Forest Carbon Partnership Facility (FCPF)
Carbon Fund

ER Monitoring Report (ER-MR)

ER Program Name and Country:	Guatemala
Reporting Period covered in this report:	01-01-2020 to 31-12-2020
Number of FCPF ERs:	4,842,708
Quantity of ERs allocated to the Uncertainty Buffer:	1,109,864
Quantity of ERs to allocated to the Pooled Reversal Buffer:	1,446,523
Number of FCPF ERs from enhanced removals through afforestation/ reforestation	--
Date of Submission:	30-06-2022
Version	Version 8.0

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Acronyms

AAI	average annual increments
AFSs	Agroforestry systems
ANACAFE	**National Coffee Association (Spanish acronym)**
BDP	Benefit Distribution Plan
CEMEC	Center for Evaluation and Monitoring (CEMEC, for its acronym in Spanish)
CEP	**Collect Earth Project**
CNCC	National Climate Change Council (Spanish acronym)
CONAP	National Council for Protected Areas (CONAP, for its acronym in Spanish)
ENREDD+	National REDD+ Strategy
ER	Emissions Reduction
ERPD	Emissions Reduction Document (ERPD)
ERP	Emission Reduction Program
ERPA	Emissions Reduction Payment Agreement
EF	**Emission factors**
FA	Absorption factors
FAO	**Food and Agriculture Organization of the United Nations**
FCF	Forest Fire Commission
FCPF	Forest Carbon Partnership Facility (FCPF)
FIP	Forest Investment Program (FIP)
FREL	Forest Reference Emission Levels
FUNDAECO	Foundation for Ecodevelopment and Conservation, for its acronym in English
GCI	Interinstitutional Coordination Group
GCF	Green Climate Fund (GCF)
GIMBUT	Inter-institutional Group for Forestry and Land Use Monitoring for its acronym in Spanish
GHG	Greenhouse Gases
GoG	Government of Guatemala (GoG)
GSCCC	Guatemalan Climate Change Science System of Climate Change
IBRD	International Bank for Reconstruction and Development (IBRD).
INAB	National Forest Institute (INAB, for its acronym in Spanish)
IPCC	**Intergovernmental Panel on Climate Change**
LULUC	Land Use, Land-Use Change and Forestry
MARN	Ministry of Environment and Natural Resources for its acronym in Spanish),
MAGA	Ministry of Agriculture, Livestock and Food for its acronym in Spanish)
MCSEAB	Mechanisms of Compensation for Environmental and Ecosystem Services for its acronym in Spanish
MINFIN	Ministry of Public Finance for its acronym in Spanish)
MOP	Manual de Operations
MRV	Monitoring, Reporting and Verification
NDC	Nationally Determined Contributions
NFI	National Forest Inventory
PINPEP	Forestry incentive program for holders of small tracts of land with forestry or agroforestry vocation.
PINFOR	Forestry incentive program
PROBOSQUE	Incentive Program for the establishment, recovery, management, production and protection of forests in Guatemala.
PPM	Permanent Sampling Plot System
PDB	Benefit sharing plan

Plant	**Forest plantations**
REDD+	Reducing emissions from deforestation and forest degradation.
REDDES	Local Networks for Development for its acronym in Spanish
SIGAP	Guatemalan System of Protected Areas (SIGAP, for its acronym in Spanish)
SIREDD+,	National Information System for GHG Emissions, Multiple Benefits, Other Impacts, Management and REDD+ Safeguards for its acronym in Spanish)
SNIGT	National GHG Inventory System for its acronym in Spanish
UNFCCC	United Nations Framework Convention on Climate Change
UVG	Universidad del Valle de Guatemala
VCS	Voluntary Carbon Standards (VCS)
WCS	Wildlife Conservation Society

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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

In this first Emissions Reduction (ER) Monitoring Report of Guatemala, the progress that the country has made to address the main causes of deforestation and forest degradation is reported, compared to what is established in the Emissions Reduction Document (ERPD). Key dates and milestones of the RE Program are listed below.

- **Establishment of the Executing Unit:** Article 5 of Decree 20-2020, issued by the Congress of the Republic on **April 15, 2020**, established the Executing Unit of the ER Program to be developed through the National Forest Institute (*INAB, for its acronym in Spanish*), who will coordinate actions with the Ministry of Environment and Natural Resources (*MARN, for its acronym in Spanish*), the Ministry of Agriculture, Livestock and Food (*MAGA*, for its acronym in Spanish) and the National Council for Protected Areas (*CONAP, for its acronym in Spanish*).1

- **Signing of the ERPA:** On **September 13, 2021**, Guatemala formalized the historic signing of the Emissions Reduction Payment Agreement (ERPA) with the Forest Carbon Partnership Facility (FCPF), through the Program Entity, which corresponds to the Ministry of Public Finance (*MINFIN, for its acronym in Spanish*) and the International Bank for Reconstruction and Development (IBRD).

- **Launch of the National Strategy to Reduce Deforestation and Forest Degradation under the REDD+ mechanism:** On **September 13, 2021**, the Ministry of Environment and Natural Resources officially delivered to the President of the Republic of Guatemala the finalized document of the REDD+ National Strategy (2020-2050), being a relevant milestone in the country, to ratify its commitment to advance in the actions of the Emission Reduction Program (ERP).2

- **Approval of the INAB and CONAP institutional modalities to implement actions within the ERP:** The ERPD established that INAB and CONAP would design institutional mechanisms framed in the Emission Reduction Program. In this sense, **in 2021** INAB approved, through the Board of Directors of the institution as the collegiate body, a manual on the Mechanisms of Compensation for Environmental and Ecosystem Services (*MCSEAB, for its acronym in Spanish*)3 and that same year CONAP, for its part, through the Honorable Council for Protected Areas, approved the Regulations to control and promote REDD+ actions in the Guatemalan System of Protected Areas (*SIGAP, for its acronym in Spanish*) through management models for the conservation and sustainable use of forests.

- **Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions:** Compared to the ERPD, the Ministry of Environment and Natural Resources has achieved a historic milestone, through the establishment of the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions, which will allow, among its many functions, to avoid the double accounting of REDD+ initiatives subject to payment based on results. The Registry was created and published in the Central American Official Newspaper in **August 2020,** through Ministerial Agreement 284-2020. Said Registry establishes the creation of operating and procedure manuals, which were prepared **in 2021** and are in the process of being approved, with an 80% progress rate.4

1 https://www.congreso.gob.gt/detalle_pdf/decretos/13525#gsc.tab=0
2 https://twitter.com/marngt/status/1448303019649556485
3 https://www.inab.gob.gt/images/informacionpublica/manuales/6.52%20Manual%20de%20Normas,%20Procesos%20y%20Procedimientos%20del%20Departamento%20de%20Conservacion%20de%20Ecosistemas%20Forestales.pdf
4 https://drive.google.com/file/d/1e4biZFoxzReLoRumKAh-iS2BRK_vG9Xl/view

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- **ERP Benefit Distribution Plan (BDP):** Compared to the ERPD, Guatemala has developed the technical, administrative and legal procedures to ensure the distribution of the benefits derived from the ER Program. The BDP includes the feedback of the entities participating in the Program and the consultations carried out with project beneficiaries to obtain approval. The BDP also has a Nesting Protocol that describes the methodological integration of existing REDD+ initiatives within the ER Program, to avoid double carbon accounting.

- **Progress in actions and interventions under the ER Program:** The Government of Guatemala has defined a total of 19 REDD+ actions for the ERP, which have been grouped into 5 major strategic options, under a programmatic-based approach, which are closely related to the national efforts that are currently being developed in the country to address deforestation and forest degradation. Emission reduction activities within the framework of the ERP may be implemented through any of the following three modalities: 1. REDD+ Project Initiative; 2. Initiative for compensation mechanisms for ecosystem and environmental services associated with forests; and 3. Management Models Initiative for the conservation and sustainable use of forests in the SIGAP.

  For the 2020 period, only the REDD+ Project Initiative implemented activities. These projects are a) GUATECARBON REDD+ Project; b) Lacandón - Forests for Life REDD+ Project; c) (Early) Local Networks for Development (*REDDES, for its acronym in Spanish*) REDD+ Project. Projects a and b are certified by the Voluntary Carbon Standards (VCS), and project c is in the process of being certified by the Verra Verified Carbon Standard (VCS). This represents a relevant milestone for Guatemala, since they are the first initiatives that, within the framework of the ERP, have carried out Emission Reduction activities. Currently, the open call phase for project submissions runs from November 29, 2023, to October 31, 2024.

  Decisive actions in the face of COVID-19: On **March 6, 2020,** through Government Decree 5-2020, a state of calamity was declared in the country because of the official pronouncement of the World Health Organization, which identified the virus called COVID-19 as an international public health emergency. In this sense, the right of free locomotion and conglomerations of people at the national level were limited. Therefore, the REDD+ activities planned by the Guatemalan Government and the REDD+ projects were limited due to the restrictions established by the Guatemalan Ministry of Health. However, despite the aforementioned, in 2020 institutional actions were continued in conjunction with stakeholders from the forestry, environmental and justice sectors through compliance with the current national regulatory framework, such as the Law of Protected Areas and its Regulations, Decree No. 4-89, the Master Plan for the Mayan Biosphere Reserve, the model of community forestry concessions, the PINPEP and PROBOSQUE Laws, among others of a similar nature.

The current program does not report changes in the strategy described in the ERPD. However, the main updates in the actions of the ER Program are listed below.

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

The program ensures the mitigation and/or minimize potential displacement as it covers a significant percentage of the country (92%), and public policies are implemented at the national level, not excluding those areas that are not part of the Program. Additionally, there are only two areas that may have potential displacement within the country. In one of them, there is a carbon project with international sales commitments that has a very strong work program to avoid emissions (The Conservation Coast by FUNDAECO), and consequently, it is unlikely that displacement will occur in those areas. The second area is also part of the Guatecarbon project and is part of a National Protected Area, so efforts continue to reduce emissions in those areas. Another noteworthy action is that the program conducts monitoring at the national

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level, which means it does so both within and outside the PRE, with the aim of confirming that there is indeed no displacement.

The risk due to displacement during the year 2020 in the area of intervention of the Program continued to be moderate, since no risks of high impact on the environment and society were identified that have led to displacement activities towards the accounting area, since Guatemala has considered as a priority to increase the strengthening of forest governance, promoting the coordination and effective participation of local actors, as part of the National Plan for the Economic Recovery of Guatemala derived from COVID-19, following the health and safety, innovation and sustainability cross-cutting principles:

The risk of displacement of emissions during the year 2020 outside the accounting area, such as the Laguna del Tigre National Park (area excluded from the ERP), has been managed mainly by reinforcing institutional presence through the Forest Fire Commission (FFC) of Petén, in areas of high incidence that affect the program area. INAB reported that in the 2020 period it estimated 63% fewer forest fires in the department of Petén, compared to 2019. In addition, it should be noted that CONAP has been conducting permanent monitoring in the Maya Biosphere Reserve for more than 20 years (through the Center for Evaluation and Monitoring (*CEMEC, for its acronym in Spanish*) together with the WCS (Wildlife Conservation Society), with daily data updates and public access. This has been a key mechanism for its detection and early preventive actions.

Likewise, the risk of displacement to the Sarstún-Motagua region, the second territory outside the accounting area of the ERP, is low given that the territory has been co-administered by CONAP and FUNDAECO for more than 25 years, with no expiration date, because it is established in the Law of Protected Areas and other laws declaring protected areas specific to Izabal. Additionally, remnants of forest outside the project area are highly fragmented and minimal.

It should be mentioned that Guatemala has an action plan for the National REDD+ Strategy, where it is expected that the first five years of implementation are carried out with the country's own resources and the support of climate funds, such as the Green Climate Fund (GCF) and the Nama Facility, as well as a small portion of payments based on results through the regulated or voluntary market, among others of a similar nature. This will make it possible to continue with the strategic approach to priority actions and, thus, mitigate displacement due to emissions with the support of civil society, the private sector, local communities and indigenous peoples.

Finally, as an improvement in the alert system and decision-making for forest fires, the National Forestry Institute (INAB) has implemented an automated heat point alert system on its website. You can find it at this link: https://sig.inab.gob.gt/portal/apps/dashboards/81d8eb742ff44fd09b5144d8aeb4ae9b (INAB Heat Point Dashboard). This system involves key stakeholders coordinating efforts across different points in the country.

Organizational agreements and involvement of partner agencies:

The institutional governance framework of the ERP Program is formed by the Ministry of Public Finance (MINFIN), as the Program Entity; the National Forest Institute (INAB), as the Program's Executing Entity; and, the Ministry of Environment and Natural Resources (MARN), the National Council for Protected Areas (CONAP), and the Ministry of Agriculture, Livestock and Food (MAGA), as strategic institutional partners. In addition, various NGOs play a role as implementing partners.

Decree 20-2020 of the Congress of the Republic of Guatemala establishes that the National Forest Institute (INAB) is the Executing Unit of the Emission Reduction Program. It will also be responsible of coordinating actions with the National Council for Protected Areas (CONAP), the Ministry of Environment and Natural Resources (MARN), and the Ministry of Agriculture, Livestock and Food (MAGA).

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In this sense, the Coordination Office of the Emission Reduction Program of the National Forest Institute (ERP Executing Unit) has led the preparation of the First Emissions Reduction Monitoring Report for the period from January 1 to December 31, 2020, through the creation of the Monitoring Group for the first emissions reduction monitoring report, which is made up of staff specialized in geographic information systems and climate change from MARN, MAGA, CONAP, as well as representatives of the ERP REDD+ Projects. In addition, it has received specialized support in carbon monitoring and accounting, complemented by academia (*Universidad del Valle de Guatemala*).

This type of coordination and inter-institutional arrangements has become an example at the national level since it is the first time that so many state organizations, REDD+ projects and strategic partners have come together to make a national effort to reduce deforestation and degradation of forests. These synergies will be strengthened by the second and third monitoring reports.

Updates on the assumptions in the financial plan and any changes in circumstances that positively or negatively affect the financial plan and the implementation of the ERP's first ERPA during 2020

The Government of Guatemala (GoG) will facilitate the management of around 75 percent of the ERP's total investment cost resources, which add up to approximately USD 226 million. This contribution includes resources for coordination, monitoring, evaluations, reports, through underlying government programs, that is, INAB incentives through PROBOSQUE, PINPEP and CONAP's Program for the restoration, protection, and conservation of protected areas and biological diversity, the National REDD+ Strategy, among others of a similar nature.

The ERPD indicates that specific actions to be implemented in the ERP would be reinforced through interventions such as the Forest Investment Program (FIP), with a total amount of 24 million US dollars, of which 3,150,000.00 dollars correspond to a donation and 20,850,000.00 dollars correspond to a loan. As of the date of this report, the Sustainable Forest Management Project is in negotiation process, and the Green Guarantee for Competitive Landscapes Project is in the implementation phase. Currently, the FIP has not yet been released.

Therefore, for the emissions reduction program, the Guatemalan Government, through Decree number 20-2020, Article 5, stipulates that the Ministry of Agriculture, Livestock, and Food (MAGA) must prioritize allocating an additional five million quetzales (5,000,000.00) to the National Institute of Forests (INAB) for program implementation and execution. The transaction of this amount was effective in January 2021, and it was the sole amount used for operational expenses of the executing unit and its collaborators. Additionally, INAB has funded certain operational expenses using its own resources and those from cooperation.

1.2 Update on major drivers and lessons learned

In 2019 as a part of the National REDD+ Strategy (2020-2050)[5] update, the main drivers of deforestation were determined as[6]:

1) Unsustainable use of forest products
2) Extension of livestock activity
3) Extension of agricultural activity

The unsustainable use of forest products is responsible for the loss of 39% of forest land with losses of 146,300 ha. For its part, the expansion of livestock activity accounts for 34% of the loss of forests and the expansion of agricultural activity causes losses of 24% of forests at the national level. The expansion of urban and industrial infrastructure generates only

[5] https://www.marn.gob.gt/wpfd_file/estrategia-nacional-redd/

[6] The information about drivers of deforestation differs from the ERPD, because updated information was used for this report.

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1% of forest loss, while 2% of forest loss is due to other causes such as natural events (landslides, eruptions, pyroclastic material emissions, rock outcrops and others).

There are also drivers of forest degradation, including:

1) Unsustainable use of forest products
2) Forest fires

For the period 2006-2016, about 154,000 ha of forest land were probably or possibly degraded by the unsustainable use of forest products throughout the country, while 13,300 ha of the degraded area is associated probably with forest fires (southern and northern areas of the country).

Below is a brief description of the lessons learned on the causes of deforestation and forest degradation in Guatemala, compiled in the National REDD+ Strategy (2020-2050)[7].

- **Strengthening of local governance: For a greater application of the framework of Forestry policies in territorial spaces in which different normative instruments are applied, the integration of the forestry sector should be sought for the sustainable management of the territory, starting with the implementation of municipal development plans through participatory, inclusive and democratic processes.**

- **Operational strengthening of institutions related to agricultural, forestry and natural resource conservation activities (MARN, INAB, CONAP, MAGA) and municipalities:** For a better performance of the governing institutions of the forestry sector in reducing deforestation and forest degradation, it is important to continue with inter-institutional coordination mechanisms at both the central and municipal levels. In addition, the strengthening of local governments through the local institutional decentralization policy must be implemented effectively.

- **Increase budget investment and other resources to strengthen Forest management and control:** To strengthen institutional presence and that of government authorities for the supervision and control of land use change, a larger budget should be taken into account to increase the adequate human resource to be able to create innovative technical and legal conditions that generate new economic, social and technological mechanisms that allow reducing deforestation and forest degradation.

- **Strengthen the REDD+ Monitoring System:** The monitoring, reporting and verification (MRV) of emissions associated with deforestation and forest degradation agents is essential for the Guatemalan Government, in order to generate an adequate follow-up of the challenges it faces. Therefore, the ENREDD+ action plan foresees that, with a national budget complemented by international financing, gaps can be closed to strengthen detection systems and early warnings of illegal activities within and outside protected areas through satellite monitoring and potential hiring of trained staff.

- **Strengthen training, awareness, and communication systems:** To reduce deforestation and forest degradation, it is important to apply awareness, communication, and dissemination programs for national mechanisms, such as the management models of the Guatemalan System of Protected Areas and incentives for forests and plantations.

To assist in the mitigation and improvement of decision-making and actions in forest fires, the National Institute of Forests (INAB) has implemented an automated hotspots alert system on its website. [8]

[7] https://www.marn.gob.gt/wpfd_file/estrategia-nacional-redd/

[8] Link: https://sig.inab.gob.gt/portal/apps/dashboards/81d8eb742ff44fd09b5144d8aeb4ae9b

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1.3 Methodological deviations

This section does not apply because the reference level has not yet been validated.

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

The MRV system of the forest sector has been built according to the capacities in the country to respond to the UNFCCC from the international point of view, and at the national level based on existing platforms, studies, data and processes, taking into account a diversity of governmental and non-governmental institutions, including academia, research centers and civil society organizations. In addition, it is based on the current legal frameworks: Forestry Law (Decree 101-96)[9], Law of Protected Areas (Decree 4-89)[10], and the Framework Law to Regulate the Reduction of Vulnerability, the Mandatory Adaptation to the Effects of Climate Change and Greenhouse Gas Mitigation (Decree 7-2013)[11]. These laws mandate the different government institutions to collect and process information according to their scope of action.

The MRV system for the Emission Reduction Program has been implemented through coordination by INAB, as the Executing Unit of the Program, with the support of technical staff from the GIS units and the climate change units/departments/ directorates of the institutions that make up CONAP, INAB, MARN and MAGA, as well as representatives of the Guatecarbon, Forests for Life and Local Networks (REDDES) REDD+ projects. The preparation of this report was complemented with the support of specialists from U*niversidad del Valle de Guatemala* [12]for carbon accounting.

All the information generated by the different institutions was integrated and systematized by INAB within the framework of the ERPA of the ER Program under the FCPF. In this sense, INAB has been an integrating unit and generator of the reports before the FCPF. It is in close coordination with MARN, as focal point before the UNFCCC, to ensure consistency between the information generated in the framework of the ERP and what is reported for other initiatives and commitments under the United Nations Framework Convention on Climate Change (UNFCCC), including GHG inventories for the LULUCF sector.

It is important to point out that each government institution of the Interinstitutional Coordination Group GCI[13] for the preparation of the First Emissions Reduction Monitoring Report has provided different inputs according to their competencies. A brief description of them is made in Table 1 below.

[9] https://www.inab.gob.gt/images/informacionpublica/2019/1.4.a%20Compendio%20de%20leyes%20y%20reglamentos%20forestales.pdf

[10] https://www.acnur.org/fileadmin/Documentos/BDL/2008/6696.pdf

[11] https://faolex.fao.org/docs/pdf/gua140260.pdf

[12] Second monitoring report will be supported by UVG and a capacity building process will take place during 2023 for INAB to be full responsible of implementing the third MR with support from other institutions.

[13] GCI is the institutional governance body for REDD+ implementation in Guatemala.

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Table 1. Participating institutions in the elaboration of the First Emissions Reduction Monitoring Report and the inputs provided.

Institution	Inputs
INAB / Emission Reduction Program Executing Entity (, Technical coordinator, departments of GIS and Climate change)	Coordinate ER monitoring report integration
	Forest Cover Maps (in collaboration with CONAP).
	National Forest Inventory.
	List with information and maps/polygons on the areas subject to incentives by PINPEP, PINFOR, and PROBOSQUE.
	Data, maps and/or polygons linked to the use of firewood and legal and illegal selective logging.
	Estimation of average annual increments (AAI), and removals due to increased carbon stocks at the national level, through forest management and reforestation (management of natural forests, plantations, AFSs, forestry incentives) and natural regeneration.
	Emission factors for degradation and Removal factors for increases in carbon stocks.
	Participate in visual interpretation of sample units of the national grid for generating LULUC Activity Data.
CONAP / Climate Change Unit and the Geospatial Analysis Directorate, Center for Evaluation and Monitoring (CEMEC) located in Petén.	Forest Cover Maps (in collaboration with INAB) Forest fires data Participate in visual interpretation of sample units of the national grid for generating LULUC Activity Data.
MAGA / Geographic, Strategic Information and Risk Management and Climate Change Unit.	Develop auxiliary data such as vegetation cover and land use maps, for a potential estimate of carbon in the land uses. Support monitoring report integration.
MARN / Science and Metrics Department and the Mitigation Department of the Climate Change Unit, as well as in the Environmental Information and Climate Change Unit.	Reference Level of National Emissions for the Forest Sector and other land uses.
	Staff to standardize and ensure that there is consistency in the data presented in the ERP before the FCPF, the Greenhouse Gas Inventories (GHGIs), the reference level presented to the UNFCCC and the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions. Coordinate visual interpretation of sample units of the national grid for generating LULUC Activity Data.
REDD+ Projects Guatecarbon, Forests for Life, Networks for Local Development (REDDES)	Technical staff
	Data from REDD+ projects, polygon activities, etc.
	Community monitoring data.
	Relevant scientific studies and research.

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Institution	Inputs
	Complaints linked to drivers of deforestation and forest degradation.
Universidad del Valle de Guatemala	Support on carbon accounting, data processing. Support on visual interpretation of sample units of the national grid for generating LULUC Activity Data. Support on ER monitoring development. Support on uncertainty and sensitivity analysis.

2.1.2 Selection and management of GHG related data and information

Data selection and management was done to maintain consistency with the FREL included in the ERPD[14], and with the national FREL presented to UNFCCC[15]. This process was done by the GCI taking into consideration using the best data available at the moment of generating the report which may also be available with the quality and in time to generate future reports. For the measurement and monitoring of activity data it is based on statistical sampling geo referencing of the territory using high and medium resolution sensors for the monitoring of forest cover, land use and land use change (LULUCF).

This approach is done by visual interpretation of samples, which is easy to replicate for each monitoring period. Emission Factors are based on carbon strata map[16] which has been developed with the systematization and analysis of the best national data on carbon in the aerial and underground biomass of forests, from forest inventories in the country with different purposes and the first cycle of the National Forest Inventory of Guatemala, with the application of allometric models suitable for the country and its relationship with its bioclimatic variables.

The absorption factors (FA) are those estimated for the increase in carbon stocks by the annual growth of forest masses. They are obtained from the parcel system permanent sampling (PPM) established in the forestry incentive programs, with growth models applied to different species (pine and broadleaf).

2.1.3 Processes for collecting, processing, consolidating and reporting GHG data and information

The process of MRV in the ERP is implemented following the IPCC general approach of using Emission and Absorption Factors (related to forest inventory data) combined with Activity Data (related to remote sensing data) to estimate emissions and absorptions. A general approach of MRV in Guatemala is summarized in Figure 1**.**

[14] https://www.forestcarbonpartnership.org/system/files/documents/CLEAN%20ENGLISH%20Guatemala%20ERPD%2030%20-08-%202019%20ENGb.pdf

[15] https://redd.unfccc.int/files/niveles_referencia_emisiones_forestales_guatemala_070222.pdf

[16] https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

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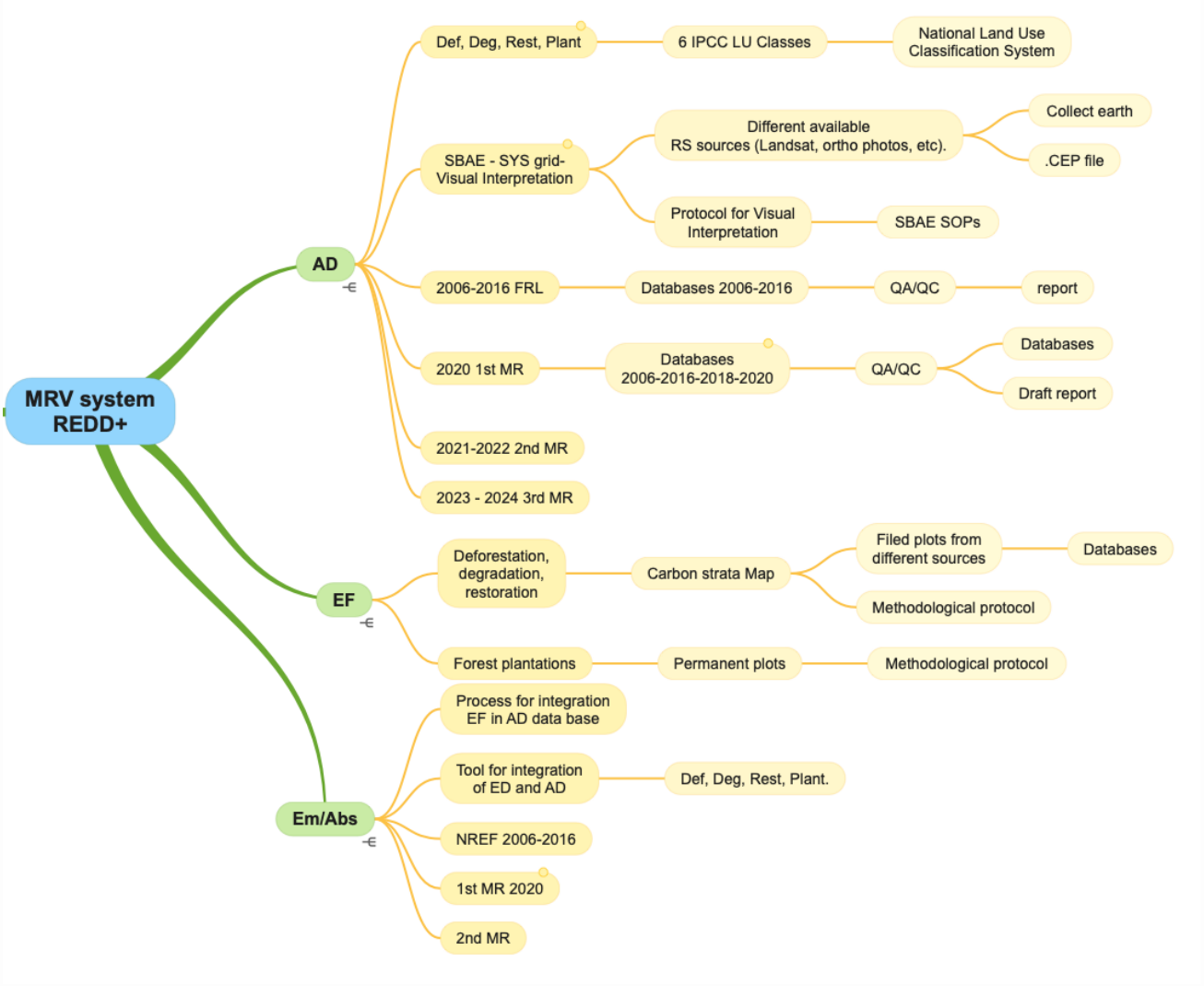

Figure 1 General approach for MRV for REDD+ in Guatemala ERP

2.1.4 Activity Data (AD)

For the collection of activity data under the ERPA, the land use categories of the Intergovernmental Panel on Climate Change (IPCC) were used for the assignment of land cover for each of the plots. This data collection is done on a sub-national area of a total of 9,985,930 hectares, representing 92% of the country's surface. The remaining area corresponds to the excluded areas of the Candelaria Triangle and several municipalities of Izabal. The total official surface area of Guatemala is 10,888,900 hectares.

Activity data for reporting emission reductions in deforestation, degradation and carbon stock increases were monitored under the ERPA, reported using data generated using a Sample Based Area estimation through the use of a visually interpreted grid of sampling points developed with the Collect Earth platform[17] and using images available in high resolution (Digital globe, Planet, Aster, Sentinel, etc.), as well as medium resolution Landsat images (Table 2). This grid

[17] https://openforis.org/tools/collect-earth/
Access to the Guatemalan information collection form:
https://drive.google.com/drive/folders/1IhxjFz5gPGKg-qCbXXBwU9cDOSnQ0E5m?usp=drive_link

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represents a geo-referenced statistical sampling of the territory and corresponds to a comprehensive approach to multi-temporal monitoring of forests and other land uses, which provides, during the ERP period, a specific and geographically-explicit analysis of the changes in the surfaces due to processes of deforestation, degradation and stock increases. Its use ensures consistency with the Forest Reference Emission Level (FREL). Currently, the grid activity data is generated every two years and the monitoring sample is 10,414 points, corresponding to the subnational area of the FCPF program.

These new activity data generated with the Collect Earth Desktop tool will be used to generate the next GHG Greenhouse Gas Inventories that will be contained within the Biennial Reports and the new National Communications that will be generated in the future, the previous four GHG Inventories GHG Greenhouse Gases that have been generated in Guatemala were prepared with methodologies other than sampling.

The grid is part of a comprehensive monitoring system for forests and other land uses, since it is complemented with the maps generated every five years to improve the cartographic model and increase its thematic accuracy and change detection (reduces uncertainty) to provide national statistics and international reports. See Table 2 and Table 3.

Table 2. Main activity data inputs of the MRV System for deforestation, degradation and increases.

Inputs	Type of Information	Scale/Resolution/Sampling Unit	Frequency	Source/Protocols
Point sampling grid for forest monitoring	Geodatabase with variables of forest cover and land use dynamics	National grid of 3.1 X 3.1 km for visual interpretation in medium and high-resolution images (11,354 sampling points) for the entire country, regarding the FCPF program area, the total points correspond to a total of 10,414.	Multi-temporal evaluation of coverage and change of use every 2 years	GIMBUT, 2018
RS images	Collection of remote sensing images (Digital Globe, Airbus, INEG, AfriGIS, CNES)	Median: 30 m (Landsat, 5,7 and 8) High: 1.24 m to 5 m (Spot, WorldView, Rapid eye, Quick Bird, Sentinel, etc.)	Period of 15 days, Monthly, Annual	Google Earth, Engine and Bing Maps with the use of the Collect Earth platform (FAO, 2015)

2.1.5 Emission/Absorption Factors (EF/AF)

Regarding emission factors, the same ones used in the FREL were used. These are based on the carbon strata map, which presents the best national data on biomass carbon in forests, as a result of a systematization and analysis of forest inventories for different purposes, allometric models and bioclimatic variables, combined with national and default (IPCC) values on the non-forest strata.

The absorption factors used for the MRV are the same ones used for the increases in carbon stocks that come from permanent sites in forest plantations of forestry incentive programs (INAB) with growth models for different species and that are used for the estimation of emissions in areas where a change from other lands to forest lands due to a plantation is detected. The main inputs for the emission and absorption factors of the MRV system and their characteristics are described in Table 3.

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Table 3. Main inputs of emission and absorption factors of the MRV System for deforestation, degradation and increases.

	Inputs	Type of Information	Scale/Resolution/Sampling Unit	Source/Protocols
Emission Factors	Carbon Strata Map	Raster and Vector Geodatabases	1 ha	GIMBUT, 2017; Gómez Xutuc 2017.
	Carbon density of land use in agriculture, livestock use and agroforestry systems	Databases and estimation process in the Quantification of carbon. Specific studies.	Districts of crop producers and agroforestry systems	ANACAFÉ 1998, Castillo 2006
	Non-forest carbon contents	Default emission factors	National/ By type of climatic region	IPCC, 2006; IPCC, 2019
Absorption Factors	Permanent plots	Databases	Plots in forest plantations	INAB, 2012. Samudio 2017.
	Growth models	Average annual increments and absorption factors	National (forest plantations)	INAB, 2012.
				Samudio 2017.

It is important to mention that the carbon strata map has the limitation of not being dynamic and depending on the availability of updating new forest measurement plots or remeasurements of the analyzed plots, which makes its long-term use very complex. Therefore, it is important to make a substantial improvement in the MRV for emission and removal factors in the medium term[18]. For this, a National Forest Inventory for multiple purposes has already been launched, where a network of 715 sites has been established where variables related to the carbon content of biomass above ground, below ground and of dead organic matter, with a design of three secondary sampling units will be collected.

Regarding the monitoring report, the Working Group for the Preparation of the First ER Report of Guatemala processes the information and results of the estimates resulting from the analysis of the activity data and emission factors during the period of the ER Program and then, subsequently transfers them to INAB so that it prepares the report to the FCPF (Figure 2). In turn, INAB transfers them to MARN for the report to the UNFCCC. It is important to mention that the diagram was created based on the structure that the executing unit has described in the operational process manual.

[18] Not to be implemented during the ERP period.

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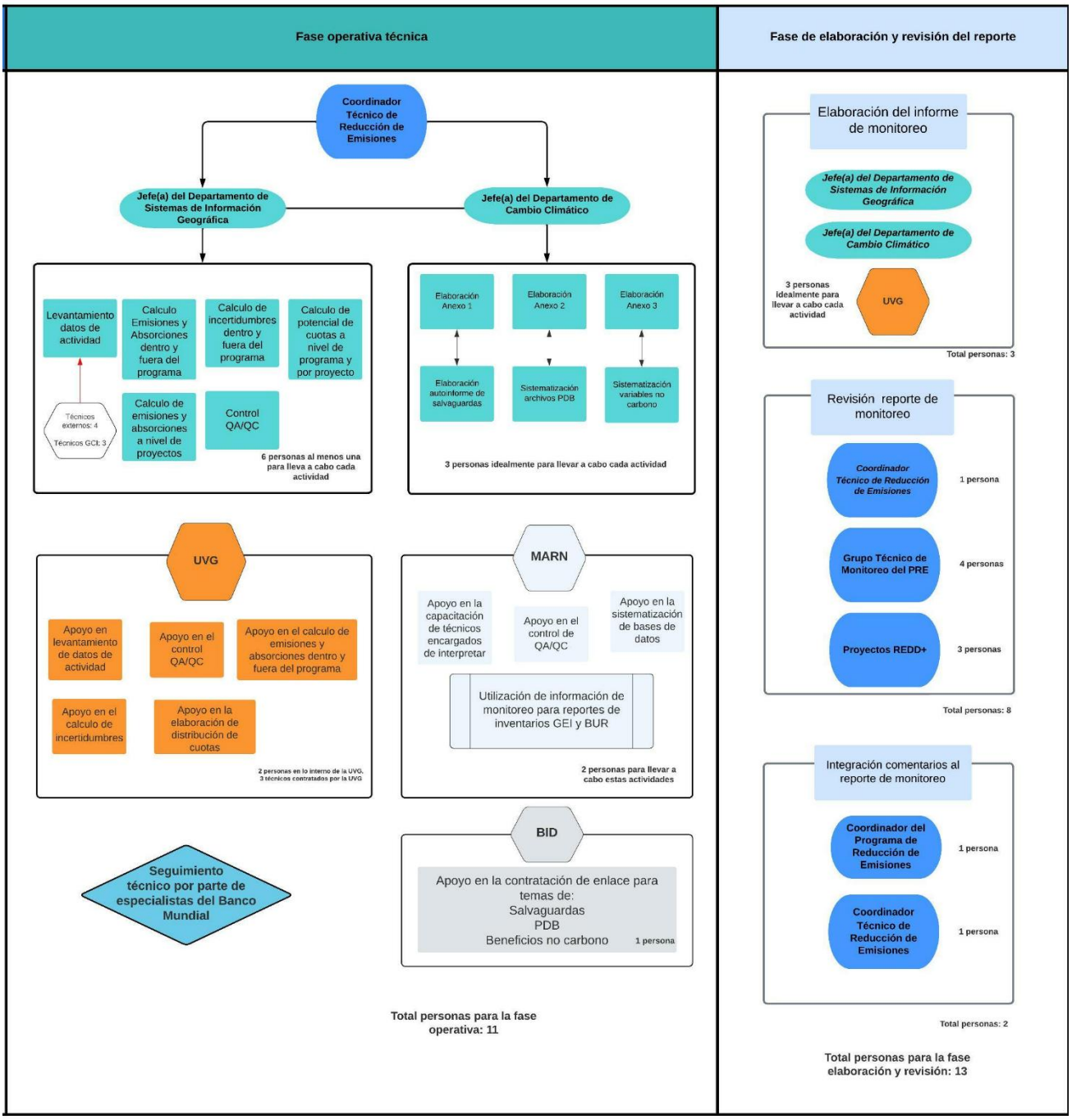

Figure 2. Process for the elaboration of the monitoring, validation and reporting report

The following (see Table 4) summarizes the parameters and operations related to activity data and emission factors associated with the Guatemalan MRV System.

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Table 4. Summary of parameters and operations of the MRV system.

