classifier and then classify imagery. To train the forest classifier, regions of different land cover classes were digitized using (1) a systematic grid of 10,000 points from Rapideye images developed by SINAC, (2) high-resolution Rapideye images, and (3) current and historical Google Earth images.	Low	Yes	No

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
		This base data was then combined with 20 predictor variables to adjust the forest classifier models. To minimize the error (i.e., uncertainty) in these classifier models, the Random Forest R package generates an error and confusion matrix, which allows for an initial quality control check based on a subset of checkpoints. To further minimize uncertainty, the random forest classifier was iteratively improved by analysts using the error and confusion matrix generated by the classifier, which identifies classes that need improved training data or predictor variables. Once the classifiers were trained, they were applied to all images to assess land use and land cover for the given two-year period. The resulting land use and land cover maps then underwent post-processing to further reduce uncertainty in classification. Through visual comparison of classified maps and high-resolution imagery, analysts performed manual editing of the time-series classification aimed at decreasing high classification errors. Analysts also performed visual verification of the country's main deforestation and reforestation areas to detect any classification errors and ensure an accurate assessment of land use change. **Permanent forest degradation and regeneration**: High-resolution imagery used to estimate degradation and regeneration were selected from June to June for the year under monitoring.			
Sampling	Random	**Land-use change areas (deforestation, reforestation, and forest remaining forest areas)**: Uncertainties associated to AD are due to the production process of land use maps. The uncertainties of the AD for land use change activities (deforestation and reforestation) and forest remaining forest activities (degradation and enhancements in forest lands) come from the uncertainties associated with the process creating land use change maps from which the activity data are obtained. The accuracy assessment of the land-use changes map 2018-2019, 2020-2021 and 2022-2024 was done following Olofsson et al.'s (2014)[101] guidelines. Due to a large number of land use change transitions, they were aggregated into four categories: Deforestation (forest to non-forest), new forests (non-forest to forest), stable forest (forest remaining forest), and stable non-forest (non-forest to non-forest). For further detail of the accuracy assessment for the reference and monitoring periods please see the uncertainty section in tables 3-1 and 3-5.	NA	NA	NA
Sampling	Random	**Permanent forest degradation and canopy cover recovery area**: The same methodology was used to estimate degradation and canopy cover recovery area in permanent forest lands for reference and monitoring periods. A Systematic Sampling (SYS) over the Level 1 Systematic Grid of 10,242 points of the Monitoring system of land-use change and ecosystems (SIMOCUTE) was used. Uncertainty of changes in canopy cover to identify areas of degradation and canopy recovery for reference and monitoring vary depending on the forest type and the conversion class. It is based on the sampling error.	Low	No	No
Extrapolation	NA	This source of uncertainty is not applicable. Costa Rica generates estimates of deforestation, regeneration, and permanent forest lands per forest type, where the total annual areas are the sum of each forest type for a given year.	NA	NA	NA

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

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Approach 3	NA	This source of uncertainty is not applicable. Activity data were estimated conducting tracking of lands or IPCC Approach 3 for reference and monitoring periods.	NA	NA	NA
Emission Factor					
DBH measurement H measurement Plot delineation	Systematic and Random	Extensive quality control procedures were implemented prior to the start of field work during estimation of AGB in the National Forest Inventory and Canopy cover and biomass relationship with additional temporal sampling plots. Field crews were organized by region. Each field crew was trained and provided with manuals to assist with identification, collection, transport, and processing of botanical samples. A terms of reference document was also provided which explained specific roles and responsibilities of each crew member. Finally, an Excel template was created to control the quality of data collection. Quality assurance measures were then taken as supervisors visited field sites to oversee the field crews and take photographic records of each field plot (please see tables 3-3 and 3-4). The quality of forest inventory data then underwent an evaluation by an independent crew that visits and remeasures 10% of the plots established in the NFI and 5% of the 100 additional plots. Thanks to these QA/QC procedures implemented before, during, and after the field campaigns the potential biases in the measurement of DBH, H, and plot delineation have been minimized. The random error associated with the measurement of these parameters has therefore been considered to be low, and thus this source of error will not be propagated.	Low	Yes	No
Wood density estimation	Systematic and Random	The wood density values were obtained directly from specialized publications (Biomass estimation tool developed by SINAC, IPCC 2003[102]; Myers 2013[103]; Tree Functional Attributes and Ecological Database, 2018[104]). High-skilled specialists conducted the tree identification following specific protocols to mitigate the error when the wood density value was assigned to each tree.	Low	Yes	No
Biomass allometric model	Systematic and Random	The biomass was calculated using Chave et al. (2005) for NFI inventory data, and Chave et al. (2014) for the 100 additional AGB plots. The propagation of error through MC simulation did not include this source of uncertainty due to the complexity of calculation, the lack of bias (given errors from allometric equations are not systematic), and the agreement of experts in the fields and of standards (cf. ART) that it is reasonable to exclude this form of error (Winrock International, personal communication, 2021).	Low	Yes	No

[102] IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Intergovernmental Panel on Climate Change (IPCC). Edited by Jim Penman, J.; Gytarsky, M.; Hiraishi, T.; Krug, T.; Kruger, D.; Pipatti, R.; Buendia, L.; Miwa, K.; Ngara, T.; Tanabe K.; Wagner, F. IPCC National Greenhouse Gas Inventories Programme. Published by the Institute for Global Environmental Strategies (IGES) for the IPCC. 583 p.

[103] Myers, R. 2013. Fenología y crecimiento de Raphia taedigera (Arecaceae) en humedales del noreste de Costa Rica. En:Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 61 (Suppl. 1): 35-45

[104] Tree Functional Attributes and Ecological Database. (2018). Wood Density. Recuperado el 10 de 12 de 2018, de http://db.worldagroforestry.org/.

Sources of uncertainty	Systematic and/or random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Sampling	Random	Sampling error is the statistical variance of the estimate of aboveground biomass, dead wood or litter. This source of error is random and is considered to be high and it has been propagated. In Costa Rica, sampling error was identified for aboveground biomass values in primary forests in its National Forest Inventory. In secondary forests and in other carbon pools, sampling error of biomass values was estimated from scientific literature. Sampling error was also identified when estimating the ratio between canopy cover and aboveground biomass based on plot data.	High	Yes	Yes
Other parameters (e.g. Carbon Fraction, root to-shoot ratios)	Systematic and Random	Below ground biomass (BGB) is derived directly from Cairns et al., (1997)[105]. The carbon fraction employed was PCC's default value (0.47). The propagation of error through MC simulation did not include either the uncertainty of the root-shoots rations or carbon fraction.	Low	No	Yes
Representative ness	NA	This source of uncertainty is not applicable. Costa Rica generates estimates of carbon stocks per forest type.	NA	NA	NA
Integration					
Model	Systematic	Manuals have been prepared for the correct use of FREL and Degradation tools[106], to avoid errors during the process of data preparation.	Low	Yes	No
Integration	Systematic	The Emission factors were calculated for each forest type according to AGB sampling plots' location to assure the comparability between transition classes of the Activity Data and those of the Emission Factors. This source of uncertainty is considered in the sampling error of the AGB inventory.	Low	Yes	No

[105] Cairns M.A., Brown S., Helmer E.H., and Baumgardner G.A. (1997). Root biomass allocation in the world's upland forests. Oecologia 111:1-11.

[106] The manual of FREL Tool can be accessed in the following link: https://drive.google.com/file/d/1INuL5Jld7nlKVsAf7mRsEepm2n8WRVpT/view?usp=sharing

5.2 Uncertainty of the estimate of Emission Reductions

Parameters and assumptions used in the Monte Carlo method

Parameter included in the model	Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
Area (hectares) of deforestation	1998-2011 Total anthropogenic deforestation: 29,887 ha yr^{-1} Primary forest anthropogenic deforestation: 12,617 ha yr^{-1} Secondary forest and tree plantation anthropogenic deforestation: 17,270 ha yr^{-1} 2018-2019 Total anthropogenic deforestation: 5,387 ha yr^{-1} Primary forest anthropogenic deforestation: 1,444 ha yr^{-1} Secondary forest and tree plantation anthropogenic deforestation: 3.943 ha yr^{-1} 2020-2021 Total anthropogenic deforestation: 4,467 ha yr^{-1} Primary forest anthropogenic deforestation: 383 ha yr^{-1} Secondary forest and tree plantation anthropogenic deforestation: 4,803 ha yr^{-1} 2022-2024 Total anthropogenic deforestation: 3,801 ha yr^{-1} Primary forest anthropogenic deforestation: 448 ha yr^{-1} Secondary forest and tree plantation anthropogenic deforestation: 3,354 ha yr^{-1}	The higher of the Sampling Error or the Bias	Truncated normal	Minimum value assumed to be 0
Area (hectares) of forests remaining forests	1998-2011 Primary forest at the end of the period (ha): 2,226,715 Secondary Forest at the end of the period (ha): 790,265 2018-2019 Primary forest at the end of the period (ha): 2,193,811 Secondary Forest at the end of the period (ha): 922,024 2020-2021 Primary forest at the end of the period (ha): 2,193,953 Secondary Forest at the end of the period (ha): 916,678 2022-2024 Primary forest at the end of the period (ha): 2,192,459 Secondary Forest at the end of the period (ha): 922,768	Sampling error	Truncated normal	Minimum value assumed to be 0
Area (hectares) of new forests	1998-2011 Non-forest converted to forest: 17,270 ha yr^{-1} 2018-2019 Non-forest converted to forest: 2,087 ha yr^{-1} 2020-2021 Non-forest converted to forest: 2,836 ha yr^{-1} 2022-2024 Non-forest converted to forest: 9,040 ha yr^{-1}	Sampling error	Truncated normal	Minimum value assumed to be 0

Parameter included in the model	Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
Degraded and enhanced forests area	1998-2011 Anthropogenic degradation (ha): 145,139 Anthropogenic forest enhancement (ha): 157,287 2018-2019 Anthropogenic degradation (ha): 56,308 Anthropogenic forest enhancement (ha): 40,141 2020-2024 Anthropogenic degradation (ha): 96,552 Anthropogenic forest enhancement (ha): 89,254	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for very moist and rain forests	Primary 621.43 $tCO2*ha^{-1}$ Secondary 624.90 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for moist forests	Primary 440.05 $tCO2*ha^{-1}$ Secondary 439.26 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for dry forests – primary	Primary 360.00 $tCO2*ha^{-1}$ Secondary 3030.03 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for mangroves	Primary 340.59 $tCO2*ha^{-1}$ Secondary 340.24 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for palm forest - primary	Primary 270.30 $tCO2*ha^{-1}$ Secondary 270.30 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for annual cropland	104.72 $tCO2*ha^{-1}$	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass for permanent cropland	114.80 $tCO2*ha^{-1}$ >400 years	Sampling error	Truncated normal	Minimum value assumed to be 0
Trotal biomass Grassland	65.21 $tCO2*ha^{-1}$	Sampling error	Truncated normal	Minimum value assumed to be 0
Total biomass Paramo	158.00 $tCO2*ha^{-1}$	Sampling error	Truncated normal	Minimum value assumed to be 0

Quantification of the Uncertainty of the estimate of Emission Reductions

The country estimated the overall uncertainty of Emission Reductions using a Monte Carlo analysis. A total of 10,000 iterations were performed to calculate the cumulative emissions for the reference and monitoring periods[107].