Parameter	• AD: Area (ha) where deforestation, degradation, restoration of degraded forest areas or forest plantations occur. • EF: Carbon content and change in carbon content for each stratum of the carbon map or type of plantation. Default non-forest carbon content from IPCC guidelines. For agroforestry systems, national information is available. • Emissions and reductions of GHG emissions due to deforestation, degradation, restoration of degraded forest areas and increases in carbon stocks.
Description	• Analysis and interpretation of 10,414 grid points to identify areas with deforestation and degradation, as well as the restoration of degraded forest areas or forest plantations. All points at national scale will be monitored to ensure that there are no leaks to areas outside the program. • Use of EF data reported in Annex 4. • Monitoring and reporting of CO2 emissions and reductions due to deforestation and degradation separately for each activity, as well as emission reductions due to increases in carbon stocks in forest plantations and restoration of degraded forest areas.
Data Units	Ha, tC, tC/ha/year, tCO_{2eq}, t CO_{2eq}/year
Source of data or measurement/ calculation methods and procedures to be applied (e.g., field measurements, remote sensing data, national data, official statistics, IPCC Guidelines, commercial and scientific literature), including the spatial level of the data (local, regional, national and international) and if and how the data or methods will be approved during the Term of the ERPA.	• For the AD, data at the subnational level from the grid was used derived from visual interpretation of remote sensors to estimate activity data. • For EFs related to forest land, field data derived from the carbon strata map are used, which integrate forest inventory plots, permanent sites, and scientific research data. And national and default tabular values for forest plantations and non-forest land uses. • The IPCC 2006 guidelines are followed for data processing.
Frequency of monitoring/ recording:	• The reporting periods are as follows: • First reporting period: 01-01-2020 to 31-12-2020. • Second reporting period: 01-01-2021 to 31-12-2022 • Third reporting period: 01-01-2023 to 12-31-2024

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Monitoring Equipment:	• For AD, data from different remote sensors of medium and high resolution, computer equipment, specialized software for processing satellite images and for surveying the sampling grid are used. • For the EF, forest inventory equipment, computer equipment and statistical software are used. Default non-forest carbon content from IPCC guidelines. • For the estimation of emissions, databases in Excel and statistical software are used.
Quality Assurance/ Quality Control procedures to be applied:	• Review of logical errors in the changes of the images interpreted for the dynamics of deforestation, degradation and increases in activity data. • Multiple interpretation (3 different interpreters) of a percentage of total sample plots was guaranteed. • All processes are described in different methodological protocols including procedures to ensure QA/QC processes as described in section 2.2.1. • Work is being done to use current protocols and refine them and translate in standard operating procedures format (SOP). • In addition, interpreters are trained prior to using the CE form in order to standardize interpretation criteria for the different land uses.
Identification of sources of uncertainty for this parameter	• Errors of interpretation of the categories. • Sample size for the analysis of the dynamics of change (deforestation, degradation and increases). • Quality of images available and used for interpretation. • Plot sampling errors. • Lack of representation of all types of forest vegetation in the carbon estimation plots available to build the carbon strata map (e.g., Dry forests). • Lack of information on estimated carbon content at the national level for most types of land use after conversion (crops, grasslands and agroforestry systems).

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2.1.6 Role of users, beneficiaries and communities in forest monitoring system

Forest community monitoring in the country during the year 2020 due to COVID-19 has been constituted from the local perspective in the primary source of information on the state of the forest, the natural resources associated with the ecosystem and the social and economic conditions of the communities directly and indirectly linked to the use and exploitation of these resources.

The Government of Guatemala has worked on the construction of a computer tool that is part of an early warning system for the prevention and control of deforestation and forest degradation. This tool was developed in the MRV of the National Climate Change System of Information (*SNICC, for its acronym in Spanish*) and also in a mobile application for smartphones aimed at providing information in the field to different users with and without Internet access. The development of this tool also seeks to support the operationalization of this system through the participation of local governments under the operational scheme of community monitoring of the country's National REDD+ Strategy. This information is available at the following link:
https://snicc.marn.gob.gt/MRV/SNMF

The community forest monitoring system contributes to the monitoring of social and environmental safeguards and the implementation of actions developed locally in the program. However, it does not participate in the monitoring of carbon variables. Below is a brief description of the role of community monitoring in 2020 in the different REDD+ Projects:

1. **Guatecarbon**: Through a community monitoring network made up of commissions for the control and protection of forest fires and a scientific commission on biodiversity, they have carried out monitoring of environmental and social issues in 11 communities of the Maya Biosphere Reserve, with a scope of at least 6,000 direct beneficiaries of the ERP.

2. **Forests for Life:** Through local workshops through community monitoring in the Sierra Lacandón Park, where the environmental and social issues of the ERP have been monitored, in at least three local communities and 120 direct beneficiaries of the program.

3. **Local Networks for Development (REDDES):** Actions were implemented to support the reduction of deforestation, degradation and increase of forest cover in 12 municipalities of the departments of Alta Verapaz, Quiché and Huehuetenango, to ensure the environmental goods and services that forests provide to indigenous communities and local organizations. These monitoring actions were carried out in at least 31 communities.

Community monitoring in the program is a process that is constantly being improved, since the participation of the local community has not yet been fully achieved. This is something that the government will work on in conjunction with the REDD+ Projects, to ensure that all activities are standardized and documented for the beneficiary communities. The Guatemalan MRV System will continue with the dynamic of empowering communities to gradually measure, monitor and report carbon stocks and, at the same time, that these activities contribute to local livelihoods and the conservation of forest biodiversity.

2.1.7 Coherence with the LULUCF sector monitoring system and the country's Climate Change MRV System

The MRV system within the framework of the ERP before the FCPF is part of the National Information System for GHG Emissions, Multiple Benefits, Other Impacts, Management and REDD+ Safeguards (*SIREDD+*, *for its acronym in Spanish*), which represents the institutional proposal within the framework of the National REDD+

Strategy for Guatemala (2020-2050). SIREDD+, in turn, is part of the National GHG Inventory System (*SNIGT, for its acronym in Spanish*), which is part of the SNICC (See Figure 4).

The SNICC aims to collect, systematize, analyze and present all the information related to climate change at the national level, including Climate science, vulnerability, loss and damage; adaptation to climate change; GHG emissions and removals; and, mitigation measures. This information may be used for sectoral and territorial planning processes, monitoring, and reporting of the country's progress, public investment programming and the formulation of public policies and application instruments on climate change. Therefore, the SNICC represents the set of data and information generated and analyzed, the necessary governance for the generation, analysis and reporting of this information and the virtual platforms that display it and make it public for the different users (Draft 1IBA, 2022).

1. All the country's climate change monitoring systems are incorporated under the SNICC, so that the organization and quality of the information can be ensured. Since monitoring related to REDD+ is part of this structure, consistency is ensured both with the country's LULUCF sector monitoring system and with the entire national climate change monitoring scheme, including the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions (Figure 3). The ERP's MRV System before the FCPF is included in this diagram under the REDD+ component, both in the carbon and safeguards sections.

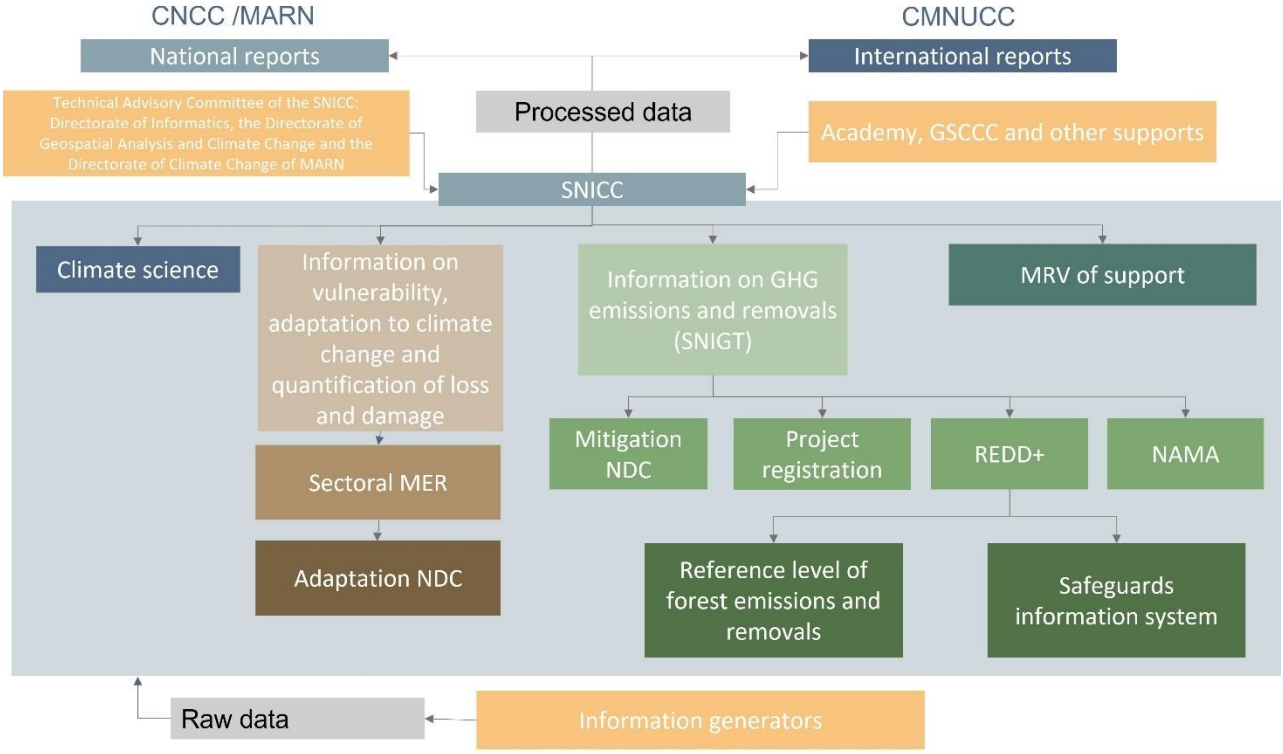

Figure 3. Operation and subsystems of the SNICC

2.1.8 Main changes with respect to what was presented in the ERPD

For this first monitoring event, some changes were made in relation to what was stated in the ERPD. One of the main changes is that it was agreed that INAB will be the entity in charge of the Executing Unit. This institution will therefore be in charge of submitting the monitoring report to the FCPF.

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Likewise, for the analysis of forest degradation, it was not possible to attribute the emissions of degradation to a specific source, whether due to firewood, wood extraction or forest fires. In addition, it had been contemplated to use data from the National Forest Inventory (NFI) for the generation of activity data and emission factors, but since this is still in the data collection stage, they were not used for this first monitoring event.

Regarding the governance of the MRV system, the ERPD mentioned the participation of the Inter-institutional Group for Forestry and Land Use Monitoring (*GIMBUT, for its acronym in Spanish*). However, the agreement that gives validity to this entity expired in 2020. Therefore, this figure has been replaced by that of the Working Group for the Preparation of the First ER Report of Guatemala, which is made up of representatives of the GIS and climate change units of the GCI institutions.

In addition to the above, the country has already defined an MRV System scheme for the issue of climate change, so the REDD+ MRV System is now linked to the rest of the climate change monitoring systems at the national level, including the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions, for which the country already has the corresponding regulations (Ministerial Agreement 284-2020[19]) according to the mandate of Article 22 of the Framework Law to Regulate the Reduction of Vulnerability, Mandatory Adaptation to the Effects of Climate Change and Greenhouse Gas Mitigation. This allows coherence and consistency between the different processes and, therefore, in the data presented.

The program´s Forest Monitoring System has not undergone any changes.

2.2 Updates to the Monitoring Approach

Not applicable. The monitoring approach has not been updated.

2.3 Measurement, monitoring and reporting approach

2.2.1. Line Diagram

The following diagram (Figure 4) shows the different components of the MRV System of the emission reduction program under the FCPF, where the main activities related to the generation of activity data, the estimation of emission/removal factors and the calculation of emissions and removals to obtain the emission reductions for the year of interest are presented. This line diagram is complemented by Figure 3, which details those responsible for the preparation of carbon accounting, safeguards, benefit sharing plan and non-carbon variables. The line diagram shows the step by step (seven steps in total) of each of the steps that are needed to have as a result the emission reductions for the monitoring period.

For the process of calculating emissions reductions, the line diagram is intended to show the different processes from the generation of activity data, the allocation of carbon content, obtaining the emission and removal factors to obtain the emissions and removals of the reference level and the first monitoring. These processes are in charge of the head of the Geographic Information Systems unit of INAB with technical support from UVG.

Each step of the line diagram is described below:

- Step 1 Sample Base Area Estimation:

Consists of the use of the collect earth tool which allows us to use the high-resolution images available in the Google Earth catalog. The tool also has external support to consult Planet, Sentinel and Landsat images, as well as to consult vegetation indexes. The document can be accessed:

[19] https://drive.google.com/file/d/1e4biZFoxzReLoRumKAh-iS2BRK_vG9Xl/view

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https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

- Step 2 Visual interpretation of the CEP form:

In this step the visual interpretation of the 11,354 sample points that are randomly distributed in Guatemala is performed. The collect earth form allows to establish the coverage and use for the current year, as well as to establish the coverage of the previous year. It also assigns whether the plot is a permanence or change in use, in addition to recording the date of the images used. The database is then exported and transformed from a comma-separated format to an Excel file. The form can be accessed through this link:

Methodological protocol:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

Point grid:
https://drive.google.com/drive/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC

CEP: https://drive.google.com/drive/folders/1IhxjFz5gPGKg-qCbXXBwU9cDOSnQ0E5m?usp=drive_link

- Intermediate step Prepare emission factors:

In this step we proceed to assign to each of the plots in Guatemala, the forest content stratum to the plots this with the objective of identifying the plots that had a change of use and to know the carbon content prior to deforestation or degradation.

The carbon layer map can be accessed through this link:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view
(Open with ArcGIS)

The methodological protocol document can be accessed through this link:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Step 3 Area estimation:
For the area estimation, each plot was weighted with the total number of plots in the country, and then the WI weight was multiplied with the total area of Guatemala to obtain hectares. After this, dynamic tables can be made to know the areas for each of the REDD+ activities that Guatemala has. The area can be found in the file "NR_MallaPuntos_Escenario_7_MC2025_05_vg", in the BL column.
The document can be accessed through this link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 4 Allocation of emission factors:

To establish the emission factors, forest strata were used to categorize the plot into primary forest, degraded forest and highly degraded forest based on the number of elements in the plot. Once the stratum is identified, the carbon content is established based on the forest stratum in which it is located and the stratum of the carbon map in which the plot is located. Additionally, the non-forest carbon content is also established in case there is a change in land use. The carbon calculation is found in column BQ for the year 2006, column BU for the year 2016 and column CA for the year 2020. The file to consult this information is called "NR_MallaPuntos_Escenario_7_MC2025_05_vg".

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The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 5: Calculation of CO2/year per activity

  To calculate the CO2 per year for each activity, the excel file called "NR_MallaPuntos_Escenario_7_MC2025_05_vg" is used and the BW column contains the tons of CO2 per year for the reference level and the CE column contains the tons of CO2 per year for the first reporting period.

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 6 Calculation of emissions/removals:

For the calculation of emissions and removals we proceed to create a pivot table using the data from the "Malla" tab of the excel file "NR_MallaPuntos_Escenario_7_MC2025_05_vg" using the columns in which the REDD+ activities that Guatemala monitored were identified. The next step is also to create a dynamic table for the first reporting period of Guatemala also using the "Malla" tab and accounting the emissions for this reporting period These calculations can be found in the tab "TablaD"

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 7 Emission reduction calculation:

After the pivot tables are created, a table is created by subtracting the reference level REDD+ activities minus the REDD+ activities of the first reporting period to obtain the total reductions. These calculations can be found in the "Table D" tab.

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

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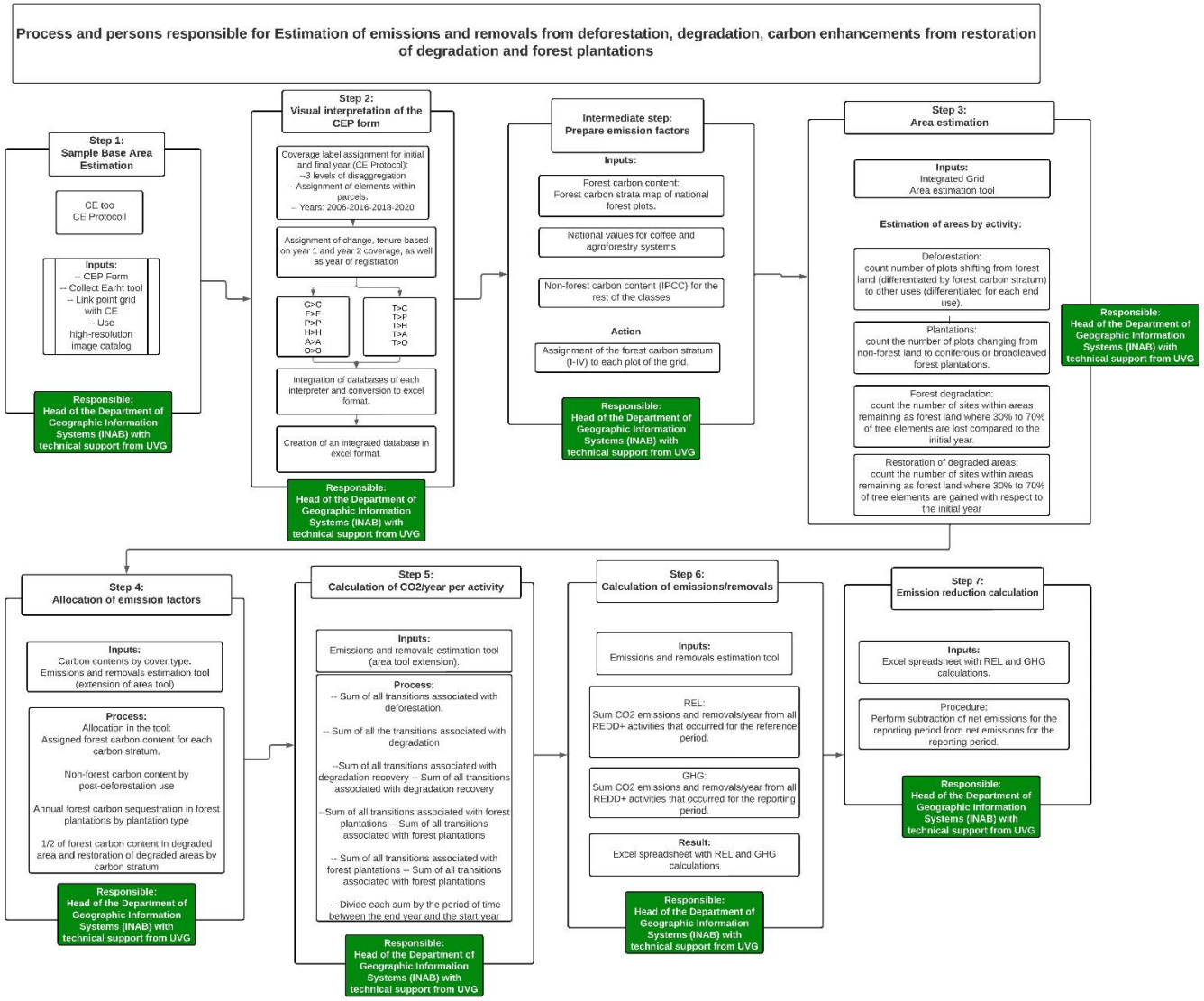

Figure 4. Components for calculating the program's emission reductions.

2.2.2. Calculation

1. Emission reduction (ER)

$$ER_{ERP}=RL_T-GHG_T \quad \text{Equation 1}$$

Where:

ER_{ERP}	=	Emission Reductions under the ER Program in year t ($tCO_2e*year^{-1}$)
RL_T	=	Gross emissions of the RL from deforestation over the Reference Period ($tCO_2e*year^{-1}$). Net annual average emissions of the RL due to deforestation and degradation and the absorptions due to the increases in carbon during the reference period(($tCO_2e*year^{-1}$) This is sourced from Annex 4 to the ER reporting Report and equations are provided below.
GHG_T	=	Monitored gross emissions from deforestation at year t ($tCO_2e*year^{-1}$) Annual net emissions from deforestation and degradation and the absorptions due to increase in carbon in the reporting period ($tCO_2e*year^{-1}$)
T		Number of years during the reporting period; dimensionless

2. Reference Level (RL)

The RL estimation may be found in Annex 4, yet a description of the equations is provided below. RL was defined as the net annual average historical emissions[20]. Annual emissions or absorptions were estimated for all land transitions by REDD+ activity, and then adding the results for all selected REDD+ activities for each year.
The REDD+ activities that are included in the reference level for Guatemala are:

- Emissions from deforestation and forest degradation.
- Absorptions from increases in forest stock that may be due to recovery of forest degradation and forest plantations.

Equation 2:

$$\mathbf{RL=(Def+deg)-(Incr)} = (\mathbf{E_{DEF}+E_{DEG}}) - (\mathbf{R_{rec}+R_{pla}}) = ((\mathbf{ADef}*\mathbf{FE})+(\mathbf{ADdeg}*\mathbf{FE})-(\mathbf{Rrec}*\mathbf{FA})-(\mathbf{Rpla}*\mathbf{FA}))$$

Where:

RL	=	Reference Level
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from Degradation
$\mathbf{R_{rec}}$	=	Removals from Forest Degradation Recovery
$\mathbf{R_{pla}}$	=	Removals due to Increased Carbon Through Forest Plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).

[20] The Reference Level has 10 years because 2006 is considered the base year of the land cover status, and from 2007 onwards, emissions occurring from 2007 until 2016, which is considered the final year of the Reference Level, are reviewed and quantified, so when it comes to accounting, it is a total of 10 years.

FE = Emission factors for deforestation and degradation and
FA = Absorption factors for carbon increases in forest biomass.

To determine the emissions of the reference level, the first step is to calculate the information from the activity data and then make the estimate in tons of CO_2 equivalent.

Below you will find the links to the files to estimate the activity data, as well as the emissions and removals of the reference level.

- File containing the estimates of emissions and removals for each of the REDD+ activities:
- File that contains the information of the point grid with its categories of land use:

2.1. Reference level activity data

2.1.1. Activity Data of deforestation

To determine the activity data, a random mesh was used consisting of 11,354 sample points for the entire country and 10,414 plots for the program area. Each plot has a total of 25 elements and the use is determined by the coverage that predominates.

Equation 3:

$$AD_{def} = \left(\frac{N_{def}}{N_{Total}}\right) * T$$

Where:

AD_{def} = Data derived from deforestation

N_{def} = Number of plots that were interpreted as deforestation in the period studied and that are categorized according to the number of tree elements, and these categories are:
- Primary forest: 20 to 25 trees per plot.
- Degraded forest: 14 to 19 trees per plot.
- Highly degraded forest: 8 to 13 trees per plot.

N_{Total} = Total number of parcels found in the program area

T = Surface area of the program expressed in hectares

2.1.2. Activity data for degradation

Equation 4:

$$AD_{deg} = \left(\frac{N_{deg}}{N_{total}}\right) * T$$

Where:

AD_{deg} = Activity data derived from forest degradation

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N_{deg} = Number of plots of Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified.

N_{total} = Total number of parcels found in the program area

T = Surface area of the program expressed in hectares

2.1.3. Forest degradation recovery activity data

Equation 5:

$$AD_{rec} = \left(\frac{N_{rec}}{N_{total}}\right) * T$$

Where:

AD_{rec} = Activity data derived from recovery from forest degradation

ND_{rec} = Number of plots of The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from very degraded forest to primary forest and from highly degraded forest to degraded forest is quantified.

N_{total} = Total number of parcels found in the program area

T = Surface area of the program expressed in hectares

2.1.4. Increases for forest plantations

Equation 6:

$$AD_{pla} = \left(\frac{N_{pla}}{N_{total}}\right) * T$$

Where:

AD_{pla} = Activity data for reforestation through forest plantations

N_{pla} = Number of plots that goes from non-forest lands to forest plantations

N_{total} = Total number of parcels found in the program area

T = Surface area of the program expressed in hectares

2.1.5. Activity data for forest land maintained as forest land

Equation 7:

$$AD_{f} = \left(\frac{N_{f}}{N_{total}}\right) * T$$

This formula is used to find out if the forest plots have undergone a degradation process or a degradation recovery process.

Where:

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AD_f	=	Activity data for forest land maintained as forest land
N_f	=	Number of plots that are categorized as forest that remain as forest.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

2.2. Reference level emission and removal data

2.2.1. Emissions from Deforestation

Equation 8:

$$\text{Edef} = \sum_{\text{j,i}} ((\text{C}_{\text{for}} - \text{C}_{\text{nofor}}) \text{ x } \frac{44}{12} \times \text{A(j, i)} \ ) / RP$$

Where:

Edef = Emissions caused by deforestation (tCO2 per year)

$\underline{A}_{(j,i)RP}$ = Area from activity data that has been converted from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, Guatemala, the forests have a division based on four carbon strata:

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Ten types of non-forest land are considered:

- Cropland (C): What are annual crops, African palm, rubber and coffee. What are annual crops, African palm, rubber and coffee.
- Agroforestry systems such as shade-grown coffee was separated.
- Grassland (P);
- Wetland (A);
- Settlement (U); and
- Other lands (O).

$\underline{C_{for}}$ = Total forest carbon content of each strata j before conversion/transition, in tons of carbon per ha.

$\underline{C_{nofor}}$ = Total non-forest carbon content of each non-forest land use after conversion, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

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The conversions identified for the reference level for Guatemala are the following:

The following tables show the forest carbon content as well as the content of other non-forest land uses. The origin of each of the values is shown in more detail in Chapter 3.

Forest carbon content

Stratum	Forest carbon content – Cfor-- (Ton/ha)
Forest I	107.639
Forest II	105.742
Forest III	87.095
Forest IV	83.628

Non-forest carbon content

Non forest land Use	Non forest carbon content – Cnofor-- (Ton/ha/yr)
Croplands (all classes not specified) and grasslands	4.7
Croplands-Coffee (intensive)	2.65
Croplands-African Palm	3.47
Croplands-Rubber	4.30
Non forest land Use	**Ton Carbon/ha/**
Agroforestry systems (shaded coffee)	20.1
Grasslands	6.73
Settlements	0
Wetlands	0
Other lands	0

2.2.2. Emissions from degradation

Equation 9:

$$Edeg = \sum_{\mathbf{j,i}} (\ (\mathrm{Cfor} - \ \mathrm{Cdeg}) \ \mathrm{x} \ \frac{44}{12} \times \ \mathrm{A(j,i)} \ \ )/RP$$

Where:

Edeg = Emissions caused by forest degradation in hectares per year

$\underline{A}_{(j,i)RP}$ = Activity data area that has undergone a degradation process within the forest cover during the reference period, in hectares per year. In the case of Guatemala, the analysis of forest degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II

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- Stratum III
- Stratum IV

Cfor = Total forest carbon content of each forest type j before conversion/transition, in tons of carbon per ha.

Cdeg = Forest carbon content of each degraded forest type j, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

2.2.3. Removals from forest degradation recovery

Equation 10:

$$Edeg = \sum_{j,i} ((\text{Cdeg} - \text{C}_{\text{for}}) \text{ x } \frac{44}{12} \times \text{A(j,i)})/RP$$

Where:

Rrec = Removals obtained from the recovery of forest degradation in hectares per year

$A_{(j,i)RP}$ = Area that has had a recovery from degradation within the forest cover during the reference period, in hectares per year. In the case of Guatemala, the analysis of forest recovery degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Cdeg = Forest carbon content of each degraded forest type j, in tons of carbon per ha.

Cfor = Total forest carbon content of each forest type j before conversion/transition, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

2.2.4. Removals due to increased carbon through forest plantations

Equation 11:

$$Rpla = \sum_{j,i} ((AAI) \text{ x } \frac{44}{12} \times \text{A(j,i)})$$

Where:

Rpla = Removals obtained by the establishment of forest plantations in hectares per year

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$\underline{A}_{(j,i)RP}$ = Area that has been identified as forest plantation. In the case of Guatemala, two types of plantations are managed:

- Broadleaf Plantation
- Conifer plantation

AAI = Average annual increase (**(tC/ha**) that was identified for each of the types of forest plantations, in this case:

- Broadleaf plantations
- Coniferous plantations

44/12 = Conversion of C to CO_2

3. Reporting period (GHG)

Net emissions during the for the reporting period[21] in the accounting area are estimated by subtracting carbon emissions and carbon removals.

Equation 12:

$$\mathbf{GHG=(Def+deg)-(Incr) = (E_{DEF}+ E_{DEG}) - (R_{rec}+ R_{pla}) =} ((\mathbf{ADdef} * \mathbf{FE}) + (\mathbf{ADdeg} * \mathbf{FE}) - (\mathbf{ADRrec} * \mathbf{FA}) - (\mathbf{ADRpla} * \mathbf{FA}))$$

Where:

GHG	=	Reporting period
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from degradation
$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), other lands that become forest lands and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE	=	Emission factors for deforestation and degradation
FA	=	Absorption factors for carbon increases in forest biomass

The first step to calculate the net emissions of the reporting period is the calculation of the activity data.

Activity data of the reporting **period**

3.1. Activity Data of deforestation

To determine the activity data, a random mesh was used consisting of 11,354 sample points for the entire country and 10,414 plots for the program area. Each plot has a total of 25 elements and the use is determined by the coverage that predominates.

[21] The monitoring period has 4 years for degradation and recovery of degradation because the year 2016 cannot be quantified again so the years 2017,2018,2019 and 2020 are used for the monitoring period and reported for the year 2020. For deforestation, the total number of years is two because 2018 is taken as the base year and from 2019 to 2020 monitoring is carried out and reported for 2020.

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Equation 13:

$$AD_{def} = \left(\frac{N_{def}}{N_{Total}}\right) * T$$

Where:

AD_{def}	=	Data derived from deforestation
N_{def}	=	Number of plots that were interpreted as deforestation in the period studied and that are categorized according to the number of tree elements, and these categories are: • Primary forest: 20 to 25 trees per plot. • Degraded forest: 14 to 19 trees per plot. • Highly degraded forest: 8 to 13 trees per plot.
N_{Total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.1.1. Activity data for degradation

Equation 14:

$$AD_{deg} = \left(\frac{N_{deg}}{N_{total}}\right) * T$$

Where:

AD_{deg}	=	Activity data derived from forest degradation
N_{deg}	=	Number of plots of Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified..
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.1.2. Forest degradation recovery activity data

Equation 15:

$$AD_{rec} = \left(\frac{N_{rec}}{N_{total}}\right) * T$$

Where:

AD_{rec}	=	Activity data derived from recovery from forest degradation
ND_{rec}	=	Number of plots of The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from very degraded forest to primary forest and from highly degraded forest to degraded forest is quantified.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

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3.1.3. Increases for forest plantations

Equation 16:

$$AD_{pla} = \left(\frac{N_{pla}}{N_{total}}\right) * T$$

Where:

AD_{pla}	=	Activity data for reforestation through forest plantations
N_{pla}	=	Number of plots that goes from other lands to forest plantations.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.1.4. Activity data for forest land maintained as forest land

Equation 17:

$$AD_f = \left(\frac{N_f}{N_{total}}\right) * T$$

This formula is used to find out if the forest plots have undergone a degradation process or a degradation recovery process.
Where:

AD_f	=	Activity data for forest land maintained as forest land
N_f	=	Number of plots that are categorized as forest that remain as forest.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.2. Reporting **period emission and removal data**

Equation 18:

3.2.1. Emissions from Deforestation

$$\text{Edef} = \sum_{\mathbf{j,i}} ((C_{for} - C_{nofor}) \text{ x } \frac{44}{12} \times A(j,i) \ )/RP$$

Where:

Edef	=	Emissions caused by deforestation in tCO2 per year.
$\underline{A}_{(j,i)RP}$	=	Area from activity data that has been converted from forest type j to non-forest type i during the reporting period, in hectares per year. In this case, Guatemala, the forests have a division based on four carbon strata:

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- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Ten types of non-forest land are considered:

- Cropland (C): What are annual crops, African palm, rubber and coffee
- Agroforestry systems such as shade-grown coffee was separated.
- Grassland (P);
- Wetland (A);
- Settlement (U); and
- Other lands (O).

Cfor = Total carbon of each forest carbon content strata before conversion/transition, in tons of carbon per ha.

Cnofor = Total carbon of each non-forest content type i after conversion, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reporting period.

Emissions from deforestation for the first monitoring report were:

Category	**Activity**
Primary	Forest Land I to Other Land
Primary	Forest Lands II to Grasslands
Primary	Forest land III to Grasslands
Primary	Forest Land III to Crops-Annuals
Primary	Forest Lands III to agroforestry systems
Primary	Forest Land IV to Settlements
Primary	Forest Lands IV to Other Lands
Primary	Forest Lands IV to Grasslands
Primary	Forest Land IV to Annual Crops
Degraded	Forest Land I to Grasslands
Degraded	Forest Lands II to Grasslands
Degraded	Forest land III to Grasslands
Degraded	Forest Lands IV to Grasslands
Degraded	Forest Lands IV to agroforestry systems
Very degraded	Forest land III to Grasslands
Very degraded	Forest Lands IV to Agricultural Lands-African Palm
Plantation	Plantations to pastures

The following tables show the forest carbon content as well as the content of other non-forest land uses. The origin of each of the values is shown in more detail in Chapter 3.

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Forest carbon content

Stratum	Forest carbon content – Cfor-- (Ton/ha)
Forest I	107.639
Forest II	105.742
Forest III	87.095
Forest IV	83.628

Non-forest carbon content

Non forest land Use	Non forest carbon content – Cnofor-- (Ton/ha/yr)
Croplands (all classes not specified)	4.7
Croplands-Coffee (intensive)	2.65
Grasslands	6.73
Croplands-African Palm	3.47
Croplands-Rubber	4.30
Agroforestry systems (shaded coffee)	20.1
Settlements	0
Wetlands	0
Other lands	0

3.2.2. Emissions from degradation

Equation 19:

$$\text{Edeg} = \sum_{\mathbf{j,i}} (\left(\text{C}_{\text{for}} - \text{C}_{\text{deg}}\right) \text{x} \frac{44}{12} \times \text{A(j, i)} \ \ )/\text{RP}$$

Where:

Edeg = Emissions caused by forest degradation in tCO2 per year.

$\underline{A}_{(j,i)RP}$ = Activity data area that has undergone a degradation process within the forest cover during the reporting period, in hectares per year. In the case of Guatemala, the analysis of forest degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Cfor = Total carbon of each forest carbon content strata forest type j before conversion/transition, in tons of carbon per ha.

Cdeg = Half of total forest carbon content of each forest carbon content strata forest type j before conversion/transition, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reporting period.

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3.2.3. Removals from forest degradation recovery

Equation 20:

$$Edeg = \sum_{\mathbf{j,i}} ((\mathrm{C_{deg}} - \mathrm{C_{for}}) \mathrm{x}\ \frac{44}{12} \times \mathrm{A(j,i)}\ )/RP$$

Where:

Rrec = Removals obtained from the recovery of forest degradation in tCO2 per year.

$\underline{A}_{(j,i)RP}$ = Area that has had a recovery from degradation within the forest cover during the reference period, in hectares per year. In the case of Guatemala, the analysis of forest recovery degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Cdeg = Half of total carbon of each forest carbon content strata before conversion/transition, in tons of carbon per ha.

Cfor = Total forest carbon content of each forest type j before conversion/transition, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the monitoring period.

3.2.4. Removals due to increased carbon through forest plantations

Equation 21:

$$Rpla = \sum_{\mathbf{j,i}} ((AAI) \mathrm{x}\ \frac{44}{12} \times \mathrm{A(j,i)}\ )/RP$$

Where:

Rpla = Removals obtained by the establishment of forest plantations in tCO2 per year.

$\underline{A}_{(j,i)RP}$ = Area that has been identified as forest plantation. In the case of Guatemala, two types of plantations are managed:

- Broadleaf Plantation
- Conifer plantation

AAI = Average annual increase that was identified for each of the types of forest plantations, in this case:

- Broadleaf plantations
- Coniferous plantations

44/12 = Conversion of C to CO_2

RP = Years consisting of the monitoring period.

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3 DATA AND PARAMETERS

3.1 Fixed Data and Parameters

Parameter:	Forest carbon content (Cfor)
Description:	Forest carbon content of four carbon strata before conversion to non-forest land Used in equations: 8,9,10,11 and 18,19,20,21.
Data unit:	Ton of carbon 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):	The information generated in the carbon strata map of Guatemala was used to establish biomass above and below ground for forest information. To obtain the carbon content, a study was carried out in which a total of 2,364 forest plots were analyzed, which was prepared by the National Council of Protected Areas with the support of GIMBUT. For more details and explanation of how the value was obtained for the four strata of forest carbon in Guatemala you can consult the report that was made, which is in the following link: https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing To obtain greater clarity on how the forest carbon content in Guatemala was constructed, the documents, databases and spatial data have been placed in the section of any comments. The criteria for data cleaning started with individual trees, identifying atypical data with respect to DBH, height was applied only where trees with inconsistent heights were identified; however, in the other sources of information it was only used as a reference. Plot debugging consisted of missing coordinate information and inconsistent locations". The most significant pool includes above-ground biomass carbon from trees greater than 10 cm in diameter (Trees greater than 10 cm DBH[22] are included, because for Guatemala it is the definition of a tree). measured at 1.3 m (DBH). Lianas and palms were not considered as part of the aboveground or belowground biomass as part of the emission factors, since there is no information available. The data of this pool is modeled in the carbon strata map at the national level, which was prepared from 2,306 plots of forest inventories, from different projects, which were

[22] For Guatemala, the following definition for a tree is used:
Woody plant with a defined stem and crown with secondary growth that, when mature, reaches a minimum height of 5 meters and a minimum diameter of 10 cm. Bamboos and palms are excluded.

	systematized, refined, standardized, and analyzed to obtain the value of biomass for each individual greater than 10 cm DBH[23]. General allometric equations were applied, differentiating between broadleaf forests in Petén, coniferous forests, broadleaf forests and mangrove forests. In the latter, three species-specific equations were used. The factor 0.47 was used to convert biomass to carbon and the result per hectare was standardized by dividing the result by the plot size. The second pool, which is related to the previous one, includes below-ground biomass (roots). To estimate below-ground biomass, an above-ground biomass ratio equation was used for all plots (Mokany, Raison & Prokushkin 2006)[24], except for the Mangrove Forest plots, where an equation was used (Komiyama et al. 2008)[25]. The following (see The equations that appear in table 5 for coniferous and deciduous forests were generated for these specific forest types. They were not made for tree species. Table 5) shows the equations used to calculate the biomass above and below ground for the Petén, conifers, broadleaves and three mangrove species forests, which take into consideration the relationship in function of the proportion of aerial biomass for the below-ground biomass. It is important to mention that all the allometric equations are implemented at the tree level, not at the level of an entire plot. Additionally, in the "Methodological report for the elaboration of the carbon strata map" in chapter 4.3 and 4.4 Allometric equations for broadleaved and coniferous forests, it is explained how the allometric equations were applied, depending on the location of the plots (page 7). https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view A regional equation is used for the vegetation types of northern Peten (Arreaga) and is applied for all trees in Peten. For the rest of the country, two equations are used that are assigned by vegetation type (coniferous and broadleaf), and three species-specific equations for mangrove trees (Rhizophora mangle L., Laguncularia racemosa (L.) Gaertn.f., Avicennia germinans (L.)L.). The equations that appear in table 5 for coniferous and deciduous forests were generated for these specific forest types. They were not made for tree species.

[24] https://drive.google.com/file/d/1kM2ZLN0ftJHTO4due1jyJx1s4_DuATA4/view?usp=drive_link
[25] https://drive.google.com/file/d/15PmlsvBZefff7-2b_GBZhMvry4y7sp2u/view?usp=drive_link

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Table 5. Allometric equations used.

Mangrove species	Equation	Source	r2	N	Dmax
Rhizophora mangle L.	0.178*DBH^2.47	Imbert and Rollet (1989)a	0.98	17	Unknown
Laguncularia racemosa (L.) Gaertn.f.	0.1023*DBH^2.50	Fromard et al. (1998)	0.97	70	10
Avicennia germinans (L.) L.	0.14*DBH^2.4	Fromard et al. (1998)	0.97	25-45	42.4
Conocarpus erectus L.[26]	0.1023*DBH^2.50	Fromard et al. (1998)			
Types of vegetation by region	**Equation**	**Source**	**r2**	**N**	**Dmax**
Broadleaf vegetation of northern Peten	10^ (-4.09992+(2.57782*LOG10(DBH))) *1000	Arreaga, 2002	95	139	130
Broadleaf vegetation	0.13647*DBH^2.38351	UVG,2018	0.939	100	79.9
Coniferous vegetation	0.15991 * DBH^2.32764	UVG,2018	0.966	80	82

With the biomass data for each individual, the conversion of tons of biomass to carbon is made, multiplying by the fraction of 0.47 and the value for one hectare is extrapolated, according to the size of each plot. The values are added for each of the plots, and results in a standardized value of tons of carbon per ha in each of them.

Each plot has geographic location data, and these were stratified bioclimatically, as an indirect measure of primary productivity, based on the ombrothermal indices generated for Guatemala, which were constructed with data obtained from the World Clim digital page, using the monthly precipitation and temperature averages. This climatic classification has been widely used in Guatemala as a basis for regional planning and for the integration of other variables of interest to forest services or biological conservation (CONAP, 2015).

The plots with their carbon content were in 6 ombric horizons, and data (the carbon content data of the analyzed plots) distribution tests were carried out for each of them, finding that none presented normality in the data distributions. Therefore, to carry out the stratification according to the ombric horizons, a comparison test of k samples (Kruskal-Wallis) was carried out, where statistically differentiated groups were detected as shown below (See Table 6).

Table 6. Grouping categories according to climatic regime.

[26] This equation is the same as the one used for the Mangrove species "Laguncularia racemosa (L.)".

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Sample	Frequency	Sum of ranks	Average Ranges	Groups		
8a. Hyperhumid Lower	381	560,291	1,471	A		
7b. Wet top	578	684,655	1,185		B	
6b. Upper sub-humid	172	203,702	1,184		B	C
8b. Hyper-humid superior	43	49,207	1,144		B	C
6a. Lower sub-humid	633	723,660	1,143		B	C
7a. Wet Bottom	556	571,552	1,028			C

As shown below, from the statistical grouping, four strata were determined at the national level according to the amount of carbon and the zones of ombric horizons (See Table 7). The groups that are observed in table 8, indicate those ombric indices that are statistically related to each other. That is why the result is four groups.

Table 7. Groups in which climatic regimes are classified.

Ombric Horizon	Groups			Final stratum
8a. Hyperhumid Lower	A			I
7b. Wet top		B		II
6b. Upper sub-humid		B	C	III
8b. Hyper-humid superior		B	C	III
6a. Lower sub-humid		B	C	III
7a. Wet Bottom			C	IV

With these data, the values were assigned to those areas whose ombric horizon did not have enough plots to be represented (e.g., Dry type), leaving the final stratification as detailed in Table 8, with which the national coverage is achieved.

Table 8. Strata assigned to horizons with insufficient values.

Stratum	Tipos_ombricos	Horizontes_ombricos
I	**8. Hyper-humid**	8a. Hyperhumid Lower
II	**7. Wet**	7b. Wet top
III	**6. Sub-humid**	6a. Lower sub-humid
		6b. Upper sub-humid
	8. Hyper-humid	8b. Hyper-humid superior
IV	**7. Wet**	7a. Wet Bottom

To have more consistent data in the estimation of tons of carbon per hectare and per stratum, descriptive statistics were made for each group and the resulting carbon

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content ranges were compared. Due to the great variability of the data according to the size of the plots and sampling designs, calculations of carbon density were made with the median and the weighted mean was also calculated for the four strata according to the proposal of Thomas and Rennie, 1987, who define that variance is a good estimator of the mean. Due to the variability of sampling designs for different purposes, data distribution (non-normal) and plot sizes, the probability density function (PDF) of the data by plot size and by stratum through goodness-of-fit tests was identified (Gómez Xutuc, 2017). Once the PDFs have been identified, it performs simulations of the carbon content per hectare, (Figure 6).

Thus, 10,000 simulations were run, truncating distributions according to the minimum and maximum of each data (tC/ha) by plot size and by stratum, respectively. The median was used for the analysis, since these are data that do not present a normal distribution.

Figure 6. Estimated values for the carbon map.

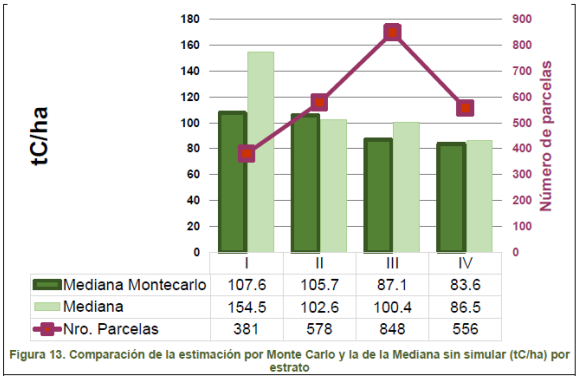

Figura 13. Comparación de la estimación por Monte Carlo y la de la Mediana sin simular (tC/ha) por estrato

Value applied:

The final values of forest biomass above and below ground were as follows.

Table 9. Carbon values obtained for each stratum.

Strata	Median	Standard deviation	Uncertainty (%)
I	107.64	30.393	28%
II	105.74	51.583	49%
III	87.09	15.781	18%
IV	83.63	41.303	49%
Strata	**Median**	**Standard deviation**	**Uncertainty (%)**
I	107.64	30.393	28%
II	105.74	51.583	49%
III	87.09	15.781	18%
IV	83.63	41.303	49%

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<table>
<tr><td>QA/QC procedures applied</td><td>Review and evaluation of atypical data for its depuration. Due to the variability in the sources of information, different procedures were carried out in the debugging of the information. For most of the plots, the previously described process was applied (see figure 2), with the exception of the inventory base, for which the following steps were followed. Methodological Document (page 6).
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

A constraint was made to limit the height of the trees in the equations so that heights well outside the range would bias the results. Additionally, plots with inadequate georeferencing were removed from the analysis.

Additional analysis was done to check the accuracy of the map against the plots of the project inventories. Since the country also submitted a reference level to the United Nations Convention on Climate Change, we proceeded to review whether the correspondence of the map's carbon layers was in line with reality. Therefore, INAB proceeded to perform an analysis to evaluate the quality of the carbon layers map, which can be found in the folder in this link:
https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view

Within the process of creating the emission factors, especially the forest carbon content, it is not clear the quality control process that was used at the time of the sample design of each of the plots in which the information was collected. This is the reason for the NO mark in QA/QC. This lack of information is mostly due to the fact that data was only collected from several sources.

Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>Table 10. Uncertainty of the carbon strata after applying the Monte Carlo method.

<table><tr><th>Strata</th><th>Median</th><th>Standard deviation</th><th>Uncertainty (%)</th></tr><tr><td>I</td><td>107.64</td><td>30.393</td><td>28%</td></tr><tr><td>II</td><td>105.74</td><td>51.583</td><td>49%</td></tr><tr><td>III</td><td>87.09</td><td>15.781</td><td>18%</td></tr><tr><td>IV</td><td>83.63</td><td>41.303</td><td>49%</td></tr></table>
The values found in</td></tr>
</table>

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	Table 10 are the result of the modeling for the carbon strata for the calculation of the uncertainty of the emission reduction. Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.
Any comment:	To access the documents and calculations related to this activity, consult the following link: Methodological report: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view Database to build the carbon strata of Guatemala: https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view Shapefile: https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view For the National Forest inventory: https://www.sifgua.org.gt/SIFGUAData/PaginasEstadisticas/Recursos-forestales/inventario-forestal.aspx and for the rest of the plots, they are based on the permanent sampling plots and inventory plots: https://mangomap.com/desarrollo-forestal/maps/103965/parcelas-permanentes-de-medici-n-forestal-ppmf-?preview=true#. It is important to mention that for the elaboration of the carbon strata map there was no consolidation methodology that fulfilled this objective, however, the task of compiling information from plots from natural forests was carried out, which is why there is information of different sampling sizes.

Parameter:	Non forest carbon content Cnofor
Description:	Non-forest carbon content after conversion of forest land to non-forest land Used in equations:8 and 18
Data unit:	Tons of carbon/ha
Source of data or description of the method for developing the data,	In order to have an estimation of the emissions that is closer to reality and to assign a biomass existence value after deforestation, depending on the type of activity that is carried out, in addition to the data obtained for the country for agroforestry systems, the

including the spatial level of the data (local, regional, national or international):

general default values were used for land converted to cropland during the year following conversion, from the 2006 IPCC Guidelines for Wet Tropical Annual and Perennial Crops and their associated error range found in IPCC Table 5.9 (2006). The values for these other non-forest use categories were used as described below (See Table 11):

Table 11. Carbon in biomass after conversion due to deforestation.

Other land uses	Ton Carbon/ha/year	Range of error and/or uncertainty	Source
Croplands (all classes not specified)	4.7	±75%	IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)
Croplands-Coffee (intensive)	2.65	1.35%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the
Croplands-African Palm	3.47[27]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Croplands-Rubber	4.30[28]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Other land uses	**Ton Carbon/ha/**	**Range of error and/or uncertainty**	**Source**
Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the
Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)

[27] modified by applying the Mokany equation

[28] modified by applying the Mokany equation

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	Settlements	0.00	N/A	IPCC 2006
	Wetlands	0.00	N/A	IPCC 2006
	Other lands	0.00	N/A	IPCC 2006

Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Reporting Period results in the process of rebuilding the estimation of reductions.

Value applied:

Other land uses	Ton Carbon/ha/year	Range of error and/or uncertainty	Source
Croplands (all classes not specified)	4.7	±75%	IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)
Croplands-Coffee (intensive)	2.65	1.35%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the
Croplands-African Palm	3.47[29]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Croplands-Rubber	4.30[30]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Other land uses	**Ton Carbon/ha/**	**Range of error and/or uncertainty**	**Source**
Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the

[29] modified by applying the Mokany equation

[30] modified by applying the Mokany equation

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	Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)
	Settlements	0.00	N/A	IPCC 2006
	Wetlands	0.00	N/A	IPCC 2006
	Other lands	0.00	N/A	IPCC 2006

Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Reporting Period results in the process of rebuilding the estimation of reductions.

QA/QC procedures applied

Does not apply because they are default values taken from the IPCC Guidelines.

Uncertainty associated with this parameter:

Table 12. Uncertainty of carbon content in non-forest land

Classification	Agriculture	Coffee	Palm	Rubber	Agroforestry	Grasslands
Median	4.67	2.65	2.40	3.00	23.64	6.72
Mean	4.70	2.65	2.40	3.00	25.21	6.75
Desviation	1.75	0.53	0.49	0.19	15.35	2.48
IC upper	7.61	3.51	3.20	3.32	52.52	10.89
Ic lower	1.78	1.77	1.60	2.68	3.09	2.69
U %	62%	33%	33%	11%	105%	61%

Any comment:

To access the documents and calculations related to this activity, consult the following link:

Chapter Croplands for Croplands:
https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf

Chapter Croplands for African Palm and Rubber:
https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_05_Ch5_Cropland.pdf

Chapter Grasslands
https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_06_Ch6_Grassland.pdf

Data for intensive coffee and Agroforestry systems (shaded coffee):

	https://drive.google.com/file/d/1kXI5Pxr_iUJOffJJTfVBTjF2iWihs3tq/view?usp=drive_link https://docs.google.com/presentation/d/1JjSan9z5CYySzZuhCwRWxW9c1tR2nyww/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true

Parameter:	Emissions from degradation (Cfor-Cdeg)
Description:	Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified. Used in equations: 9,19
Data unit:	Tons of carbon/ha
Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):	To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link To quantify forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation.

For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot goes from 17 tree elements to 12 tree elements, the plot changes its category to a very degraded forest, which represents 48% of the plot's cover and with a carbon content of 45.12 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha that were lost due to a degradation process.

For thereporting period a total of 370 plots were identified and designated as degraded because the primary forest became degraded or very degraded forest, or a degraded forest became very degraded forest. These 370 plots equaled a total of 185, 508.91 ha for the monitoring period while for the reporting period the total was 46,377.23 ha/year.

Value applied:

Carbon above and below ground

Table 13. Criteria used to classify degraded plots.

Elements	% Coverage	Category	Carbon tC/ha			
			Stratum 1	Stratum II	Stratum III	Stratum IV
25	100	Primary	94.4	69.0	80.5	74.8
24	96		90.7	66.2	77.2	71.8
23	92		86.9	63.5	74.0	68.8
22	88		83.1	60.7	70.8	65.8
21	84		79.3	57.9	67.6	62.8
20	80		75.5	55.2	64.4	59.8
19	76	Degraded	71.8	52.4	61.1	56.8
18	72		68.0	49.7	57.9	53.8
17	68		64.2	46.9	54.7	50.9
16	64		60.4	44.1	51.5	47.9
15	60		56.7	41.4	48.3	44.9
14	56		52.9	38.6	45.1	41.9
13	52	Very Degraded	49.1	35.9	41.8	38.9
12	48		45.3	33.1	38.6	35.9
11	44		41.5	30.4	35.4	32.9
10	40		37.8	27.6	32.2	29.9
9	36		34.0	24.8	29.0	26.9
8	32		30.2	22.1	25.7	23.9

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QA/QC procedures applied	Does not apply because they are default values, taken from the forest carbon content and emission factors used for deforestation. The assumption was when Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified.
Uncertainty associated with this parameter:	Table 14. Standard deviation values to be used for modeling degradation values

Carbon Layer	Category	Median	Standard deviation
Stratum I	Primary	107.64	6.26
	Degraded	73.19	7.04
	Very degraded	47.36	5.16
Stratum II	Primary	105.74	6.33
	Degraded	71.90	6.45
	Very degraded	50.76	5.84
Stratum III	Primary	87.10	3.51
	Degraded	59.22	6.03
	Very degraded	41.81	5.78
Stratum IV	Primary	83.63	4.82
	Degraded	56.87	5.78
	Very degraded	40.14	4.91

Classification	Median	Desviation	IC upper
Forest Land I Primary A Degraded	30.14	8.3	43.78
Forest Land I Primary To Highly Degraded	52.75	6.89	63.95
Forest Land I Degraded to Very Degraded	22.68	7.58	35.13
Forest Land II Primary A Degraded	22.07	5.66	31.39
Forest Land II Primary To Very Degraded	35.97	5.18	44.41
Forest Land II Degraded to Very Degraded	13.77	5.87	23.67
Forest Land III Primary A Degraded	22.46	8.61	36.86
Forest Land III Primary To Very Degraded	51.5	1.34	53.71
Forest Land III Degraded to Severely Degraded	29.09	8.5	42.8
Forest Land IV Primary A Degraded	26.88	6.76	38.03
Forest Land IV Primary to Very Degraded	39.01	6.18	49.16
Forest Land IV Degraded to Severely Degraded	12.07	6.85	23.32

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	_____ _____ _____ _____ _____ _____ _____ _____ _____ These are the values corresponding to the forest carbon content that arise the Montecarlo Model.
Any comment:	To access the documents and calculations related to this activity, consult the following link: Methodological report: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view Database to build the carbon strata of Guatemala: https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing Shapefile: https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view?usp=sharing

Parameter:	Removals from forest degradation recovery (Cdeg-Cfor)
Description:	The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from very degraded forest to primary forest and from highly degraded forest to degraded forest is quantified. Used in equations: 10 and 20.
Data unit:	Ton of carbon/ha
Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):	To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: To quantify the recovery of forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be:

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- Primary forest: forest that conserves 20 to 25 tree elements within the plot.
- Degraded forest: forest that conserves 14 to 19 tree elements within the plot.
- Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot.

After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020.

To assign this amount of carbon it is necessary to identify the amount of tree elements the plot has, since this will establish the amount of carbon before the process of forest degradation recovery and the amount of carbon after the recovery of forest degradation.

For example, a plot has 12 tree elements in a first moment, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12 TonC/ha. In a second moment this plot changes from 12 tree elements to 19 tree elements, the plot changes its category to a degraded forest, which represents 68% of the plot's cover and with a carbon content of 60.16 TonC/ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha.

For the monitoring period, a total of 412 plots were identified and designated as recovery of forest degradation since the very degraded forest became a degraded forest (102 plots) and from a degraded forest to a primary forest (249 plots). These 412 plots equaled a total of 334,555.06 ha for the monitoring period while for the reporting period the total was 83,638.77 ha/year.

Value applied:

Carbon above and below ground

Table 15. Criteria is used to classify degraded plots.

Elements	% Coverage	Category	Carbon tC/ha			
			Stratum I	Stratum II	Stratum III	Stratum IV
25	100	Primary	94.4	69.0	80.5	74.8
24	96		90.7	66.2	77.2	71.8
23	92		86.9	63.5	74.0	68.8
22	88		83.1	60.7	70.8	65.8
21	84		79.3	57.9	67.6	62.8
20	80		75.5	55.2	64.4	59.8
19	76	Degraded	71.8	52.4	61.1	56.8
18	72		68.0	49.7	57.9	53.8

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17	68		64.2	46.9	54.7	50.9
16	64		60.4	44.1	51.5	47.9
15	60		56.7	41.4	48.3	44.9
14	56		52.9	38.6	45.1	41.9
13	52	Very Degraded	49.1	35.9	41.8	38.9
12	48		45.3	33.1	38.6	35.9
11	44		41.5	30.4	35.4	32.9
10	40		37.8	27.6	32.2	29.9
9	36		34.0	24.8	29.0	26.9
8	32		30.2	22.1	25.7	23.9

QA/QC procedures applied

Not applicable at the moment, due to the approach used to calculate the data.

The assumption was used when the recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from degraded forest to primary forest and from very highly degraded forest to degraded forest is quantified.

Uncertainty associated with this parameter:

Table 16. Standard deviation values to be used to model forest degradation recovery valuesCarbon Layer	Category	Median	Standard deviation
Stratum I	Primary	107.64	6.26
	Degraded	73.19	7.04
	Very degraded	47.36	5.16
Stratum II	Primary	105.74	6.33
	Degraded	71.90	6.45
	Very degraded	50.76	5.84
Stratum III	Primary	87.10	3.51
	Degraded	59.22	6.03
	Very degraded	41.81	5.78
Stratum IV	Primary	83.63	4.82
	Degraded	56.87	5.78
	Very degraded	40.14	4.91

These are the values corresponding to the forest carbon content that arise from the Montecarlo Model.

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Any comment:	To access the documents and calculations related to this activity, consult the following link: Methodological report: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view Database to build the carbon strata of Guatemala: https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing Shapefile: https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view?usp=sharing

Parameter:	Removals due to increased carbon through forest plantations (AAI)
Description:	Carbon content that is recovered through the implementation of coniferous and broadleaf plantations.
Data unit:	Tons of carbon per hectare
Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):	To estimate this data, data from growth curves taken from 28 species of trees in forest plantations in Guatemala were used (INAB 2014). These results come from the assessment of sampling units called "Permanent Forest Measurement Plots (*PPMF, for its acronym in Spanish*)," which are distributed in 90 municipalities within the 22 departments of Guatemala, and their location is due to the behavior of the geographical distribution of the forest plantations established mainly with the PINFOR Forestry Incentive Program of the National Forest Institute (INAB) since 1998. The Average Annual Growth Increments (AAGIs) were obtained by dividing the forest species by type of forest (broadleaf and coniferous), identifying which type of forest each forest species belongs to. Robust estimates of AAGIs for broadleaf and coniferous forests were generated from the Permanent Forest Measurement Plots (PPMF) database. The best fitted functions to probability density data (PDD) are normal for broadleaf forests and gamma for coniferous forests. Monte Carlo simulations were performed on these distributions to make more precise estimates and the final values of the AAGIs were calculated. Table 17 show the AAGIs for each plantation type in Guatemala. Table 17. AAGI for each type of forest plantation. Capture factor: Median (m^3 ha^{-1} $year^{-1}$) AAGI in broadleaf forest: 3.43 AAGI in coniferous forest: 7.88 The document called "Wood Densities of Tropical Tree Species" was used for the selection of wood densities. It contains a scientific study of tree densities in tropical

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forests in America. Also, as support and by way of comparison, the document "Conifers of Guatemala" was used, which contains densities of tree species belonging to the coniferous forest group (DATAFORG 2000, Reyes et al. 1992).

With the ordered basic density data, an average wood density was obtained for the broadleaf and coniferous forest. To obtain the average wood density for each type of forest, the species belonging to each tree community were identified and the arithmetic mean was calculated (See Table 18).

Table 18. Wood density according to the different types of plantations.

Type of forest	Density g/cm^3
Broadleaf Forests	0.588
Coniferous Forests	0.588

Biomass Expansion Factors (BEFs) are added to these values, which correspond to the ratio between aerial biomass and below-ground biomass (AB:BB) and the carbon fraction (CF), with IPCC default values, as shown below (See Table 19).

Table 19. Expansion factors, below-ground aerial biomass ratio and carbon fraction for forest plantations.

	BEF	AB:BB	CF
Broadleaf Forest	1.50	0.24	0.47
Coniferous Forest	1.20	0.24	0.47

Finally, the carbon per hectare per year data is converted to a COe_{q2} removal or absorption factor by multiplying it by the IPCC default factor of 44/12. Once all the calculations have been made, the values for plantations in broadleaf forests and plantations in coniferous forests are obtained (See Table 20)

Value applied:

Carbon above and below ground

Table 20. Values for plantations in broadleaf forests and plantations in coniferous forests

Classification	AAI **(tC/ha)**	**RF (t CO_{2eq}/ha)**
Broadleaf Forest	1.7631	6.47
Coniferous Forest	3.2404	11.89

QA/QC procedures applied

Not applicable at the moment, due to the approach used to calculate the data.

The following criteria were used to filter the information on forest plantations:

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	• Records of plantation initiation between the years 2001 to 2010. • Agroforestry systems and reforestation modality (on the recommendation of Winrock International's advisors, the quantification of existing areas of • Agroforestry Systems within the PINPEP forestry incentive, as these are incentivized areas that are sequestering carbon). • The records should contain location polygon not points. • Plantation area in hectares for each record. Based on the criteria described above, the data was cleaned and selected using software for geographic data management. For more information, in the any comments section you can find the protocol to calculate the IMA.
Uncertainty associated with this parameter:	Table 21. Uncertainty of carbon contents in lands that are recovered through forest plantations. **Classification** / **Broadleaf Forest** / **Coniferous Forest** Median / 37,823 / 85,258 Average / 82,184 / 101,185 Deviation / 22,808,404,571 / 4,778,004,942 CI – lower limit / 3,088 / 14,698 CI – upper limit / 414,596 / 271,351 % / 536 / 148
Any comment:	To access the documents and calculations related to this activity, consult the following link: Database: https://drive.google.com/drive/folders/1QFuxCTGlG_qJXF4JLCOvxUWVugyRr8HX?usp=drive_link Document: https://drive.google.com/file/d/1tS8nzi-YIzMB-JWCCuH94vk2p_WwPEGc/view?usp=drive_link

Activity data for reference period

Parameter:	Deforestation

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Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 3 Additionally, to convert the data to emissions we used equation 8.
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	To generate activity data for deforestation, Collect Earth was used as a platform for the collection of land cover and land use information for years of interest. For the identification of these land covers and land uses, Guatemala uses the IPCC classification to establish the land use of the observed parcel, which uses a methodological protocol that hierarchizes up to three levels of land use in Guatemala, which can be consulted at the following link: https://docs.google.com/document/d/11ZWGtbORra3bPPAeAogHDgFYfZG67e0R/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true For the case of deforestation, a reference level was used that covers the state of land cover and land use that persisted during 2006 and the state of land cover that persisted during 2016, which covers a period of 11.08. It is important to mention that the source of information for 2006 was the orthophotos of Guatemala, which began to collect information in December 2005. For the identification of deforestation, plots were identified in which, during the period 2006-2016, they lost the totality of their forest cover or suffered a degradation process greater than 70% loss of the elements corresponding to the trees. Subsequently, the calculation was made in hectares. After interpreting the 11,354 sampling points at the national level and labeling the change, a filter was performed to identify those points that were deforestation points, which identified a total of 35 plots equivalent to 280,296.02 hectares during the monitoring period and for the reporting period the total was 24,950.93 hectares per year. An additional step was to count the total number of three elements in the plot and establish a category in which the forest is located, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After identifying the forest category in which the plot is located, the carbon content was counted in proportion to the number of tree elements found in the plot. For example, if a plot has 17 trees, these represent 68% of the total plot and are located according to the strata map, in Stratum I which has a total of 94 TonC/ha, this plot will have a total of 60.16 TonC/ha. If the plot was deforested to agricultural land which has a total non-forest carbon

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	of 4.7 Tonne C/ha, the carbon lost by this deforestation process is a total of 55.46 Tonne C/ha. This allows the deforestation of the plot to be quantified proportionally and not directly to the amount of carbon assigned by the carbon strata map. Subsequently, a grouping of the main changes in deforestation was made to make the total sum of carbon dioxide equivalent emitted in the reporting period. The total number of interpreters who performed the analysis of the images were three specialists: Ulises Armas, Claudia Saput and Melany Ramírez.
Value applied	Total Hectares and Hectares per year for each of the changes due to deforestation for the reference level

Category	Category	Ha	Ha/Year
Primary	Forest Land I to Settlements	959.92	86.64
Primary	Forest Land I to Other Land	959.92	86.64
Primary	Forest Land I to Grasslands	3,839.67	346.54
Primary	Forest Land I to Annual Crops	1,919.84	173.27
Primary	Forest Land I to Agricultural Lands-Coffee	-	-
Primary	Forest Land I to Agricultural Land-Other	2,879.75	259.91
Primary	Forest Land I to Agricultural Oilland	1,919.84	173.27
Primary	Forest Land I to Agricultural Land-African Palm	-	-
Primary	Forest Lands I to agroforestry systems	2,879.75	259.91
Primary	Forest Lands II to Settlements	-	-
Primary	Forest Lands II to Other Lands	959.92	86.64
Primary	Forest Lands II to Grasslands	23,038.03	2,079.24
Primary	Forest Land II to Annual Crops	2,879.75	259.91
Primary	Forest Land II to Agricultural Lands-Coffee	-	-
Primary	Forest Land II to Agricultural Land-Other	1,919.84	173.27
Primary	Forest Land II to Agricultural Lands-Rubber	1,919.84	173.27
Primary	Forest Lands II to Agricultural Lands-African Palm	1,919.84	173.27
Primary	Forest Land II to agroforestry systems	959.92	86.64
Primary	Forest Land III a Settlements	959.92	86.64
Primary	Forest Land III to Other Land	-	-
Primary	Forest land III to Grasslands	57,595.07	5,198.11
Primary	Forest Land III to Crops-Annuals	4,799.59	433.18
Primary	Forest land III to agricultural land-coffee	-	-
Primary	Forest Land III to Agricultural Lands-Rubber	-	-
Primary	Forest Lands III to Agricultural Lands-African Palm	-	-
Primary	Forest Lands III to agroforestry systems	959.92	86.64
Primary	Forest Land IV to Settlements	-	-
Primary	Forest Lands IV to Other Lands	2,879.75	259.91
Primary	Forest Lands IV to Grasslands	55,675.24	5,024.84

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		Primary	Forest Land IV to Annual Crops	8,639.26	779.72	
		Primary	Forest Lands IV to Agricultural Lands-Coffee	1,919.84	173.27	
		Primary	Forest Land IV to Agricultural Land-Other	959.92	86.64	
		Primary	Forest Land IV to Agricultural Lands-Rubber	959.92	86.64	
		Primary	Forest Lands IV to Agricultural Lands-African Palm	4,799.59	433.18	
		Primary	Forest Lands IV to agroforestry systems	3,839.67	346.54	
		Degraded	Forest Land I to Settlements	-	-	
		Degraded	Forest Land I to Other Land	-	-	
		Degraded	Forest Land I to Grasslands	1,919.84	173.27	
		Degraded	Forest Land I to Annual Crops	-	-	
		Degraded	Forest Land I to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land I to Agricultural Land-Other	959.92	86.64	
		Degraded	Forest Land I to Agricultural Oilland	-	-	
		Degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Degraded	Forest Lands I to agroforestry systems	959.92	86.64	
		Degraded	Forest Lands II to Settlements	-	-	
		Degraded	Forest Lands II to Other Lands	-	-	
		Degraded	Forest Lands II to Grasslands	6,719.43	606.45	
		Degraded	Forest Land II to Annual Crops	3,839.67	346.54	
		Degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land II to Agricultural Land-Other	-	-	
		Degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Land II to agroforestry systems	1,919.84	173.27	
		Degraded	Forest Land III a Settlements	-	-	
		Degraded	Forest Land III to Other Land	-	-	
		Degraded	Forest land III to Grasslands	19,198.36	1,732.70	
		Degraded	Forest Land III to Crops-Annuals	2,879.75	259.91	
		Degraded	Forest land III to agricultural land-coffee	-	-	
		Degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Lands III to agroforestry systems	1,919.84	173.27	
		Degraded	Forest Land IV to Settlements	959.92	86.64	
		Degraded	Forest Lands IV to Other Lands	-	-	
		Degraded	Forest Lands IV to Grasslands	13,438.85	1,212.89	
		Degraded	Forest Land IV to Annual Crops	6,719.43	606.45	
		Degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land IV to Agricultural Land-Other	-	-	
		Degraded	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands IV to Agricultural Lands-African Palm	2,879.75	259.91	
		Degraded	Forest Lands IV to agroforestry systems	-	-	
		Very degraded	Forest Land I to Settlements	-	-	
		Very degraded	Forest Land I to Other Land	-	-	

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		Very degraded	Forest Land I to Grasslands	-	-	
		Very degraded	Forest Land I to Annual Crops	959.92	86.64	
		Very degraded	Forest Land I to Agricultural Lands-Coffee	959.92	86.64	
		Very degraded	Forest Land I to Agricultural Land-Other	-	-	
		Very degraded	Forest Land I to Agricultural Oilland	-	-	
		Very degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Very degraded	Forest Lands I to agroforestry systems	-	-	
		Very degraded	Forest Lands II to Settlements	-	-	
		Very degraded	Forest Lands II to Other Lands	-	-	
		Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-	
		Very degraded	Forest Lands II to Grasslands	959.92	86.64	
		Very degraded	Forest Land II to Annual Crops	959.92	86.64	
		Very degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Very degraded	Forest Land II to Agricultural Land-Other	-	-	
		Very degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Very degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Very degraded	Forest Land II to agroforestry systems	-	-	
		Very degraded	Forest Land III a Settlements	959.92	86.64	
		Very degraded	Forest Land III to Other Land	-	-	
		Very degraded	Forest Lands II to Wetlands and Water Bodies	959.92	86.64	
		Very degraded	Forest land III to Grasslands	-	-	
		Very degraded	Forest Land III to Crops-Annuals	-	-	
		Very degraded	Forest land III to agricultural land-coffee	-	-	
		Very degraded	Forest land III to agricultural land-other	-	-	
		Very degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Very degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Very degraded	Forest Lands III to agroforestry systems	959.92	86.64	
		Very degraded	Forest Land IV to Settlements	-	-	
		Very degraded	Forest Lands IV to Other Lands	-	-	
		Very degraded	Forest Lands IV to Grasslands	4,799.59	433.18	
		Very degraded	Forest Lands IV a Wetlands and Water Bodies	-	-	
		Very degraded	Forest Land IV to Annual Crops	959.92	86.64	
		Very degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Very degraded	Forest Land IV to Agricultural Land-Other	959.92	86.64	
		Very degraded	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Very degraded	Forest Lands IV to Agricultural Lands-African Palm	959.92	86.64	
		Very degraded	Forest Lands IV to agroforestry systems	-	-	
			Planting to pastures II	959.92	86.64	
			Planting to pastures III	3,839.67		
			Planting to pastures IV	1,919.84	173.27	
			Planting to annual crops IV	959.92	86.64	
			Plantation of coffee crops	959.92	86.64	
		Total		280,296.02	24,950.93	

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<table>
<tr><td></td><td>For more information, see the file
“Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_”
And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg”

https://drive.google.com/drive/u/1/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC
In the “Tables-Report-NR” tab.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated.

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90 % confidence interval and an expected 5% error.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>The uncertainty values of the activity data for deforestation
<table><tr><th colspan="2">DEF-NR-HA-</th></tr><tr><td>Median</td><td>330,932</td></tr><tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>378,451</td></tr><tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>283,050</td></tr><tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>47,700</td></tr><tr><td>Relative margin (D / A)</td><td>14%</td></tr></table>
The uncertainty values of the activity data can be found at the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_
Tab: Table-Report in Spanish.</td></tr>
<tr><td>Any comment:</td><td>To access the documents and calculations related to this activity, consult the following link:

For more information, see the file
“Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_”:

And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg”
Link:</td></tr>
</table>

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	https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Degradation
Description:	Degraded forest land The following equations were used to calculate this parameter: Activity data: Equation 4
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: https://docs.google.com/document/d/11ZWGtbORra3bPPAeAogHDgFYfZG67e0R/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true To quantify forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation. For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the

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carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot changes from 17 tree elements to 12 tree elements, the plot changes category to a very degraded forest, which represents 48% of the plot coverage and with a carbon content of 45.12 TonC/ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha which were lost by a degradation process.

For the reference level, a total of 353,249.78 ha was identified while the annualized data results in a total of 31,881.75 ha/year. These areas are equivalent to a total of 368 plots that were identified as a forest permanence and suffered a forest degradation process.

Value applied

Table 22. Total Hectares and Average hectares per year that have been degraded within the 2006-2016 period

Category	Ha	Ha/Year
Forest Land I Primary A Degraded	24,957.86	2,252.51
Forest Land I Primary To Highly Degraded	10,559.10	952.99
Forest Land I Degraded to Very Degraded	5,759.51	519.81
Forest Land II Primary A Degraded	60,474.83	5,458.02
Forest Land II Primary To Very Degraded	22,078.11	1,992.61
Forest Land II Degraded to Very Degraded	8,639.26	779.72
Forest Land III Primary A Degraded	41,276.47	3,725.31
Forest Land III Primary To Very Degraded	14,398.77	1,299.53
Forest Land III Degraded to Severely Degraded	19,198.36	1,732.70
Forest Land IV Primary A Degraded	87,352.53	7,883.80
Forest Land IV Primary to Very Degraded	23,997.95	2,165.88
Forest Land IV Degraded to Severely Degraded	33,597.13	3,032.23
Degraded plantations	959.92	86.64
Total	353,249.78	31,881.75

For more information, see the file Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_:

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

In the “Tables-Report-NR” tab.

QA/QC procedures applied:

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.

Uncertainty associated with this parameter:

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	Table 23. Uncertainties of degradation in the monitoring period **DEG-NR-HA-** **Median** 357,768 **Upper bound 90% CI** (Percentile 0.95) 415,631 **Lower bound 90% CI** (Percentile 0.05) 300,014 **Half Width Confidence Interval at 90% (B – C / 2)** 57,808 **Relative margin (D / A)** **16%** The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20myo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Forest Degradation Recovery
Description:	Land recovered from forest degradation The following equations were used to calculate this parameter: Activity data: Equation 5
Data unit:	Hectares per year
Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link:

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	To quantify the recovery of forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon it is necessary to identify the amount of tree elements the plot has, since this will establish the amount of carbon before the process of forest degradation recovery and the amount of carbon after the recovery of forest degradation. For example, a plot has 12 tree elements in a first moment, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12 TonC/ha. In a second moment this plot changes from 12 tree elements to 19 tree elements, the plot changes its category to a degraded forest, which represents 68% of the plot's cover and with a carbon content of 60.16 TonC/ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha. For the reference level, a total of 284 plots were identified and designated as recovery of forest degradation since the very degraded forest became a degraded forest, from very degraded forest to primary forest and from degraded forest to primary forest. In terms of hectares, a total of 272,616.68 ha were identified throughout the reference level and 24,604.39 ha/year.
Value applied	Table 24. Hectares per year of forest increments through forest restoration.

Category	Ha	Ha/Year
Forest Land I Highly Degraded to Degraded	3,839.67	346.54
Forest Land I Highly Degraded to Primary	4,799.59	433.18
Forest Land I Degraded to Primary	29,757.45	2,685.69
Forest Land II Highly Degraded to Degraded	14,398.77	1,299.53
Forest Land II Highly Degraded to Primary	6,719.43	606.45
Forest Land II Degraded to Primary	46,076.06	4,158.49
Forest Land III Highly Degraded to Degraded	9,599.18	866.35
Forest Land II Highly Degraded to Primary	10,559.10	952.99

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	Forest Land III Degraded to Primary	49,915.73	4,505.03
	Forest Land IV Highly Degraded to Degraded	19,198.36	1,732.70
	Forest Land IV Highly Degraded to Primary	11,519.01	1,039.62
	Forest Land IV Degraded to Primary	66,234.33	5,977.83
	Total	272,616.68	24,604.39

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_02mayo2025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

In the "Tables-Report-NR" tab.

QA/QC procedures applied:

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.

Uncertainty associated with this parameter:

Table 25. Restoration uncertainties of degraded areas

RDEG-NR-HA-	
Median	278,343
Upper bound 90% CI (Percentile 0.95)	328,317
Lower bound 90% CI (Percentile 0.05)	226,770
Half Width Confidence Interval at 90% (B – C / 2)	50,774
Relative margin (D / A)	**18%**

The uncertainty values of the activity data can be found at the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link
Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_
Tab: Table-Report in Spanish.