		Reporting Period 2018-2024	Crediting Period 2018-2024
		Total Emission Reductions	Total Emission Reductions
A	Median	45,688,874	45,688,874
B	Upper bound 90% CI (Percentile 0.95)	53,035,347	53,035,347
C	Lower bound 90% CI (Percentile 0.05)	37,998,354	37,998,354
D	Half Width Confidence Interval at 90% (B – C)/ 2	7,518,497	7,518,497
E	Relative margin (D / A)	16%	16%
F	Uncertainty discount	4%	4%

The forest degradation column was removed because it was not estimated using proxy data.

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

To identify the relative contribution of each parameter to the overall uncertainty, a sensitivity analysis was conducted in which the uncertainty of each REDD+ activity was selectively removed; Monte Carlo simulations were then run, and uncertainties were combined. As shown in the table below, the Emissions from forest degradation are the largest source of uncertainty. When this source of uncertainty was removed, the total uncertainty decreased by over 7.49%. Emissions from deforestation and removals from A/R and canopy-cover recovery also contributed to uncertainty. When the uncertainty for each of these was removed, uncertainty decreased by 1.82%, 0.12%, and 0.2%, respectively[108].

Error source selectively removed from uncertainty analyses	Final % uncertainty of ERs	% change in total uncertainty of ERs
Deforestation Emissions from Primary Forests	14.64%	1.82% decrease
Deforestation Emissions from Secondary Forests	16.31%	0.15 % decrease
Emissions from Forest Degradation	8.96%	7.49% decrease
Removals A/R	16.34%	0.12% decrease
Removals canopy cover recovery	16.48%	0.02% increase

[107] MC propagation analyses to estimate the uncertainty of Emission Reductions can be found in the "Reference Period" Excel Uncertainty worksheet, which is available at the following link: https://docs.google.com/spreadsheets/d/1nwgFFeN5qWZ8sZhxF2XFvvqOuQZO7BeY/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

[108] Sensitivity analysis to estimate the uncertainty of Emission Reductions can be found in the "Reference Period" Excel Sensitivity Analysis worksheet, which is available at the following link: https://docs.google.com/spreadsheets/d/1nwgFFeN5qWZ8sZhxF2XFvvqOuQZO7BeY/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

6 TRANSFER OF TITLE TO ERS

6.1 Ability to transfer title

The Benefit Sharing Plan[109] states that FONAFIFO will provide direct payments or monetary benefits from the Emissions Reduction Purchase Agreements (ERPA) to forest landowners. The REDD+ Secretary has developed a Standards and Procedure Manual for the Emissions Reduction Payment Program, outlining the technical and legal requirements for joining the ER Program and signing a CREF. To participate in the ER Program, landowners must sign a Forest Emissions Reduction Agreement (CREF) [110] with FONAFIFO. The compensation for forest owners is fixed and based on the forest area's contribution to emissions reduction. Figure 6-1 illustrates the process of transferring ownership of emission reductions. Concerning the transferability of ER titles, Executive Decree No. 40464-MINAE[111] specifies the types of land tenure that can generate ER titles.

I. **Indigenous Territories**. Indigenous territories are privately owned and titled to the Association for Integral Indigenous Development (ADII), which represents the Indigenous Community and exercises collective ownership. To be eligible for the Emission Reduction Program and receive payment for emission reductions, the ADII must submit an application to the ER Program. This application should include a document titled "informed consent," proof of having an accountant, an exclusive bank account for resource management, and either a cadastral plan of the territory or a decree creating the Indigenous Territory. The REDD+ Secretariat will then conduct a technical and legal analysis of the forest lands submitted by the ADII to confirm ownership/possession and check for geographical overlaps with other forest owners (public or private) that may indicate a dispute over ownership. This analysis helps identify eligible areas for submission to the ER Program. In addition, the Indigenous Territory community must prepare and approve a Territorial Forest Environmental Plan (PAFT). This plan includes an investment or resource distribution plan. Before signing a Contract of Emissions Reductions from Forest (CREF), the PAFT and the act creating an Internal Committee for the Supervision of Indigenous Territorial Investment Plan must be presented. Finally, to transfer the title to ERs, the ADII President will sign the CREF contract, transferring the title of ERs to FONAFIFO.

II. **Lands included in the Payment for Environmental Services (PES) Program**. These lands are part of the Payment for Environmental Services Program (PES-P). Forest owners have signed a PES contract transferring the title of the ERs to the National Forest Financing Fund (FONAFIFO). Before signing, FONAFIFO verifies the beneficiary's land ownership to assess the area eligible for benefits under the ER Program.

III. **State Natural Heritage owned by Other State Institutions (OSI)**: A section of the State Natural Heritage (SNH) is owned by Other State Institutions (OSI), which are distinct from SINAC. OSIs can serve as beneficiaries of the ER Program. For OSIs with forest lands interested in participating, the REDD+ Secretariat assesses geographic overlaps to spot land disputes with other forest owners and to identify areas eligible for ER Program benefits. The transfer of titles to ERs is carried out through a CREF contract, in which the institution's representative officially transfers the titles to FONAFIFO.

IV. **Privately Owned Lands with Contracts of Emissions Reductions from Forest (CREF)**. Private forest owners whose lands are registered in the National Registry can directly participate as beneficiaries of the ER Program. For forest possessors whose land rights are not registered in the National Registry, Executive Decree No. 43649-MINAE and Law No. 8640 allow such land to be included in the ER Program (see the Manual of Requirements and Procedures for the Emission Reduction Payment Program, article 15). To

[109] The Benefit Sharing Plan of Costa Rica's National REDD+ Strategy can be accessed at the following link: https://www.forestcarbonpartnership.org/system/files/documents/costa_rica_final_bsp-february_2022.pdf

110 Manual of Requirements and Procedures for the Emissions Reduction Program can be accessed at the following link https://www.imprentanacional.go.cr/pub/2022/09/16/ALCA197_16_09_2022.pdf (Page 14)

[111] Decree 40464-MINAE is accessible at the following link: http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?param1=NRTC&nValor1=1&nValor2=84456&nValor3=108959&strTipM=TC

prove their right of possession, possessors must fulfill a series of requirements, including a cadastral plan and affidavits from the possessor, witnesses, and adjoining landowners. All these requirements must be evaluated to establish the right. The REDD+ Secretariat checks for geographical overlaps with other forest owners (private and public) that may indicate land ownership disputes. This helps determine the eligible area that can benefit from the ER Program. Once the legal requirements are met and the eligible area is determined, a CREF contract is signed with the landowner to transfer title to the emission reductions to FONAFIFO.

V. **State Natural Heritage (SNH):** Forest lands within the State Natural Heritage are eligible for submission to the ER Program. The State's ownership of SNH is documented in the National Registry and in regulations that designate its status as part of the Protected Wild Areas System. The REDD+ Secretariat checks for geographic overlaps between SNH and other forest owners that may indicate land ownership disputes and determines which areas are eligible to receive benefits from the ER Program. Transferring title to ERs does not require signing a specific contract because the State owns the land.

Calculation of the Percentage of ERs able to transfer the Title to the ERs

To determine the percentage of eligible Emission Reductions (ERs) that can transfer their title, it is necessary to calculate the proportion of the total forest area they occupy. This can be achieved by dividing the documented ER-owned area participating in the Emission Reduction Program (See Table 12) by the total forest area during the monitoring period, including primary and secondary forests[112].

Table 6-1 summarizes the number of contracts signed to transfer emission-reduction titles under the ER Program. Notably, State Natural Heritage Forest lands, being state-owned, do not require a transfer-of-carbon-title contract. Table 6-2 presents the corresponding areas for the contracts and state-owned lands, as recorded in the ER Program Data Management System (DMS).

Please be advised that no reported areas are currently undergoing legal, technical analysis, or georeferencing for this report. Regarding the Indigenous Territories (IT), it is essential to note that 20 of the 24 have completed preparation of the PAFT and signed CREF contracts with FONAFIFO. The remaining four territories have submitted Letters of Interest to the REDD+ Secretariat for participation in the ER Program. FONAFIFO is in the process of formalizing the CREF contracts with three of these four territories: China Kicha, Quitirrisi, and Alto San Antonio. Terraba is the only Indigenous Territory currently under preparation of the Forest and Environmental Territorial Plans (PAFT).

The percentage of eligible Emission Reductions (ERs) that can transfer their title is calculated annually. The total area covered by active PES and Biodiversity contracts changes each year due to contract expirations, so the percentage of ERs that can be transferred varies accordingly. Table 6-2, Row E shows the annual percentage of ERs that can transfer their title: 43.1% for 2018, 43.2% for 2019, 43.5% for 2020, 42.7% for 2021, 41.0% for 2022, 40.3% for 2023, and 40.9% for 2024.