Any comment:

To access the documents and calculations related to this activity, consult the following link:

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_02mayo2025_actualizado_"

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	And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Increased Carbon Through Forest Plantations
Description:	Increased Carbon Through Forest Plantations The following equations were used to calculate this parameter: Activity data: Equation 6
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Regarding the information on forest plantations for the reference level, a total of 33 points corresponding to this activity were identified, of which 20 points correspond to coniferous plantations and 13 points correspond to broadleaf plantations. The total hectare per year for the reference level was 23,606 hectares. But when it comes to using the legacy approach proposed by the World Bank, the total number of plantations is 31,677.29 hectares and 2,858.96 hectares per year.
Value applied	Table 26. Hectares per year of carbon increases through forest plantations. **Category** / **Ha** / **Ha/Year** Plantations I conifers: 19,198.36 / 1,732.70 Plantations of Broadleaf Plantations: 12,478.93 / 1,126.26 Total: 31,677.29 / 2,858.96 For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_*vg*" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link In the "Tables-Report-NR" tab.
QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty associated with this parameter:	Table 27. Forest plantation uncertainties **PLANT-NR-HA-**

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	Median 32,259 **Upper bound 90% CI** (Percentile 0.95) 49,572 **Lower bound 90% CI** (Percentile 0.05) 16,055 **Half Width Confidence Interval at 90% (B – C / 2)** 16,758 **Relative margin (D / A)** **52%** The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

3.2 Monitored Data and Parameters

Parameter:	Deforestation
Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 13
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	For deforestation, the land representation categories being used are those according to the IPCC categories. Table 28. Deforestation within the monitoring period and the reporting period

Category	Category	Ha	Ha/Year
Primary	Forest Land I to Settlements	-	-
Primary	Forest Land I to Other Land	959.92	479.96
Primary	Forest Land I to Grasslands	-	-
Primary	Forest Land I to Annual Crops	-	-
Primary	Forest Land I to Agricultural Lands-Coffee	-	-

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		Primary	Forest Land I to Agricultural Land-Other	-	-	
		Primary	Forest Land I to Agricultural Oilland	-	-	
		Primary	Forest Land I to Agricultural Land-African Palm	-	-	
		Primary	Forest Lands I to agroforestry systems	-	-	
		Primary	Forest Lands II to Settlements	-	-	
		Primary	Forest Lands II to Other Lands	-	-	
		Primary	Forest Lands II to Grasslands	3,839.67	1,919.84	
		Primary	Forest Land II to Annual Crops	-	-	
		Primary	Forest Land II to Agricultural Lands-Coffee	-	-	
		Primary	Forest Land II to Agricultural Land-Other	-	-	
		Primary	Forest Land II to Agricultural Lands-Rubber	-	-	
		Primary	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Primary	Forest Land II to agroforestry systems	-	-	
		Primary	Forest Land III a Settlements	-	-	
		Primary	Forest Land III to Other Land	-	-	
		Primary	Forest land III to Grasslands	5,759.51	2,879.75	
		Primary	Forest Land III to Crops-Annuals	959.92	479.96	
		Primary	Forest land III to agricultural land-coffee	-	-	
		Primary	Forest Land III to Agricultural Lands-Rubber	-	-	
		Primary	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Primary	Forest Lands III to agroforestry systems	959.92	479.96	
		Primary	Forest Land IV to Settlements	959.92	479.96	
		Primary	Forest Lands IV to Other Lands	1,919.84	959.92	
		Primary	Forest Lands IV to Grasslands	3,839.67	1,919.84	
		Primary	Forest Land IV to Annual Crops	959.92	479.96	
		Primary	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Primary	Forest Land IV to Agricultural Land-Other	-	-	
		Primary	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Primary	Forest Lands IV to Agricultural Lands-African Palm	-	-	
		Primary	Forest Lands IV to agroforestry systems	-	-	
		Degraded	Forest Land I to Settlements	-	-	
		Degraded	Forest Land I to Other Land	-	-	
		Degraded	Forest Land I to Grasslands	1,919.84	959.92	
		Degraded	Forest Land I to Annual Crops	-	-	
		Degraded	Forest Land I to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land I to Agricultural Land-Other	-	-	
		Degraded	Forest Land I to Agricultural Oilland	-	-	
		Degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Degraded	Forest Lands I to agroforestry systems	-	-	
		Degraded	Forest Lands II to Settlements	-	-	
		Degraded	Forest Lands II to Other Lands	-	-	
		Degraded	Forest Lands II to Grasslands	1,919.84	959.92	
		Degraded	Forest Land II to Annual Crops	-	-	
		Degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land II to Agricultural Land-Other	-	-	
		Degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	

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		Degraded	Forest Land II to agroforestry systems	-	-	
		Degraded	Forest Land III a Settlements	-	-	
		Degraded	Forest Land III to Other Land	-	-	
		Degraded	Forest land III to Grasslands	2,879.75	1,439.88	
		Degraded	Forest Land III to Crops-Annuals	-	-	
		Degraded	Forest land III to agricultural land-coffee	-	-	
		Degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Lands III to agroforestry systems	-	-	
		Degraded	Forest Land IV to Settlements	-	-	
		Degraded	Forest Lands IV to Other Lands	-	-	
		Degraded	Forest Lands IV to Grasslands	1,919.84	959.92	
		Degraded	Forest Land IV to Annual Crops	-	-	
		Degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land IV to Agricultural Land-Other	-	-	
		Degraded	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands IV to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Lands IV to agroforestry systems	959.92	479.96	
		Very degraded	Forest Land I to Settlements	-	-	
		Very degraded	Forest Land I to Other Land	-	-	
		Very degraded	Forest Land I to Grasslands	-	-	
		Very degraded	Forest Land I to Annual Crops	-	-	
		Very degraded	Forest Land I to Agricultural Lands-Coffee	-	-	
		Very degraded	Forest Land I to Agricultural Land-Other	-	-	
		Very degraded	Forest Land I to Agricultural Oilland	-	-	
		Very degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Very degraded	Forest Lands I to agroforestry systems	-	-	
		Very degraded	Forest Lands II to Settlements	-	-	
		Very degraded	Forest Lands II to Other Lands	-	-	
		Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-	
		Very degraded	Forest Lands II to Grasslands	-	-	
		Very degraded	Forest Land II to Annual Crops	-	-	
		Very degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Very degraded	Forest Land II to Agricultural Land-Other	-	-	
		Very degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Very degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Very degraded	Forest Land II to agroforestry systems	-	-	
		Very degraded	Forest Land III a Settlements	-	-	
		Very degraded	Forest Land III to Other Land	-	-	
		Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-	
		Very degraded	Forest land III to Grasslands	1,919.84	959.92	
		Very degraded	Forest Land III to Crops-Annuals	-	-	
		Very degraded	Forest land III to agricultural land-coffee	-	-	
		Very degraded	Forest land III to agricultural land-other	-	-	
		Very degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Very degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Very degraded	Forest Lands III to agroforestry systems	-	-	

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Very degraded	Forest Land IV to Settlements	-	-
Very degraded	Forest Lands IV to Other Lands	-	-
Very degraded	Forest Lands IV to Grasslands	-	-
Very degraded	Forest Lands IV a Wetlands and Water Bodies	-	-
Very degraded	Forest Land IV to Annual Crops	-	-
Very degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land IV to Agricultural Land-Other	-	-
Very degraded	Forest Land IV to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands IV to Agricultural Lands-African Palm	959.92	479.96
Very degraded	Forest Lands IV to agroforestry systems	-	-
Total		**32,637.21**	**16,318.60**

For monitoring, a total of 35 deforestation points were identified, which is equivalent to a total of 32,637.21 and an annual deforestation rate of 16,318.60 for the reporting period.

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link
Within the tab "Tables_PM_Report".

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

To generate the deforestation activity data, the Collect Earth platform was used to collect information on land cover and use in the years of interest. Guatemala uses the IPCC classification to determine land use in each plot, following a methodological protocol that hierarchizes land use into three levels. This protocol is available at the following link.

Deforestation monitoring covered the state of land cover and use during 2018 and 2020, covering a two-year period, and was reported for the year 2020. During this time, high- and medium-resolution images were consulted.

Plots were identified that, between 2018 and 2020, lost all their forest cover or suffered a degradation of more than 70% of their trees. Subsequently, the loss in hectares was calculated, annualizing it to obtain the 2020 data.

After analyzing 11,354 sampling points nationwide, those that showed deforestation were filtered, identifying 35 plots equivalent to 32,637.21 hectares during the monitoring period, and 16,318.60 hectares annually for the reporting period. In addition, the number of trees per plot was counted to classify the forest into:
- Primary forest: 20 to 25 trees per plot.
- Degraded forest: 14 to 19 trees per plot.
- Highly degraded forest: 8 to 13 trees per plot.

Then, the carbon content was calculated based on the trees present. For example, a plot with 17 trees represents 68% of the total and, according to the stratum map, in Stratum I

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<table>
<tr><td></td><td>with 94 TonC/ha, it would have 60.16 TonC/ha. If the plot was converted to agricultural land with 4.7 TonC/ha, the carbon loss would be 55.46 TonC/ha.

This method allows deforestation to be quantified proportionally, not only according to the carbon assigned by the strata map. Finally, the main deforestation changes were grouped</td></tr>
<tr><td>QA/QC procedures applied:</td><td>A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated.

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.</td></tr>
<tr><td>Uncertainty for this parameter:</td><td>Table 29. Uncertainties for deforestation in the monitoring period

<table>
<tr><th colspan="2">DEF-PM-HA-</th></tr>
<tr><td>Median</td><td>50,403</td></tr>
<tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>65,211</td></tr>
<tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>37,078</td></tr>
<tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>14,067</td></tr>
<tr><td>Relative margin (D / A)</td><td>28%</td></tr>
</table>

The uncertainty values of the activity data can be found at the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_
Tab: Table-Report in Spanish.</td></tr>
<tr><td>Any comment:</td><td>To access the documents and calculations related to this activity, consult the following link:

For more information, see the file
“Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_”

And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg”

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link</td></tr>
</table>

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	Tab: Cuadros_Informe_PM

Parameter:	Degradation
Description:	Degraded forest land The following equations were used to calculate this parameter: Activity data: Equation 14
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	Table 30. Hectares that have been degraded within the 2016-2020 monitoring period and reporting period

Category	Ha	Ha/Year
Forest Land I Primary A Degraded	23,997.95	5,999.49
Forest Land I Primary To Highly Degraded	4,799.59	1,199.90
Forest Land I Degraded to Very Degraded	3,839.67	959.92
Forest Land II Primary A Degraded	31,677.29	7,919.32
Forest Land II Primary To Very Degraded	3,839.67	959.92
Forest Land II Degraded to Very Degraded	8,639.26	2,159.82
Forest Land III Primary A Degraded	23,997.95	5,999.49
Forest Land III Primary To Very Degraded	3,839.67	959.92
Forest Land III Degraded to Severely Degraded	11,519.01	2,879.75
Forest Land IV Primary A Degraded	46,076.06	11,519.01
Forest Land IV Primary to Very Degraded	9,599.18	2,399.79
Forest Land IV Degraded to Severely Degraded	8,639.26	2,159.82
Total	180,464.56	45,116.14

For forest degradation, a monitoring period was used corresponding to the state of land cover that persisted throughout 2016 and the state of land cover that persisted from the year 2020, which covers a period of 4 years and for purposes of reporting the data for the monitoring report the value corresponding to the year 2020 is taken. During this monitoring period, both high and medium resolution images available were consulted.

For forest degradation, a total of 180,464.56 hectares were counted for the period 2016-2020, while for the first reporting period corresponding to the year 2020, the amount of hectares degraded was **45,116.14 ha/year.**

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

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	Within the tab “Tables_PM_Report”.
Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link To quantify forest degradation, it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation. For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot goes from 17 tree elements to 12 tree elements, the plot changes its category to a very degraded forest, which represents 48% of the plot's cover and with a carbon content of 45.12 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha that were lost due to a degradation process.
QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.
Uncertainty for this parameter:	Table 31. Uncertainties of degradation in the monitoring period

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	<table><tr><th colspan="2">DEG-PM-HA-</th></tr><tr><td>Median</td><td>187,322</td></tr><tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>228,346</td></tr><tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>147,866</td></tr><tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>40,240</td></tr><tr><td>Relative margin (D / A)</td><td>21%</td></tr></table> The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file “Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_” And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg” https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

Parameter:	Forest Degradation Recovery
Description:	Land recovered from forest degradation The following equations were used to calculate this parameter: Activity data: Equation 15
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	Table 32. Hectares of forest increments through forest restoration for the monitoring and reporting period. <table><tr><th>Category</th><th>Ha</th><th>Ha/Year</th></tr><tr><td>Forest Land I Highly Degraded to Degraded</td><td>5,759.51</td><td>1,439.88</td></tr><tr><td>Forest Land I Highly Degraded to Primary</td><td>9,599.18</td><td>2,399.79</td></tr><tr><td>Forest Land I Degraded to Primary</td><td>23,997.95</td><td>5,999.49</td></tr><tr><td>Forest Land II Highly Degraded to Degraded</td><td>19,198.36</td><td>4,799.59</td></tr></table>

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Forest Land II Highly Degraded to Primary	12,478.93	3,119.73
Forest Land II Degraded to Primary	71,993.84	17,998.46
Forest Land III Highly Degraded to Degraded	30,717.37	7,679.34
Forest Land II Highly Degraded to Primary	14,398.77	3,599.69
Forest Land III Degraded to Primary	48,955.81	12,238.95
Forest Land IV Highly Degraded to Degraded	43,196.30	10,799.08
Forest Land IV Highly Degraded to Primary	21,118.19	5,279.55
Forest Land IV Degraded to Primary	90,232.28	22,558.07
Total	391,646.50	97,911.62

For forest degradation recovery, a monitoring period was used corresponding to the state of land cover that persisted throughout 2016 and the state of land cover that persisted from the year 2020, which covers a period of 4 years and for purposes of reporting the data for the monitoring report the value corresponding to the year 2020 is taken. During this monitoring period, both high and medium resolution images available were consulted.

For the recovery of degradation, a total of **391,646.50 hectares** were accounted for the period 2016-2020, while for the first reporting corresponding to the year 2020, the number of hectares recovered was **97,911.62 ha/year**.

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

Within the tab "Tables_PM_Report".

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

To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for collecting information on land cover and use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and use to each of the plots, a methodological protocol was used that hierarchizes the land cover and use based on the land representation classification used by the IPCC, which can be consulted at the following link:

To quantify the recovery of forest degradation, it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is located, which can be:

- Primary forest: forest that conserves 20 to 25 tree elements within the plot.
- Degraded forest: forest that conserves 14 to 19 tree elements within the plot.

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	• Highly degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a carbon stratum map, of which there are 4 in total. The next step is to establish the amount of carbon that the plot has at a first moment in this case the year 2016 and then to establish the amount of carbon that the plot has at a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the amount of tree elements that the plot has, since with this we will establish the amount of carbon that there is before the process of recovery of forest degradation and the amount of carbon after the recovery of forest degradation. For example, a plot has 12 tree elements at first, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12 TonC/ha. In a second moment this plot goes from 12 tree elements to 19 tree elements, the plot changes category, to a degraded forest, which represents 68% of the coverage of the plot and with a carbon content of 60.16 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha. For the reporting period, a total of 351 plots were identified that were designated as forest degradation recovery, since the highly degraded forest became a degraded forest, from a highly degraded forest to a primary forest, and from a degraded forest to a primary forest.
QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty for this parameter:	Table 33. Restoration uncertainties of degraded areas **RDEG-PM-HA-** **Median** 394,761 **Upper bound 90% CI** (Percentile 0.95) 456,693 **Lower bound 90% CI** (Percentile 0.05) 333,728 **Half Width Confidence Interval at 90% (B – C / 2)** 61,483 **Relative margin (D / A)** **16%** The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

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	Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

Parameter:	Increased Carbon Through Forest Plantations
Description:	Increased Carbon Through Forest Plantations The following equations were used to calculate this parameter: Activity data: Equation 1*6*
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	Table 34. Hectares per year of carbon increases through forest plantations. **Category** | **Ha** | **Ha/Year** Plantations I conifers | 959.92 | 959.92 Plantations of Broadleaf Plantations | - | For forest plantations, a total of **959.92 hectares** were counted for the period 2018-2020, and for the year of the first reporting, the total number of hectares that were recovered through carbon enhancements through forest plantations was **959.92 ha/year.** For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Within the tab "Tables_PM_Report".
Source of data and description of	To generate the activity data for this parameter, Collect Earth was used as a platform for the collection of land use information for the years of interest, which allows us to identify the permanence and changes that occurred in these years. For the identification of these

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<table>
<tr><td>measurement/calculation methods and procedures applied:</td><td>land uses, Guatemala uses the IPCC classification to establish the land use of the parcel being observed. To use the Collect Earth form, Guatemala has a methodological protocol for its use, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

For the case of forest plantations, a monitoring period covering the state of land cover that persisted during 2018 and the state of land cover that persisted during 2020 was used, which covers a period of two years and for reporting purposes the year corresponding to 2020 was also used. During this monitoring period, both high and medium resolution images were consult.

The total number of interpreters who carried out the analysis of the images were three specialists: Ulises Armas, Claudia Saput and Melany Ramirez.

Regarding the information on forest plantations, only one plot corresponding to coniferous plantations was identified. To obtain the data per hectare, the equation found in section 3.1.4 was used.

Activity data and Calculation of hectares and emissions/absorptions
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link</td></tr>
<tr><td>QA/QC procedures applied:</td><td>For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.</td></tr>
<tr><td>Uncertainty for this parameter:</td><td>Table 35. Forest plantation uncertainties

<table><tr><th colspan="2">PLANT-PM-HA-</th></tr><tr><td>Median</td><td>1,709</td></tr><tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>4,365</td></tr><tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>182</td></tr><tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>2,091</td></tr><tr><td>Relative margin (D / A)</td><td>122%</td></tr></table>
The uncertainty values of the activity data can be found at the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_
Tab: Table-Report in Spanish.</td></tr>
</table>

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Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

4 QUANTIFICATION OF EMISSION REDUCTIONS

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

The Reference Level values for the first reporting in Guatemala are shown below. The reporting period covered in this report covers a full calendar year, therefore the application of Guideline number 3 of the Methodological Framework is not necessary.

Year of Monitoring *t*	Average annual historical emissions from deforestation over the Reference Period (tCO_{2-e}/yr)	Annual historical emissions from forest degradation over the Reference Period (tCO_{2-e}/yr)	Average annual historical removals by sinks over the Reference Period (tCO_{2-e}/yr)	Adjustment, if applicable (tCO_{2-e}/yr)	Reference level (tCO_{2-e}/yr)
2020	6,585,053	3,099,806	(2,271,827)	-	7,413,032
Total	6,585,053	3,099,806	(2,271,827)	-	7,413,032

To access the calculations of the reference level, as well as the reporting period, you can access the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

Documents:
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" under the "Summary in Spanish" tab and the point mesh file named "NR_MallaPuntos_Escenario_7_MC2024_05_vg" or the document template "MR FCPF_1stRP_05mayo2025_"

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

The values for Guatemala's first reporting are shown below. The reporting period covered in this report covers a full calendar year, therefore the application of Guideline number 3 of the Methodological Framework is not necessary.

	Emissions from deforestation	If applicable, emissions from forest degradation	If applicable, removals by sinks (tCO_{2-e}/yr)	Net emissions and removals

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Year of Monitoring Period	(tCO_{2-e}/yr)	(tCO_{2-e}/yr)*		(tCO_{2-e}/yr)
2020	4,147,978	4,054,278	-8,933,522	-731,266
Total	4,147,978	4,054,278	-8,933,522	-731,266

To access the calculations of the reference level, as well as the reporting period, you can access the following link: https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

Documents:
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" under the "Summary in Spanish" tab and the point mesh file named "NR_MallaPuntos_Escenario_7_MC2024_05_vg" or the document template "MR FCPF_1stRP_05mayo2025_"

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4.3 Calculation of emission reductions

The following table shows the calculated emission reductions for Guatemala for its first reporting event.

	Deforestation	If applicable, forest degradation	If applicable, enhanced removals from afforestation/ reforestation (A/R)	If applicable, enhanced removals from other activities besides A/R*	Total (tCO_{2-e})
Emission or removals in the Reference Level (tCO_{2-e})	6,585,053	3,099,806	(2,271,827)		7,413,032
Emission or removals under the ER Program during the Reporting Period (tCO_{2-e})	4,147,978	4,054,278	(8,933,522)		(731,266)
Emission Reductions during the Reporting Period (tCO_2-e)	2,437,075	(954,472)	6,661,695	-	8,144,298

To access the calculations of the reference level, as well as the reporting period, you can access the following link: https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

Documents:
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" under the "Summary in Spanish" tab and the point mesh file named "NR_MallaPuntos_Escenario_7_MC2024_05_vg" or the document template "MR FCPF_1stRP_05mayo2025_"

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5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

5.1 Identification, assessment and addressing sources of uncertainty

Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Activity Data						
Measurement	YES	YES	In the case of Guatemala, according to the sampling carried out for the generation of activity data, there may be sources of error associated with the quality and resolution of satellite images, the visual interpretation of samples, and sampling design. The error associated with the quality and resolution of the images could be considered low, since medium and high-resolution images have been used and the size of the analyzed plot (1ha) allows a correct visual interpretation of the images. In addition, the use of the Collect Earth tool allows to visualize the best images available on the dates of interest, ensuring to have images without clouds and with the requirements for their proper interpretation and reducing as much as possible the uncertainty that originates from this source.	High Bias and random	Yes	No

Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Another source of uncertainty comes from the main process for the estimation of the DA which is the visual interpretation of each of the points of the grid, for this part there has been a series of processes to minimize errors, with the choice of professional interpreters, who have gone through a training process on the use of the tools, an interpretation protocol has been developed which is the basis for the definition of classes. In addition, some scripts have been programmed to facilitate interpretation and avoid making mistakes during this process; a reliability value is even assigned to each of the data that is collected at each point in the mesh. Finally, a review of 5% of the samples is made by 3 interpreters and a comparative matrix of each evaluated point is made and a percentage of error is obtained in the interpretation of each of the original interpreters. For the measurement of the four REDD+ activities in Guatemala: A mesh composed of 11,354 samples points was used, which was used both at the reference level and in the			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			first reporting. With the sample mesh, the objective was to collect the land cover using the six IPCC classes and which were entered into a Collect Earth desktop form to display and interpret the high-resolution images for the year of study. Each plot on the Collect Earth form was made up of 25 elements for which coverage was assigned based on these elements, which could be trees, grasslands, agricultural land, bare soil, bodies of water and wetlands, as well as other land. In this way, each one of the interpreters was assigned a total of 3,700 plots (average) for each one to carry out the visual interpretation using the high-resolution images of Google Earth that were synchronized with Collect Earth. The imagery source was primarily high-resolution Google Earth imagery, followed by Planet, Sentinel, and Landsat imagery only when no imagery was available in Google Earth, or there were clouds or shadows in the Google Earth image. After the interpretation of the 11,354 sample points, the classes of			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			change or permanence were identified with labels to identify deforestation, degradation, and carbon increases through recovery from degradation and forest plantations. In this exercise, a review was made to assess the consistency of the coverage of the plot and whether it was coherent with the other dates. This process was carried out in an Excel sheet. After processing the labels, the total points for each of the four activities of the program were counted and then in another Excel tool to calculate hectares, total carbon and finally to be able to calculate the total number of CO2 emissions and absorptions. To reduce the error derived from visual interpretation, the Collect Earth methodological protocol was used to homogenize criteria among the interpreters, a forum was created in which the interpreters, when they had a sample with great difficulty, helped each other and how exercises were also done. To assess the degree of agreement between them as part of quality control.			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			For the interpretation of the plots, 638 plots were interpreted and the information was cross-checked to obtain the percentage of coincidence between the three interpreters. Due to the restrictions derived from the COVID-19 pandemic, the interpreters worked remotely, sending their results every 15 days to be reviewed. It is important to mention that among the interpreters there was communication with them to resolve doubts if the plot was too difficult to interpret. The temporal analysis was also done to identify possible incongruent transitions since having four points in time allowed to find out those non-logical changes that the plot could obtain. All this process was carried out using the Excel tool to process the information. When these non-logical changes were identified, the plot was reviewed again and the information was edited to ensure that the plot information was correct. Of the total of 638 samples for transitions and permanence that were identified for both the first			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			reporting and the reference level that was reviewed. For deforestation and degradation, 48 and 42 samples were established, while for carbon increments through degradation recovery and plantations, the samples were 56 and 18 respectively. These subsequent samples were chosen randomly and with a confidence interval of 95% and an error of 5%. Finally, it is important to mention that it can be considered that the interpreters do not have the same experience to interpret satellite images, so it is possible that the interpretation error is high. To reduce the error in the measurement/interpretation of the mesh of points, improvement points have been identified to implement in the following reporting, for example, the collect data form was tried to automate the entry of information through selection lists, as well as periodic review of the interpretation of the specialists.			
Representative ness	Yes	No	To detect areas of change due to emissions and removals from deforestation, degradation, and increases in carbon stocks,	Low Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Guatemala used a multipurpose grid to collect information. This grid was prepared in the context of the second forest inventory of Guatemala, which seeks to be able to represent the soil cover with a sampling precision of 10% with a confidence interval of 95%, which is sufficient with 672 samples. With this information, Guatemala decided to use a 3.1x3.1 grid system using a non-aligned systematic sampling design, making the sample proportional to the country's area. Within each grid, a randomly located point was located, thus allowing the evaluation of the change in use of the land cover. The grid design generated a total of 11,354 sample points located randomly within each grid for the entire surface of the country. After locating the 11,354 sample points, a Collect Earth form was generated to collect the information using high-resolution images found in the Google Earth image catalog. In the event that a High-Resolution image is not available, images from			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			the Landsat, Sentinel or Planet family are used depending on their availability. This Collect Earth form asked about the six IPCC classes as well as other land cover based on the land cover mapping of Guatemala. If, in case, a change was detected, the form indicated what kind of coverage it went to, as well as the year and the sensor with which the information was captured. Within the actions to minimize the error due to the collection of information, Guatemala generated an interpretation protocol so that each specialist or interpreter could address it in case they had doubts when choosing the land cover. Monthly meetings were also held to resolve doubts that had a high degree of interpretation, but since most of the images are of high resolution, it can be considered that the protection against uncertainty due to the collection of information is low. Regarding land cover representativeness, interpretation protocols have been refined to facilitate interpretation in future			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			reporting, in which the steps to choose the best land representativeness either by permanence or change have been detailed by means of decision trees. Operational processes have also been identified to achieve a better interpretation.			
Sampling	No	Yes	Regarding sampling error, this is the type of error that is quantified for its propagation in uncertainty, the sampling design is systematic with a mesh of 3.1 km x 3.1 km with a site located within each of the quadrants of the mesh. With the density of the sample you have, it is enough to capture the dynamics of the forests with an acceptable error. However, if you wanted to make an estimate of a smaller area, or for a specific type of change, this would require a densification of the mesh in those areas of interest. Because the grid of points used for collect earth is linked to the national forest inventory of Guatemala, it is considered that the choice of sampling points went through an adequate quality control process to ensure that the points can represent well the land cover area of Guatemala.	High Random and bias	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			The value used for uncertainty propagation is the sampling error that comes from the activity data for each of the transitions that are identified.			
Extrapolation	Yes	No	Extrapolation is not applied because Guatemala at no time used information to extrapolate activity data or emission factors. This is because Guatemala had information from the point grid, the carbon strata map and the IPCC default emission factors, as well as the non-forest carbon content. The data from the plots were not extrapolated so this source of uncertainty does not apply.	High Bias	Yes	No
Approach 3	Yes	No	This approach is applicable because the data collection was done by visual interpretation of land cover for the reference level and the reporting period. This approach does not apply to the case of Guatemala because Guatemala has a point grid that allows traceability of land use classes without the need to resort to other	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			sources of information to identify land use.			
Emission Factor						
DBH measurement	Yes	Yes	The measurement of the DBH was measured directly since information from different forest inventories that various projects in Guatemala have implemented over time was used. In Guatemala, a tree is defined as having a DBH greater than 10 centimeters at breast height. In the process of creating the emission factors, especially the forest carbon content, it is not clear what quality control process was used to measure the WTP. This is the reason why it was marked NO in QA/QC. However, when plots with DBH that were out of range were being purified, they were excluded in order to avoid errors in the calculations. It is considered that the error in the collection of information on the measurement factors is high because it comes from different sources of information that applied different methods and objectives at the time of collecting the information were different among the institutions and/or organizations that were in	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			charge of generating the data. It is also considered high because it is not known if quality control methods were applied during and after the data analysis process. Being information coming from various sources of forest inventories, there is no estimate of random or systematic errors that can contribute to the total uncertainty, because what can be considered high contribution. It is expected that when the information from the second forest inventory of Guatemala is available, we will have better information on this value and seek to reduce the contribution to the total error of the calculation.			
H measurement	Yes	Yes	The allometric equations used to generate the carbon strata map do not use height to estimate carbon content. Within the process of creating the emission factors, especially the forest carbon content, it is not clear what quality control process was used when measuring the height of the trees within the plot. This is the	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			reason why it was marked NO in QA/QC. However, when debugging plots with heights that were out of range, they were excluded in order to avoid errors in the calculations. It is expected that when the information from the second forest inventory of Guatemala is available, we will have better information on this value and seek to reduce the contribution to the total error of the calculation.			
Plot delineation	Yes	Yes	There was no control over the size and shape of the plots, nor in the process of plot establishment. The use of plots of different origins and sizes leads to considerable errors, in addition to the fact that each group of plots has different purposes and therefore different types of sampling. This gives us an idea that EFS are one of the main sources of uncertainty in the estimation of emissions and removals. To use the data collected from these plots, Guatemala created a carbon strata map. This was done by,	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			weighting the plots based on their size. In this process, modeling was done with the Monte Carlo and Bootstrap methods to better represent the distribution functions of the sample used. With this, the errors of each EF reported on the map became considerably low (see the FE section and the Carbon Strata Map protocol). Given that there are no specific QA-QC protocols for the plot delineation, the government of Guatemala decided to apply the highest uncertainty discount (15%). This approach serves as a conservative strategy to account for potential discrepancies and uncertainties inherent in the data. By applying the highest uncertainty discount, we aim to mitigate the risks associated with the lack of standardized quality measures, ensuring that any variability or errors in the inventory are adequately considered. This method provides a buffer against unforeseen inaccuracies, thereby safeguarding the integrity of the inventory's conclusions and facilitating more			

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			reliable decision-making. While this is not a substitute for comprehensive QA/QC processes, it is a necessary interim solution to address the current limitations and uphold the credibility of the forest inventory data. Yet, it is important to highlight that Guatemala is currently working on the second forest inventory. This inventory, which is being elaborated between the National Forest Institute and FAO, as well as national and international experts, considers a much better sampling design that will help reduce the contribution to the overall error. The data from the 2nd NFI will be used in subsequent crediting periods (if any).			
Biomass allometric model	Yes	Yes	For the calculation of biomass, three allometric equations were used for natural forests, both broadleaf and coniferous, the latter was standardized through studies carried out by the Universidad del Valle de Guatemala: UVG (2018) for coniferous, UVG (2018) for broadleaf; and for the northern lowlands the equation of Williams Arreaga (2002), with these the aerial biomass was calculated for each tree	High Bias and Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			(includes from the stem to the branches), using only the DBH (diameter at height of 1.3 m). In the case of the mangrove forest, three equations were applied according to the species found (permanent sampling plots from the southern coast of Guatemala administered by INAB were used). In the process of creating the emission factors, especially the forest carbon content, it is not clear what quality control process was used to create each of the formulas of the allometric model that was chosen for the calculation of the carbon content. This lack of information is mostly due to the fact that data was only collected from several sources. Given that there are no specific QA-QC protocols for the biomass allometric models, the government of Guatemala decided to apply the highest uncertainty discount (15%). This approach serves as a conservative strategy to account for potential discrepancies and uncertainties inherent in the data. By applying the highest uncertainty			

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			discount, we aim to mitigate the risks associated with the lack of standardized quality measures, ensuring that any variability or errors in the inventory are adequately considered. This method provides a buffer against unforeseen inaccuracies, thereby safeguarding the integrity of the inventory's conclusions and facilitating more reliable decision-making. While this is not a substitute for comprehensive QA/QC processes, it is a necessary interim solution to address the current limitations and uphold the credibility of the forest inventory data. It is anticipated that the data for estimating future emission factors will come from Guatemala's second national forest inventory. This improvement will apply the information to the surveys that have been used in Guatemala, which will help the error contribution of the allometric models to be reduced and not come from different sources of information. This information is integrated in the carbon strata map so that the error cannot be propagated. For this			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			reason, the formula found in the FPCF uncertainty guidelines was applied to add an additional 10% to the emission factor error.			
Sampling	No	Yes	The sampling design for the calculation of forest carbon of the plots varies since there are data from plots with a size ranging from 0.02 to 1 hectare in size of the plot, this because the collection of more than 3,000 plots distributed in most of Guatemala and covering more than 203 thousand trees that were inventoried. Derived from the fact that this information also comes from various information sources and it is not clear if there were quality control processes, this causes the contribution of sampling uncertainty to be high. For the propagation of the error, the probabilistic density function values were used for each of the carbon strata and for each of the different plot sizes with which the four strata of the carbon map were developed. Since the sample selected for the second forest inventory of Guatemala was elaborated between	High Bias and Random	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			the National Forest Institute and FAO, as well as national and international experts, it is considered that the choice of sampling intensity for the second forest inventory of Guatemala was appropriate and it is considered that this information can help to reduce the contribution to the overall error.			
Other parameters (e.g., Carbon Fraction, roots-shoot ratios)	Yes	Yes	For the carbon fraction, the IPCC factor 0.47 was used, while to establish the belowground carbon fraction, the Mokany equation was used because it was established that this equation was the most appropriate in proportion to the area biomass. Using the forest carbon content per hectare, the Mokany equation was applied to obtain the proportion of subterranean carbon. This information is integrated in the carbon strata map so that the error cannot be propagated. For this reason, the formula found in the FPCF uncertainty guidelines was applied to add an additional 10% to the emission factor error. Since this component of the emission factor is related to the information	High Random and Bias	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			captured from forest plots, it is expected that with the second forest inventory in Guatemala, standard operating procedures will be applied to reduce bias and error in the aerial biomass.			
Representativeness	Yes	No	The map of carbon strata covers the entire territory since plots from different forest inventories in Guatemala were used to ensure that forest carbon is represented on the map. Also, as part of the review by the UNFCCC reference level, an analysis was made on the correspondence of the map information with INAB's physical plots (document included in annexed folder 01. Datos_Fuentes/01. Carbono_forestal/Mapa Estratos de Carbono / 01_ControCalidad). Since the sample selected for the second forest inventory of Guatemala was elaborated between the National Forest Institute and FAO, as well as national and international experts, it is considered that the choice of sampling intensity for the second forest inventory of Guatemala was appropriate and it is considered that this information can	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			help to reduce the contribution to the overall error.			
Wood density	Yes	Yes	The average wood density was obtained for broadleaved and coniferous forest. To do that, for each type of forest, the species in each community of trees were identified and the arithmetic mean was calculated. Wood density was used to transform cubic meters from mean annual increments to convert volume to carbon. Since the information comes from the literature, in the short-term exercises should be carried out to corroborate these densities for species found in Guatemala, since there is no quality assurance control of the data on published data.	High Bias	Yes	No
Integration						
Model	Yes	No	There is an Excel file containing all the variables to estimate the uncertainty of the reductions. We will be working for the second reporting in a manual to perform this calculation. All sources of error were quantified in the activity data and emission	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			factors, which were propagated in the integration, so it is assumed that the uncertainty calculation will be low. In addition, a logic function was performed within the tool to estimate emissions/removals to verify that the total area of the points coincides with the total area of the program. As for the Monte Carlo model, recommendations have been received to update the model, which is a process of continuous improvement to facilitate its understanding in a sample and transparent manner.			
Integration	Yes	No	Emission factors were calculated for each forest stratum according to the location of the dot grid plots to ensure comparability between the transition classes of activity data and those of emission factors. This source of uncertainty is considered as one of the main sources of uncertainty. It is hoped that with the information from Guatemala's second forest inventory, as well as the	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			implementation of standard operating procedures for visual interpretation, the integration of activity data with emission factors can be improved for subsequent monitoring to reduce or mitigate the impact of possible sources of error in the calculation of uncertainty.			

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
	TonC/ha	Confidence interval			
Emission Factors					
Forest Land I to Settlements	107.65	10.42	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	107.65	10.42	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	100.88	11.27	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	102.97	10.70	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	102.97	10.70	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	104.65	10.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Lands I to agroforestry systems	84.21	27.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	105.66	10.27	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	98.91	11.11	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	100.94	10.69	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	100.94	10.69	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	102.65	10.29	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	64.07	5.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	82.15	27.04	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	87.13	5.70	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	80.43	7.11	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	82.40	6.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	63.81	25.53	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	83.49	7.83	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	76.79	8.90	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	78.77	8.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Lands IV to Agricultural Lands-Coffee	78.77	8.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	78.77	8.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	80.49	7.87	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	81.08	7.87	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	60.04	26.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	66.33	12.23	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	67.06	11.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	49.57	27.48	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	65.04	11.54	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	67.06	11.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	48.35	27.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	52.71	10.81	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	54.66	10.37	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	35.86	26.81	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	56.92	9.52	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Lands IV to Grasslands	50.15	10.30	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	52.21	9.96	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	54.52	9.59	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	42.60	8.83	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	46.12	10.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	44.10	10.48	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	46.12	10.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land II a Settlements	50.85	9.66	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	41.89	9.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	35.10	10.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	33.41	8.80	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	35.50	8.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	35.50	8.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	37.76	7.96	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures II	51.22	14.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Planting to pastures III	51.22	14.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures IV	51.22	14.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to annual crops IV	51.22	14.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantation of coffee crops	51.22	14.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary A Degraded	34.46	15.45	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary To Highly Degraded	60.31	13.23	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Very Degraded	25.86	14.20	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary A Degraded	33.86	14.90	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary To Very Degraded	54.87	14.17	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Very Degraded	21.17	14.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary A Degraded	27.99	11.54	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary To Very Degraded	45.32	11.20	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Severely Degraded	17.35	13.95	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary A Degraded	26.69	12.58	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary to Very Degraded	43.47	11.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Land IV Degraded to Severely Degraded	16.83	12.73	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degraded plantations	14.12	7.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Degraded	-25.79	14.24	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Primary	-60.36	13.42	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Primary	-34.61	15.40	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Degraded	-21.16	14.18	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	-55.09	14.26	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Primary	-33.96	14.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Highly Degraded to Degraded	-17.43	13.85	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	-45.25	11.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Primary	-27.68	11.60	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Degraded	-16.88	12.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Primary	-43.61	11.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Primary	-26.82	12.45	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations I conifers	-9.23	5.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Plantations of Broadleaf Plantations	-14.28	7.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

Reference level						
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	**Confidence interval**			
Deforestation					
Forest Land I to Settlements	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	23,038.03	9,207.79	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Forest Lands II to Agricultural Lands-African Palm	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	57,595.07	14,535.65	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	4,799.59	4,206.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	55,675.24	14,292.60	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	8,639.26	5,642.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	4,799.59	4,206.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Forest Lands IV to agroforestry systems	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	6,719.43	4,976.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	**Confidence interval**			
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	19,198.36	8,407.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	13,438.85	7,035.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	6,719.43	4,976.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Forest Land I to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Forest land III to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	4,799.59	4,206.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV a Wetlands and Water Bodies	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures II	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures III	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Planting to pastures IV	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to annual crops IV	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantation of coffee crops	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degradation					
Forest Land I Primary A Degraded	24,957.86	9,582.93	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary To Highly Degraded	10,559.10	6,237.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Very Degraded	5,759.51	4,607.55	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary A Degraded	60,474.83	14,892.63	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary To Very Degraded	22,078.11	9,014.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Very Degraded	8,639.26	5,642.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary A Degraded	41,276.47	12,314.58	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary To Very Degraded	14,398.77	7,282.29	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Severely Degraded	19,198.36	8,407.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary A Degraded	87,352.53	17,876.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary to Very Degraded	23,997.95	9,397.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Severely Degraded	33,597.13	11,114.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	**Confidence interval**			
Degraded plantations	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Increases in carbon stocks (Hectares)					
Forest Land I Highly Degraded to Degraded	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Primary	4,799.59	4,206.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Primary	29,757.45	10,461.56	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Degraded	14,398.77	7,282.29	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	6,719.43	4,976.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Primary	46,076.06	13,007.98	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Highly Degraded to Degraded	9,599.18	5,947.27	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	10,559.10	6,237.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Primary	49,915.73	13,536.74	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Degraded	19,198.36	8,407.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Primary	11,519.01	6,514.34	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Primary	66,234.33	15,581.53	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations I conifers	19,198.36	8,407.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Reference level					
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	Confidence interval			
Plantations of Broadleaf Plantations	12,478.93	6,780.04	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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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	Confidence interval			
Deforestation					
Forest Land I to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	5,759.51	4,607.55	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Land I to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	2,879.75	3,258.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Lands II to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	1,919.84	2,660.64	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Forest Lands IV a Wetlands and Water Bodies	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantation to pasture	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degradation					
Forest Land I Primary A Degraded	23,997.95	9,397.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary To Highly Degraded	4,799.59	4,206.28	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Very Degraded	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary A Degraded	31,677.29	10,792.80	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary To Very Degraded	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Very Degraded	8,639.26	5,642.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary A Degraded	23,997.95	9,397.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary To Very Degraded	3,839.67	3,762.38	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Severely Degraded	11,519.01	6,514.34	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary A Degraded	46,076.06	13,007.98	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary to Very Degraded	9,599.18	5,947.27	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Severely Degraded	8,639.26	5,642.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Increases in carbon stocks (Hectares)					

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Forest Land I Highly Degraded to Degraded	5,759.51	4,607.55	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Primary	9,599.18	5,947.27	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Primary	23,997.95	9,397.25	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Degraded	19,198.36	8,407.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	12,478.93	6,780.04	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Primary	71,993.84	16,240.55	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Highly Degraded to Degraded	30,717.37	10,628.49	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	14,398.77	7,282.29	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Primary	48,955.81	13,406.54	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Degraded	43,196.30	12,596.60	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Primary	21,118.19	8,816.57	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Primary	90,232.28	18,166.36	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations I conifers	959.92	1,881.44	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

Quantification of the uncertainty of the estimate of Emission Reductions

		Reporting Period	Crediting Period
		Total Emission Reductions*	Total Emission Reductions*
A	**Median ($TonCO_2$)**	7,959,303	7,959,303
B	**Upper bound 90% CI** (Percentile 0.95) **($TonCO_2$)**	11,435,996	11,435,996
C	**Lower bound 90% CI** (Percentile 0.05) **($TonCO_2$)**	4,511,918	4,511,918

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D	**Half Width Confidence Interval at 90% (B – C / 2) (TonCO_2)**	3,462,039	3,462,039
E	**Relative margin (D / A)**	43%	43%
F	**Uncertainty discount**	8%	8%

The Montecarlo model can be accessed through the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

The SimoVoio Excel module was used to perform this calculation. In the tab "Table Report" you can find the information of the table presented in the following document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_.xlsx.

***Guatemala proposes to use the maximum discount for the uncertainty buffer of 15% for the following reasons:

1. within the process of creating the emission factors, especially the forest carbon content it is not clear what quality control process was used during the information gathering process for each of the plots where the field information (forest inventory) was collected. This is the reason for the NO mark in QA/QC. This lack of information is due to the fact that in the absence of data from a complete and nationally implemented national forest inventory, forest inventory data from various sources were used, including forest inventory sites from forest concessions, research data, and partial data from the first national forest inventory.

2. Since the country does not yet have the main information to obtain the conservation status of forests (primary, degraded and very degraded), the best available information was used, in this case the grid of points to obtain statistical information on carbon content associated with canopy cover in order to model the emission factors in the Monte Carlo model and the Sensitivity analysis.

3. It has not been possible to propagate all the errors in the Monte Carlo uncertainty, because the EFs are associated with a carbon strata map that reports carbon above and below ground in a combined form and during the process the conversion of biomass to carbon is done without reporting separately the carbon fraction. Therefore, neither the stem-root error nor the carbon fraction error has been propagated.

4. An additional 10% error has been propagated in the forest carbon due to the fact that the errors of the allometric models used cannot be propagated.

5.3 Sensitivity analysis and identification of areas for improvement of Monitoring, reporting, and verification system.

The Sensit module of the SimVoi program was used to perform the sensitivity analysis, and the results are shown in Table 36:

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The sensitivity analysis that 23 elements of the reduction calculation contribute 94.68% of the uncertainty of the reductions. Of these elements, the removals factors from forest degradation recovery contribute 74.35%, while the remaining 19.71% come from degradation emission factors. Deforestation contributes 0.62% to the uncertainty of emission reductions. These percentages are from the baseline information as well as from the first reporting period.

Table 36. Senility analysis of emission reductions

Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
PM-FE-RDEG-Forest Lands IV Degraded to Primary	- 8.8	- 21.3	- 33.7	7,114,616.2	8,144,297.2	9,173,978.3	2,059,362.1	24.50%
PM-FE-RDEG-Forest Lands II Degraded to Primary	- 14.1	- 29.0	- 44.0	7,159,631.1	8,144,297.2	9,128,963.4	1,969,332.3	22.41%
PM-FE-DEG-Forest Lands IV Primary to Degraded	33.4	20.8	8.3	7,613,040.4	8,144,297.2	8,675,554.1	1,062,513.7	6.52%
PM-FE-RDEG-Forest Lands III Degraded to Primary	- 12.8	- 24.4	- 36.0	7,623,582.7	8,144,297.2	8,665,011.8	1,041,429.1	6.27%
PM-FE-RDEG-Forest Land IV Highly Degraded to Degraded	- 2.8	- 15.2	- 27.5	7,654,267.7	8,144,297.2	8,634,326.8	980,059.1	5.55%
PM-FE-DEG-Forest Lands II Primary A Degraded	41.4	26.5	11.6	7,711,553.3	8,144,297.2	8,577,041.2	865,487.8	4.33%
PM-FE-RDEG-Forest Land III Heavily Degraded to Degraded	- 0.3	- 14.2	- 28.0	7,754,332.4	8,144,297.2	8,534,262.1	779,929.7	3.51%
NR-FE-DEG-Forest Land IV Primary to Degraded	14.2	21.9	39.3	7,920,149.1	8,144,297.2	8,647,350.9	727,201.8	3.06%
PM-FE-DEG-Forest Land I Primary A Degraded	40.8	25.3	9.9	7,804,468.3	8,144,297.2	8,484,126.1	679,657.8	2.67%
PM-FE-RDEG-Forest Land I Degraded to Primary	- 10.4	- 25.8	- 41.2	7,805,613.3	8,144,297.2	8,482,981.1	677,367.8	2.65%
NR-FE-DEG-Forest Lands II Primary A Degraded	19.0	27.8	48.8	7,968,779.8	8,144,297.2	8,565,276.2	596,496.4	2.06%
NR-FE-RDEG-Forest Lands IV Degraded to Primary	- 39.1	- 21.2	- 14.2	7,752,217.0	8,144,297.2	8,297,942.4	545,725.4	1.72%
PM-FE-DEG-Forest Land III Primary A Degraded	29.7	18.1	6.6	7,890,497.7	8,144,297.2	8,398,096.8	507,599.1	1.49%
PM-FE-RDEG-Forest Lands II Very Degraded to Degraded	- 1.7	- 15.9	- 30.0	7,894,758.5	8,144,297.2	8,393,836.0	499,077.5	1.44%
NR-FE-RDEG-Forest Lands II Degraded to Primary	- 48.9	- 26.2	- 19.0	7,798,268.4	8,144,297.2	8,253,276.6	455,008.2	1.20%
PM-FE-RDEG-Forest Land IV Heavily Degraded to Primary	- 23.5	- 34.8	- 46.1	7,924,980.6	8,144,297.2	8,363,613.8	438,633.2	1.11%
NR-FE-RDEG-Forest Lands III Degraded to Primary	- 39.2	- 23.0	- 16.0	7,875,774.1	8,144,297.2	8,259,113.2	383,339.1	0.85%
NR-FE-DEF-Primary-Forest Land IV to Grasslands	67.9	74.4	85.8	8,025,030.9	8,144,297.2	8,353,101.6	328,070.7	0.62%
PM-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 38.1	- 52.4	- 66.6	7,981,159.7	8,144,297.2	8,307,434.8	326,275.1	0.62%
NR-FE-DEG-Forest Lands III Primary A Degraded	16.4	19.4	39.5	8,102,762.8	8,144,297.2	8,417,950.7	315,187.9	0.57%
NR-FE-RDEG-Forest Lands I Degraded to Primary	- 49.7	- 28.3	- 18.9	7,933,861.4	8,144,297.2	8,237,087.4	303,226.0	0.53%
PM-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 28.7	- 39.9	- 51.2	7,995,858.3	8,144,297.2	8,292,736.2	296,877.9	0.51%
PM-FE-DEG-Forest Land III Degraded to Very Degraded	29.1	15.1	1.1	7,996,946.4	8,144,297.2	8,291,648.1	294,701.7	0.50%
NR-FE-DEG-Forest Land IV Degraded to Very Degraded	4.0	16.2	29.4	8,007,874.4	8,144,297.2	8,290,835.1	282,960.7	0.46%
NR-FE-DEF-Primary-Forest Land III to Grasslands	73.2	77.1	87.4	8,070,415.6	8,144,297.2	8,341,320.4	270,904.8	0.42%
NR-FE-DEG-Forest Land I Primary A Degraded	19.1	28.2	49.9	8,069,137.6	8,144,297.2	8,324,316.0	255,178.4	0.38%
PM-FE-RDEG-Forest Land I Heavily Degraded to Primary	- 36.1	- 49.5	- 62.9	8,026,207.6	8,144,297.2	8,262,386.9	236,179.3	0.32%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
PM-FE-DEG-Forest Land II Degraded to Very Degraded	34.9	20.7	6.4	8,031,428.2	8,144,297.2	8,257,166.3	225,738.1	0.29%
NR-FE-DEG-Forest Land II Primary A Very Degraded	40.9	47.6	69.3	8,095,188.3	8,144,297.2	8,302,292.7	207,104.3	0.25%
PM-FE-DEG-Forest Land IV Degraded to Very Degraded	24.6	11.9	- 0.8	8,043,522.8	8,144,297.2	8,245,071.7	201,548.9	0.23%
PM-FE-DEG-Forest Land IV Primary to Very Degraded	52.8	41.5	30.2	8,045,045.1	8,144,297.2	8,243,549.4	198,504.3	0.23%
NR-FE-DEG-Forest Land IV Primary To Very Degraded	32.3	40.8	54.8	8,076,346.2	8,144,297.2	8,255,501.7	179,155.5	0.19%
NR-FE-DEG-Forest Land III Degraded to Very Degraded	3.3	16.7	31.2	8,059,259.8	8,144,297.2	8,236,577.3	177,317.5	0.18%
NR-FE-DEF-Primary-Forest Lands II to Grasslands	88.0	96.7	110.2	8,077,662.5	8,144,297.2	8,247,084.1	169,421.7	0.17%
NR-FE-RDEG-Forest Land IV Heavily Degraded to Degraded	- 29.3	- 13.2	- 4.5	8,042,322.1	8,144,297.2	8,199,571.9	157,249.8	0.14%
PM-FE-DEF-Primary-Forest Land II to Grasslands	110.2	95.8	88.0	8,043,187.6	8,144,297.2	8,199,620.3	156,432.7	0.14%
PM-FE-RDEG-Forest Land I Very Degraded to Degraded	1.3	- 12.9	- 27.2	8,069,111.7	8,144,297.2	8,219,482.8	150,371.1	0.13%
PM-FE-DEF-Primary-Forest Land III to Grasslands	77.6	70.5	63.4	8,069,256.6	8,144,297.2	8,219,337.9	150,081.2	0.13%
NR-FE-DEF-Degraded-Forest Land III to Grasslands	41.7	51.3	63.4	8,083,741.0	8,144,297.2	8,221,064.7	137,323.6	0.11%
NR-FE-RDEG-Forest Land II Highly Degraded to Degraded	- 35.5	- 16.1	- 7.2	8,051,531.1	8,144,297.2	8,186,660.4	135,129.3	0.11%
PM-FE-DEF-Primary-Forest Land IV to Grasslands	85.8	68.5	67.9	8,023,108.2	8,144,297.2	8,148,453.8	125,345.6	0.09%
PM-FE-DEG-Forest Land I Primary to Very Degraded	70.1	56.8	43.6	8,086,110.8	8,144,297.2	8,202,483.7	116,372.9	0.08%
PM-FE-DEF-Degraded-Forest Land III to Grasslands	63.4	51.3	41.7	8,080,810.1	8,144,297.2	8,194,926.0	114,115.9	0.08%
NR-FE-DEG-Forest Land III Primary To Very Degraded	34.1	44.4	56.5	8,095,194.9	8,144,297.2	8,201,910.1	106,715.2	0.07%
PM-FE-DEG-Forest Land I Degraded to Very Degraded	34.7	20.5	6.2	8,094,301.6	8,144,297.2	8,194,292.9	99,991.3	0.06%
PM-FE-DEG-Forest Land II Primary to Very Degraded	74.4	60.3	46.1	8,094,412.1	8,144,297.2	8,194,182.4	99,770.2	0.06%
PM-FE-DEF-Degraded-Forest Lands IV to agroforestry systems	58.5	33.4	4.9	8,100,147.2	8,144,297.2	8,194,497.9	94,350.7	0.05%
NR-FE-DEG-Forest Land I Primary A Very Degraded	33.4	46.6	59.8	8,098,084.2	8,144,297.2	8,190,510.3	92,426.1	0.05%
NR-FE-DEF-Degraded-Forest Lands IV to Grasslands	39.8	46.1	60.4	8,116,449.2	8,144,297.2	8,208,079.8	91,630.6	0.05%
PM-FE-DEF-Primary-Forest Lands III to agroforestry systems	84.9	67.0	33.8	8,112,804.5	8,144,297.2	8,202,658.3	89,853.8	0.05%
NR-DA-DEF-DEF-Plantation to pastures III	77.3	3,839.7	7,602.1	8,099,576.1	8,144,297.2	8,189,018.4	89,442.2	0.05%
NR-FE-RDEG-Forest Land III Highly Degraded to Degraded	- 31.3	- 10.8	- 3.6	8,079,232.4	8,144,297.2	8,167,220.9	87,988.5	0.04%
NR-FE-RDEG-Forest Land IV Heavily Degraded to Primary	- 55.1	- 41.0	- 32.4	8,090,565.7	8,144,297.2	8,176,939.1	86,373.5	0.04%
PM-FE-DEF-Degraded-Forest Lands I to Grasslands	78.6	68.6	54.2	8,109,036.0	8,144,297.2	8,195,119.8	86,083.8	0.04%
NR-FE-DEG-Forest Land II Degraded to Very Degraded	6.8	15.0	35.3	8,120,767.4	8,144,297.2	8,202,261.3	81,493.9	0.04%
PM-FE-DEF-Degraded-Forest Lands II to Grasslands	76.6	60.9	53.5	8,089,245.3	8,144,297.2	8,170,476.7	81,231.3	0.04%
PM-FE-DEG-Forest Land III Primary to Very Degraded	48.6	37.5	26.3	8,104,883.7	8,144,297.2	8,183,710.7	78,827.0	0.04%
NR-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 56.5	- 40.2	- 34.0	8,087,559.5	8,144,297.2	8,166,155.3	78,595.8	0.04%
NR-DA-DEF-DEF-Plantation to coffee crops	- 921.5	959.9	2,841.4	8,105,596.5	8,144,297.2	8,182,997.9	77,401.4	0.03%
PM-FE-DEF-Degraded-Forest Lands IV to Grasslands	60.4	48.5	39.8	8,102,227.7	8,144,297.2	8,174,746.8	72,519.1	0.03%
NR-DA-DEF-DEF-Plantation to pastures II	- 921.5	959.9	2,841.4	8,108,136.8	8,144,297.2	8,180,457.7	72,320.8	0.03%
NR-FE-PLANT-Conifer Plantations I	- 8.6	- 3.2	2.1	8,110,491.6	8,144,297.2	8,178,102.9	67,611.3	0.03%
NR-FE-DEF-Primary-Forest Lands IV to agroforestry systems	29.6	60.2	82.2	8,105,425.9	8,144,297.2	8,172,328.6	66,902.8	0.03%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEF-DEF-Plantation to pastures III	13.4	35.9	65.9	8,115,684.1	8,144,297.2	8,182,434.4	66,750.3	0.03%
NR-FE-PLANT-Plantation establishments	- 9.5	- 1.8	6.0	8,112,214.3	8,144,297.2	8,176,380.2	64,165.9	0.02%
NR-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 69.5	- 54.4	- 40.9	8,110,756.9	8,144,297.2	8,174,181.7	63,424.8	0.02%
PM-FE-DEF-Very Degraded-Forest Land III to Grasslands	42.1	33.3	24.5	8,113,307.9	8,144,297.2	8,175,286.6	61,978.7	0.02%
PM-FE-DEF-Primary-Forest Land IV to Other Lands	91.5	83.6	75.8	8,116,741.2	8,144,297.2	8,171,853.3	55,112.1	0.02%
NR-FE-DEG-Forest Land I Degraded to Very Degraded	11.6	13.6	40.0	8,140,429.0	8,144,297.2	8,194,575.9	54,146.9	0.02%
PM-FE-DEF-Plantation-Plantations to pastures	95.0	80.4	65.7	8,118,487.7	8,144,297.2	8,170,106.8	51,619.1	0.02%
NR-FE-DEF-Primary-Forest Lands I to agroforestry systems	53.1	87.5	107.1	8,111,443.7	8,144,297.2	8,162,931.8	51,488.1	0.02%
NR-FE-DEF-Degraded-Forest Lands II to Grasslands	53.5	61.5	76.6	8,126,414.3	8,144,297.2	8,177,733.7	51,319.4	0.02%
NR-DA-DEF-DEF-Plantation to Grasslands IV	- 740.8	1,919.8	4,580.5	8,119,175.5	8,144,297.2	8,169,419.0	50,243.5	0.01%
NR-FE-RDEG-Forest Land I Heavily Degraded to Primary	- 61.9	- 46.5	- 31.1	8,119,843.5	8,144,297.2	8,168,751.0	48,907.4	0.01%
NR-FE-DEF-Primary-Forest Land IV to Crops-Annuals	70.5	78.9	87.2	8,120,289.5	8,144,297.2	8,167,889.8	47,600.3	0.01%
NR-FE-DEF-Degraded-Forest Land IV to Crops-Annuals	42.1	47.9	62.1	8,131,577.8	8,144,297.2	8,175,857.7	44,279.9	0.01%
NR-DA-DEF-DEF-Planting to annual crops IV	- 921.5	959.9	2,841.4	8,125,268.8	8,144,297.2	8,163,325.7	38,056.9	0.01%
PM-FE-PLANT-Conifer Plantations I	2.0	- 3.2	- 8.6	8,125,711.8	8,144,297.2	8,163,025.6	37,313.7	0.01%
PM-FE-DEF-Primary-Forest Land I to Other Lands	118.1	107.6	97.2	8,125,974.3	8,144,297.2	8,162,633.9	36,659.6	0.01%
NR-FE-RDEG-Forest Land I Very Degraded to Degraded	- 40.0	- 28.0	- 11.5	8,129,005.2	8,144,297.2	8,165,195.6	36,190.4	0.01%
NR-FE-DEF-Degraded-Forest Lands II to agroforestry systems	16.9	51.8	71.4	8,122,089.9	8,144,297.2	8,156,748.1	34,658.2	0.01%
NR-FE-DEF-Degraded-Forest Lands III to agroforestry systems	4.9	45.3	58.5	8,118,623.1	8,144,297.2	8,152,684.7	34,061.6	0.01%
NR-FE-DEF-Grassland Planting IV	13.9	28.5	65.9	8,134,979.7	8,144,297.2	8,168,058.6	33,078.9	0.01%
PM-FE-DEF-Primary-Forest Land IV to Crops-Annuals	70.5	62.2	53.9	8,129,646.9	8,144,297.2	8,158,947.5	29,300.6	0.00%
NR-FE-DEF-Primary-Forest Land I to Grasslands	89.7	100.9	112.3	8,130,073.0	8,144,297.2	8,158,716.1	28,643.1	0.00%
NR-FE-DEF-Degraded-Forest Land II to Crops-Annuals	56.0	64.0	78.1	8,134,064.7	8,144,297.2	8,162,166.6	28,101.9	0.00%
PM-FE-DEF-Very degraded-Forest Land IV to agricultural land-African palm	41.3	33.3	25.4	8,130,285.0	8,144,297.2	8,158,309.5	28,024.5	0.00%
NR-FE-DEF-Very Degraded-Forest Land IV to Grasslands	24.6	30.7	42.2	8,134,580.1	8,144,297.2	8,162,548.8	27,968.7	0.00%
PM-FE-DEF-Primary-Forest Lands IV to Settlements	91.5	83.6	75.8	8,130,519.2	8,144,297.2	8,158,075.3	27,556.0	0.00%
NR-FE-DEF-Primary-Forest Lands IV to Agricultural Lands-African Palm	73.2	76.8	89.0	8,138,621.3	8,144,297.2	8,163,614.7	24,993.4	0.00%
PM-FE-DEF-Primary-Forest Land III to Crops-Annuals	71.4	65.0	58.5	8,132,931.4	8,144,297.2	8,155,663.0	22,731.6	0.00%
NR-FE-DEF-Primary-Forest Land III to Crops-Annuals	75.9	77.5	88.8	8,141,758.5	8,144,297.2	8,162,274.4	20,515.9	0.00%
NR-FE-DEF-Primary-Forest Land I to Agricultural Land-Other	92.1	102.9	113.5	8,133,989.7	8,144,297.2	8,154,386.4	20,396.7	0.00%
NR-FE-DEF-Primary-Forest Land II to Crops-Annuals	90.3	101.0	111.7	8,134,065.2	8,144,297.2	8,154,440.4	20,375.2	0.00%
NR-FE-DEF-Degraded-Forest Land III to Crops-Annuals	44.2	53.4	65.0	8,135,591.0	8,144,297.2	8,155,351.2	19,760.2	0.00%
NR-FE-DEF-Degraded-Forest Lands IV to Agricultural Lands-African Palm	44.8	45.6	64.0	8,143,567.0	8,144,297.2	8,161,836.8	18,269.8	0.00%
NR-FE-DEF-Degraded-Forest Lands I to Agroforestry Systems	17.8	48.8	72.8	8,134,462.1	8,144,297.2	8,151,922.9	17,460.8	0.00%
NR-FE-DEF-Primary-Forest Lands II to agroforestry systems	51.0	85.6	105.1	8,133,304.6	8,144,297.2	8,150,482.0	17,177.3	0.00%
NR-FE-DEF-Primary-Forest Lands III to agroforestry systems	33.8	67.0	84.9	8,133,762.8	8,144,297.2	8,149,981.8	16,219.1	0.00%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEF-Degraded-Forest Lands I to Grasslands	54.2	60.0	78.6	8,140,594.4	8,144,297.2	8,156,133.0	15,538.6	0.00%
NR-FE-DEF-Primary-Forest Lands IV to Other Lands	75.7	78.1	91.3	8,142,036.0	8,144,297.2	8,156,958.0	14,922.0	0.00%
NR-FE-DEF-Primary-Forest Land I to Crops-Annuals	92.1	100.8	113.5	8,138,793.3	8,144,297.2	8,152,391.1	13,597.8	0.00%
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-Other	90.3	101.0	111.7	8,137,475.9	8,144,297.2	8,151,059.3	13,583.5	0.00%
NR-FE-DEF-Primary-Forest Land I to Agricultural Land-Rubber	94.2	103.3	115.1	8,138,493.6	8,144,297.2	8,151,762.6	13,269.0	0.00%
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-Rubber	92.4	95.1	113.0	8,142,598.4	8,144,297.2	8,155,670.1	13,071.7	0.00%
NR-FE-DEF-Primary-Forest Lands I a Settlements	80.0	90.4	118.1	8,140,987.2	8,144,297.2	8,153,075.5	12,088.3	0.00%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Coffee	70.5	81.0	87.2	8,137,659.8	8,144,297.2	8,148,237.6	10,577.8	0.00%
NR-FE-DEF-DEF-Plantation to pastures II	36.6	58.1	65.9	8,137,474.8	8,144,297.2	8,146,792.3	9,317.5	0.00%
NR-FE-DEF-Planting to annual crops IV	15.9	30.6	45.2	8,139,638.5	8,144,297.2	8,148,956.0	9,317.5	0.00%
NR-FE-DEF-Plantation to coffee crops	36.6	62.2	65.9	8,136,178.7	8,144,297.2	8,145,496.2	9,317.5	0.00%
NR-FE-DEF-Very Degraded-Forest Land IV to Agricultural Land-Other	17.0	25.4	43.9	8,141,619.2	8,144,297.2	8,150,176.5	8,557.3	0.00%
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-African Palm	96.7	102.3	107.8	8,140,777.5	8,144,297.2	8,147,816.9	7,039.4	0.00%
NR-FE-DEF-Degraded-Forest Lands I to Agricultural Lands-Others	56.0	59.9	78.1	8,143,057.1	8,144,297.2	8,150,082.6	7,025.5	0.00%
NR-FE-DEF-Very Degraded-Forest Lands II to Grasslands	33.6	48.3	54.6	8,139,642.6	8,144,297.2	8,146,299.2	6,656.7	0.00%
NR-FE-DEF-Primary-Forest Land I to Other Lands	97.2	107.6	118.1	8,140,987.4	8,144,297.2	8,147,604.6	6,617.3	0.00%
NR-FE-DEF-Very degraded-Forest Lands III to agroforestry systems	7.9	18.2	28.5	8,141,019.8	8,144,297.2	8,147,574.7	6,554.9	0.00%
NR-FE-DEF-Primary-Forest Land II to Other Lands	95.4	105.7	116.0	8,141,018.1	8,144,297.2	8,147,541.6	6,523.5	0.00%
NR-FE-DEF-Very degraded-Forest Land I to Agricultural Land-Coffee	36.1	49.0	56.2	8,140,178.4	8,144,297.2	8,146,568.2	6,389.8	0.00%
NR-FE-DEF-Very Degraded-Forest Land II to Crops-Annuals	36.1	50.3	56.2	8,139,775.2	8,144,297.2	8,146,165.0	6,389.8	0.00%
NR-FE-DEF-Very Degraded-Forest Land III to Settlements	41.2	41.8	60.5	8,144,096.8	8,144,297.2	8,150,235.5	6,138.7	0.00%
NR-FE-DEF-Degraded-Forest Lands IV to Settlements	47.3	50.2	66.4	8,143,387.6	8,144,297.2	8,149,437.5	6,050.0	0.00%
NR-FE-DEF-Very degraded-Forest Lands II to Wetlands and Water Bodies	32.5	38.3	51.3	8,142,435.2	8,144,297.2	8,148,428.0	5,992.9	0.00%
NR-FE-DEF-Very degraded-Forest land I to crops-annuals	33.9	47.0	51.5	8,140,132.3	8,144,297.2	8,145,740.6	5,608.3	0.00%
NR-FE-DEF-Very Degraded-Forest Land IV to Crops-Annuals	27.1	38.8	43.9	8,140,569.9	8,144,297.2	8,145,926.0	5,356.1	0.00%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Other	70.5	78.9	87.2	8,141,629.7	8,144,297.2	8,146,918.6	5,288.9	0.00%
NR-FE-DEF-Very degraded-Forest Land IV to agricultural land-African palm	29.8	40.0	45.7	8,141,050.8	8,144,297.2	8,146,109.4	5,058.6	0.00%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Rubber	72.7	79.3	88.4	8,142,180.1	8,144,297.2	8,147,177.3	4,997.2	0.00%
NR-FE-DEG-Degraded plantations	20.5	28.2	35.9	8,141,851.2	8,144,297.2	8,146,743.2	4,892.0	0.00%
NR-FE-DEF-Primary-Forest Land III a Settlements	81.4	87.1	92.8	8,142,490.5	8,144,297.2	8,146,112.1	3,621.6	0.00%
NR-DA-DEF-Primary-Forest Lands I to Settlements	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land I to Other Lands	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land I to Grasslands	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land I A Crops-Annuals	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land I to Agricultural Land-Other	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land I to Agricultural Land-Rubber	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-DA-DEF-Primary-Forest Lands I to agroforestry systems	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Other Lands	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Grasslands	13,830.2	23,038.0	32,245.8	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Crops-Annuals	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-Other	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-Rubber	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-African Palm	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Lands II to agroforestry systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land III a Settlements	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land III to Grasslands	43,059.4	57,595.1	72,130.7	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land III to Crops-Annuals	593.3	4,799.6	9,005.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Lands III to agroforestry systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Other Lands	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Lands IV to Grasslands	41,382.6	55,675.2	69,967.8	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Crops-Annuals	2,996.9	8,639.3	14,281.6	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Coffee	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Other	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Rubber	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-African Palm	593.3	4,799.6	9,005.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Primary-Forest Lands IV to agroforestry systems	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands I to Grasslands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land I to Agricultural Land-Other	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands I to Agroforestry Systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands II to Grasslands	1,742.9	6,719.4	11,695.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land II to Annual-Crops	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands II to agroforestry systems	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land III to Grasslands	10,791.4	19,198.4	27,605.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land III to Crops-Annuals	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands III to agroforestry systems	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands IV to Settlements	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land IV to Grasslands	6,403.2	13,438.9	20,474.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Land IV to Crops-Annuals	1,742.9	6,719.4	11,695.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Degraded-Forest Lands IV to Agricultural Lands-African Palm	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very degraded-Forest land I to annual crops	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Land I to Agricultural Land-Coffee	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Lands II to Grasslands	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-DA-DEF-Very Degraded-Forest Land II to Annual-Crops	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Land III to Settlements	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very degraded-Forest Lands II to Wetlands and Water Bodies	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very degraded-Forest Lands III to agroforestry systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Land IV to Grasslands	593.3	4,799.6	9,005.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Land IV to Crops-Annuals	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very Degraded-Forest Land IV to Agricultural Land-Other	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEF-Very degraded-Forest Land IV to Agricultural Land-African Palm	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land I Primary A Degraded	15,374.9	24,957.9	34,540.8	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land I Primary A Very Degraded	4,321.8	10,559.1	16,796.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land I Degraded to Very Degraded	1,152.0	5,759.5	10,367.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land II Primary A Degraded	45,582.2	60,474.8	75,367.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land II Primary To Very Degraded	13,063.8	22,078.1	31,092.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land II Degraded to Very Degraded	2,996.9	8,639.3	14,281.6	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Lands III Primary to Degraded	28,961.9	41,276.5	53,591.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land III Primary A Very Degraded	7,116.5	14,398.8	21,681.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land III Degraded to Very Degraded	10,791.4	19,198.4	27,605.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Lands IV Primary to Degraded	69,476.0	87,352.5	105,229.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land IV Primary A Very Degraded	14,600.7	23,997.9	33,395.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Forest Land IV Degraded to Very Degraded	22,483.1	33,597.1	44,711.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-DEG-Degraded plantations	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land I Highly Degraded to Degraded	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land I Heavily Degraded to Primary	593.3	4,799.6	9,005.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land I Degraded to Primary	19,295.9	29,757.5	40,219.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Lands II Very Degraded to Degraded	7,116.5	14,398.8	21,681.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land II Heavily Degraded to Primary	1,742.9	6,719.4	11,695.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Lands II Degraded to Primary	33,068.1	46,076.1	59,084.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land III Heavily Degraded to Degraded	3,651.9	9,599.2	15,546.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land II Heavily Degraded to Primary	4,321.8	10,559.1	16,796.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land III Degraded to Primary	36,379.0	49,915.7	63,452.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land IV Heavily Degraded to Degraded	10,791.4	19,198.4	27,605.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land IV Heavily Degraded to Primary	5,004.7	11,519.0	18,033.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-RDEG-Forest Land IV Degraded to Primary	50,652.8	66,234.3	81,815.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-PLANT-Conifer Plantations I	10,791.4	19,198.4	27,605.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
NR-DA-PLANT-Plantation establishments	5,698.9	12,478.9	19,259.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land I to Other Land	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
PM-DA-DEF-Primary-Forest Land II to Grasslands	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land III to Grasslands	1,152.0	5,759.5	10,367.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land III to Crops-Annuals	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Lands III to agroforestry systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land IV to Settlements	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land IV to Other Lands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land IV to Grasslands	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Primary-Forest Land IV to Crops-Annuals	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Degraded-Forest Lands I to Grasslands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Degraded-Forest Lands II to Grasslands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Degraded-Forest Land III to Grasslands	- 378.7	2,879.8	6,138.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Degraded-Forest Lands IV to Grasslands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Degraded-Forest Lands IV to agroforestry systems	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Very Degraded-Forest Land III to Grasslands	- 740.8	1,919.8	4,580.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Very Degraded-Forest Land IV to Agricultural Land-African Palm	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEF-Plantation-Plantations to pastures	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land I Primary A Degraded	14,600.7	23,997.9	33,395.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land I Primary to Very Degraded	593.3	4,799.6	9,005.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land I Degraded to Very Degraded	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation II Primary to Degraded	20,884.5	31,677.3	42,470.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation II Primary A Very Degraded	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation II Degraded to Very Degraded	2,996.9	8,639.3	14,281.6	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation III Primary to Degraded	14,600.7	23,997.9	33,395.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation III Primary A Very Degraded	77.3	3,839.7	7,602.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation III Degraded to Very Degraded	5,004.7	11,519.0	18,033.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation IV Primary to Degraded	33,068.1	46,076.1	59,084.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation IV Primary to Very Degraded	3,651.9	9,599.2	15,546.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-DEG-Forest Land Degradation IV Degraded to Very Degraded	2,996.9	8,639.3	14,281.6	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land I Very Degraded to Degraded	1,152.0	5,759.5	10,367.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land I Heavily Degraded to Primary	3,651.9	9,599.2	15,546.5	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Lands I Degraded to Primary	14,600.7	23,997.9	33,395.2	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land II Highly Degraded to Degraded	10,791.4	19,198.4	27,605.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land II Heavily Degraded to Primary	5,698.9	12,478.9	19,259.0	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Lands II Degraded to Primary	55,753.3	71,993.8	88,234.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land III Highly Degraded to Degraded	20,088.9	30,717.4	41,345.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land II Heavily Degraded to Primary	7,116.5	14,398.8	21,681.1	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
PM-DA-RDEG-Forest Lands III Degraded to Primary	35,549.3	48,955.8	62,362.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land IV Heavily Degraded to Degraded	30,599.7	43,196.3	55,792.9	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land IV Heavily Degraded to Primary	12,301.6	21,118.2	29,934.8	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-RDEG-Forest Land IV Degraded to Primary	72,065.9	90,232.3	108,398.6	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%
PM-DA-PLANT-Conifer Plantations I	- 921.5	959.9	2,841.4	8,144,297.2	8,144,297.2	8,144,297.2	-	0.00%

To access the table and data used in the sensitivity analysis, click on the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Archivo_Sensibilidad_RE_22mayo2025_actualizado _ and the information can be found under the tab “AS_Reducciones_PM_junio”.

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6 TRANSFER OF OWNERSHIP OF EMISSION REDUCTIONS

6.1 Ability to transfer ownership of emission reductions

The Framework Law of Climate Change 7-2013, in its Article 22, stipulates that the rights, ownership, and negotiation of carbon emission reductions units or other greenhouse gases (as well as certificates) shall belong to the legal owners of the projects that generate greenhouse gas emission removals or reductions. For this purpose, these owners must register in the Registry of Greenhouse Gas Emission Reduction or Removal Projects ("the Registry") of the Ministry of Environment and Natural Resources (MARN). Furthermore, the same article establishes that the legal owners of projects may be individuals or legal entities, or the State, provided they are owners or legal possessors of the lands or property where the projects are carried out.

Subsequently, in April 2020, the Congress of the Republic of Guatemala, through the approval of Article 5 of Decree 20-2020, established that the Ministry of Public Finance (MINFIN) is the Program Entity of the Guatemala Emissions Reductions Program (ER P), and the authorized entity, on behalf of the Republic of Guatemala, to negotiate and sign the agreements or contracts for the Emissions Reduction Program, through the Emissions Reduction Payment Agreements (ERPA) with the World Bank, which acts *as* trustee of Tranche A and Tranche B of the Forest Carbon Partnership Facility (FCPF) Carbon Fund for an amount of up to 10.5 million tons of Carbon Dioxide (tCO2e) equivalent as contracted volume.

Likewise, Article 5 of Decree 20-2020 authorized MINFIN to enter sub agreements (contracts or agreements) for Emission Reduction (ER) title transfer, as applicable. The same Decree identifies as beneficiaries and ER title owners the individuals or entities that implement the REDD+ measures described in the ERP Document (ERPD), in accordance with the Benefit-Sharing Plan, in addition to land owners and possessors where the projects are carried out (pursuant to Article 22 of the Climate Change Law).