[112] Forest remaining as forest values reported in the FREL tool, obtained with the land use and land use change maps. The FREL Tool can be accessed at the following link: https://docs.google.com/spreadsheets/d/10pGRdz-No_UfcHredBBkZRh9hVX7HVVH/edit?usp=sharing&ouid=101528572552038951719&rtpof=true&sd=true

Table 6-1 *Landowner types and their number of contracts for transferring emission reduction titles under the ER Program.*

Forest Cover Owner Type			Contracts transfer title to ERs						
			2018	2019	2020	2021	2022	2023	2024
1	CREF beneficiaries who have either registered or non-registered properties	With signed contracts or have been approved for signing.	745	732	735	760	775	807	653
		Legal and technical analysis in process	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
		Geo-referencing process of the beneficiary's property	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2	Indigenous Territories		32	32	33	31	32	32	26
3	Biodiversity Fund		1	1	1	1	1	1	1
	FONAFIFO PES Program		5110	5171	5535	5198	4444	4188	4808
4	State Natural Heritage-SINAC		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	SNH-Other State Institutions		20	20	20	20	20	20	20

Source: SICREF

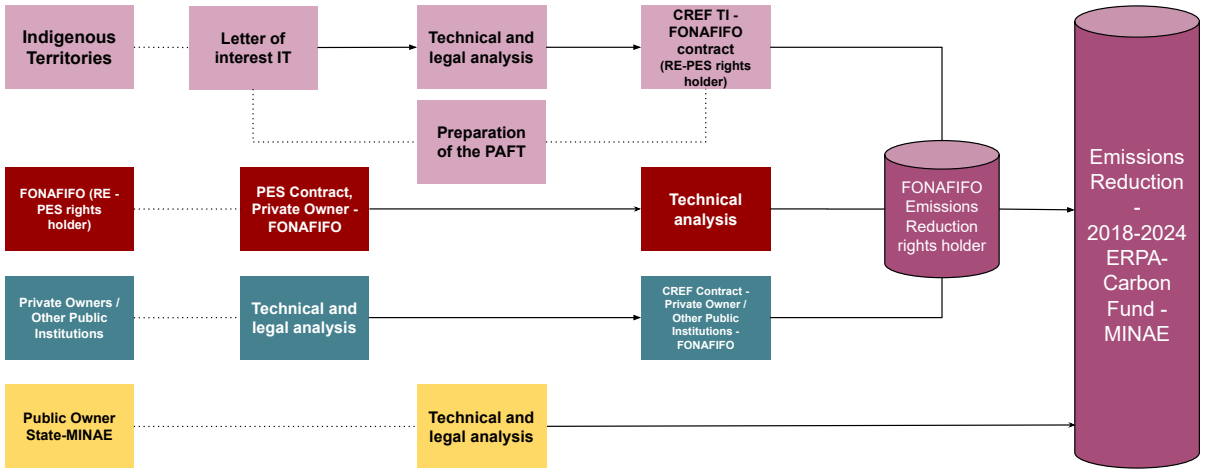

Figure 6-1*: Process for transferring title to Emission Reductions ERPA - Carbon Fund - MINAE 2018-2024*

Challenges in documenting ownership of Emissions Reduction

The ER-Program has faced significant hurdles in documenting emissions-reduction ownership. These challenges are crucial to understand, as they directly affect potential participants' interest and the program's overall success. During the initial phase of field visits for property geolocation, potential participants showed little interest because of the proposed payment (US$7/ha per year). This initial estimate of emissions-reduction compensation was less attractive to landowners than the current PES amount (US$64/ha per year).

The CREF payment has been increased to US$18 per hectare per year to address this issue. The Ministry has allowed the use of US$38.8 million from the REDD+ result-based payment granted to the country by the Green Climate Fund. This payment compensates for a reduction of 14.08 million tons of carbon dioxide equivalent ($MtCO_2eq$) in emissions during 2014-2015, resulting in an increase in the CREF payment. FONAFIFO has added these resources to the funds obtained from the Emission Reduction Purchase Agreement (ER-PA). With this combination of resources, the ER-Program can now pay US$18 per hectare per year for 7 years under the project.

Forest Owners in unregistered properties

Also, it is essential to note that unregistered farms represent the greatest potential to enter the ER Program because they cannot participate in PPES. However, unregistered farms lack several legal requirements that are difficult to obtain. The REDD+ Secretariat sought ways to involve unregistered farms, which account for a significant share of ownership and farm size. In August 2022, Executive Decree N 43649-MINAE was released[113], allowing forest holders in Protected Areas to join the ER Program (CREF) and the Payment for Environmental Services Program. This positively affected the RE Program's recruitment level and increased the volume of work to review legal and technical requirements. The unregistered farms generate the greatest volume of work, given the number of requirements set out in the procedure's manual and in the Eco-Markets law (8640), which establishes the legal conditions for holders.

In accordance with the provisions outlined in Transitory III of Executive Decree No. 44647-MJP, titled "General Regulation of the Real Estate Registry," issued on August 28, 2024, and published in Scope No. 163 of La Gaceta No. 177 dated September 24, 2024, the National Cadaster has, effective March 24, 2026, undertaken the legal cancellation of cadastral plans that have not resulted in registry transactions within the Real Estate Department Registry and are not subject to the provisional deadlines stipulated by Executive Decree No. 34331.

This situation did not affect the Forest Emission Reduction Contracts formalized on unregistered properties before the publication of Transitory III, and therefore did not affect the reported ERs. It affects applications for entry into the Emissions Reduction Program that are currently under technical-legal assessment, concerning unregistered properties and payments for greenhouse gas emission reductions for the period from 2018 to 2024. Notably, in both scenarios, the cadastral plans outlining the properties were active from January 1, 2018, to December 31, 2024. This interval corresponds to the period during which the forests on these properties helped reduce greenhouse gas emissions as part of the Program.

To align with the principles of legal certainty, non-retroactivity, reasonableness, proportionality, and the preservation of administrative acts, the Manual of Procedures for the Payment Program for the Reduction of Forest Emissions of Greenhouse Gases is being revised. This update aims to recognize the validity of cadastral plans created prior to March 24, 2026, provided that their cancellation results solely from the transitional provisions mentioned and not from technical errors, inherent issues, or actions by the administered parties.

Adjustment of forest area reported for Indigenous territories

During the preliminary assessment of the forest area of the Indigenous Territories, a total of 177,278 hectares was reported. This estimate was derived from the forest cover identified in the coverage maps for 2019 and 2021. However, in accordance with the provisions of the CREF Procedures Manual, the determination of the effective area is not restricted solely to the analysis of forest cover, but necessitates the application of technical, legal, and field assessments that enable a more precise identification of the areas meeting the criteria established for their recognition.

During the legal and technical analysis phase, it was found that several indigenous territories include farms registered to other private owners. As a result, these areas were excluded from the calculation of the effective area, in accordance with the relevant legal criteria and the methodology established for determining eligible areas.

Furthermore, an adjustment process was conducted based on field verifications performed across various territories. These visits served as a crucial input for validating the previously analyzed cartographic and legal

[113] Executive Decree N 43649-MINAE can be accessed at following link https://onfcr.org/wp-content/uploads/MODIF-PSA-publicado-en-La-Gaceta-165-31-Ago-22.pdf (Page 11)

information. During the inspections, technical personnel conducted field visits in collaboration with the individual designated by each Integral Development Association (ADI), who provided information on the areas under the control and effective authority of the indigenous communities.

The information collected during these visits facilitated the identification of ground circumstances that could not be ascertained solely through desk-based analysis, thereby necessitating further modifications to the delimitation of the effective areas. Consequently, by integrating cartographic, legal, and field analyses, a more accurate estimate aligned with the territorial reality of each indigenous territory was achieved.

Initiatives implemented to enhance recruitment within the ER Program

The REDD+ Secretary implemented three additional measures to recruit the largest number of ER Program beneficiaries while ensuring that at least 55% of the country's forest land is protected.

i. **Recruitment of former PES beneficiaries/applicants**: REDD+ Secretariat reviewed the historic PES database to identify potential beneficiaries who are either no longer receiving PES or were initially deemed unsuitable due to not meeting PPES priorities. The REDD Secretariat reached out to these potential beneficiaries via phone calls or email to inform them about the ER Program and invite their participation.

ii. **Engagement of Forestry Organizations and Regency Agents**: The principal forest owner organizations and Forest Regency Agents were contacted to seek their partners' participation.

iii. **Open call for participation**: In August 2021, a new call was made to explain the ER Program and invite forest owners to participate. This call will be open until the end of the crediting period.

iv. **Increase in CREF payment for Other State Institutions:** Within the framework of the Forest Emissions Reduction Program, the Ministry of Environment and Energy recognized the necessity to enhance the economic recognition awarded to public institutions for their efforts in conserving and protecting forests under its jurisdiction. These institutions receive an amount of US$6.66 per hectare annually for the period 2018-2024, financed through resources from the Emission Reduction Purchase Agreement (ERPA), entered between Costa Rica and the World Bank. As part of this process, through official letter DM-279-2026, dated April 8, 2026, the Minister of Environment and Energy, Mr. Franz Tattenbach, in his capacity as Minister, instructed the National Forest Financing Fund (FONAFIFO) to implement the necessary adjustments to elevate the economic compensation to US$10.00 per hectare annually, in view of the responsibilities assumed by public institutions in the protection, conservation, and maintenance of the forested areas under their jurisdiction. In accordance with this directive, the Board of Directors of FONAFIFO, by means of the Third Agreement of Ordinary Session No. 03-2026, conducted on April 15, 2026, sanctioned the revision to the Manual of Procedures for the Emissions Reduction Program, thereby officially authorizing the augmentation of the recognition amount for CREF contracts. Such adjustment shall be applied retroactively for the period spanning 2018 to 2024. The difference in the amount paid will be recognized in the last outstanding payment of the period 2022 to 2024.

Table 6-2: Forest area identified until May 30, 2026 as eligible to participate in the Emission Reduction Program of Costa Rica

	Forest Cover Owner Type			2018 (ha)	2019 (ha)	2020 (ha)	2021 (ha)	2022 (ha)	2023 (ha)	2024 (ha)
Reported on Substantial Volume of ER	1	CREF beneficiaries who have either registered or non-registered properties	With signed contracts or have been approved for signing.	95,038	90,868	89,096	96,985	106,639	111,575	89,150
			Legal and technical analysis in process	-	-	-	-	-	-	-
			Geo-referencing process of the beneficiary's property	-	-	-	-	-	-	-
	2	Indigenous Territories		148,945	148,152	146,585	146,867	171,619	177,608	143,356
	3	FONAFIFO PES Program		393,260	399,417	411,651	376,127	289,217	254,950	329,848
		Biodiversity Fund		5,077	7,347	8,934	9,930	9,194	9,799	8,519
	4	State Natural Heritage-SINAC		667,040	666,517	665,530	665,165	666,981	667,879	669,503
		SNH-Other State Institutions		32,728	32,701	32,730	32,731	32,723	32,731	32,732
Subtotal				1,342,090	1,345,002	1,354,525	1,327,804	1,276,375	1,254,540	1,273,107
Non-reported areas on Substantial	4	SNH-Other State Institutions		32,896	32,468	31,970	32,075	32,878	34,921	33,407
	5	Forest cover in inalienable areas		35,098	35,762	34,662	34,940	34,518	34,946	35,244
	6	Forest cover in Protected Wilderness Areas (outside National Parks, Biological Reserves, and National Monuments)		314,865	294,385	311,438	320,030	332,139	331,518	329,122
	7	Forest Cover in Overlay Analysis		89	847	688	190	193	261	1,077
	8	Forest owners NOT ELIGIBLE for the RE program		-	-	-	-	-	-	-
Subtotal				382,949	363,462	378,758	387,236	399,727	401,646	398,849
Total				1,725,039	1,708,464	1,733,283	1,715,039	1,676,102	1,656,187	1,671,957
A. Forest Cover Area with documented ownership (ha):				1,342,090	1,345,002	1,354,525	1,327,804	1,276,375	1,254,540	1,273,107
B. Forest Cover Area without documented ownership (ha):				382,949	363,462	378,758	387,236	399,727	401,646	398,849
C. Forest Cover Area not considered in the ER-P (C=D-A-B) (ha)				1,391,796	1,408,372	1,377,348	1,395,591	1,439,125	1,459,040	1,443,269
D. Total area of forest cover (ha):				3,116,835	3,116,835	3,110,631	3,110,631	3,115,226	3,115,226	3,115,226
E. Percentage of ERs able to transfer the Title to the ERs (E=A/D) [1]:				43.1%	43.2%	43.5%	42.7%	41.0%	40.3%	40.9%

Notes:

[1] A geospatial overlay analysis of ER title owners determines the percentage of ERs able to transfer the Title to the ERs. This analysis considers the following geo-databases: (i) forest land in the State Natural Heritage, (ii) private forest owners with CREF contracts, (iii) private forest owners with active PES contracts during the monitoring period, (iv) private forest owners with active Biodiversity contracts, and (v) Indigenous Territories. The geospatial overlay analysis is conducted annually, and only active PES and Biodiversity contracts are considered. As the total area of active PES and Biodiversity contracts changes annually due to contract expirations, the percentage of ERs that can be transferred varies from year to year.