In July 2021, MINFIN sent the World Bank a Letter of ER Title Transfer, which explains the legal ER Title Transfer approach within the framework of ERP implementation. This letter has the endorsement of the entities involved in the ERP, the Office of the Attorney General of the Nation (PGN, in Spanish), and the World Bank[31]. The letter was reviewed by the PGN on two occasions, in 2021 and 2022, to ensure that there are no encumbrances in the ER Title transfer process. The letter was approved by the trustee on February 28, 2023.

According to the ER Title Transfer Letter, MINFIN has the capacity to transfer the ERs, on behalf of the State of Guatemala, generated by the ERP during the 2020-2024 period to FCPF and contracted through the ERPAs. It also established that the Program Entity and the Program Executing Unit will ensure the transfer of ownership of the ERs through agreements or contracts with REDD+ initiatives representatives. Furthermore, the letter specifies that is based on the specific characteristics of the ERP, which enables the following REDD+ Initiatives: a) Early and new REDD+ Projects, b) Management Models of the Guatemalan System of Protected Areas (SIGAP in Spanish), and c) Compensation Mechanisms for Ecosystem and Environmental Services associated with Forests (MCSEABs, in Spanish), respecting the legal regime and land tenure of the Republic of Guatemala.

Consequently, MINFIN, acting on behalf of the State of Guatemala, demonstrated its capacity to transfer ER Titles based on: (1) reference to existing legal and regulatory frameworks; (2) reference to the inter-institutional agreement for the implementation of the ERP; (3) reference to the sub-agreements templates (agreements or contracts to be signed with the administrative holders of REDD+ Initiatives, including those with legal and customary rights, as identified through the evaluation conducted in accordance with Criterion 28 of the Methodological Framework; (4) reference to the registration of REDD+ Initiatives in the Registry, and to the benefit-sharing arrangements under the Benefit-Sharing Plan (BSP).

6.1.1 Reference to existing legal and regulatory frameworks

Article 5 of Decree 20-2020: issued by the Congress of the Republic on April 15, 2020:

[31] Transfer of ownership letter: https://drive.google.com/file/d/1AS_3Rv0AbvY_y1my7sgrGXA9OYIt-N65/view?usp=drive_link

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a) Authorizes MINFIN as the Program Entity and INAB as the Program Implementing Unit (PIU) to coordinate actions, among others, with MARN, the Ministry of Agriculture, Agriculture, and Livestock (MAGA, in Spanish) and the National Protected Area Council, (CONAP, in Spanish).
b) Authorizes MINFIN to approve negotiations and sign the ERPAs with the World Bank as trustee of Tranche A and Tranche B of the FCPF Carbon Fund. This authorization extends to signing the corresponding ER Title transfer agreements.
c) Describes the eligible beneficiaries under the BSP as follows:
    - It states in its third paragraph, "For the purpose of the ERP, both land owners or possessors, in line with Article 22 of the Climate Change Framework Law, as well as individuals or entities that implement the REDD+ measures described in the ERPD, are considered beneficiaries and ER Title owners. Therefore, these individuals and entities will be considered beneficiaries according to the BSP or its regulations, as applicable, which may include municipalities".
d) Authorizes the opening of an account at the Bank of Guatemala for the management of ERP resources in accordance with applicable regulations.
e) Indicates that MINFIN, through its Financial Directorate, will make payment to the ERP beneficiaries.
f) Authorizes amendments as necessary. "Given the dynamic nature of the ERP, updates may be required, for which MINFIN is authorized to sign the corresponding amended sub-agreements (contracts or agreements), including notifying the incorporation of other projects into the program through amendment letters signed by the Parties."
g) Authorizes the use of the World Bank's ER Registry: "For the corresponding registration, the platform enabled by the World Bank for this purpose may be used, at the request of the Ministry of Public Finance."

Additionally, Article 35 (r) of Decree 114-97 of the Congress of the Republic of Guatemala, Law of the Executive Branch, stipulates that the MINFIN has the powers, among others, *"…to administer the establishment, in any of the institutions of the national banking system, of trusts, funds and other financial instruments and the execution of Central Government programs, as well as to regulate, register and control their operation…".*

Therefore, Article 22 of the Framework Law on Climate Change establishes the principle of legal ownership of the ERs generated from REDD+ activities and projects to the owners or titleholders of the projects, who may be individuals or legal entities, or the State as legitimate land owners or possessors on which the projects are carried out. Ownership of ERs is established either through land rights or by being project implementer. In both cases, it is a requirement that the holders register their project in the MARN Registry. Therefore, to make the transfer of ownership effective, the projects must be previously registered. For the purposes of the ERP, REDD+ Initiatives must be registered in said Registry.

The Program Entity and the PIU will ensure the ER title transfer under the ERP to MINFIN through agreements or contracts (in accordance with Decree 20-2020) with the REDD+ Initiatives representatives, documents that contain a ER title transfer clause.

6.1.2 Reference to the inter-institutional agreement for ERP implementation

To facilitate this process, in February 2023, MINFIN and INAB signed a subsidiary agreement for inter-institutional cooperation and coordination for the implementation of the ERP, under the ERPA framework [32]. This agreement specifies INAB's role in ERP implementation on behalf of MINFIN as the Program Entity, in compliance with the conditions of effectiveness established in Annex I of the ERPAs.

Among the responsibilities assigned to INAB regarding ER title transfer are the following:

a) Oversee implementation of Contracts for the Participation, Compliance, and ER title transfer entered between the REDD+ Initiative Projects (RIP) and INAB within the ERP framework;
b) Issue ER certificates generated by RIPs in accordance with the BSP and Program Operational Manual (POM);
c) Transfer the ER titles generated under the ERPAs to the World Bank as the trustee of the FCPF Carbon Fund.

[32] Subsidiary agreement between MINFIN and INAB: https://drive.google.com/file/d/16jDejdvNdiYCRZQK67ota_66ZICrBWfU/view?usp=drive_link

6.1.3 Reference to sub-agreements signed by the RIP administrative title holders

As indicated in Article 5 of Decree 20-2020, MINFIN is authorized to sign subagreements (agreements or contracts) to transfer ER Titles, as applicable. MINFIN, as the Program Entity, on behalf of the State of Guatemala, will sign subagreements (agreements or contracts) with REDD+ projects and an inter-institutional agreement so that, through INAB as the PIU, subagreements (agreements or contracts) are signed with RIP representatives to formalize the transfer of all rights and titles over the ERs contracted under the ERPAs. Additionally, projects are required to be registered in the Registry, pursuant to Article 22 of the Climate Change Law, as also explained in the ER Title Transfer Letter.

Likewise, the BSP requires that, to be eligible for benefits and before distributing benefits from the ERPA, sub-agreements (contracts or agreements) must be signed with the RIP administrative title holders. These contracts or agreements must include clauses for the ER title transfer from the RIPs to the State of Guatemala.

In this regard, in November 2023, INAB launched a call for RIPs, which can be of three types: (i) REDD+ Projects, existing and new; (ii) MCSEABs, to be implemented outside protected areas; and SIGAP Models.

As a result of the call for proposals, which was in effect from November 2023 to June 2024, a total of 1,227 projects proposals were received by the 35 INAB subregional offices, of which 3 correspond to REDD+ Projects, 1,205 to MCSEABs, and 19 to SIGAP Models.

To date, INAB's subregional offices have reviewed 100% of the proposals received, determining through technical and legal analysis the feasibility of implementing their respective Forest Management Plans and its annexes for the admission of the files, as well as compliance for the first reporting period (2020) with RIP admission procedures established in the POM.

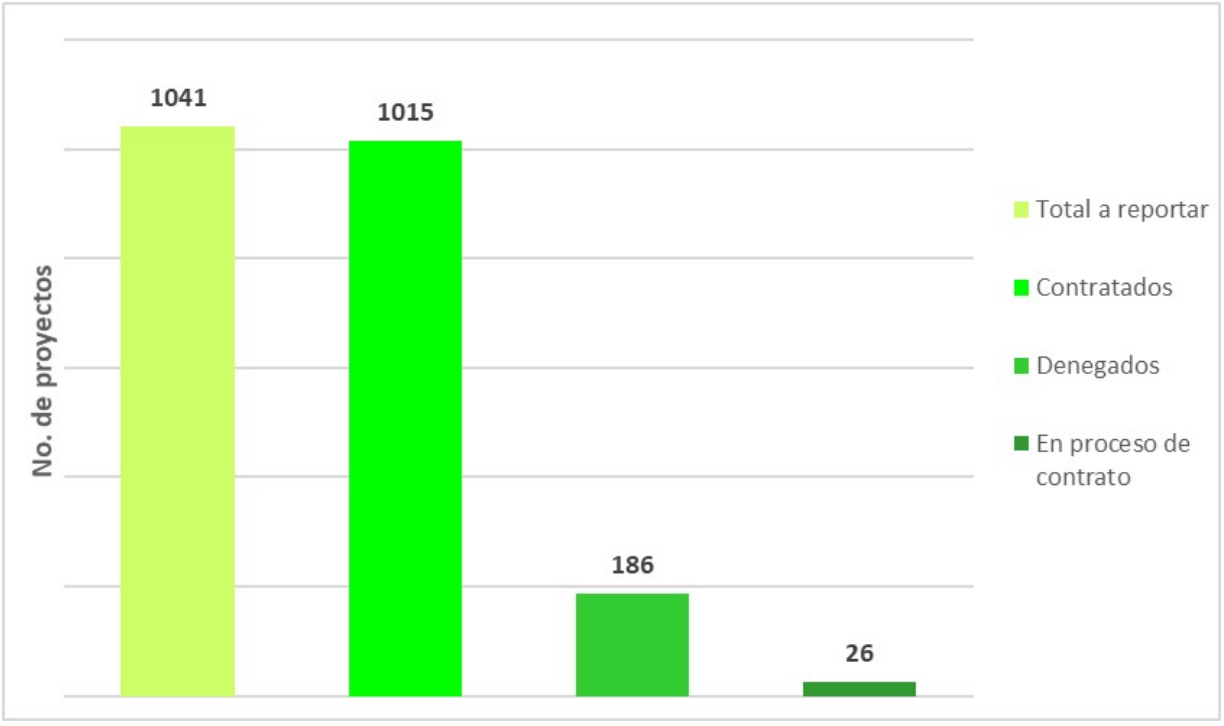

Figure 5. Results of the management of REDD+ initiative project files received under the Emissions Reduction Program.

As of September 2025, the records show: (i) 1,041 files were admitted; (ii) 26 are in the process of contract signing; (iii) 186 were denied, and (iv) 1,015 have signed a Unilateral Contract for Participation, Compliance and ER Title Transfer with INAB (See Figure 5).

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The criteria for projects prioritization and payment methodology (Annex 25 of the POM) were applied to select the 1,041 files admitted and considered to estimate the ER Title Transfer percentage. The 1,041 admitted RIPs supports 100% of the verified ERs generated by the ERP and to be transferred to the Carbon Fund.

Out of the 1,041 projects that were admitted, 1,015 projects have signed a Unilateral Contract for Participation, Compliance and ER Title Transfer with INAB. The ER Titles of these 1015 will be transferred to the Carbon Fund and included in the payment list for the first ERPA reporting period. The remaining 26 projects, which are still in the process of contract signing will be considered for the second reporting report.

It is important to highlight that, during the admission phase, certain RIPs, such as the REDD+ projects (Guatecarbon, Lacandón Bosques para la Vida, and Local Networks for Development), experienced changes in the areas they originally submitted to the ERP. Only the newly defined areas were considered for the allocation of ER quotas (according to the Nesting Protocol) and corresponding benefit sharing. For some areas that were excluded of the Guatecarbon Project, the ERs will not be transferred to the Carbon Fund because there is no capacity to transfer the associated ER titles (See Section 6.4).

6.1.4 Reference to the benefit-sharing arrangements under the Benefit-Sharing Plan

The BSP establishes a fair benefit-sharing mechanism to ensure that the benefits resulting from the sale of ERs to the Carbon Fund are effectively distributed by the State of Guatemala. The BSP requires that all ERs generated by RIPs under the ERP be registered in the MARN Registry. After registration and verification, the corresponding records in the World Bank Carbon Assets Tracking System (CATS) will be updated to avoid discrepancies between the two registries regarding ERs generated under the ERP.

The legal approach outlined in the ER Title Transfer Letter sent in July 2021 to the World Bank and the Letter of Understanding for Interinstitutional Cooperation signed between MARN and INAB [33] establishes, in its third clause, that INAB will provide the MARN Climate Change Directorate both the physical list and the respective digital files of the certified RIPs. MARN, in turn, commits to receiving these documents to fulfill its role as administrator of the Registry platform. However, a sequencing issue was identified in the ER title transfer process: the MARN Registry requires a certificate based on tons of CO2e according to the Third-Party Verification Report to be able register RIPs. Yet, the transfer of ER titles must occur before the Verification Report can be finalized, creating a procedural challenge.

As a result, in July 2025, the MARN sent the Official Letter No. MI-2200-2025/APOT- hmhv to the World Bank[34]. This letter confirmed that INAB and MARN coordinated a pre-registration procedure for RIP in the Registry to ensure compliance with the commitments established in the Letter of Understanding for Inter-Institutional Cooperation between the INAB and MARN, within the ERP framework. The procedure is as follows:

1. INAB will submit to MARN a Management Resolution that includes a certified list of RIPs which have received a compliance resolution for their management plans for the 2020 reporting period and meet the BSP eligibility criteria, prior to carrying out the corresponding ER Title Transfer within the ERP framework.

2. Once MARN receives this certified list, it will issue a letter confirming receipt and providing details on all RIPs. Both the certified list and the confirmation letter will be shared with the World Bank to verify the number of RIPs and their areas.

3. After the ERMR for the first reporting period (2020) has been verified and validated, and the carbon certificates issued by INAB are available, both INAB and MARN will comply with the internal processes and procedures as established in:
   a) The BSP, the POM, and

[33] Letter of Understanding: https://drive.google.com/file/d/167QWNtYmcPBMPyupGpjXblih33daWVaP/view?usp=drive_link

[34] Letter of pre-registration procedure for REDD+ Initiative Projects: https://drive.google.com/file/d/1B5eyeTjyJBFHFEZwRRcFl5HTiGrSnLP1/view?usp=drive_link

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b) The Administrative Manual of Procedures for the Registration of Greenhouse Gas (GHG) Emission Removal or Reduction Projects, exclusively for the ERP.

For MARN, this means initiating internal procedures to issue proof of registration in the ERP Registry to each of the beneficiaries for whom the ER Title Transfer was approved.

The document confirms that this procedure fully comply with both the provisions of the referenced Letter of Understanding and Article 22 of Decree 7-2013 of the Congress of the Republic of Guatemala, *the Climate Change Framework Law.*

In summary, MARN will pre-register the RIPs in the Registry using the list of holders provided by INAB. This step is required to complete this section of the ERMR. After the World Bank approval, the independent auditor will finalize the Verification Report. The Registry will be completed once INAB issues a certificate to each RIP for their contribution to the ERs generated by the ERP, which is necessary for MINFIN to make payments to the beneficiaries.

On July 18, 2025, the World Bank confirmed by email that the proposed procedure is acceptable for ER Title Transfer once Program Entity has assured its legal validity.

6.1.5 Percentage of emission reductions to be transferred to the Carbon Fund

Considering the above, the percentage of ERs that the country can transfer to the Carbon Fund for the first reporting period (2020) will be determined with reference to RIPs that satisfy the following criteria:

1. Having signed a Unilateral Contract for Participation, Compliance and ER Title Transfer for RIPs under the ERP
2. Have a resolution confirming compliance with the management plans for the first ERPA reporting period (2020) and that they meet the BSP eligibility criteria.

Table 37 shows the number of projects with a signed unilateral contracts and RIPs in the process of contract delivery for ER Title transfer within the ERP framework.

Table 37. Types of landowners/possessors and number of files with unilateral contracts for the ER title transfer under the ERP.

Type of Organization	Area (ha)	Area (%)	File (Count)
Association	3,810.30	0.56%	21
Cooperative	1,496.13	0.22%	5
Company	404.32	0.06%	2
Individual	44,879.31	6.54%	259
Municipality	19,272.30	2.81%	50
Environmental NGO	470,288.98	68.56%	10
Artificial person	142.63	0.02%	1
Grouped Project	72,493.97	10.57%	441
Civil Society	99.02	0.01%	1
Commercial Company	73,091.26	10.66%	225
Total	685,978.26	100.00%	1,015

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Table 38. Types of landowners and number of files with contracts and in the process of being awarded contracts for the transfer of emission reduction titles under the PRE.

Sector titular	No. De expedientes	Área (ha)	Porcentaje de Área
ASOCIACIÓN	22	3,899.48	0.56%
COOPERATIVA	5	1,496.13	0.22%
EMPRESA	2	404.32	0.06%
INDIVIDUAL	267	46,208.78	6.67%
MUNICIPALIDAD	51	20,324.86	2.94%
ONG AMBIENTAL	10	470,289.00	67.93%
PERSONA JURÍDICA	1	142.63	0.02%
PROYECTO AGRUPADO	454	75,041.14	10.84%
SOCIEDAD CIVIL	1	99.02	0.01%
SOCIEDAD MERCANTIL	228	74,380.85	10.74%
Total general	**1041**	**692,286.20**	**100.00%**

Based on the contracts signed during this reporting period, the country can demonstrate the capacity to transfer title to 91.45% of the verified ERs, corresponding to the 1,015 projects that meet the requirements, as explained above (relative to the total of 1,041 projects, corresponding to 100% of the ERs).

6.2 Implementation and operation of Program and Projects Data Management System

The Program uses its own data management system Guatemala's Framework Law on Climate Change mandates MARN to create a National Climate Change Information System through Article 9. Consequently, The SNICC has been created. Additionally, in response to the needs of the RE Program, a national centralized mitigation module has been developed, which include a list of all the records and monitoring of REDD+ initiative projects to be implemented in Guatemala within the RE Program (Including REDD+ Projects -Early and new-; Management Models for the Conservation and Sustainable Use of Forests in the SIGAP and Compensation Mechanisms for Ecosystem and Environmental Services Associated with Forests -MCSEABs-). This as well as the transparency mechanisms before the UNFCCC and the monitoring of the implemented measures. To consult the REDD+ project registry module and monitoring system, please click on the following LINK:

https://snicc.marn.gob.gt/Busqueda/Resultado?powerbi=https://app.powerbi.com/view?r=eyJrIjoiMmE4NjBlMDYtMmY5OS00YmMzLTljYmUtNzY4YzBjNTZlMDNlIiwidCI6IjhmYmFhNWJmLTJlY2MtNGRjOC1iNTZiLThmOTJlMzA3ZjA3NiIsImMiOjR9

The management of the information of the REDD+ Initiative Projects will be conducted through the processes and procedures established in the Operational Manual of the Benefit Distribution Plan, which in turn contains the necessary administrative processes within the RE Program. This will take place in the corresponding Regional, Subregional and central offices of the INAB.

As this is the first ERMR of the national RE Program, no benefits or ER title transfers have been generated yet, therefore an audit by a third party in accordance with the FC has not been necessary. However, the country has developed, through its MOP Benefit Sharing Plan, the scheme and procedures to transfer emission reductions from future beneficiaries.

6.3 Implementation and operation of ER transaction registry

Under the Emissions Reduction Program, the Ministry of Public Finance, acting as the entity of the Emissions Reduction Program and the Executing Unit, the National Institute of Forests (INAB), decided to use the World Bank's Carbon Asset

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Tracking System (CATS[35]) as the official registry to carry out emissions reduction transactions. This system will start operating after the approval of Guatemala's first ER monitoring report.

Furthermore, Article 22 of Decree 7-2013 of the Congress of the Republic of Guatemala establishes that "the Ministry of Environment and Natural Resources, taking into account the proposals of the National Climate Change Council created by this law, shall issue the necessary regulations for the creation and operation of the Registry of Projects for the Removal or Reduction of Greenhouse Gas Emissions, for the procedures of disclosure, promotion, registration, validation, monitoring, and verification of projects."

To avoid double accounting in the Emissions Reduction Program, holders of REDD+ projects (Early and New), the MCSEAB, and the Management Models for the conservation and sustainable use of forests in the SIGAP will be obliged by the BSP Operational Manual to register the certificates issued by INAB in the Registry of Projects for the Removal or Reduction of Greenhouse Gas Emissions, after the validation and verification process of the monitoring reports.

In addition to the above, the REDD+ Lacandon, Forests for Life, and Guatecarbon projects, in accordance with the Guatemalan nesting protocol: All REDD+ initiatives currently registered under VERRA-VCS or future initiatives that potentially wish to register under various standards must be registered in the National Registry of REDD+ Initiatives of Guatemala. This is required by Article 22 of Decree No. 7-2013 as a commitment in the ER ownership transfer agreements.

6.4 ERs transferred to other entities or other schemes

During the review process of the areas participating in the ERP, a particular situation was identified regarding the project initially included in the Guatecarbon Project, in which the Industrial Forestry Concession La Gloria, proposed by Baren Comercial, was part of the same territorial block under the early REDD+ project.

Subsequently, Baren Comercial decided to withdraw from the Guatecarbon REDD+ Project and submitted a SIGAP Management Model RIP to the ERP. This RIP covers 21.54% (13,700.59 ha) of the La Gloria area originally under Guatecarbon. As a result of the admission and evaluation processes for Baren Comercial's SIGAP Model carried out by the PIU, an area of 13,700.59 ha was recognized, admitted, and registered within the scope of the PRE Program.

Baren Comercial, for its part, claimed the REs corresponding to the remaining 49,890.51 hectares (not included in the ERP), with the objective of participating in the voluntary carbon market, thus deciding not to participate in the current ERP legal framework.

In compliance with the provisions established in the ERPAs and in accordance with the principles of integrity, exclusivity and non-double accounting of the REs, the PIU proceeded to estimate and discount 48,865 gross REs generated in the areas in question (49,890.51 ha). Therefore, the PIU will only recognize, verify, and transfer to the Trustee the ERs corresponding to the surface area of 13,700.59 hectares of La Gloria, officially admitted within the ERP as SIGAP Management Model.

This measure aims to preserve transparency, traceability and legal certainty in ER Title Transfer, avoiding any risk of duplication, ER ownership conflict or overlap with credits generated in the voluntary market, and ensuring compliance with the commitments assumed by the Program Entity with the Trustee within the framework of the ERPAs.

[35] https://cats.worldbank.org/?tab=AboutCats

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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)

This section is not applicable because this is the first reporting period as such there are no reversal.

7.2 Quantification of Reversals during the Reporting Period

This section has no information since no reversals have been reported for this first reporting, so it is not applicable to fill out the table.

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**	*from previous ER Monitoring Reports*		–

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	accumulated since the Crediting Period Start Date)		
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

This section has no information since no reversals have been reported for this first reporting, so it is not applicable to fill out the table.

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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*	

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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]**		
Complete either a), b) or c) below, depending on the situation, to estimate the amount of the replenishment:			
M.	**a) If L < 0.5, Pooled Buffer replenishments equal (B+C) *D-E, noting that the replenishment should not be larger than the value of J-K**		
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

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Default Risk	*N/P*	**10 %**	*N/P*	*10 %*
A. Lack of extensive and updates support from the parties involved	*On October 12, 2021, the GoG officially launches the ER Program for the general knowledge of the population, causing interest in participating in said program, which in turn generates interest in both the public and private sectors to participate.* *Guatemala currently has more than 15 years of experience in the distribution of economic benefits through forestry incentive programs (PINFOR, PINPEP Law and PROBOSQUE Law). To date, the incentives granted amount to some USD 400 million directly to more than 525,000 users, and whose mechanism highlights the transparency of the process:* 30) *INAB certifies compliance with forest management plans by users (beneficiaries),* *ii) The Ministry of Public Finance reviews and approves the files sent by INAB, and issues bank deposits directly to users and makes the payment of administrative expenses to INAB, and* *iii) The Comptroller General of Accounts, as an external entity, performs external audits of INAB to guarantee the transparency of the processes. In the specific case of the Lacandón Project, it has a governance committee and they have duly established that the GoG can sign agreements with Fundación Defensores de la Naturaleza (FDN, for its acronym in Spanish) for the transfer of ER's to the MINFIN and to the benefit distribution system, in a legal order in which all those involved have approved it and are informed.* *In the case of the beneficiary cooperatives of the* ***Lacandón – Forests for Life REDD+ Project****, they have agreed jointly with Fundación Defensores de la Naturaleza on the modality and rule for assigning the benefits of payment for project results. Beneficiary cooperatives will receive the equivalent of 55% of the benefits of payment for project results, of which 47% will be for incentives, 4% through the support received through the agriculture program and 4% in daily wages through the support received through forest protection. Likewise, cooperatives will carry out agricultural support activities for their members to promote conservation agricultural practices and increased productivity, which are considered non-monetary benefits.* *In the case of the forestry concessions represented by ACOFOP for the* ***GUATECARBON Project*** *in which they participate together with CONAP, they have an agreement in which CONAP recognizes as co-proponent and CONAP by the national legal system has the representation of the project.* *In the case of the* ***Local Networks for Development (REDDES) Project*** *coordinated by CALMECAC, the benefit*	**10%**	*The risk is considered a medium risk and has a discount of 5%, as presented in the ERP.*	*5%*

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	distribution mechanism is under development as part of the project in general. *Complaint mechanisms at the level of REDD+ projects and ER Program: The Mechanism for Information and Attention to Complaints (MIAQ, for its acronym in Spanish). In the development of the REDD+ Mechanism in its Preparedness phase, a REDD+ MIAQ was prepared, which will be strengthened after the signing of the ERPA. Its design ensures agility, access, quick response times and respect for confidentiality. This MIAQ, which will also be in charge of Gender-based Violence complaints (including special management procedures) and labor complaints, will be coordinated by INAB in association with MARN, and will be accessible -personally, anonymously or directly through a telephone line without cost, through the regional and departmental offices of INAB, MAGA, MARN and CONAP. Complaints, questions, or reports are expected to be resolved within 30 business days of receipt.* *Although Guatemala has successful experiences in forest governance, benefit distribution and extensive REDD+ stakeholder involvement, it has been considered a "medium" risk due to discussions and decision-making to change the focus of the ER Program to sub-national level, given that: i) In the framework of the preparedness meetings, FUNDAECO has expressed its intention not to participate in the ER Program with the Carbon Fund of the FCPF, due to commitments acquired prior to the signing of the Letter of Intent; and, ii) The social conflict linked to evictions that occurred in the Laguna del Tigre National Park and the Candelaria Zone, which is important to highlight that they occurred outside the national REDD+ process.* *All REDD+ initiatives in any of their modalities must be entered into the national registry as established in Article 22 of the Framework Law on Climate Change for procedures for disclosure, promotion, registration, validation, monitoring and verification of projects.*			
B. Lack of institutional capacity or ineffective vertical/cross-sectoral coordination	*Guatemala has more than 15 years of experience in inter-institutional coordination for the forestry sector, which is made up of two main institutional governance platforms that have allowed coordination between institutions and sectors (public, private, municipalities, academia, NGOs, etc.) for the design and implementation of public policies for the sector. These are: i) The INAB Board of Directors made up of representatives from the public sector (MAGA and the Ministry of Public Finance), private sector (Chamber of Industry and Forestry Association), local governments (ANAM), NGOs and academia (National Central School of Agriculture and Universities that teach forestry and related studies within related professions); and, ii) The National Council for Protected Areas (CONAP) with*	**10 %**	*No change has occurred so far, it's low and a 10% discount applies, as stated in the ERPD.*	*0%*

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	representation from the central government (MARN, MAGA, MCD/INAH INGUAT), local governments (National Association of Municipalities –ANAM-) and NGOs. Both INAB and CONAP have regional offices (9 and 10, respectively) to fulfill their mandate in accordance with the administrative structure of the State and in coordination with their different partners. *Through this instance, the implementers have representation from the national level, in which it is considered for the Board of Directors of INAB, with a chair within the Board that belongs to the ASOREMA (National Association of Non-Governmental Organizations of Natural Resources and Environment), of which the implementers are part and they have also occupied the chair of this organization within the Board of Directors. Likewise, within the National Council for Protected Areas (CONAP), the environmental NGOs registered in the CONAP have a position that is elected in an assembly, in which the latter have also had the representation of the implementers of REDD+ projects.* *At the local level, in the case of the Sierra de las Minas Biosphere Reserve, which is a protected area that includes the territory of 14 Guatemalan municipalities, distributed in 5 departments, whose Secretary of the Board is held by Fundación Defensores de la Naturaleza, and is chaired by CONAP, the same happens in the Sierra del Lacandón National Park. In the case of Petén, in addition to the MBR Committee, there is a Committee for Laguna del Tigre, the latter established in a specific Law with the participation of both committees of implementers such as ACOFOP and Fundación Defensores de la Naturaleza. This is how, in this way, participation according to national and local governance play a role as articulators of work to improve coordination processes.* *It is important to mention that these instances have coordinated actions for the conservation of the natural forest, establishment of forest plantations and land, under productive forest management, which represents a better protection of water and soil, benefiting more than 3.9 million people, while the rural economy has improved.* *Similarly, the GCI, established since 2012 (MARN, MAGA, INAB and CONAP), has been the inter-institutional platform that has facilitated coordination linked to REDD+ and which is based on an inter-institutional agreement signed in May 2015. This agreement allows articulate efforts of institutions that, in turn, in Article 20 of the Framework Law on Climate Change, mandates these institutions to adjust and design policies, strategies, programs, plans and projects for the reduction of emissions in the forestry sector and climate change of land use.*			

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	This platform has allowed the articulation of institutions, from the GCI and external ones, for the implementation of projects such as the ER-PIN and project proposals before the NAMA Facility. *Additionally, there are multisectoral platforms for coordinating actions such as: a) The Workgroup for the Prevention and Reduction of Illegal Logging; b) the Firewood Workgroup in which the Strategy for Sustainable Production and Efficient Use of Firewood is coordinated; and, c) the Restoration Workgroup, in which the National Forest Landscape Restoration Strategy is coordinated.* *The participation of the Ministry of Public Finance leading the ER Program has been strategic both at the level of inter-institutional and sectoral coordination, as well as for the alignment of the program with the country's public policy priorities.*			
C. Long-term ineffectiveness in managing underlying drivers	*The Law of Protected Areas and its regulations create the SIGAP that houses 340 protected areas that cover just over 32% of the national territory. It establishes, among others, the conservation, rational management and restoration of wild flora and fauna, related resources and their natural and cultural interactions, as well as guidelines for preparing Management Plans that articulate Annual Operational Plans and sub-zoning. Likewise, CONAP has, through Decree 5-90 for the creation and setting of limits of the Mayan Reserve in Petén, which establishes a Coordinating Committee of the Mayan Reserve constituted by CONAP, other government agencies that co-manage and participation of civil society, for surveillance and also strategies that, up to today, have allowed to analyze in this governance scheme, the strategies that have allowed implementing actions based on the best possible management of Forest Concessions, early warning systems against forest fires in communities within the Reserve, as well as joint patrols to identify threats to the integrity of Natural Resources. The GoG, through the CONAP Secretariat, has begun coordination to extend the term of forest concessions in the north of the country. This minimizes the pressure on the tropical forest.* *The Forestry Law contemplates policy tools to seek harmonization between the management and protection of the forest and the economic activities linked to the drivers, for example, livestock, basic grains and other crops such as coffee, among others. Under this framework, the Forestry Incentives Program (PINFOR, for its acronym in Spanish) was created, which ended in 2016, the PINPEP Law, which is the Forestry Incentives Program for owners of small extensions of land for forestry or agroforestry (aimed at people who own plots of land with an extension smaller than 15 ha by paying them to plant trees or manage natural forests), and in*	**5 %**	*No change has occurred so far, it is medium and a 2% discount is applied*	*3%*

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	2017 the PROBOSQUE Law that gives continuity to the PINFOR Incentive Program and also expands the type of beneficiaries, ensuring the granting of forestry incentives for another 30 years and, with it, contributing to the management and conservation of forest resources with the participation of municipalities, indigenous communities, associations, the private sector, among others. *Through PINFOR, during the period from 1998 to 2016, the State of Guatemala spent GTQ 1,942,907,687 (USD 255 million) for forestry incentives, for a total of 10,418 projects, equivalent to 383,568 hectares of reforestation (36%) and forest management of natural forests (64%), whose beneficiaries are divided into nine groups called "Types of Owners." These are: i) Associations; ii) Committees; iii) Communities; iv) Cooperatives; v) Companies; vi) Foundations; vii) Individuals; viii) Municipalities; and, ix) Government Organizations. This, in addition to revitalizing the local economy, has contributed economically in vulnerable areas of Guatemala, which leads to a reduction in the pressure exerted on the forests and their value enhancement.* *With the PINPEP Law, during the period from 2007 to 2016, the State of Guatemala derogated Q 634,804,592.45 (about USD 85.5 million) for forestry incentives, for a total of 25,745 projects, equivalent to 91,641.54 hectares of reforestation (15%) and management of natural forests (85%), whose beneficiaries are divided into nine groups called "Types of Owners." These are: i) Associations; ii) Committees; iii) Communities; iv) Cooperatives; v) Companies; vi) Foundations; vii) Individuals; viii) Municipalities; and, ix) Government Organizations.* *With the PROBOSQUE Law, it is expected that during 2017-2046 the establishment, recovery and management of:* *• Establishment of 200,000 ha of forest plantations for industrial purposes.* *• Establishment and maintenance of 100,000 ha of forest plantations for energy purposes.* *• Establishment and maintenance of 300,000 ha of agroforestry systems.* *• Management of 125,000 ha of natural forest for production purposes.* *• 375,000 ha of natural forest for the purpose of protection and provision of environmental services.* *• Restoration of 200,000 ha of degraded forest land.* *• Despite these achievements, all the underlying factors of deforestation and forest degradation have not yet been addressed, since these forestry incentive programs, inside and outside protected areas, have a maximum duration of up to 10 years, but after this period there is no incentive for users to avoid changing the use of the*			

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	forest. However, this is sought to be addressed through the Forest Investment Program (FIP), which is part of the ER Program.			
D. Exposure and vulnerability to natural disturbances	*In the case of effective prevention of natural disturbances or mitigation of their impacts, The Emissions Reduction Program addresses exposure to natural disturbances through CONRED. At the national level, Guatemala has a comprehensive legal framework related to disaster mitigation and reduction (disturbances), supported by the 'Law 109-96 National Coordinator for Disaster Reduction.' This law includes regulations and functions aimed at preventing, mitigating, responding to, and participating in the rehabilitation and reconstruction of damages resulting from the effects of disasters in the Republic of Guatemala. It considers broad integration of public and private sector agencies and institutions. Importantly, this law does not establish a completion deadline and has been in place since its inception, providing tools to enhance processes and better address vulnerability to natural disturbances. At the same time, Guatemala has a National Response Plan, a National Protocol for the Comprehensive Management of Disaster Risk due to Extended Dry Spell for the Republic of Guatemala, and the National Protocol for the Season of temperature Decrease in the Republic of Guatemala 2018-2019. The country has not shown sufficient capacity for the effective prevention and mitigation of impacts associated with natural phenomena. This is reflected in the economic losses that the country has suffered in strategic sectors due to floods and droughts associated with climate change. According to ECLAC (2012), in the last 3 decades, the economic impacts associated with hydrometeorological phenomena amount to almost USD 3,500 million, impacting mainly on the agriculture and infrastructure sectors. If ambitious and immediate goals are not established and achieved, ECLAC (2018) estimates that the economic cost by 2030 would be equivalent to 5.8% of the GDP (annual average).* *Hurricanes Eta and Iota arrived in Guatemala as tropical depressions, and the rains, floods and landslides associated with these events had a significant impact on the population, especially in the most vulnerable communities in Guatemala. The majority of affected people reside in rural areas, self-identify as belonging to indigenous peoples, and live-in levels of poverty due to their update and multidimensional poverty below the national average. In economic terms, it is estimated that the total effects of these tropical depressions were equivalent to approximately 6,002 million quetzales. Damages accounted for 52% of the impact; losses, to 31%; and, additional costs, 17%. The economic impact of*	**5 %**	*No change in risk, as stated in the ERPD.*	*5%*

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	these events is estimated at 0.1 percentage points of the GDP. These disasters also occurred in the context of COVID-19. All of this, together, has serious consequences in the short and medium term. Disasters are an opportunity to rethink the development of countries and this assessment is a contribution in that direction, with a development approach focused on resilience and inclusion, which, in a context of increasing risk of disasters caused by climate change, will allow Guatemala to get closer to the achievement of the Sustainable Development Goals. (ECLAC, 2021) *Although the GoG has a legal framework for protection against forest fires, the country does not have sufficient capacity for their effective prevention and mitigation. The following are included within the Legal Framework:* *• Constitution of the Republic (Articles 64, 97, 119 and 126), the Law of the Executive Branch (Decree 114-97, Articles 29, 29bis, 37 and 47);* *• Framework Law on Climate Change (Articles 1, 2, 3, 4, 5, 6, 7, 9, 13, 14, 15 and 23);* *• Constitutive Law of the Guatemalan Army (Decree 72-90, Article 4);* *• Municipal Code (Decree 12-2002, Articles 33, 35, 58, 67, 68 and 96);* *• Forest Law (Decree 101-96, Articles 1, 4, 6, 8, 36, 37, 38 and 93);* *• PROBOSQUE Law (Decree 2-2015);* *• PINPEP Law (Decree 51-2010);* *• Law of Protected Areas (Decree 4-89, Articles 1 and 4);* *• Law of the National Coordination Office for Reduction of Natural or Caused Disasters (Decree 109-96, Articles 1, 3, 4, 6, 9, 10 and 21);* *• Government Agreement 156-2017 (Decree 101-96, Articles 1, 4, 6, 8, 36, 37, 38 and 93);* *• Forestry Law Regulations, Board of Directors Resolution 01.43.2005 (Articles 33, 37, 38, 39, 52 and 88).* *Likewise, the National Protocol for the Forest Fire Season 2018-2019 of the National Coordination Office for Disaster Reduction (CONRED, for its acronym in Spanish) was approved, which establishes guidelines for the prevention, preparedness and control against forest fires, as part of the tools of public policy and which is applicable to all centralized and decentralized government institutions. In addition, in its preparedness section, it establishes strategies and tactics regarding the fire season.* *According to the historical recurrence of hot spots 2003-2017, forest fires in the MBR are probably the greatest threat to the integrity of this area, whose highest peaks have coincided with prolonged droughts. Regarding natural disturbances, Guatemala presents high*			

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	vulnerability to climatic phenomena (storms, droughts), going from a moderate level of climatic vulnerability in the year 2010 to a high level, for the year 2030. It is estimated that 59% of the events recorded in the period 1900-2015, were climatic events (storms and hurricanes, landslides, floods, droughts and extreme temperatures), causing monetary losses of up to USD 4,421 million. *In the area of forest concessions, there are positive experiences that demonstrate the effectiveness in controlling forest fires (this is regulated in each of the Concession Contracts). It is necessary to reinforce the control and surveillance of forest fires in some territories, but mainly those associated with an anthropogenic origin.* *During the reporting period, the risk of droughts and forest fires was low.*			
		Total Reversal Risk Set-Aside Percentage		*23%*
		Total Reversal Risk Set-Aside Percentage of the Document for the Reduction of Emissions or the previous Monitoring Report (whichever is more recent)		*23%*

It is clear what the risks are that can generate reversals at the national level (Lack of extensive and sustained support from the involved parties, Lack of institutional capacity or ineffective vertical/cross-sectoral coordination, Long-term ineffectiveness in managing underlying drivers, and Exposure and vulnerability to natural disturbances). The current ER program through the instruments required for its execution (MOP, PDB, SNICC, National REDD+ Strategy, CONAP Regulations for endorsement in protected areas, REDD+ Registry, CAT's System, Client Connection) generates an inter-institutional strengthening of NGOs, private initiatives, and local communities; in turn, it promotes continuous improvement due to the effort to meet international standards to obtain carbon benefits. This generates confidence and interest in society about the implementation of REDD+ projects.