Private voluntary projects are not included among the REs eligible to transfer the Title to the REs, since they do not receive PSA or CREF, nor do they form part of State Natural Heritage; therefore, they are not registered in the Data Management System of the ER-Program. The table below contains information on the two private voluntary projects identified in the ER-Program accounting area.

Year	BaunInvest Reforestation Project (1795)	VisionForest (530)	Total
2017	20,496	664	21,160
2018	20,496	664	21,160
2019	20,496	664	21,160
2020	20,496	664	21,160
2021	13,366	664	14,030
2022	13,366	664	14,030
2023	13,366	664	14,030
2024	13,366	664	14,030

https://registry.goldstandard.org/projects/details/1795
https://registry.goldstandard.org/projects/details/530

Source: You can access annual summaries (2018, 2019, 2020, 2021, 2022, 2023 and 2024) of eligible areas in both geo-database and Excel file formats by clicking on the link below: https://drive.google.com/drive/folders/1FnNzGGvyEaEzjL_5EC8FNrp5GHcMTCjh?usp=sharing
Furthermore, the worksheet with the calculation of the percentage of transferrable ERs can be accessed at the following link: https://docs.google.com/spreadsheets/d/1MEHo8-GDZ3NBKwU7QRH8zYLY-JMZe2xH/edit?usp=sharing&rtpof=true&sd=true

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

The country has decided to maintain its own comprehensive national REDD+ Program and Projects Data Management System (MF I.37.1). Costa Rica Emission Reduction Program´s data management system is part of the National System of Climate Change Metrics of Costa Rica (SINAMECC). SINAMEC is Costa Rica's official platform to coordinate climate information in the country (Figure 6-2). The system tracks national climate change policy progress, enables data-driven decision-making, and facilitates reporting under national and international commitments. SINAMECC was officially established in 2018 by Executive Decree No. 41127-MINAE[114]. The system operates as a sub-module of the National Environmental Information System (SINIA), linked to the National Statistical System (SINIA). Climate Change Directorate (DCC) of the Ministry of Environment and Energy (MINAE) coordinates SINAMECC[115]. This system also has the SINAMECC Committee made up of the National Meteorological Institute (IMN), the Secretariat for Sector Planning for the Environment, Energy, Seas and Territorial Planning (SEPLASA), the National Center for Geo-environmental Information (CENIGA), and the National Institute of Statistics and Censuses (INEC)[90].

SIMAMECC has three modules: i. Mitigation, ii. Adaptation, and iii. Climate Finance. The mitigation module aims to register and measure climate change mitigation actions in Costa Rica with transparency. A mitigation action is an initiative that reduces greenhouse gas emissions or increases carbon dioxide removals, such as sector initiatives - NAMAs. Also, it includes private projects within the Country Program for C-neutrality and actions derived from public policy associated with sectoral development plans. For transparency purposes, as far as possible, all actions - small or large in scale and impact - must be part of SINAMECC, which seeks to ensure that the effects of the mitigation action are reflected in the national inventory of greenhouse gases.

The country is implementing the Mitigation Action Registry. Mitigation actions in Costa Rica use multiple metrics and different baselines, which prevent the aggregation and definition of collective progress in reducing emissions at the national level. Therefore, the Mitigation Action Registry will document the initiatives together with a procedure for harmonization with the National Greenhouse Gas Inventory. A preliminary design for the Mitigation Action Registry has been prepared[116].

The REDD+ Secretariat has completed the documentation forms required by the SINAMECC Mitigation Actions Registry for the Costa Rica Emission Reduction Program (PRE)[117]. This template includes the following information, among others (MF I.37.2): i. Initiative Name, ii. Entity promoting the initiative (name, business name, representative, and information contact), iii. The scale of the mitigation action, iv. Description, REDD + type activity, and carbon pools considered, v. Methodological framework or Standard, vi. Project Life Cycle (Credit Period), vii. Reference Level used; viii. Existence of a purchase-sale contract for the reduction of emissions, and ix. Ex Ante Estimation of Emissions Reduction. The REDD+ Secretariat will document, in the Costa Rica Emission Reduction Program´s data management system, the title-right owner and beneficiaries' information, the geographic limits of the properties, and the forest area included in the PRE.

The REDD+ Secretariat has implemented the ER Program Data Management System (DMS). The ER Program's DMS includes i. the entity that has title to ERs produced; ii. the geographical boundaries of the State Natural Heritage (National Parks, National Monuments, and Biological Reserves, inalienable areas), Indigenous Territories, and Private-

[114] Decree 41127-MINAE can be accessed at the following link
http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?nValor1=1&nValor2=86584
[115] Decree 35669-MINAE can be accessed at the following link
http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?nValor1=1&nValor2=66973 [90]
http://sinamecc.go.cr/acerca-de
[116] Concept note of Design and testing of a cross-sectorial Measurement, Reporting, Verification and Registry framework for Costa Rica's National Climate Change Metrics System
http://sinamecc.go.cr/biblioteca-sinamecc/conceptoSinamecc
[117] The documentation form completed for the ER-P can be accessed at the following link
https://docs.google.com/spreadsheets/d/1ltS_8NvZeF79ZfqAVrTVcltq2_UB88GB/edit?usp=sharing&ouid=101528572552038951719&rtpof=tru

Owned Forest Properties; and iii. The scope of REDD+ activities. The DMS system produces the input information shown in Table 6-2, with ERs classified by owner type and year. Figure 6-3 shows the line diagram of the ER-Program Data Management System. Table 6-3 provides details on the users, analysts, reviewers, and approvals functions of the ER-Program Data Management System. The REDD+ Secretariat, together with the FONAFIFO Legal Department, has prepared a manual of requirements and procedures for the Emissions Reduction Program. The manual details the beneficiary approval procedures in PRE, including decision rules for overlap cases between landowners and legal requirements, for both private owners and the SNH and IT. Finally, it indicates the general terms of the rights session and the payment of the RE[118].

DMS implementation included the following tasks:

- *Calls for CREF beneficiaries*: The REDD+ Secretary of Costa Rica and FONAFIFO have made two calls for participating in the Emissions Reduction Program (PRE) and later to sign Emissions Reduction Contracts (CREF). The first was in October 2020, and the second was in August 2021. FONAFIFO invited forest owners to express their interest in participating and learn about the Program by filling out a form[119] on FONAFIFO's website[120]. Farm owners with forests, natural regeneration, forest management (primary or secondary), or forest plantations can participate in the CREF mechanism. FONAFIFO promoted the campaign through various media, including national-circulation newspapers, Facebook, the website, and individual invitations to several organizations and relevant stakeholders. The REDD+ Secretariat is building a database of all applications.
- *Analysis of ER owners*: As part of the ER Program's entry process and to demonstrate ownership of emission reductions, the REDD Secretariat built a geospatial database of potential ER Program beneficiaries, including private forest owners, Indigenous peoples, SINAC, FONAFIFO, and other institutions administering State Natural Heritage.
- *Property geolocation analysis*: The database enables the REDD+ Secretariat to locate overlaid areas across private and public ownership. Also, to determine if the overlaying is due to location errors in the cadastre plan. The Geospatial Analyst of the REDD Secretariat prepared CREF non-overlapped maps for each application received during the calls. The procedure for the overlay analysis is in the manual of requirements and procedures for the Emissions Reduction Program[121].
- *Field visits*: The REDD+ Secretary's Field Analyst visited the properties of potential beneficiaries to identify and resolve any location-related issues. The Secretary has visited more than 150 locations with applications to the ER Program. Property accessibility has resulted in a problem. Remote properties usually lack clear boundaries, complicating the verification of the cadastre map and increasing recruitment costs.
- *Legal analysis*: After the overlay issues have been resolved, the REDD Secretary conducts a legal analysis and then proceeds with the CREF signature.
- *Payment - SICREF*: The REDD+ Secretariat, in collaboration with FONAFIFO, established the SICREF, an administrative system for processing payments to private owners, indigenous peoples, and other state institutions. The system records beneficiary information, forest areas, and the payment years specified in CREF contracts. SICREF complies with the administrative standards set by FONAFIFO.

[118] Manual of Requirements and Procedures for the Emissions Reduction Program can be accessed at the following link https://www.imprentanacional.go.cr/pub/2022/09/16/ALCA197_16_09_2022.pdf

[119] Application to Join the CREF Project https://forms.office.com/Pages/ResponsePage.aspx?id=ytnVe7YiPUK3Aloh1bsHR3mtNt1gTYhOgux9YcGhPN9UNkRVT1NFMDZES0FMR0dEVTRXSTMwQ0kzWC4u

[120] www.ganacontubosque.com

[121] Ibid 104

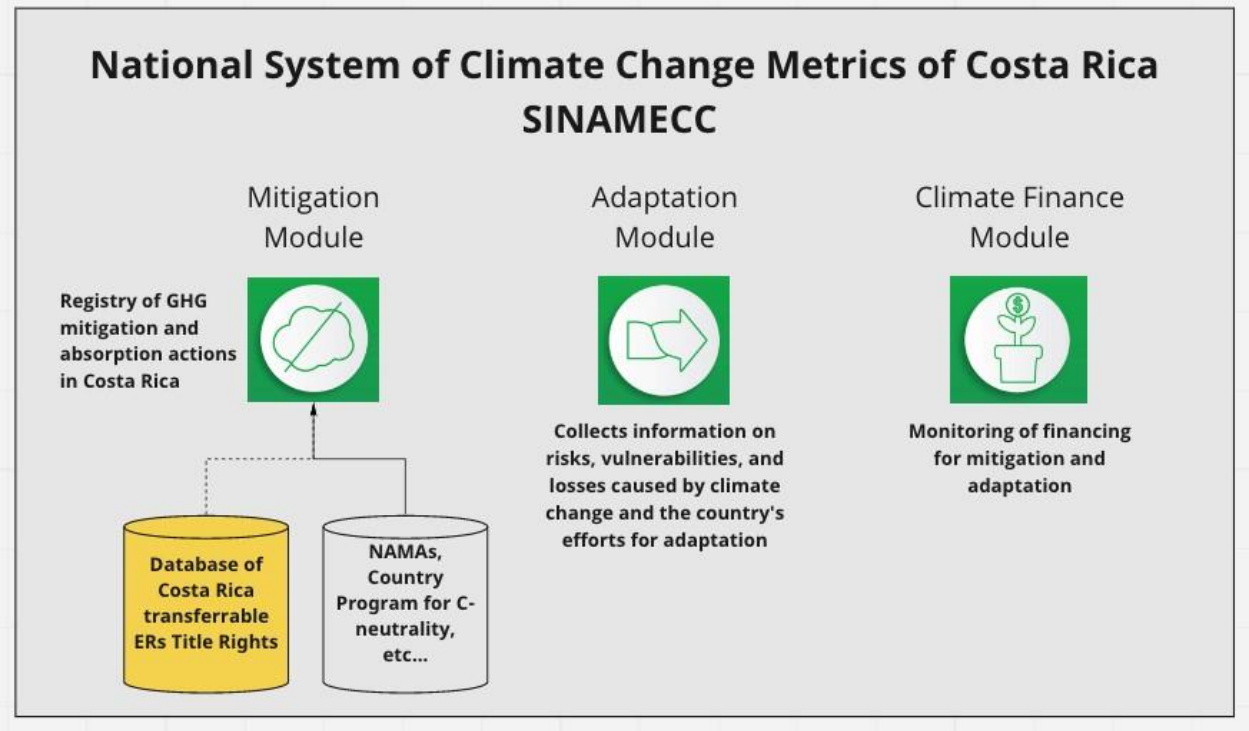

Figure 6-2: National System of Climate Change Metrics of Costa Rica (SINAMECC). Costa Rica Emission Reduction Program´s data management system is part of the SINAMEC. This system is Costa Rica's official platform to coordinate climate information in the country.

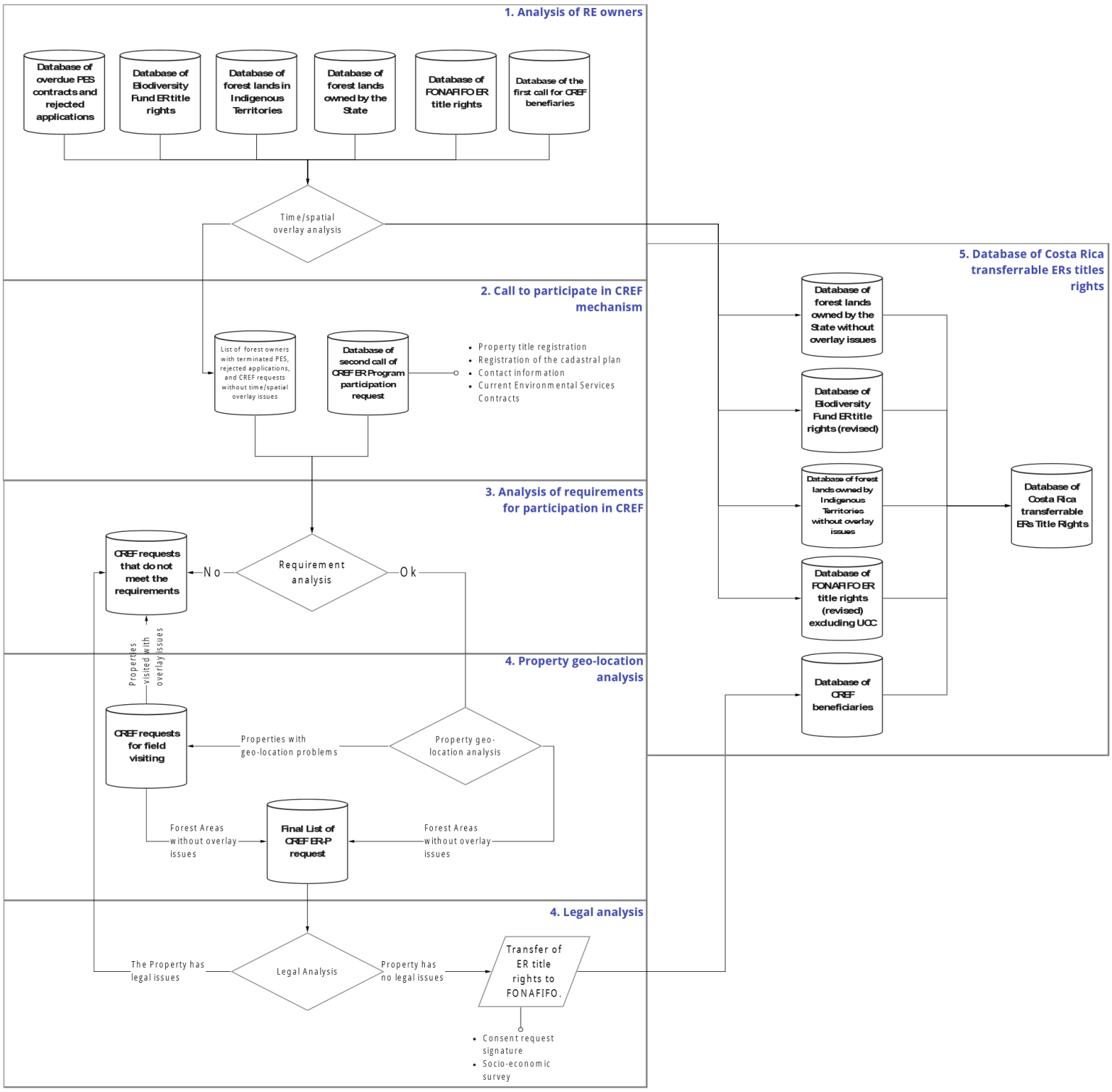

Figure 6-3: Line diagram for the building process of Costa Rica ER-Program Data Management System.

Table 6-3: Functions of the ER-Program Data Management System.

Registration process phases	User / Analyst	Reviewer	Approval	Issuance of Opinion
Receipt of CREF requests	Landowner with forest cover	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Approval of the closing report for the receipt of CREF applications
Receipt Payment for Environmental Services Program geodatabase.	FONAFIFO	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Approval of database reception report
Receipt of the State Natural Heritage geodatabase	SINAC	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Approval of database reception report
Receipt of Biodiversity Fund geodatabase	FUNBAN	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Approval of database reception report
Preparation of the Indigenous Territories geodatabase	Geospatial Analyst (REDD+ Secretariat)	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Approval of database reception report
CREF Requirements Analysis	Requirements Analyst (REDD+ Secretariat)	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Requirements review report approval
Spatial overlap analysis between ER´s owners	Geospatial Analyst (REDD+ Secretariat)	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	CREF effective area maps
Geolocation field review of properties.	Field Analyst (Forestry Engineer - REDD+ Secretariat)	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Corrected CREF effective area map
Legal Analysis	CREF recruitment officer (REDD+ Secretariat)	Legal Analyst (FONAFIFO)	Head of FONAFIFO´s Legal Department	RE title-right contract
Registry ER title-rights	Geospatial Analyst (REDD+ Secretariat)	CREF recruitment officer (REDD+ Secretariat)	Head of REDD + Secretariat	Record ID of the property in the database.

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6.3 Implementation and operation of ER Transaction Registry

The Government of Costa Rica has decided to use the FCPF ER Transaction Registry in conjunction with its own national registry, which is currently being developed as part of the National Climate Change Metrics System (Sistema Nacional de Métrica de Cambio Climático, SINAMECC). As part of the measures to avoid double-counting of ERs generated from the Costa Rica FCPF ER Program in the national transaction registry and the FCPF ER Transaction Registry, once the national registry is operational, the Government of Costa Rica will only recognize, including for purposes of reporting to the Trustee, authorization and/or corresponding adjustments units that are duly registered in the Costa Rican national registry. Both Parties will take all reasonable efforts to ensure that the Costa Rican national registry component of SINAMECC and the FCPF ER Transaction Registry will incorporate all features necessary to enable communication and operational compatibility between the systems.

Costa Rica anticipates receiving support in the implementation of the ER Transaction Registry. The country has submitted a concept note for the **Scaling Climate Action by Lowering Emissions (SCALE) program**. SCALE is a World Bank initiative designed to assist client countries in implementing nature-based emission reduction (ER) programs that promote livelihoods and enhance resilience. The program is structured into three distinct phases: Identification (Phase 1) for program design; Readiness (Phase 2) for capacity building and program registration; and Monitoring and Transaction (Phase 3) for results-based payments for verified emission reductions. The specific application of this program in Costa Rica is known as IMAB+ (Integrated Actions for Enhancing Mitigation, Adaptation, and Biodiversity Outcomes).

The SCALE-CR proposal is a strategic initiative designed to modernize **Costa Rica's climate and nature finance architecture** over a 24-month period. The program aims to transition the country from traditional forest conservation to an integrated model that includes **agriculture, livestock, and green construction** under a unified carbon market framework. Key components include the development of **interoperable monitoring, reporting, and verification (MRV) systems** and legal frameworks aligned with **Article 6 of the Paris Agreement**. The implementation of the **Emission Reduction (ER) transaction registry** in the SCALE-Costa Rica proposal is a critical component of the country's transition toward an integrated climate and nature finance architecture. The primary goal is to move from fragmented, siloed systems to a unified national registry that meets international compliance standards. By establishing this registry, Costa Rica aims to create **investor-grade transparency** and regulatory certainty, positioning itself to transact high-integrity carbon in compliance and voluntary markets.

Actions undertaken by the Participant prior to the implementation of the National Registry.

FONAFIFO is responsible for implementing Costa Rica's REDD+ Strategy. Its key responsibilities include ensuring compliance with standards to prevent double-counting when issuing forest carbon credits. While Costa Rica develops the National Registry, FONAFIFO maintains an interim registry for credit issuance under the Costa Rica REDD+ Strategy and voluntary forestry projects (see Tables 6-4 and 6-5).

Before issuing a jurisdictional REDD+ carbon credit, FONAFIFO and the REDD+ Secretariat perform a double-counting check for any forest emission reduction jurisdictional or voluntary projects within the national territory that have already issued credits. This double-counting control is conducted between voluntary projects and jurisdictional REDD+ projects (**Voluntary Projects Scenario**) and among different jurisdictional REDD+ projects (**Jurisdictional Projects Scenario**). It is essential to note that the country will include the following double-counting-checking process in the National Registry (see figure 6-4).