8 EMISSION REDUCTIONS AVAILABLE FOR TRANSFER TO THE CARBON FUND

		Year	**2020**
A.	**Emission Reductions during the Reporting period (tCO_2-e)**	*from section 4.3*	8,144,298
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)**		

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C.	**Number of Emission Reductions estimated using measurement approaches (A-B)**		8,144,298
D.	**Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested**	*from section 6.1*	91.45%
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*	48,865
	If applicable, any buffer replenishments	*section 7.3 P*	0
F.	**Total ERs [(B+C)*D-E] minus, if applicable, any replenishments as per section 7.3, P**		7,399,095
G.	**Conservativeness Factor to reflect the level of uncertainty from non-proxy based approaches associated with the estimation of ERs during the Crediting Period**	*from section 5.2*	15%
H.	**Quantity of ERs to be allocated to the Uncertainty Buffer (0.15*B/A*F)+(G*C/A*F)**		1,109,864
I.	**Total reversal risk set-aside percentage applied to the ER program**	*from section 7.4*	23%
J.	**Quantity of ERs to be allocated to the Pooled Reversal Buffer (F-H)*I**		1,446,523
K.	**Number of FCPF ERs (F- H – J)**		4,842,708
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%

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M	**Number of FCPF ERs from enhanced removals from afforestation/reforestation (L * K) [Optional if the country wishes to generate enhanced removals]**	0

Guatemala proposes to use the maximum discount for the uncertainty buffer of 15% for the following reasons:

1. within the process of creating the emission factors, especially the forest carbon content it is not clear what quality control process was used during the information gathering process for each of the plots where the field information (forest inventory) was collected. This is the reason for the NO mark in QA/QC. This lack of information is due to the fact that in the absence of data from a complete and nationally implemented national forest inventory, forest inventory data from various sources were used, including forest inventory sites from forest concessions, research data, and partial data from the first national forest inventory.

2. Since the country does not yet have the main information to obtain the conservation status of forests (primary, degraded and very degraded), the best available information was used, in this case the grid of points to obtain statistical information on carbon content associated with canopy cover in order to model the emission factors in the Monte Carlo model and the Sensitivity analysis.

3. It has not been possible to propagate all the errors in the Monte Carlo uncertainty, because the EFs are associated with a carbon strata map that reports carbon above and below ground in a combined form and during the process the conversion of biomass to carbon is done without reporting separately the carbon fraction. Therefore, neither the stem-root error nor the carbon fraction error has been propagated.

4. An additional 10% error has been propagated in the forest carbon due to the fact that the errors of the allometric models used cannot be propagated.

To see the tool that the FCPF recommends to use is through the following link;
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link
The file is called: " template MR FCPF_1stRP_05mayo2025_ ".

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ANNEX 1: INFORMATION ON THE IMPLEMENTATION OF THE SAFEGUARDS PLANS

This section of the Repoting Report for the 2020 period is intentionally left blank, considering that the content of annexes 1, 2 and 3 is currently undergoing a process of completion and review parallel and independent of carbon accounting through specialists. Of the world bank on safeguards.

Upon having the corresponding approvals of annexes 1, 2 and 3, this content will be incorporated into the structure of the reporting report.

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

This section of the Reporting Report for the 2020 period is intentionally left blank, considering that the content of annexes 1, 2 and 3 is currently undergoing a process of completion and review parallel and independent of carbon accounting through specialists. Of the world bank on safeguards.

Upon having the corresponding approvals of annexes 1, 2 and 3, this content will be incorporated into the structure of the reporting report.

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

This section of the Reporting Report for the 2020 period is intentionally left blank, considering that the content of annexes 1, 2 and 3 is currently undergoing a process of completion and review parallel and independent of carbon accounting through specialists. Of the world bank on safeguards.

Upon having the corresponding approvals of annexes 1, 2 and 3, this content will be incorporated into the structure of the reporting report.

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ANNEX 4: CARBON ACCOUNTING – ADDENDUM TO THE ERPD

Technical corrections

Technical corrections applied to the reference level of the program.

Emission factors

The corrections to the reference level were of the order of improving the emission factors for forest and non-forest classes corresponding to numeral 1 (Improvement of emission factors) of the Methodological Framework Number 2. For the correction of the forest carbon content classes, the values were updated because an error was found in quantifying more trees in the plots of the different inventories, which caused the forest carbon content data to be incorrect. The wood density data for the annual growth of forest plantations was also updated. While for the non-forest classes the refinement of the IPCC guidelines of 2019 was used.

The updates made for the forest and non-forest uses used in the first reporting are shown below

Other land uses	ERPD	RFL updated
Forest carbon content		
Carbon stratum I	122.1	107.6
Carbon stratum II	101.7	105.7
Carbon stratum III	97.1	87.1
Carbon stratum IV	125.2	83.6
Wood density for broadleaf plantation forest growth	1.8	1.76
Wood density for the growth of coniferous forest plantations	3.25	3.24
Non-forest carbon content		
Croplands	5	4.7
Cropland-Coffee (intensive)	10	2.65
Cropland-African palm	10	3.47
Cropland-Rubber	10	4.30
Agroforestry systems (shade-grown coffee)	28.4	20.1
Pastures	5	6.73
Settlements	0	0
Wetlands	0	0
Other lands	0	0

Activity data

Likewise, improvements were made to the activity data of the reference level corresponding to numeral 2 (Improvement to activity data) and the numeral 2.B.I (Corrections to activity data resulting from the use of reference data of higher accuracy and/or precision: Use of imagery that is of higher spatial and temporal resolution (e.g. very high-resolution imagery or satellite data) than the one used at the time of submission of the ER-PD (i.e. a country may not have been aware of it, could not afford to use it, or did not have the capacity to use it, newly available high

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resolution satellite data is made available).) of Methodological Framework Number 2, by having more high resolution imagery and quality control processes.

As a result of the activity data collection for the first reporting period of the program and the submission of a reference level to the United Nations Framework Convention on Climate Change (UNFCCC), a review of samples with non-logical changes was conducted as part of a QA/QC process. Land cover information was updated by identifying non-logical changes within the reference level period 2006-2016.

The classes in which changes were made are detailed below:

Exchange rate revised and reinterpreted	Plots with error	Change or Dynamic Correction	Corrected parcels
Permanent grasslands (P>P)	266	Permanent forest land (F>F)	220
		Degradation (F>F, with loss of trees)	31
		Degradation recovery (F>F, with tree gain)	15
Deforestation (Forest Land to other non-forest lands)	66	Permanent forest land (F>F)	48
		Degradation (F>F, with loss of trees)	14
		Degradation recovery (F>F, with tree gain)	4
Permanent cropland (C>C)	52	Permanent forest lands	43
		Degradation (F>F, with loss of trees)	5
		Degradation recovery (F>F, with tree gain)	4
Permanent forest land (F>F)	41	Permanent Forest Lands (Element Count)	16
		Permanent cropland (C>C)	13
		Permanent Settlements (A>A)	6
		Permanent grasslands (P>P)	3
		Degradation (F>F, with loss of trees)	1
		Degradation recovery (F>F, with tree gain)	2
Grasslands to other non-forest lands (P>T)	3	Permanent forest land (F>F)	3
Permanent wetlands and bodies of water (H>H)	3	Permanent forest land (F>F)	3
Degradation (F>F, with loss of trees)	1	Permanent forest land (F>F)	1
Degradation recovery (F>F, with tree gain)	1	Recovery from degradation (element count)	1
Natural Regeneration (T>F)	1	Degradation (F>F, with loss of trees)	1
		Total Corrected	434

It was also considered that, for the recovery of the forest area, only the recovery through forest plantations was going to be taken into account and the legacy approach was used, so the calculation was what a forest would recover annually using the information coming from the grid of points.

Program area

Due to the fact that at the time of calculating the first reporting report, the shapefile used for the ERPD calculations was not available, a new shapefile from the program was used. This can be considered as a material correction and is allowed in the "Guidelines on the application of the methodological framework Number 2 On technical corrections to

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GHG emissions and removals reported in the reference period", in table section 3 "Corrections of material errors, omissions and misstatements.

Guatemala changed the approach to calculate carbon accounting at the national level in the point grid file, so in the file "NR_MallaPuntos_Escenario_7_MC2024_05" the area of the whole country is used. However, when calculating the program's emission reductions, a filter was used to only account for emissions, removals and reductions from the program.

Old program area (Ha) ERPD	Updated program area (ha) FRL Updated	National accounting area
9,985,930	**9,468,895.160**	**10,898,907.65**

To view the shapefile (PRE_Projectos_REDD_V1 PRE_Projectos_REDD_V1) of the program area, click the following link:

https://drive.google.com/drive/folders/1SCHVKlyXr4rwux_PqEvUXG1GrNKqBCy4?usp=drive_link

In addition to this, a review of the points that were inside the shapefile used by the program, which is "PRE_Projects_REDD_V2" was also made, and it was observed that 15 points were outside the shapefile, so it was decided that it was better to exclude them from the GHG accounting in Guatemala. For this reason, the number of points went from 11,369 to 11,354. For the program's carbon accounting, the number of points used was 10,414, which can be found in the program's official area.

Start Date of the Crediting Period

The date of the credit period is from January 1, 2020 to December 31, 2024.

According to the ERPAs, section 6.0.1, the start date of the program is January 1, 2020, and the first Reporting period is from 01/01/2020 to 12/31/2020[36].

The date complies with the following conditions:

1. It is not earlier than the date the first ER Program Measure(s) (including any Subproject(s)) begins generating Ers, i.e., first implementation: Section 4.3.1 of the ERPD lists all the programs that support REDD+ implementation (PROBOSQUE, PINPEP, etc.) which have been implemented in the years prior to the start of the ERPD (2010 and 2015).

It is justified with objective evidence by the ER Program Entity and is independently assessed by a Verification Body during validation. The images used during the visual interpretation process for the first reporting are all images that are available for the period from 01/01/2020 to 31/12/2020 within the database of Google Earth, Planet, Sentinel or Landsat, in case there is no image in that period either because there is no availability or there is presence of clouds or shadows in the period of interest, the images closest to the date of interest were searched and used.

2. It is not prior to January 1, 2016, so it complies with this clause due to the fact that the credit period begins on 01/01/2020 and ends on 12/31/2024.

[36] fcpf_erpa_tranche_a_-_b_-_guatemala.pdf (forestcarbonpartnership.org)

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3. It does not fall within the Reference period: There is no conflict with the reference level because the period starts on January 1, 2020. The reference period covers 01/01/2006 to 31/12/2016.

4. It is demonstrated that the ER Program complies with requirements since the start date on safeguards, carbon accounting and double-counting as specified in the MF. See Annex 1, Annex 4, Chapter 3 and 4 of this report. Annexes 1, 2 and 3 have been worked on, but at the time of submitting the report only the carbon accounting was presented, as the FMT allows it, since these documents were still being reviewed and updated. Annex 4 details the carbon accounting, as well as the control that double accounting does not exist.

Carbon pools, sources and sinks

Description of Sources and Sinks selected

Sources/sinks	Included?	Rationale/explanation
Deforestation	Yes	All area of classifications and forest land changing to other non-forest land.
Degradation	Yes	All area of forest land classifications remaining as forest land and losing when occurs within the plots that remain as forest permanence and that go from primary forest to degraded forest, from primary forest to highly degraded forest and from degraded forest to highly degraded forest is quantified.
Carbon stock increases	Yes	Area that belongs to other non-forest land and is converted to forest plantations and the restoration of degraded areas: The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from degraded forest to primary forest and from highly degraded forest to degraded forest is quantified.

Description of carbon pools and greenhouse gases selected

Carbon stocks	**Selected?**	**Justification/Explanation**
Above-ground biomass (AGB)	*Yes*	This is the most significant pool, which includes above-ground biomass carbon of trees greater than 10 cm in diameter, measured at 1.3 m (DBH). The data of this pool is modeled in the map of carbon strata at the national level, which was prepared from 2,306 plots of forest inventories, from different projects, which were systematized, refined, standardized and analyzed to obtain the value of biomass for each individual greater than 10 cm DBH. General allometric equations were applied, differentiating broadleaf forests in Petén, coniferous forests, broadleaf forests and mangrove forests; in the latter, three species-specific equations were used. The factor of 0.47 was used to convert biomass into carbon and the result per hectare was standardized by dividing the result by the size of the plot.
Below-ground biomass (BGB)	*Yes*	This pool is related to the previous one and biomass below the ground (roots) is included, using an equation for the Petén, coniferous and broadleaf forests, which represents a relationship based on the proportion of above-ground biomass. For the mangrove forest, three specific equations were used for the species found in that place.
Leaf litter	*No*	There are no data for all types of forest in the country and, using partial data, it is estimated that emissions represent 5.6% of total emissions from deforestation and degradation.

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Soil organic carbon (SOC)	*No*	There are no data for all types of forest in the country and, using partial data, it is estimated that emissions **represent 5.54% of total** emissions from deforestation and degradation.

GHG	Selected?	Justification/Explanation
CO2	*Yes*	Emissions and absorptions in tons of CO_{2eq} for all the aforementioned activities are included.
Other GHGs	*No*	For the 2006-2016 period, there are preliminary estimates based on tabular data of fires of emissions of CH4 and N2O 24,556.51 tCO_{2eq}/year from forest fires, which represents less than 1% of total emissions.

8. Reference Level

Reference Period

The FREL is based on GHG emissions at the subnational level in the area of the emission reduction program, in the historical period from 01/01/2006 to 31/12/2016, accounting for CO_{2eq}, for emissions in deforestation and degradation, and removals of CO_{2eq} for the increase in carbon stocks. This period has 2016 as its end year in compliance with criterion 11 of the methodological framework and covers a historical period of 10 years accounting for GHG emissions and absorptions from 2007. The FREL is under an emissions reduction agreement with the FCPF for a period of 5 years.

In a previous version for the period 2000-2010, estimates are made from fire scars, assuming that all fires consume tree biomass; so, the data differ from these new estimates. The period comprises 10 years since the initial forest cover is identified in 2006 and changes that imply emissions are identified until the following year.

The activity data information on coverage and dynamics is generated with a sampling based on a systematically distributed grid for the entire country in a multi-temporal analysis in the time period 2006-2016, from medium and high-resolution satellite images.

In the national grid and in the program area, in the historical period of the FREL, the change of use is determined due to the loss of forest land, degradation due to the loss of forest cover in areas that remain as forest land, and the increase in the area with commercial forest plantations on land that was previously not forested, according to the national definitions described in the next section.

8.2 Forest definition used in the construction of the Reference Level

According to the national definition, the forest is the continuous area with dominant tree cover[37] with a minimum canopy cover of 30%, forming a stand of a minimum of 0.5 hectares and a minimum width of 60 meters (GIMBUT 2018b). Forests and other land uses are defined below in the consistent representation of land with its classification criteria, to provide greater clarity in the quantification of the FREL, as well as in the characterization of the forest land dynamics processes that are identified from REDD+ activities in the FREL.

[37] Tree: Woody plant with a defined stem and crown with secondary growth that, when mature, reaches a minimum height of 5 meters and a minimum diameter of 10 cm.

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The definition of the forest used differs from that used in the Forest Report Assessment (FRA) 2015, which is as follows: *Forest land or land without any use that extends over 0.5 hectares, endowed with trees that reach a height greater than 5 m and a canopy cover greater than 10 percent. The term specifically excludes tree stands used in agricultural production systems, for example fruit plantations and agroforestry systems. The term also excludes trees that grow in urban parks and gardens.*

On the other hand, the GHGI presented in the Third National Communication on Climate Change does not include a definition of forest, nor does it include the input used to detect deforestation. However, it can be assumed that operationally it should be similar due to the forest classifications identified, as well as to the other uses that are reported.

Although there could be differences in the definitions, operationally the definition has remained constant, since the classifications and figures reported in terms of the amount of forest, both in the FRA and in the National Communication are similar, and the differences can be attributed to the use of different inputs and methodologies, rather than to a difference in definition. In addition, the definition presented in this document will be used in the next official reports to the UNFCCC.

FRA 2020 defines forest as: "forest land or land without any use extending over 0.5 hectares, with trees reaching a height of more than 5 meters and a canopy cover of more than 10 percent". This definition is only different in the minimum cover parameter, which is 10 percent, however, Guatemala's FRA 2020 was conducted using the methods and inputs from cover maps and forest dynamics coverage from 2001 to 2016, so the definition of forest in the FRA is in practice also consistent (**(GdG, 2022)**[38].

The following table describes the different Indicators for the use of the definition of forest under the different initiatives that Guatemala is working on and shows how in each one the definition of forest is consistent.

Indicators and their forestry definition parameters in different inputs, tools and reports in the LULUCF sector in the Republic of Guatemala.

Indicator	Wall-to-wall maps	Second Forest Inventory	FRA-FAO	National REDD+ Strategy	Definition of Forest in PRE-FCPF; FREL-UNFCC
Minimum area (Ha)	0.5	0.54	0.5	0.5	0.5
Minimum coverage (%)	30-40	30	10	30	30
Width (m)	60	60	NA	60	NA
Height (trees)	5	5	5	5	5
Diameter (trees)	10	10	NA	10	10

8.3 Average annual historical emissions over the Reference Period

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

[38] https://redd.unfccc.int/media/nivel_referencia_forestal_final.pdf

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Annual historical average of emissions during the Reference Period

The land use approach, in the three REDD+ activities of deforestation, degradation and increases in forest carbon stocks (IPCC, 2006). CO_{2eq} emissions and removals were obtained by multiplying the activity data corresponding to the area converted from forest land to other land for deforestation, the forest land that remains as forest land that loses coverage due to degradation, and the other land that is converted to forest land, through the recovery of degraded areas and the establishment of forest plantations to increase carbon stocks, by emission and absorption factors (Equation 8, which corresponds to the calculation section).

$$\mathbf{RL=(Def+deg)-(Incr)} = (\mathbf{E_{DEF}+E_{DEG}}) - (\mathbf{R_{rec}+R_{pla}}) = ((\mathbf{ADef} * \mathbf{FE}) + (\mathbf{ADdeg} * \mathbf{FE}) - (\mathbf{Rrec} * \mathbf{FA}) - (\mathbf{Rpla} * \mathbf{FA}))$$

Where:

RL	=	Reference Level
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from degradation
$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE	=	Emission factors for deforestation and degradation.
FA		Absorption factors for carbon increases in forest biomass.

To determine the emissions of the reference level, the first step is to calculate the information from the activity data and then make the estimate in tons of CO_2 equivalent.

In each of the tables below you will find information describing each of the REDD+ activities that were used as activity data. In each of the tables you will find links to files for estimating activity data, as well as reference level emissions and removals.

- File containing the emissions and removals estimates for each of the REDD+ activities can be found in the section Any comment from the tables used to report the reference level.
- File containing the information of the grid of points with their land use categories can be found in the section Any comment from the tables used to report the reference level.

Guatemala does not consider the annual loss of biomass due to forest removal (harvesting), the collection of fuel wood and other losses caused by disturbances, storms, insects and forest and diseases. The estimates for each activity are made separately with specific assumptions based on the information available, and their methods of obtaining activity data and their emission and absorption factors.

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

Activity data for reference period

Parameter:	Deforestation
Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 3

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	Additionally, to convert the data to emissions we used equation 8.
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	To generate activity data for deforestation, Collect Earth was used as a platform for the collection of land cover and land use information for years of interest. For the identification of these land covers and land uses, Guatemala uses the IPCC classification to establish the land use of the observed parcel, which uses a methodological protocol that hierarchizes up to three levels of land use in Guatemala, which can be consulted at the following link: https://docs.google.com/document/d/11ZWGtbORra3bPPAeAogHDgFYfZG67e0R/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true For the case of deforestation, a reference level was used that covers the state of land cover and land use that persisted during 2006 and the state of land cover that persisted during 2016, which covers a period of 11.08. It is important to mention that the source of information for 2006 was the orthophotos of Guatemala, which began to collect information in December 2005. For the identification of deforestation, plots were identified in which, during the period 2006-2016, they lost the totality of their forest cover or suffered a degradation process greater than 70% loss of the elements corresponding to the trees. Subsequently, the calculation was made in hectares. After interpreting the 11,354 sampling points at the national level and labeling the change, a filter was performed to identify those points that were deforestation points, which identified a total of 35 plots equivalent to 280,296.02 hectares during the monitoring period and for the reporting period the total was 24,950.93 hectares per year. An additional step was to count the total number of three elements in the plot and establish a category in which the forest is located, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After identifying the forest category in which the plot is located, the carbon content was counted in proportion to the number of tree elements found in the plot. For example, if a plot has 17 trees, these represent 68% of the total plot and are located according to the strata map, in Stratum I which has a total of 94 TonC/ha, this plot will have a total of 60.16 TonC/ha. If the plot was deforested to agricultural land which has a total non-forest carbon of 4.7 Tonne C/ha, the carbon lost by this deforestation process is a total of 55.46 Tonne C/ha. This allows the deforestation of the plot to be quantified proportionally and not directly to the amount of carbon assigned by the carbon strata map. Subsequently, a grouping of the

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	main changes in deforestation was made to make the total sum of carbon dioxide equivalent emitted in the reporting period. The total number of interpreters who performed the analysis of the images were three specialists: Ulises Armas, Claudia Saput and Melany Ramírez.
Value applied	Total Hectares and Hectares per year for each of the changes due to deforestation for the reference level

Category	Category	Ha	Ha/Year
Primary	Forest Land I to Settlements	959.92	86.64
Primary	Forest Land I to Other Land	959.92	86.64
Primary	Forest Land I to Grasslands	3,839.67	346.54
Primary	Forest Land I to Annual Crops	1,919.84	173.27
Primary	Forest Land I to Agricultural Lands-Coffee	-	-
Primary	Forest Land I to Agricultural Land-Other	2,879.75	259.91
Primary	Forest Land I to Agricultural Oilland	1,919.84	173.27
Primary	Forest Land I to Agricultural Land-African Palm	-	-
Primary	Forest Lands I to agroforestry systems	2,879.75	259.91
Primary	Forest Lands II to Settlements	-	-
Primary	Forest Lands II to Other Lands	959.92	86.64
Primary	Forest Lands II to Grasslands	23,038.03	2,079.24
Primary	Forest Land II to Annual Crops	2,879.75	259.91
Primary	Forest Land II to Agricultural Lands-Coffee	-	-
Primary	Forest Land II to Agricultural Land-Other	1,919.84	173.27
Primary	Forest Land II to Agricultural Lands-Rubber	1,919.84	173.27
Primary	Forest Lands II to Agricultural Lands-African Palm	1,919.84	173.27
Primary	Forest Land II to agroforestry systems	959.92	86.64
Primary	Forest Land III a Settlements	959.92	86.64
Primary	Forest Land III to Other Land	-	-
Primary	Forest land III to Grasslands	57,595.07	5,198.11
Primary	Forest Land III to Crops-Annuals	4,799.59	433.18
Primary	Forest land III to agricultural land-coffee	-	-
Primary	Forest Land III to Agricultural Lands-Rubber	-	-
Primary	Forest Lands III to Agricultural Lands-African Palm	-	-
Primary	Forest Lands III to agroforestry systems	959.92	86.64
Primary	Forest Land IV to Settlements	-	-
Primary	Forest Lands IV to Other Lands	2,879.75	259.91
Primary	Forest Lands IV to Grasslands	55,675.24	5,024.84
Primary	Forest Land IV to Annual Crops	8,639.26	779.72
Primary	Forest Lands IV to Agricultural Lands-Coffee	1,919.84	173.27
Primary	Forest Land IV to Agricultural Land-Other	959.92	86.64
Primary	Forest Land IV to Agricultural Lands-Rubber	959.92	86.64
Primary	Forest Lands IV to Agricultural Lands-African Palm	4,799.59	433.18
Primary	Forest Lands IV to agroforestry systems	3,839.67	346.54
Degraded	Forest Land I to Settlements	-	-

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		Degraded	Forest Land I to Other Land	-	-	
		Degraded	Forest Land I to Grasslands	1,919.84	173.27	
		Degraded	Forest Land I to Annual Crops	-	-	
		Degraded	Forest Land I to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land I to Agricultural Land-Other	959.92	86.64	
		Degraded	Forest Land I to Agricultural Oilland	-	-	
		Degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Degraded	Forest Lands I to agroforestry systems	959.92	86.64	
		Degraded	Forest Lands II to Settlements	-	-	
		Degraded	Forest Lands II to Other Lands	-	-	
		Degraded	Forest Lands II to Grasslands	6,719.43	606.45	
		Degraded	Forest Land II to Annual Crops	3,839.67	346.54	
		Degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land II to Agricultural Land-Other	-	-	
		Degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Land II to agroforestry systems	1,919.84	173.27	
		Degraded	Forest Land III a Settlements	-	-	
		Degraded	Forest Land III to Other Land	-	-	
		Degraded	Forest land III to Grasslands	19,198.36	1,732.70	
		Degraded	Forest Land III to Crops-Annuals	2,879.75	259.91	
		Degraded	Forest land III to agricultural land-coffee	-	-	
		Degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Lands III to agroforestry systems	1,919.84	173.27	
		Degraded	Forest Land IV to Settlements	959.92	86.64	
		Degraded	Forest Lands IV to Other Lands	-	-	
		Degraded	Forest Lands IV to Grasslands	13,438.85	1,212.89	
		Degraded	Forest Land IV to Annual Crops	6,719.43	606.45	
		Degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land IV to Agricultural Land-Other	-	-	
		Degraded	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands IV to Agricultural Lands-African Palm	2,879.75	259.91	
		Degraded	Forest Lands IV to agroforestry systems	-	-	
		Very degraded	Forest Land I to Settlements	-	-	
		Very degraded	Forest Land I to Other Land	-	-	
		Very degraded	Forest Land I to Grasslands	-	-	
		Very degraded	Forest Land I to Annual Crops	959.92	86.64	
		Very degraded	Forest Land I to Agricultural Lands-Coffee	959.92	86.64	
		Very degraded	Forest Land I to Agricultural Land-Other	-	-	
		Very degraded	Forest Land I to Agricultural Oilland	-	-	
		Very degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Very degraded	Forest Lands I to agroforestry systems	-	-	
		Very degraded	Forest Lands II to Settlements	-	-	
		Very degraded	Forest Lands II to Other Lands	-	-	

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Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-
Very degraded	Forest Lands II to Grasslands	959.92	86.64
Very degraded	Forest Land II to Annual Crops	959.92	86.64
Very degraded	Forest Land II to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land II to Agricultural Land-Other	-	-
Very degraded	Forest Land II to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands II to Agricultural Lands-African Palm	-	-
Very degraded	Forest Land II to agroforestry systems	-	-
Very degraded	Forest Land III a Settlements	959.92	86.64
Very degraded	Forest Land III to Other Land	-	-
Very degraded	Forest Lands II to Wetlands and Water Bodies	959.92	86.64
Very degraded	Forest land III to Grasslands	-	-
Very degraded	Forest Land III to Crops-Annuals	-	-
Very degraded	Forest land III to agricultural land-coffee	-	-
Very degraded	Forest land III to agricultural land-other	-	-
Very degraded	Forest Land III to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands III to Agricultural Lands-African Palm	-	-
Very degraded	Forest Lands III to agroforestry systems	959.92	86.64
Very degraded	Forest Land IV to Settlements	-	-
Very degraded	Forest Lands IV to Other Lands	-	-
Very degraded	Forest Lands IV to Grasslands	4,799.59	433.18
Very degraded	Forest Lands IV a Wetlands and Water Bodies	-	-
Very degraded	Forest Land IV to Annual Crops	959.92	86.64
Very degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land IV to Agricultural Land-Other	959.92	86.64
Very degraded	Forest Land IV to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands IV to Agricultural Lands-African Palm	959.92	86.64
Very degraded	Forest Lands IV to agroforestry systems	-	-
	Planting to pastures II	959.92	86.64
	Planting to pastures III	3,839.67	
	Planting to pastures IV	1,919.84	173.27
	Planting to annual crops IV	959.92	86.64
	Plantation of coffee crops	959.92	86.64
Total		280,296.02	24,950.93

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_"
And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/u/1/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC
In the "Tables-Report-NR" tab.

QA/QC procedures applied:	A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated.

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	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90 % confidence interval and an expected 5% error.
Uncertainty associated with this parameter:	The uncertainty values of the activity data for deforestation **DEF-NR-HA-** **Median** 330,932 **Upper bound 90% CI** (Percentile 0.95) 378,451 **Lower bound 90% CI** (Percentile 0.05) 283,050 **Half Width Confidence Interval at 90% (B – C / 2)** 47,700 **Relative margin (D / A)** **14%** The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_": And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" Link: https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Degradation
Description:	Degraded forest land The following equations were used to calculate this parameter: Activity data: Equation 4
Data unit:	Hectares

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Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: https://docs.google.com/document/d/11ZWGtbORra3bPPAeAogHDgFYfZG67e0R/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true To quantify forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation. For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot changes from 17 tree elements to 12 tree elements, the plot changes category to a very degraded forest, which represents 48% of the plot coverage and with a carbon content of 45.12 TonC/ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha which were lost by a degradation process. For the reference level, a total of 353,249.78 ha was identified while the annualized data results in a total of 31,881.75 ha/year. These areas are equivalent to a total of 368 plots that were identified as a forest permanence and suffered a forest degradation process.
Value applied	Table 37. Total Hectares and Average hectares per year that have been degraded within the 2006-2016 period **Category** | **Ha** | **Ha/Year**

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Forest Land I Primary A Degraded	24,957.86	2,252.51
Forest Land I Primary To Highly Degraded	10,559.10	952.99
Forest Land I Degraded to Very Degraded	5,759.51	519.81
Forest Land II Primary A Degraded	60,474.83	5,458.02
Forest Land II Primary To Very Degraded	22,078.11	1,992.61
Forest Land II Degraded to Very Degraded	8,639.26	779.72
Forest Land III Primary A Degraded	41,276.47	3,725.31
Forest Land III Primary To Very Degraded	14,398.77	1,299.53
Forest Land III Degraded to Severely Degraded	19,198.36	1,732.70
Forest Land IV Primary A Degraded	87,352.53	7,883.80
Forest Land IV Primary to Very Degraded	23,997.95	2,165.88
Forest Land IV Degraded to Severely Degraded	33,597.13	3,032.23
Degraded plantations	959.92	86.64
Total	353,249.78	31,881.75

For more information, see the file Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_:

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

In the "Tables-Report-NR" tab.

QA/QC procedures applied:

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.

Uncertainty associated with this parameter:

Table 38. Uncertainties of degradation in the monitoring period

DEG-NR-HA-	
Median	357,768
Upper bound 90% CI (Percentile 0.95)	415,631
Lower bound 90% CI (Percentile 0.05)	300,014
Half Width Confidence Interval at 90% (B – C / 2)	57,808
Relative margin (D / A)	**16%**

The uncertainty values of the activity data can be found at the following link:

https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_

Tab: Table-Report in Spanish.

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Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20myo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Forest Degradation Recovery
Description:	Land recovered from forest degradation The following equations were used to calculate this parameter: Activity data: Equation 5
Data unit:	Hectares per year
Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: To quantify the recovery of forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon it is necessary to identify the amount of tree elements the plot has, since this will establish the amount of carbon before the process of forest degradation recovery and the amount of carbon after the recovery of forest degradation. For example, a plot has 12 tree elements in a first moment, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12

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TonC/ha. In a second moment this plot changes from 12 tree elements to 19 tree elements, the plot changes its category to a degraded forest, which represents 68% of the plot's cover and with a carbon content of 60.16 TonC/ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha.

For the reference level, a total of 284 plots were identified and designated as recovery of forest degradation since the very degraded forest became a degraded forest, from very degraded forest to primary forest and from degraded forest to primary forest. In terms of hectares, a total of 272,616.68 ha were identified throughout the reference level and 24,604.39 ha/year.

Value applied

Table 39. Hectares per year of forest increments through forest restoration.

Category	Ha	Ha/Year
Forest Land I Highly Degraded to Degraded	3,839.67	346.54
Forest Land I Highly Degraded to Primary	4,799.59	433.18
Forest Land I Degraded to Primary	29,757.45	2,685.69
Forest Land II Highly Degraded to Degraded	14,398.77	1,299.53
Forest Land II Highly Degraded to Primary	6,719.43	606.45
Forest Land II Degraded to Primary	46,076.06	4,158.49
Forest Land III Highly Degraded to Degraded	9,599.18	866.35
Forest Land II Highly Degraded to Primary	10,559.10	952.99
Forest Land III Degraded to Primary	49,915.73	4,505.03
Forest Land IV Highly Degraded to Degraded	19,198.36	1,732.70
Forest Land IV Highly Degraded to Primary	11,519.01	1,039.62
Forest Land IV Degraded to Primary	66,234.33	5,977.83
Total	272,616.68	24,604.39

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_02mayo2025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

In the "Tables-Report-NR" tab.

QA/QC procedures applied:

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.

Uncertainty associated with this parameter:

Table 40. Restoration uncertainties of degraded areas

RDEG-NR-HA-	
Median	278,343

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	<table><tr><td>**Upper bound 90% CI** (Percentile 0.95)</td><td>328,317</td></tr><tr><td>**Lower bound 90% CI** (Percentile 0.05)</td><td>226,770</td></tr><tr><td>**Half Width Confidence Interval at 90% (B – C / 2)**</td><td>50,774</td></tr><tr><td>**Relative margin (D / A)**</td><td>**18%**</td></tr></table> The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_02mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

Parameter:	Increased Carbon Through Forest Plantations
Description:	Increased Carbon Through Forest Plantations The following equations were used to calculate this parameter: Activity data: Equation 6
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Regarding the information on forest plantations for the reference level, a total of 33 points corresponding to this activity were identified, of which 20 points correspond to coniferous plantations and 13 points correspond to broadleaf plantations. The total hectare per year for the reference level was 23,606 hectares. But when it comes to using the legacy approach proposed by the World Bank, the total number of plantations is 31,677.29 hectares and 2,858.96 hectares per year.
Value applied	Table 41. Hectares per year of carbon increases through forest plantations. <table><tr><th>Category</th><th>Ha</th><th>Ha/Year</th></tr></table>

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	<table><tr><td>Plantations I conifers</td><td>19,198.36</td><td>1,732.70</td></tr><tr><td>Plantations of Broadleaf Plantations</td><td>12,478.93</td><td>1,126.26</td></tr><tr><td>Total</td><td>31,677.29</td><td>2,858.96</td></tr></table> For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_": And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link In the "Tables-Report-NR" tab.
QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty associated with this parameter:	Table 42. Forest plantation uncertainties <table><tr><th colspan="2">PLANT-NR-HA-</th></tr><tr><td>Median</td><td>32,259</td></tr><tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>49,572</td></tr><tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>16,055</td></tr><tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>16,758</td></tr><tr><td>Relative margin (D / A)</td><td>52%</td></tr></table> The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_NR

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Emission factors

Parameter:	Forest carbon content (Cfor)
Description:	Forest carbon content of four carbon strata before conversion to non-forest land Used in equations: 8,9,10,11 and 18,19,20,21.
Data unit:	Ton of carbon 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):	The information generated in the carbon strata map of Guatemala was used to establish biomass above and below ground for forest information. To obtain the carbon content, a study was carried out in which a total of 2,364 forest plots were analyzed, which was prepared by the National Council of Protected Areas with the support of GIMBUT. For more details and explanation of how the value was obtained for the four strata of forest carbon in Guatemala you can consult the report that was made, which is in the following link: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view To obtain greater clarity on how the forest carbon content in Guatemala was constructed, the documents, databases and spatial data have been placed in the section of any comments. The criteria for data cleaning started with individual trees, identifying atypical data with respect to DBH, height was applied only where trees with inconsistent heights were identified; however, in the other sources of information it was only used as a reference. Plot debugging consisted of missing coordinate information and inconsistent locations". The most significant pool includes above-ground biomass carbon from trees greater than 10 cm in diameter (Trees greater than 10 cm DBH[39] are included, because for Guatemala it is the definition of a tree). measured at 1.3 m (DBH). Lianas and palms were not considered as part of the aboveground or belowground biomass as part of the emission factors, since there is no information available. The data of this pool is modeled in the carbon strata map at the national level, which was prepared from 2,306 plots of forest inventories, from different projects, which were systematized, refined, standardized, and analyzed to obtain the value of biomass for each individual greater than 10 cm DBH[40]. General allometric equations were applied, differentiating between broadleaf forests in Petén, coniferous forests, broadleaf forests and mangrove forests. In the latter, three species-specific equations were used. The factor 0.47 was used to convert biomass to carbon and the result per hectare was standardized by dividing the result by the plot size.

[39] For Guatemala, the following definition for a tree is used:
Woody plant with a defined stem and crown with secondary growth that, when mature, reaches a minimum height of 5 meters and a minimum diameter of 10 cm. Bamboos and palms are excluded.

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The second pool, which is related to the previous one, includes below-ground biomass (roots). To estimate below-ground biomass, an above-ground biomass ratio equation was used for all plots (Mokany, Raison & Prokushkin 2006)[41], except for the Mangrove Forest plots, where an equation was used (Komiyama et al. 2008)[42].

The following (see

The equations that appear in table 5 for coniferous and deciduous forests were generated for these specific forest types. They were not made for tree species.

Table 5) shows the equations used to calculate the biomass above and below ground for the Petén, conifers, broadleaves and three mangrove species forests, which take into consideration the relationship in function of the proportion of aerial biomass for the below-ground biomass. It is important to mention that all the allometric equations are implemented at the tree level, not at the level of an entire plot.