It is important to note that the REDD+ Strategy is implemented at the national level; therefore, the "Results" column in Table 6-4 encompasses the entire national territory. The total quantity of Emission Reductions (ERs) generated during a monitoring period can be classified into two distinct categories:

i. **ERs with Contracts**: This category includes ERs associated with a Contract for Emission Reductions (CREF), a Contract for Payment for Environmental Services (PES) signed by the forest owner, or ERs generated in the State Natural Heritage (SNH). In these cases, the carbon rights have been transferred to FONAFIFO. Costa Rica issues credits only for forest areas where the carbon rights have been transferred.

ii. **ERs without Contracts**: These are ERs without a CREF, PES contract, or outside of the SNH. The country plans to submit these emission reductions for Results-Based Payments to the REDD+ Program within the Green Climate Fund for the years 2020, 2021, and 2022.

Voluntary Projects Scenario: Each time a monitoring report is submitted for validation and verification, the REDD+ Secretariat reviews the various voluntary project registries (see Table 6-5) to identify any credits issued in the national territory for the same years, area, and carbon pools in which the country has issued credits from the REDD+ Strategy, thus avoiding double counting. This checking process is outlined as follows:

1. **Carbon Pools Overlapping**: The first step is to determine whether the voluntary project includes any carbon pools that are part of the Jurisdictional REDD+ project's carbon accounting framework. If the AFOLU project includes additional carbon pools, the credits from those pools will not be deducted from the Jurisdictional REDD+ project's carbon issuance.
2. **Carbon Accounting Areas Overlapping**: If the voluntary project involves one or more carbon pools that overlap with the Jurisdictional REDD+ project's carbon accounting framework, the subsequent step is to verify whether the voluntary project coincides with the Jurisdictional REDD+ project area. Since Costa Rica exclusively issues credits for forest areas where carbon rights have been transferred to FONAFIFO, the REDD+ Secretariat will confirm if the voluntary project overlaps with the State Natural Heritage or forest areas where carbon rights have been transferred through a Contract for Emission Reductions (CREF) or a Contract for Payment of Environmental Services (PES) signed by the forest owner. The REDD+ Secretariat will compare the geodatabase of PES and CREF contracts with the carbon accounting area of the voluntary projects. In the absence of overlap with the PES/CREF geodatabase, the credits from the voluntary project will not be deducted from the carbon issuance of the Jurisdictional REDD+ project.
3. **Carbon Credit Vintage Overlapping**: If the voluntary project overlaps with the SNH/PES/CREF geodatabase, the REDD+ Secretariat shall verify whether the voluntary project issues credits for the same years as the Jurisdictional REDD+ project. If both projects issue credits within the same year, the credits from the voluntary project shall be deducted from the carbon issuance of the Jurisdictional REDD+ project.

Jurisdictional Projects Scenario:

Since jurisdictional REDD+ projects are implemented nationally, their accounting areas overlap entirely. It is also important to note that the carbon accounting framework for current REDD+ projects in Costa Rica considers the same carbon pools. Therefore, the checking process is limited to overlapping carbon credit vintages.

1. **Carbon Credit Vintage Overlapping:** No deduction is required if one or more REDD+ projects issue credits in different years. If both REDD+ projects issue credits in the same year, any previously issued credits will be deducted from the new credits being issued. It is essential to clarify that the country will not submit the portion of ERs (credits and buffer) issued under REDD+ projects for result-based payment to the GCF.

Double issuance, double-selling, and double-use control:

Costa Rica has engaged in forest carbon credit transactions through the Forest Carbon Partnership Facility (FCPF), specifically via the Carbon Fund Emission Reduction Payment Agreement (ERPA), and through the LEAF coalition via the EMERGENT ERPA.

Under the FCPF—Carbon Fund ERPA, carbon credits are issued within the Carbon Assets Tracking System (CATS). CATS functions as an Emission Reduction (ER) Transaction Registry, meticulously designed and implemented to support the issuance and management of ER units generated under World Bank programs. The system offers a robust and dependable architecture for creating, governing, storing, and maintaining data, thereby ensuring operational transparency and security. It also mitigates risks associated with double-counting, including double issuance, double claiming, double selling, or double use of ER units generated through World Bank initiatives (refer to CATS Operational Guidelines).

TREES Credits issued to the Emergent ERPA are registered in the ART Registry. ART ensures transparency by requiring that REDD+ program registration and verification documents be made public. The ART Registry prevents double-

counting or double-selling by serializing credits and linking to online public reports on credit issuance, credit retirement, and credit cancellation (See the About the ART-Registry section at https://www.artredd.org/art-registry/)

In addition to the CATS and ART-Registry double-counting risk mitigation system, the Participant's implementation of the double-counting checking process also prevents double-selling of carbon credits by deducting voluntary and jurisdictional credits issued by projects that overlap in spatial area, carbon pool, and vintage.

It is important to note that 95% of the FCPF Carbon Fund (Tranche B) and 100% of the Emergent ERPAs (Pathways 1 and 2) carbon credits have been negotiated, ensuring that they will be used exclusively for Costa Rica's Nationally Determined Contribution (NDC) achievement. In contrast, the carbon credits from the FCPF Carbon Fund Tranche A will not be utilized for this purpose. The emission reductions (ERs) associated with TREES credits will also be retired in the ART Registry. Below is a description of the tranches and pathways considered by Costa Rica in the ERPAs with the FCPF Carbon Fund and Emergent.

- FCPF-Carbon Fund-Tranche A: Carbon Fund's Tranche A has unrestricted use of emission reductions (ERs), e.g., for compliance or resale. Tranche A receives a pro rata share of the fund's overall contributions, which is 5%.
- FCPF-Carbon Fund-Tranche B: Carbon Fund's Tranche B restricts the use of emission reductions (ERs) for compliance or resale. Tranche B receives a pro rata share of the fund's overall contributions, which is 95%.
- LEAF Coalition Pathway 1: Sovereign contributors will provide results-based payments (RBPs) and neither take title to the ERs nor use them towards their NDC targets. Suppliers receiving RBPs will be required to retire the ERs on the ART registry, but the Supplier Country may include the underlying mitigation in accounting for its NDC.
- LEAF Coalition Pathway 2: Private sector buyers may replicate the sovereign approach (e.g., RBP without taking title). Suppliers receiving RBPs will be required to retire the ERs on the ART registry, but the Supplier Country may include the underlying mitigation in accounting for its NDC.

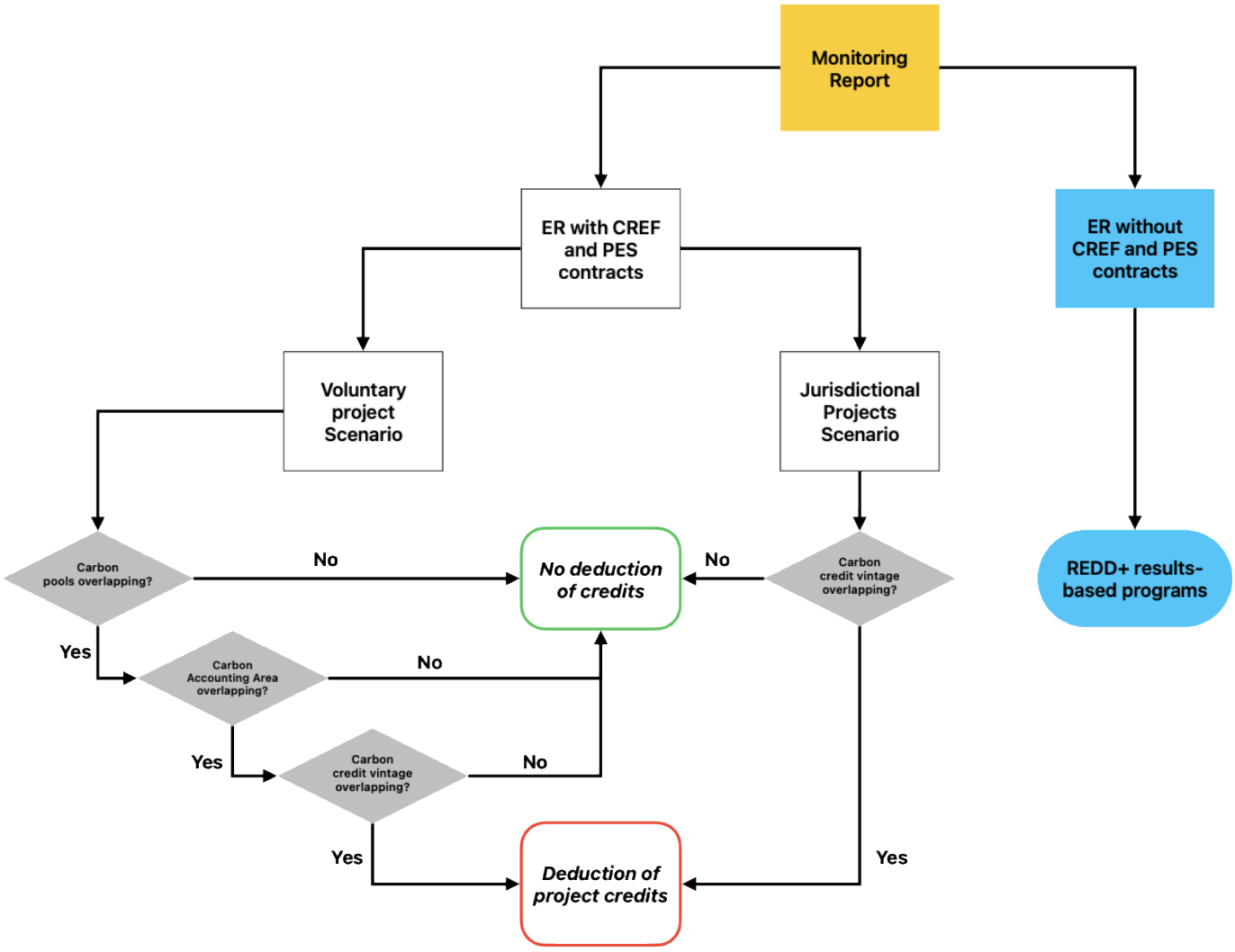

Figure 6-4: Double-counting control process for credits issued under the REDD+ Strategy implementation in Costa Rica.

Table 6-4: Interim registry of results and forest carbon credits issued from Costa Rica REDD+ Strategy.

Year	Results (tCO2)	Number of ERs for payments or Credits issued [1]	Initiative / Program / Fund	Registry	Refence documentation
2014 and 2015	14,794,747	10,559,833	Green Climate Fund	Lima Hub	Technical Annex of the Republic of Costa Rica (2019)
2017, 2018 and 2019	11,178,554	1,171,032	LEAF coalition	ART	TREES Verification Report (June 2026)
2018 and 2019	10,486,289	4,489,008	FCPF	CATS	Supplementary Verification Statement (July 2024)
2020 and 2021	9,852,768	4,827,732	FCPF	CATS	Verification Report (September 2024)

[1] Including buffers

Note: FONAFIFO has submitted a Results-Based Payments proposal to the Green Climate Fund for 2020-2022. This aligns with the Carbon Fund ERPA reporting period. REs were generated in 58% of the Program's territory, excluding Indigenous Territories, State Natural Heritage lands, and private lands where transferring REs to the Carbon Fund was not feasible due to challenges in beneficiary recruitment under CREF. FONAFIFO notified the World Bank before submitting the proposal. The Bank indicated that, overall, it had no objections, primarily because FONAFIFO clarified that the areas in this proposal differ from those involved in previous RE transfers under ERPA agreements.

Table 6-5: Interim registry of forest carbon credits issued from voluntary projects.

Year	Number of Credits issued	Voluntary project	Registry	Carbon accounting overlapping with PES/CREF geodatabase
2014	17,040	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2015	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2016	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.

2017	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2018	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2019	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2020	20,496	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2021	13,366	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2022	13,366	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2023	13,366	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.
2024	13,366	BAUMINVEST REFORESTATION PROJECT	Gold Standard	No overlapping.
	664	VISIONSWALD - VISIONFOREST	Gold Standard	No overlapping.

6.4 ERs transferred to other entities or other schemes

Four Afforestation and Reforestation (AR) projects in Costa Rica are listed in the Gold Standard Registry. These projects are: the Reforestation Project in Costa Rica 01 (GS11708), the BaumInvest Forest Landscape Restoration Program (GS11707), the BaumInvest Reforestation Project (GS2913), and VisionsWald - VisionForest (GS3264). Projects GS11707 and GS11708 have not issued credits in Costa Rica for vintages from 2014 to 2024.

To avoid double-counting of Emission Reductions (ERs) generated from the Costa Rica Forest Carbon Partnership Facility (FCPF) ER Program with these specific initiatives, the Private Voluntary Projects have not been included in the ERs that can transfer the Title to the ERs. It is also important to note that these Private Voluntary Projects do not receive PSA, CREF, or form part of State Natural Heritage. As a result, they are not registered in the ER-Program's Data Management System.

Table 6-6 shows the FCPF units registered in CATS and the TREES units registered in the ART Registry that were issued under Costa Rica's Emission Reduction Program between 2018 and 2024. Because this report includes a Methodological Deviation, two deductions have been applied in the worksheet "Section 8" of the FCPF ERMR template used to calculate the FCPF ERs[122], in rows E1 and E2:

- E1: 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
- E2: In the event of an approved methodological deviation (Section 1.3), this row must also include a deduction for all FCPF ERs already issued in previous Reporting Periods, along with their associated Uncertainty and Pooled Reversal Buffer allocations.

For E1, the TREES units and buffers were deducted (see line 8 in Table 6-6), while for E2, the FCPF ERs and buffers were deducted (see line 5 in Table 6-6).

Table 6-6: FCPF units registered in CATS and TREES units registered in ART Registry issued between 2018 and 2024.

FCPF ERs registered in CATS [1], [2], [3]	2018	2019	Subtotal	2020	2021	Subtotal	Total
1. Number of ERs allocated to the Uncertainty Buffer	274,566	264,116	538,681	258,206	248,068	506,274	1,044,955
2. Number of ERs allocated to the Reversal Buffer Pool	100,675	96,842	197,516	94,676	90,958	185,634	383,150
3. Number of ERs allocated to the Pooled Reversal Buffer	100,675	96,842	197,516	94,675	90,959	185,634	383,150
4. Number of FCPF ERs	1,812,141	1,743,153	3,555,295	1,704,163	1,637,250	3,341,413	6,896,708
5. Number of FCPF ERs and Buffers	2,288,057	2,200,953	4,489,008	2,151,720	2,067,235	4,218,955	8,707,963
TREES Units registered in ART Registry [4]	**2018**	**2019**	**Subtotal**	**2020**	**2021**	**Subtotal**	**Total**
6. Number of ERs allocated to the Buffer Pool Contribution REMV	14,274	16,991	31,265	-	-	-	31,265
7. Number of TREES Units	159,173	204,302	363,475	-	-	-	363,475
8. Number of TREES Units and Buffers	173,447	221,293	394,740	-	-	-	394,740

[1] CR Verification Report - First Period
[2] CR Verification Report supplementary - First Period
[3] CR Verification Report - Second Period
[4] Verification Report - First TMR

[122] FCPF ERMR template used to calculate the FCPF ERs can be accessed at the following link: https://drive.google.com/file/d/1XwxzYT1NhvED1mx9QiPJb2Oq1ZByw6CM/view?usp=sharing

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)

Sections 7.1, 7.2, and 7.3 are not applicable because no reversals have occurred.

7.2 Quantification of Reversals during the Reporting Period

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

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]**		
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]**		
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**		
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**		
Q.	**Total Pooled Reversal Buffer replenishment for the Reporting Period**		

7.4 Reversal Risk assessment

Risk Factor	Risk Indicators	Default Reversal Risk Set-Aside Percentage	Discount	Resulting Reversal Risk set-aside percentage
Default risk	*N/A*	**10%**	*N/A*	*10%*
Lack of broad and sustained stakeholder support	The support and participation of diverse stakeholders are central to Costa Rica's REDD+ strategy, which emphasizes inclusion, transparency, and the equitable distribution of benefits among various social and economic sectors[123]. ***Indigenous Peoples' Participation*** Support for indigenous communities is managed through a robust framework designed to respect their autonomy and traditional knowledge. • **PAFT (Territorial Forestry Environmental Plans):** Developed through a collaborative process, 19 out of 24 territories have completed these plans, which identify community priorities for climate finance investment. • **Direct Investment:** As of 2024, 12 territories have signed **Emissions Reduction Forest Contracts (CREF)**, allowing them to receive direct financial benefits for forest conservation based on the priorities set in their PAFTs. • **Governance and Monitoring:** Indigenous stakeholders participate in the **CISITI** (Internal Committee for Supervision of Indigenous Territorial Investment), which ensures transparent management of funds through community-led monitoring and oversight commissions. ***Empowerment of Women*** Gender equality is a strategic pillar of the REDD+ implementation, aimed at reducing socioeconomic gaps for rural and indigenous women. • **Gender Action Plan (PAG):** This plan promotes women's access to financial incentives and leadership roles in forest governance. • **GIGUP (Gender Equality Award):** This initiative recognizes and supports productive units led by women that implement sustainable practices, with 95 women recognized by 2024. • **Land Access:** Support includes the **"Tierra para Mujeres" (Land for Women) bill**, which seeks to prioritize land titling and credit access for rural women. • **Foro Nacional de Mujeres Rurales (FNMR):** This forum provides a permanent space for women from 29 rural territories to influence public policy and access information on green financing. ***Productive Sectors and Smallholders*** The strategy engages the private sector and small-to-medium producers through specialized market and conservation initiatives: • **Deforestation-Free Coffee:** A pilot project with the coffee sector led to the first export of **deforestation-free coffee** to Europe in 2024, supported by a technical implementation guide for over 800 farming families. • **Regional Forestry Networks:** Six regional networks have been consolidated to support small and medium producers, helping them integrate into sustainable forestry value chains. • **Environmental Service Payments (PSA):** Traditional and modernized PSA schemes continue to support private landowners, with specific points added to evaluation criteria for women-owned farms to encourage balanced participation. ***Transparency and Feedback Mechanisms*** To maintain stakeholder trust and ensure effective governance, the strategy employs several transparency tools:	**10%**	*Reversal Risk is considered low: 10% discount*	*0%*

[123] Secretaria REDD+, 2025. Abordaje y respeto a las salvaguardas de Cancún en la implementación de la Estrategia de Reducción de Emisiones por Deforestación y Degradación de Bosques en Costa Rica. Tercer Informe Periodo: enero 2021 a diciembre 2025. Accesible en https://redd.unfccc.int/media/tercer_so1_costa_rica_2021_2024.pdf .

	• **Monitoring Committee:** This body includes representatives from the social sector, academia, NGOs, and the industrial sector to oversee strategy compliance. • **MIRI (Information, Feedback, and Grievance Mechanism):** This system provides an accessible channel for all stakeholders—especially rural and indigenous groups—to clarify doubts, provide feedback, or file complaints regarding REDD+ activities. • **SIS (Safeguards Information System):** A digital platform hosted by SINIA that provides public access to indicators and evidence regarding how social and environmental safeguards are being respected.			
Lack of institutional capacities and/or ineffective vertical/cross sectorial coordination	**Insufficient experience implementing programs and policies, lack of cross-sectoral cooperation and between gov. levels.** The implementation of the REDD+ Strategy in Costa Rica is managed through a multi-tiered institutional framework led by the **Ministry of Environment and Energy (MINAE)**, which coordinates actions across several specialized agencies and oversight bodies[124]. ***Core Governance Structure*** The governance of the National REDD+ Strategy (EN-REDD+) is formalized by executive decree and organized into three main bodies: • **National REDD+ Secretariat:** Led by the National Forestry Financing Fund (FONAFIFO) and the National System of Conservation Areas (SINAC), this body is responsible for the day-to-day coordination and execution of the strategy. • **Board of Directors:** This group provides political supervision and strategic direction. It is composed of the Executive Directors of both FONAFIFO and SINAC, along with the Vice Minister of Environment. • **Monitoring Committee:** Tasked with ensuring compliance with the strategy, this committee facilitates social dialogue. It includes representatives from the social sector, producers, academia, the private sector, NGOs, and the industrial sector. ***Primary Implementing Agencies*** Two main institutions share the responsibility for field-level implementation and financial management: • **FONAFIFO (National Forestry Financing Fund):** FONAFIFO serves as the central agency for Costa Rica's REDD+ program. It established the reference level during the REDD+ readiness phase, manages a Service Comptroller, and oversees the Feedback and Grievance Redress Mechanism (FGRM) along with the National REDD+ Consultation process. Since 1997, FONAFIFO has regulated the Payments for Ecosystem Services (PES) Program, demonstrating Costa Rica's ability to coordinate and implement REDD+ initiatives nationwide. Beyond PES, FONAFIFO has executed the Emissions Reduction Agreement (CREF), a specialized PES scheme that channels climate finance to private landowners and indigenous territories, facilitating direct payments from the Emissions Reduction Purchase Agreements (ERPA). The REDD+ Secretary has developed Standards and Procedures for CREF, outlining technical and legal requirements for participation. From 2021 to 2024, FONAFIFO managed the **Emissions Reduction Forest Contract (CREF)**. • **SINAC (National System of Conservation Areas):** SINAC is responsible for the management of **Protected Wild Areas (ASP)**, which cover over 25% of the national land territory. It also oversees the **National Integrated Fire Management Program (PNMIF)** and manages biological corridors and community surveillance programs like **COVIRENA**. ***Specialized and Inter-institutional Capacities*** The strategy relies on several other entities to address specific social, technical, and legal requirements: • **SIMOCUTE:** This serves as the official national platform for coordinating and integrating information regarding land use, land cover changes, and ecosystems. It includes the **National Forest Inventory (INF)** managed by SINAC and the **Satellite Terrestrial Monitoring System (SMST)** overseen by the National Meteorological Institute. • **INDER (National Institute of Rural Development):** INDER is essential for addressing land tenure issues, managing the **National Plan for the Recovery of Indigenous Territories (Plan-RTI)**, and supporting rural development initiatives like the "Land for Women" project.	**10%**	*Reversal Risk is considered low: 10% discount*	*0%*

[124] Ibid 95.

	• **INAMU (National Institute for Women):** In collaboration with MINAE, INAMU helps implement the **Gender Action Plan**, including the **Gender Equality Award for Productive Units (GIGUP)** and the National Rural Women's Forum. • **UTCI (Indigenous Consultation Technical Unit):** Adscribed to the Ministry of Justice and Peace, this unit monitors and ratifies that all processes involving indigenous territories comply with **ILO Convention 169** and the principle of Free, Prior, and Informed Consent (FPIC). • **UNDP (United Nations Development Programme):** Through the **REDD+ PBR Project**, the UNDP provides critical technical and financial support for results-based payment initiatives, assisting in the development of Territorial Forestry Environmental Plans (PAFT) for indigenous communities.			
Lack of long term effectiveness in addressing underlying drivers	**Costa Rica REDD+ results.** Costa Rica decoupled agricultural production from deforestation by implementing solid legal frameworks, innovative agricultural and environmental policies, and Payment for Environmental Services schemes (REDD+ financial mechanisms), which together generated agricultural and livestock intensification, plus the growing development of Ecotourism. FOLU emissions have decreased from 14 in 1998 to 0.9 million tCO2-e yr-1 in 2021. Costa Rica has demonstrated that emissions can be reduced effectively, as planned in the ER Program. Deforestation in Costa Rica has historically been driven by the lack of ecosystem service value that incentivizes converting forest land to agriculture and pasture. During this monitoring period 2012-2024, the government of Costa Rica signed 724,011 ha of PES contracts with 9,716 private forest owners under the activities of Protection, Reforestation, Regeneration, and Forest Management. There have not been any new deforestation drivers identified and those listed in ER-PD. In addition, the Intensification of agriculture and livestock helped to produce a positive balance of mature forests loss and forest regeneration, improving the agriculture sector's added value and exports (see Figure 1). Between 2012 and 2024, the loss of mature forest was 35,661 hectares mainly for grasslands, while 198,686 hectares of forest were regenerated mainly from pasture lands. Finally, Ecotourism facilitated the Internalization of the benefits of biodiversity conservation. Ecotourism in Costa Rica has become an effective forest conservation strategy. An explicit conservation mechanism, a local economic benefit, and strict monitoring and application of environmental regulations have accompanied ecotourism.	**5%**	*Reversal Risk is considered low: 5% discount*	*0%*
Exposure and vulnerability to natural disturbances	**Costa Rica considers the following natural risks affecting its forest lands:** • Low-intensity natural disturbances are frequent and cause small and diffuse impacts that cannot be easily differentiated from those caused by anthropogenic factors. The emissions caused by these disturbances are measured through the degradation accounting approach but excluded from the degradation reference level. They will be excluded in future measurement reports of the Program results, posing no risk of reversals. • High-intensity natural disturbances are not a cause of deforestation and degradation. The high-intensity natural disturbances occasionally result in significant impacts occurring at a lower frequency. These disturbances include volcanic eruptions, earthquakes/tsunamis and extreme climate events. Most of the impact areas of volcanic eruptions are easily identifiable in the Landsat images and can be clearly separated from the impacts caused by anthropogenic activities. For this reason, the impacts on forests caused by these volcanic events have been excluded from the reference level, although they are transparently reported. The same will be done in future reports on the measurement of the program results. Since these areas have been excluded, their risk of reversals in Costa Rica is zero. Geological and extreme weather risks, on the other hand, are low.	**5%**	*Reversal Risk is considered low: 5% discount*	*0%*
		Total Reversal Risk set-aside percentage		*10%*
		Total Reversal Risk set-aside percentage from previous ER MR		*10%*

8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

FCPF ERMR template used to calculate the FCPF ERs can be accessed at the following link:
https://drive.google.com/file/d/1XwxzYT1NhvED1mx9QiPJb2Oq1ZByw6CM/view?usp=sharing

	Year		2018	2019	2020	2021	2022	2023	2024	Total
A.	**Emission Reductions during the Reporting period (tCO_2-e)**	*from section 4.3*	6,487,597	6,293,448	6,970,165	6,779,223	6,631,166	6,524,135	6,430,792	46,116,526
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	0	0	0
C.	**Number of Emission Reductions estimated using Measurement approaches (A-B)**		6,487,597	6,293,448	6,970,165	6,779,223	6,631,166	6,524,135	6,430,792	46,116,526
D.	**Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested**	*from section 6.1*	43.06%	43.15%	43.55%	42.69%	40.97%	40.27%	40.87%	
E.1	**ERs sold, assigned or otherwise used by any other entity for sale, public relations, compliance or**		173,447	221,293						394,740

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	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								
E.2	**In the event of an approved methodological deviation (Section 1.3), this row must also include the deduction of all FCPF ERs already issued in previous Reporting Periods, along with their associated Uncertainty and Pooled Reversal Buffer allocations.**	*from section 6.4*	2,288,057	2,200,953	2,151,720	2,067,235	0	0	0	8,707,965
	If applicable, any buffer replenishments	*section 7.3 P*	0	0	0	0	0	0	0	0
F.	**Total ERs [(B+C)*D-E] minus, if applicable, any replenishments as per section 7.3, P**		332,014	293,553	883,440	826,544	2,716,930	2,627,350	2,628,088	10,307,919
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*	4%	4%	4%	4%	4%	4%	4%	4%

H.	**Quantity of ERs to be allocated to the Uncertainty Reversal Buffer (0.15*B/A*F)+(G*C/A*F)**		13,280	11,742	35,337	33,061	108,677	105,094	105,123	412,314
I.	**Total Reversal Risk set-aside percentage applied to the ER program**	*from section 7.4*	10%	10%	10%	10%	10%	10%	10%	
J.	**Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*I**		31,873	28,181	84,810	79,348	260,825	252,225	252,296	989,558
K.	**Number of FCPF ERs (F- H – J)**		286,861	253,630	763,293	714,135	2,347,428	2,270,031	2,270,669	8,906,047
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*	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%	0.00000000%	
M	**Number of FCPF ERs from enhanced Removals from afforestation/reforestation (L * K) [Optional if the country wishes to generate enhanced Removals]**		0	0	0	0	0	0	0	0

OPTIONAL USE - Disaggregation of ERs, Enhanced Removals and HFLD [Copy and Paste results from the ER-MR Template Tool, Section 8]

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Year		20xx	…	…	…	…	TOT
P	**1. ERs from enhanced Removals from afforestation/reforestation**						
	2. If applicable, enhanced Removals from other activities besides A/R						
	3. If applicable, forest degradation						
	4. Deforestation						
	5. Adjustment, if applicable						
	Total						
Q	**1. Total net deducible ERs from enhanced removals from A/R, if any**						
	2. ERs to be allocated to the Uncertainty Buffer from enhanced removals from A/R, if any						
	3. ERs to be allocated to the Pooled Reversal Buffer from enhanced removals from A/R, if any						
	4. Total net deducible ERs from enhanced Removals from other activities besides A/R, if any						
	5. ERs to be allocated to the Uncertainty Buffer from enhanced Removals from other activities besides A/R, if any						
	6. ERs to be allocated to the Pooled Reversal Buffer from enhanced Removals from other activities besides A/R, if any						
	7. Total net deducible ERs from forest degradation, if any						
	8. ERs to be allocated to the Uncertainty Buffer from forest degradation, if any						

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	9. ERs to be allocated to the Pooled Reversal Buffer from forest degradation, if any						
	10. Total net deducible ERs from deforestation, if any						
	11. ERs to be allocated to the Uncertainty Buffer from deforestation, if any						
	12. ERs to be allocated to the Pooled Reversal Buffer from deforestation, if any						
	13. Total net deducible ERs from adjustment, if any						
	14. ERs to be allocated to the Uncertainty Buffer from adjustment, if any						
	15. ERs to be allocated to the Pooled Reversal Buffer from forest degradation						
	Total						

CALCULATION OF UNCERTAINTY BUFFER RELEASE AND REVERSAL RISK SET-ASIDE

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Years of the Crediting Period							
R	**1. ERs previously allocated to the Uncertainty Buffer during all the ERPA Reporting Periods from PROXY-based approaches, per year**	*CATS and/or previously verified ER MRs*					
	2. ERs previously allocated to the Uncertainty Buffer during all the ERPA Reporting Periods from NON-PROXY based approaches, per year (if any)	*CATS and/or previously verified ER MRs*					
	3. Total ERs previously allocated to the Uncertainty Buffer during all the ERPA Reporting Periods, both proxy and non-proxy approaches [R.1 + R.2]	*Calculated automatically*					
	4. Uncertainty (%) of the total ERs achieved cumulatively during the entire Crediting Period (applicable to non-proxy based approaches)	*Paragraph 37 FCPF Buffer Guidelines; data obtained from the last ER MR*					
	5. Recalculated quantity of ERs to allocate to the Uncertainty Buffer at the end of the Crediting Period [((Row F of each ER MR Reporting Period, per year) x (R.4)) + R.2]	*Paragraph 37 FCPF Buffer Guidelines; data obtained from each ER MR, Section 8*					
	6. Difference between the recalculated ERs to allocate to the Uncertainty Buffer and the cumulative quantity already allocated [R.5 - R.3]	*Paragraph 37 FCPF Buffer Guidelines; Calculated automatically*					
	7. Release ERs from the Uncertainty Buffer (If R.6 is negative)	*Paragraph 38 FCPF Buffer Guidelines*					
	7.1. Actual Reversal Risk Set-Aside (%) [Row I of the last ER MR Reporting Period]	*Paragraph 38 FCPF Buffer Guidelines; data obtained from last ER MR, Section 8*					
	7.2. Released Uncertainty ERs to be deposited into the Pooled Reversal Buffer account [R.7 x R.7.1]	*Paragraph 38 FCPF Buffer Guidelines*					
	7.3. Remaining ERs to be transferred following instructions of the ER Program Entity or World Bank [R.7 - R.7.2]	*Paragraph 38 FCPF Buffer Guidelines*					
	8. Additional ERs shall be allocated to the Uncertainty Buffer (If R.6 is positive)	*Paragraph 39 FCPF Buffer Guidelines*					