Additionally, in the "Methodological report for the elaboration of the carbon strata map" in chapter 4.3 and 4.4 Allometric equations for broadleaved and coniferous forests, it is explained how the allometric equations were applied, depending on the location of the plots (page 7).

https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

A regional equation is used for the vegetation types of northern Peten (Arreaga) and is applied for all trees in Peten. For the rest of the country, two equations are used that are assigned by vegetation type (coniferous and broadleaf), and three species-specific equations for mangrove trees (Rhizophora mangle L., Laguncularia racemosa (L.) Gaertn.f., Avicennia germinans (L.)L.).

The equations that appear in table 5 for coniferous and deciduous forests were generated for these specific forest types. They were not made for tree species.

Table 43. Allometric equations used.

Mangrove species	Equation	Source	r2	N	Dmax
Rhizophora mangle L.	0.178*DBH^2.47	Imbert and Rollet (1989)a	0.98	17	Unknown
Laguncularia racemosa (L.) Gaertn.f.	0.1023*DBH^2.50	Fromard et al. (1998)	0.97	70	10
Avicennia germinans (L.) L.	0.14*DBH^2.4	Fromard et al. (1998)	0.97	25-45	42.4
Conocarpus erectus L.[43]	0.1023*DBH^2.50	Fromard et al. (1998)			

[41] https://drive.google.com/file/d/1kM2ZLN0ftJHTO4due1jyJx1s4_DuATA4/view?usp=drive_link

[42] https://drive.google.com/file/d/15PmlsvBZefff7-2b_GBZhMvry4y7sp2u/view?usp=drive_link

[43] This equation is the same as the one used for the Mangrove species "Laguncularia racemosa (L.)".

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Types of vegetation by region	Equation	Source	r2	N	Dmax
Broadleaf vegetation of northern Peten	10^ (-4.09992+(2.57782*LOG10(DBH))) *1000	Arreaga, 2002	95	139	130
Broadleaf vegetation	0.13647*DBH^2.38351	UVG,2018	0.939	100	79.9
Coniferous vegetation	0.15991 * DBH^2.32764	UVG,2018	0.966	80	82

With the biomass data for each individual, the conversion of tons of biomass to carbon is made, multiplying by the fraction of 0.47 and the value for one hectare is extrapolated, according to the size of each plot. The values are added for each of the plots, and results in a standardized value of tons of carbon per ha in each of them.

Each plot has geographic location data, and these were stratified bioclimatically, as an indirect measure of primary productivity, based on the ombrothermal indices generated for Guatemala, which were constructed with data obtained from the World Clim digital page, using the monthly precipitation and temperature averages. This climatic classification has been widely used in Guatemala as a basis for regional planning and for the integration of other variables of interest to forest services or biological conservation (CONAP, 2015).

The plots with their carbon content were in 6 ombric horizons, and data (the carbon content data of the analyzed plots) distribution tests were carried out for each of them, finding that none presented normality in the data distributions. Therefore, to carry out the stratification according to the ombric horizons, a comparison test of k samples (Kruskal-Wallis) was carried out, where statistically differentiated groups were detected as shown below (See Table 6).

Table 44. Grouping categories according to climatic regime.

Sample	Frequency	Sum of ranks	Average Ranges	Groups		
8a. Hyperhumid Lower	381	560,291	1,471	A		
7b. Wet top	578	684,655	1,185		B	
6b. Upper sub-humid	172	203,702	1,184		B	C
8b. Hyper-humid superior	43	49,207	1,144		B	C
6a. Lower sub-humid	633	723,660	1,143		B	C
7a. Wet Bottom	556	571,552	1,028			C

As shown below, from the statistical grouping, four strata were determined at the national level according to the amount of carbon and the zones of ombric horizons (See Table 7). The groups that are observed in table 8, indicate those ombric indices that are statistically related to each other. That is why the result is four groups.

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Table 45. Groups in which climatic regimes are classified.

Ombric Horizon	Groups			Final stratum
8a. Hyperhumid Lower	A			I
7b. Wet top		B		II
6b. Upper sub-humid		B	C	III
8b. Hyper-humid superior		B	C	III
6a. Lower sub-humid		B	C	III
7a. Wet Bottom			C	IV

With these data, the values were assigned to those areas whose ombric horizon did not have enough plots to be represented (e.g., Dry type), leaving the final stratification as detailed in Table 8, with which the national coverage is achieved.

Table 46. Strata assigned to horizons with insufficient values.

Stratum	Tipos_ombricos	Horizontes_ombricos
I	**8. Hyper-humid**	8a. Hyperhumid Lower
II	**7. Wet**	7b. Wet top
III	**6. Sub-humid**	6a. Lower sub-humid
		6b. Upper sub-humid
	8. Hyper-humid	8b. Hyper-humid superior
IV	**7. Wet**	7a. Wet Bottom

To have more consistent data in the estimation of tons of carbon per hectare and per stratum, descriptive statistics were made for each group and the resulting carbon content ranges were compared. Due to the great variability of the data according to the size of the plots and sampling designs, calculations of carbon density were made with the median and the weighted mean was also calculated for the four strata according to the proposal of Thomas and Rennie, 1987, who define that variance is a good estimator of the mean. Due to the variability of sampling designs for different purposes, data distribution (non-normal) and plot sizes, the probability density function (PDF) of the data by plot size and by stratum through goodness-of-fit tests was identified (Gómez Xutuc, 2017). Once the PDFs have been identified, it performs simulations of the carbon content per hectare, (Figure 6).

Thus, 10,000 simulations were run, truncating distributions according to the minimum and maximum of each data (tC/ha) by plot size and by stratum, respectively. The median was used for the analysis, since these are data that do not present a normal distribution.

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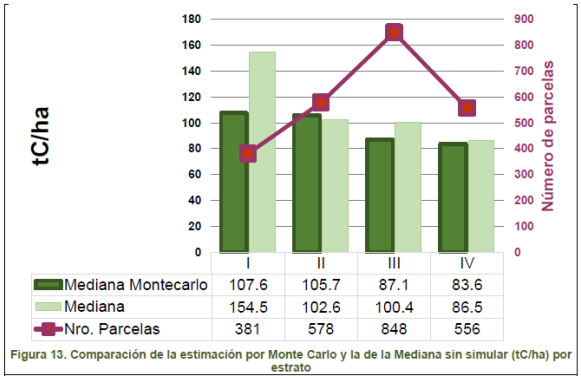
Figure 6. Estimated values for the carbon map.



Value applied:

The final values of forest biomass above and below ground were as follows.

Table 47. Carbon values obtained for each stratum.

Strata	Median	Standard deviation	Uncertainty (%)
I	107.64	30.393	28%
II	105.74	51.583	49%
III	87.09	15.781	18%
IV	83.63	41.303	49%

QA/QC procedures applied

Review and evaluation of atypical data for its depuration. Due to the variability in the sources of information, different procedures were carried out in the debugging of the information. For most of the plots, the previously described process was applied (see figure 2), with the exception of the inventory base, for which the following steps were followed. Methodological Document (page 6).

https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

A constraint was made to limit the height of the trees in the equations so that heights well outside the range would bias the results. Additionally, plots with inadequate georeferencing were removed from the analysis.

Additional analysis was done to check the accuracy of the map against the plots of the project inventories. Since the country also submitted a reference level to the United Nations Convention on Climate Change, we proceeded to review whether the correspondence of the map's carbon layers was in line with reality. Therefore, INAB proceeded to perform an analysis to evaluate the quality of the carbon layers map, which can be found in the folder in this link:

https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view

Within the process of creating the emission factors, especially the forest carbon content, it is not clear the quality control process that was used at the time of the sample design of

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<table>
<tr><td></td><td>each of the plots in which the information was collected. This is the reason for the NO mark in QA/QC. This lack of information is mostly due to the fact that data was only collected from several sources.

Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>Table 48. Uncertainty of the carbon strata after applying the Monte Carlo method.

<table><tr><th>Strata</th><th>Median</th><th>Standard deviation</th><th>Uncertainty (%)</th></tr><tr><td>I</td><td>107.64</td><td>30.393</td><td>28%</td></tr><tr><td>II</td><td>105.74</td><td>51.583</td><td>49%</td></tr><tr><td>III</td><td>87.09</td><td>15.781</td><td>18%</td></tr><tr><td>IV</td><td>83.63</td><td>41.303</td><td>49%</td></tr></table>
The values found in
Table 10 are the result of the modeling for the carbon strata for the calculation of the uncertainty of the emission reduction.

Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.</td></tr>
<tr><td>Any comment:</td><td>To access the documents and calculations related to this activity, consult the following link:

Methodological report:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Database to build the carbon strata of Guatemala:
https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing
Shapefile:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view?usp=sharing</td></tr>
</table>

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	For the National Forest inventory: https://www.sifgua.org.gt/SIFGUAData/PaginasEstadisticas/Recursos-forestales/inventario-forestal.aspx and for the rest of the plots, they are based on the permanent sampling plots and inventory plots: https://mangomap.com/desarrollo-forestal/maps/103965/parcelas-permanentes-de-medici-n-forestal-ppmf-?preview=true#. It is important to mention that for the elaboration of the carbon strata map there was no consolidation methodology that fulfilled this objective, however, the task of compiling information from plots from natural forests was carried out, which is why there is information of different sampling sizes.

Parameter:	**Non forest carbon content (Nofor)**
Description:	Non-forest carbon content after conversion of forest land to non-forest land Used in the equations: 8,18
Data unit:	Tons of carbon/ha
Source of data and description of measurement/calculation methods and procedures applied:	In order to have an estimation of the emissions that is closer to reality and to assign a biomass existence value after deforestation, depending on the type of activity that is carried out, in addition to the data obtained for the country for agroforestry systems, the general default values were used for land converted to cropland during the year following conversion, from the 2006 IPCC Guidelines for Wet Tropical Annual and Perennial Crops and their associated error range found in IPCC Table 5.9 (2006). The values for these other non-forest use categories were used as described below (See Table 49):

Table 49. Carbon in biomass after conversion due to deforestation.

Other land uses	Ton Carbon/ha/year	Range of error and/or uncertainty	Source
Croplands (all classes not specified)	4.7	±75%	IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)
Croplands-Coffee (intensive)	2.65	1.35%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the coffee agroecosystem in

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				Guatemala. PROMECAFE Newsletter. 1999; 7-14
	Croplands-African Palm	3.47[44]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands) Above-ground biomass only[45]
	Croplands-Rubber	4.30[46]	±75%	IPCC 2019 (Volume 4, Table 5.3Table 5.3, chapter 5 Croplands, annual croplands) Above-ground biomass only[47]
	Other land uses	**Ton Carbon/ha/**	**Range of error and/or uncertainty**	**Source**
	Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the coffee agroecosystem in Guatemala. PROMECAFE Newsletter. 1999; 7-14
	Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)
	Settlements	0.00	N/A	IPCC 2006
	Wetlands	0.00	N/A	IPCC 2006
	Other lands	0.00	N/A	IPCC 2006
	Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Reporting period results in the process of rebuilding the estimation of reductions.			
Value applied:				

[44] modified by applying the Mokany equation

[45] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

[46] modified by applying the Mokany equation

[47] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

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Other land uses	Ton Carbon/ha/year	Range of error and/or uncertaint	Source
Croplands (all classes not specified)	4.7	±75%	IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)
Croplands-Coffee (intensive)	2.65	1.35%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide
Croplands-African Palm	3.47[48]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Croplands-Rubber	4.30[50]	±75%	IPCC 2019 (Volume 4, Table 5.3Table 5.3, chapter 5 Croplands, annual
Other land uses	**Ton Carbon/ha/**	**Range of error and/or uncertainty**	**Source**
Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide
Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)
Settlements	0.00	N/A	IPCC 2006
Wetlands	0.00	N/A	IPCC 2006
Other lands	0.00	N/A	IPCC 2006

[48] modified by applying the Mokany equation

[49] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

[50] modified by applying the Mokany equation

[51] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

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	Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Reporting period results in the process of rebuilding the estimation of reductions.
QA/QC procedures applied:	Does not apply because they are default values taken from the IPCC Guidelines.
Uncertainty associated with this parameter:	Table 50. Uncertainty of carbon content in non-forest land

Classification	Agriculture	Coffee	Palm	Rubber	Agroforestry	Grasslands
Median	4.67	2.65	2.40	3.00	23.64	6.72
Mean	4.70	2.65	2.40	3.00	25.21	6.75
Desviation	1.75	0.53	0.49	0.19	15.35	2.48
IC upper	7.61	3.51	3.20	3.32	52.52	10.89
Ic lower	1.78	1.77	1.60	2.68	3.09	2.69
U %	62%	33%	33%	11%	105%	61%

Any comment:	To access the documents and calculations related to this activity, consult the following link: Chapter Croplands for Croplands: https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf Chapter Croplands for African Palm and Rubber: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_05_Ch5_Cropland.pdf Chapter Grasslands https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_06_Ch6_Grassland.pdf Data for intensive coffee and Agroforestry systems (shaded coffee): https://drive.google.com/file/d/1kXI5Pxr_iUJOffJJTfVBTjF2iWihs3tq/view?usp=drive_link https://docs.google.com/presentation/d/1JjSan9z5CYySzZuhCwRWxW9c1tR2nyww/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true

Parameter:	Emissions from degradation (Cfor-Cdeg)
Description:	Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified. Used in equations: 9,19

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Data unit:	Tons of carbon/ha
Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):	To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: https://drive.google.com/drive/folders/1tEoT1GJPzitSpmoW3nLxhi5entlqBUAo?usp=drive_linkTo quantify forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation. For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot goes from 17 tree elements to 12 tree elements, the plot changes its category to a very degraded forest, which represents 48% of the plot's cover and with a carbon content of 45.12 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha that were lost due to a degradation process. For thereporting period a total of 370 plots were identified and designated as degraded because the primary forest became degraded or very degraded forest, or a degraded forest became very degraded forest. These 370 plots equaled a total of 185, 508.91 ha for the monitoring period while for the reporting period the total was 46,377.23 ha/year.
Value applied:	Carbon above and below ground Table 51. Criteria used to classify degraded plots. **% Category Carbon tC/ha**

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Elements	Coverage		Stratum 1	Stratum II	Stratum III	Stratum IV
25	100	Primary	94.4	69.0	80.5	74.8
24	96		90.7	66.2	77.2	71.8
23	92		86.9	63.5	74.0	68.8
22	88		83.1	60.7	70.8	65.8
21	84		79.3	57.9	67.6	62.8
20	80		75.5	55.2	64.4	59.8
19	76	Degraded	71.8	52.4	61.1	56.8
18	72		68.0	49.7	57.9	53.8
17	68		64.2	46.9	54.7	50.9
16	64		60.4	44.1	51.5	47.9
15	60		56.7	41.4	48.3	44.9
14	56		52.9	38.6	45.1	41.9
13	52	Very Degraded	49.1	35.9	41.8	38.9
12	48		45.3	33.1	38.6	35.9
11	44		41.5	30.4	35.4	32.9
10	40		37.8	27.6	32.2	29.9
9	36		34.0	24.8	29.0	26.9
8	32		30.2	22.1	25.7	23.9

QA/QC procedures applied

Does not apply because they are default values, taken from the forest carbon content and emission factors used for deforestation.

The assumption was when Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified.

Uncertainty associated with this parameter:

Table 52. Standard deviation values to be used for modeling degradation values

Carbon Layer	Category	Median	Standard deviation
Stratum I	Primary	107.64	6.26
	Degraded	73.19	7.04
	Very degraded	47.36	5.16
Stratum II	Primary	105.74	6.33
	Degraded	71.90	6.45
	Very degraded	50.76	5.84
Stratum III	Primary	87.10	3.51
	Degraded	59.22	6.03
	Very degraded	41.81	5.78
Stratum IV	Primary	83.63	4.82
	Degraded	56.87	5.78
	Very degraded	40.14	4.91

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	These are the values corresponding to the forest carbon content that arise the Montecarlo Model.
Any comment:	To access the documents and calculations related to this activity, consult the following link: Methodological report: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view Database to build the carbon strata of Guatemala: https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing Shapefile: https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view?usp=sharing

Parameter:	Removals from forest degradation recovery (Cdeg-Cfor)
Description:	The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from very degraded forest to primary forest and from highly degraded forest to degraded forest is quantified. Used in equations: 10 and 20.
Data unit:	Ton of carbon/ha
Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):	To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link: To quantify the recovery of forest degradation it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be: - Primary forest: forest that conserves 20 to 25 tree elements within the plot. - Degraded forest: forest that conserves 14 to 19 tree elements within the plot. - Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and

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	then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon it is necessary to identify the amount of tree elements the plot has, since this will establish the amount of carbon before the process of forest degradation recovery and the amount of carbon after the recovery of forest degradation. For example, a plot has 12 tree elements in a first moment, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12 TonC/ha. In a second moment this plot changes from 12 tree elements to 19 tree elements, the plot changes its category to a degraded forest, which represents 68% of the plot's cover and with a carbon content of 60.16 TonC/ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha. For the monitoring period, a total of 412 plots were identified and designated as recovery of forest degradation since the very degraded forest became a degraded forest (102 plots) and from a degraded forest to a primary forest (249 plots). These 412 plots equaled a total of 334,555.06 ha for the monitoring period while for the reporting period the total was 83,638.77 ha/year.
Value applied:	Carbon above and below ground Table 53. Criteria is used to classify degraded plots.

Elements	% Coverage	Category	Carbon tC/ha			
			Stratum I	Stratum II	Stratum III	Stratum IV
25	100	Primary	94.4	69.0	80.5	74.8
24	96		90.7	66.2	77.2	71.8
23	92		86.9	63.5	74.0	68.8
22	88		83.1	60.7	70.8	65.8
21	84		79.3	57.9	67.6	62.8
20	80		75.5	55.2	64.4	59.8
19	76	Degraded	71.8	52.4	61.1	56.8
18	72		68.0	49.7	57.9	53.8
17	68		64.2	46.9	54.7	50.9
16	64		60.4	44.1	51.5	47.9
15	60		56.7	41.4	48.3	44.9
14	56		52.9	38.6	45.1	41.9
13	52	Very Degraded	49.1	35.9	41.8	38.9
12	48		45.3	33.1	38.6	35.9
11	44		41.5	30.4	35.4	32.9
10	40		37.8	27.6	32.2	29.9
9	36		34.0	24.8	29.0	26.9

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		8	32		30.2	22.1	25.7	23.9

QA/QC procedures applied

Not applicable at the moment, due to the approach used to calculate the data.

The assumption was used when the recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from degraded forest to primary forest and from very highly degraded forest to degraded forest is quantified.

Uncertainty associated with this parameter:

Table 54. Standard deviation values to be used to model forest degradation recovery valuesCarbon Layer	Category	Median	Standard deviation
Stratum I	Primary	107.64	6.26
	Degraded	73.19	7.04
	Very degraded	47.36	5.16
Stratum II	Primary	105.74	6.33
	Degraded	71.90	6.45
	Very degraded	50.76	5.84
Stratum III	Primary	87.10	3.51
	Degraded	59.22	6.03
	Very degraded	41.81	5.78
Stratum IV	Primary	83.63	4.82
	Degraded	56.87	5.78
	Very degraded	40.14	4.91

These are the values corresponding to the forest carbon content that arise from the Montecarlo Model.

Any comment:

To access the documents and calculations related to this activity, consult the following link:

Methodological report:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Database to build the carbon strata of Guatemala:
https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view?usp=sharing
Shapefile:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view?usp=sharing

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<table>
<tr><td>Parameter:</td><td>Removals due to increased carbon through forest plantations (AAI)</td></tr>
<tr><td>Description:</td><td>Carbon content that is recovered through the implementation of coniferous and broadleaf plantations.</td></tr>
<tr><td>Data unit:</td><td>Tons of carbon per hectare</td></tr>
<tr><td>Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):</td><td>
To estimate this data, data from growth curves taken from 28 species of trees in forest plantations in Guatemala were used (INAB 2014). These results come from the assessment of sampling units called “Permanent Forest Measurement Plots (PPMF, for its acronym in Spanish),” which are distributed in 90 municipalities within the 22 departments of Guatemala, and their location is due to the behavior of the geographical distribution of the forest plantations established mainly with the PINFOR Forestry Incentive Program of the National Forest Institute (INAB) since 1998.

The Average Annual Growth Increments (AAGIs) were obtained by dividing the forest species by type of forest (broadleaf and coniferous), identifying which type of forest each forest species belongs to. Robust estimates of AAGIs for broadleaf and coniferous forests were generated from the Permanent Forest Measurement Plots (PPMF) database. The best fitted functions to probability density data (PDD) are normal for broadleaf forests and gamma for coniferous forests. Monte Carlo simulations were performed on these distributions to make more precise estimates and the final values of the AAGIs were calculated. Table 55 show the AAGIs for each plantation type in Guatemala.

Table 55. AAGI for each type of forest plantation.
<table>
<tr><th>Capture factor</th><th>Median (m^3 ha^{-1} $year^{-1}$)</th></tr>
<tr><td>AAGI in broadleaf forest</td><td>3.43</td></tr>
<tr><td>AAGI in coniferous forest</td><td>7.88</td></tr>
</table>

The document called “Wood Densities of Tropical Tree Species” was used for the selection of wood densities. It contains a scientific study of tree densities in tropical forests in America. Also, as support and by way of comparison, the document “Conifers of Guatemala” was used, which contains densities of tree species belonging to the coniferous forest group (DATAFORG 2000, Reyes et al. 1992).

With the ordered basic density data, an average wood density was obtained for the broadleaf and coniferous forest. To obtain the average wood density for each type of forest, the species belonging to each tree community were identified and the arithmetic mean was calculated (See Table 56)

Table 56. Wood density according to the different types of plantations.
<table>
<tr><th>Type of forest</th><th>Density g/cm^3</th></tr>
<tr><td>Broadleaf Forests</td><td>0.58</td></tr>
<tr><td>Coniferous Forests</td><td>0.58</td></tr>
</table>
</td></tr>
</table>

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	Biomass Expansion Factors (BEFs) are added to these values, which correspond to the ratio between aerial biomass and below-ground biomass (AB:BB) and the carbon fraction (CF), with IPCC default values, as shown below (See **Table 57**). Table 57. Expansion factors, below-ground aerial biomass ratio and carbon fraction for forest plantations. BEF / AB:BB / CF Broadleaf Forest: 1.50 / 0.2 / 0.47 Coniferous Forest: 1.20 / 0.2 / 0.47 Finally, the carbon per hectare per year data is converted to a COe_{q2} removal or absorption factor by multiplying it by the IPCC default factor of 44/12. Once all the calculations have been made, the values for plantations in broadleaf forests and plantations in coniferous forests are obtained Table 58
Value applied:	Carbon above and below ground Table 58. Values for plantations in broadleaf forests and plantations in coniferous forests **Classification** / **RF (tC/ha)** / **RF (t CO_{2eq}/ha)** Broadleaf Forest: 1.76 / 6.47 Coniferous Forest: 3.24 / 11.89
QA/QC procedures applied:	Not applicable at the moment, due to the approach used to calculate the data. The following criteria were used to filter the information on forest plantations: • Records of plantation initiation between the years 2001 to 2010. • Agroforestry systems and reforestation modality (on the recommendation of Winrock International's advisors, the quantification of existing areas of • Agroforestry Systems within the PINPEP forestry incentive, as these are incentivized areas that are sequestering carbon). • The records should contain location polygon not points. • Plantation area in hectares for each record. Based on the criteria described above, the data was cleaned and selected using software for geographic data management. For more information, in the any comments section you can find the protocol to calculate the IMA.
Uncertainty associated with this parameter:	Table 59. Uncertainty of carbon contents in lands that are recovered through forest plantations.

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		Classification	**Broadleaf Forest**	**Coniferous Forest**	
		Median	37,823	85,258	
		Average	82,184	101,185	
		Deviation	22,808,404,571	4,778,004,942	
		CI – lower limit	3,088	14,698	
		CI – upper limit	414,596	271,351	
		%	536	148	
Any comment:	To consult the data, you can do it through this link: Database: https://drive.google.com/drive/folders/1QFuxCTGlG_qJXF4JLCOvxUWVugyRr8HX?usp=drive_link Document: https://drive.google.com/file/d/1tS8nzi-YIzMB-JWCCuH94vk2p_WwPEGc/view?usp=drive_link				

8.4 Estimated Reference Level

Calculation of the average annual historical emissions over the Reference Period

Accreditation period year *t*	**Annual average of historical emissions derived from deforestation during the Reference Period (tCO_{2eq}/year)**	**If applicable, annual average of historic emissions from forest degradation during the Reference Period (tCO_{2eq}/year)**	**If applicable, annual average of historical removals by sinks during the Reference Period (tCO_{2eq}/year)**	**Adjustment, if applicable (tCO_{2eq}/year)**	**Reference level (tCO_{2eq}/year)**
2020	6,585,053	3,099,806	-2,271,827		7,413,032
2021	6,585,053	3,099,806	-2,271,827		7,413,032
2022	6,585,053	3,099,806	-2,271,827		7,413,032
2023	6,585,053	3,099,806	-2,271,827		7,413,032
2024	6,585,053	3,099,806	-2,271,827		7,413,032

The reference level of the Guatemalan Emission Reduction Program in deforestation, degradation and carbon increases was calculated using the baseline presented in the ERPD, which covers 11.08 years, from 2006 to 2016. Within the ERPA agreement, it is estimated that each year there is a net emission of around 7,413,032tons of CO_{2eq}/year.

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The sampling approach was used, with which the activity data were created, and the information generated through the carbon strata of Guatemala was used to obtain information on above and below-ground biomass. A literature review was also done to obtain data on carbon content factors for non-forest uses.

8.5 Upward or downward adjustments to the average annual historical emissions over the Reference Period (if applicable)

Explanation and justification of proposed upward or downward adjustment to the average annual historical emissions over the Reference Period

No adjustments have been made to the reference period.

Quantification of the proposed upward or downward adjustment to the average annual historical emissions over the Reference Period

Not applicable.

8.6 Relation between the Reference Level, the development of a FREL/FRL for the UNFCCC and the country's existing or emerging greenhouse gas inventory

Guatemala has a reference level in the UNFCCC that has been recently presented in the month of February 2022 and which maintains coherence and consistency with the FREL that is subject to an ERPA before the FCPF, since the same activity data and emission/absorption factors were used. The difference between the two reference levels is that the one presented to the UNFCCC is at the national level, so it includes the points of the areas excluded from the ERP under the ERPA, which are the Candelaria triangle and the municipalities of Izabal. The fact that both reference levels have been calculated in the same way allows reinforcing and implementing the country's REDD+ Strategy.

It is also important to mention that the activity data and emission and absorption factors used in these reference levels are the same as those used for the LULUCF sector in the GHGIs presented in the Third National Communication on Climate Change. This allows for the coherence and consistency of national data and processes to be maintained. The difference between the reference levels and the GHGIs is that the GHGIs include additional activities that are not considered in the REDD+ framework.

9 APPROACH FOR MEASUREMENT, MONITORING AND REPORTING

9.1 Measurement, monitoring and reporting approach for estimating emissions occurring under the ER Program within the Accounting Area

>> The MRV system of the forest sector has been built according to the capacities in the country, and based on existing platforms, studies, data and processes, considering a diversity of governmental and non-governmental institutions, including academia, research centers and civil society organizations. In addition, it is based on the current legal frameworks: Forestry Law (Decree 101-96), Law of Protected Areas (Decree 4-89), and the Framework Law to Regulate the Reduction of Vulnerability, the Mandatory Adaptation to the Effects of Climate Change and Greenhouse Gas Mitigation (Decree 7-2013). These laws mandate the different government institutions to collect and process information according to their scope of action.

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The ERPA MRV system is part of this forest sector MRV system. For the implementation of this specific system, it is considered that it will be coordinated by INAB, as the Executing Unit of the Program, with the support of the Working Group for the Preparation of the First ER Report of Guatemala and integrated by technical staff from the GIS units and the climate change units/departments/ directorates of the institutions of the GCI, as well as by representatives of REDD+ projects. The preparation of this report was complemented with the support of specialists from U*niversidad del Valle de Guatemala* for the carbon accounting section.

All the information generated by the different institutions was integrated and systematized by INAB within the framework of the ERPA of the ER Program under the FCPF. In this sense, INAB has been an integrating unit and generator of the reports before the FCPF. It is in close coordination with MARN, as focal point before the UNFCCC, to ensure consistency between the information generated in the framework of the ERP and what is reported for other initiatives and commitments under the United Nations Framework Convention on Climate Change (UNFCCC), including GHG inventories for the LULUCF sector. It is important to point out that each government institution participating in the development of data for the preparation of the First Emissions Reduction Monitoring Report provides different inputs according to their competencies and existing and current inputs.

Table 60. Participating institutions in the elaboration of the First Emissions Reduction Reporting Report and the inputs provided.

Institution	**Inputs**
INAB / Emission Reduction Program Executing Entity (Coordinator, Technical coordinator, departments of GIS and Climate change)	Coordinate ER monitoring report integration
	Forest Cover Maps (in collaboration with CONAP).
	National Forest Inventory.
	List with information and maps/polygons on the areas subject to incentives by PINPEP, PINFOR, and PROBOSQUE.
	Data, maps and/or polygons linked to the use of firewood and legal and illegal selective logging.
	Estimation of average annual increments (AAI), and removals due to increased carbon stocks at the national level, through forest management and reforestation (management of natural forests, plantations, AFSs, forestry incentives) and natural regeneration.
	Emission factors for degradation and Removal factors for increases in carbon stocks.
	Participate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.
CONAP / Climate Change Unit and the Geospatial Analysis Directorate, Center for Evaluation and Monitoring (CEMEC) located in Petén	Forest Cover Maps (in collaboration with INAB) Forest fires data Participate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.
MAGA / Geographic, Strategic Information and Risk Management and Climate Change Unit	Develop ancillary data such as vegetation cover and land use maps, for a potential estimate of carbon in the land uses. Support monitoring report integration.

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Institution	Inputs
MARN / Science and Metrics Department and the Mitigation Department of the Climate Change Unit, as well as in the Environmental Information and Climate Change Unit.	Reference Level of National Emissions for the Forest Sector and other land uses.
	Staff to standardize and ensure that there is consistency in the data presented in the ERP before the FCPF, the Greenhouse Gas Inventories (GHGIs), the reference level presented to the UNFCCC and the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions. Coordinate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.
REDD+ Projects Guatecarbon, Forests for Life, Networks for Local Development (REDDES)	Technical staff
	Data from REDD+ projects, polygon activities, etc.
	Community monitoring data.
	Relevant scientific studies and research.
	Complaints linked to drivers of deforestation and forest degradation.
Universidad del Valle de Guatemala	Support on carbon accounting, data processing. Support on visual interpretation of sample units of the national grid for generating LULUC Activity Data. Support on ER monitoring report development. Support on uncertainty and sensitivity analysis.

Regarding the monitoring report, the Working Group for the Preparation of the First ER Report of Guatemala processes the information and results of the estimates resulting from the analysis of the activity data and emission factors during the period of the ER Program and then, subsequently transfers them to INAB so that it prepares the report to the FCPF (Figure 7). In turn, INAB transfers them to MARN for the report to the UNFCCC.

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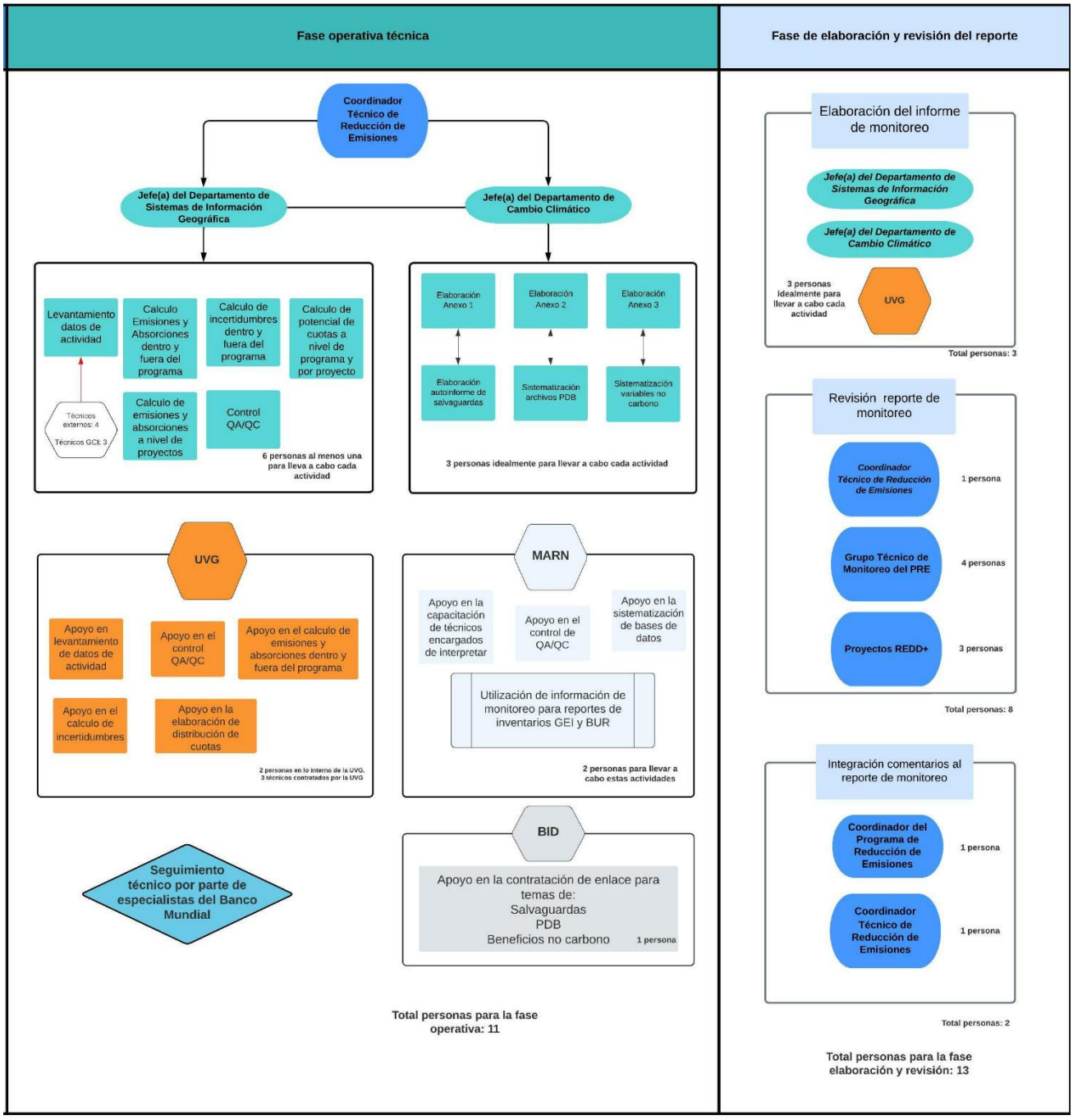

Figure 5. Process for the elaboration of the monitoring, validation and reporting report

Line diagrams

The following diagram (Figure 8) shows the different components of the MRV System of the emission reduction program under the FCPF, where the main activities related to the generation of activity data, the estimation of emission/removal factors and the calculation of emissions and removals to obtain the emission reductions for the year of interest are presented. This line diagram is complemented by Figure 3, which details those responsible for the preparation of carbon accounting, safeguards, benefit sharing plan and non-carbon variables. The line diagram shows the step by step (seven steps in total) of each of the steps that are needed to have as a result the emission reductions for the monitoring period.

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For the process of calculating emissions reductions, the line diagram is intended to show the different processes from the generation of activity data, the allocation of carbon content, obtaining the emission and removal factors to obtain the emissions and removals of the reference level and the first monitoring. These processes are in charge of the head of the Geographic Information Systems unit of INAB with technical support from UVG.

Each step of the line diagram is described below:

- Step 1 Sample Base Area Estimation:

Consists of the use of the collect earth tool which allows us to use the high-resolution images available in the Google Earth catalog. The tool also has external support to consult Planet, Sentinel and Landsat images, as well as to consult vegetation indexes. The document can be accessed:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

- Step 2 Visual interpretation of the CEP form:

In this step the visual interpretation of the 11,354 sample points that are randomly distributed in Guatemala is performed. The collect earth form allows to establish the coverage and use for the current year, as well as to establish the coverage of the previous year. It also assigns whether the plot is a permanence or change in use, in addition to recording the date of the images used. The database is then exported and transformed from a comma-separated format to an Excel file. The form can be accessed through this link:

Methodological protocol:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

Point grid:
https://drive.google.com/drive/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC

CEP: https://drive.google.com/drive/folders/1IhxjFz5gPGKg-qCbXXBwU9cDOSnQ0E5m?usp=drive_link

- Intermediate step Prepare emission factors:

In this step we proceed to assign to each of the plots in Guatemala, the forest content stratum to the plots this with the objective of identifying the plots that had a change of use and to know the carbon content prior to deforestation or degradation.

The carbon layer map can be accessed through this link:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view
(Open with ArcGIS)

The methodological protocol document can be accessed through this link:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Step 3 Area estimation:
For the area estimation, each plot was weighted with the total number of plots in the country, and then the WI weight was multiplied with the total area of Guatemala to obtain hectares. After this, dynamic tables can be made to know the areas for each of the REDD+ activities that Guatemala has. The area can be found in the file "NR_MallaPuntos_Escenario_7_MC2025_05_vg.
The document can be accessed through this link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 4 Allocation of emission factors:

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To establish the emission factors, forest strata were used to categorize the plot into primary forest, degraded forest and highly degraded forest based on the number of elements in the plot. Once the stratum is identified, the carbon content is established based on the forest stratum in which it is located and the stratum of the carbon map in which the plot is located. Additionally, the non-forest carbon content is also established in case there is a change in land use. The carbon calculation is found in column BQ for the year 2006, column BU for the year 2016 and column CA for the year 2020. The file to consult this information is called:

"NR_MallaPuntos_Escenario_7_MC2025_05_vg".

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 5: Calculation of CO2/year per activity

To calculate the CO2 per year for each activity, the excel file called "NR_MallaPuntos_Escenario_7_MC2025_05_vg" Each point of the mesh had its carbon content calculated.

The excel file can be consulted at the following link:

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 6 Calculation of emissions/removals:

For the calculation of emissions and removals we proceed to create a pivot table using the data from the "Malla" tab of the excel file "NR_MallaPuntos_Escenario_7_MC2025_05_vg" using the columns in which the REDD+ activities that Guatemala monitored were identified. The next step is also to create a dynamic table for the first reporting period of Guatemala also using the "Malla" tab and accounting the emissions for this reporting period These calculations can be found in the tab "TablaD"

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

- Step 7 Emission reduction calculation:

After the pivot tables are created, a table is created by subtracting the reference level REDD+ activities minus the REDD+ activities of the first reporting period to obtain the total reductions. These calculations can be found in the "Table D" tab.

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

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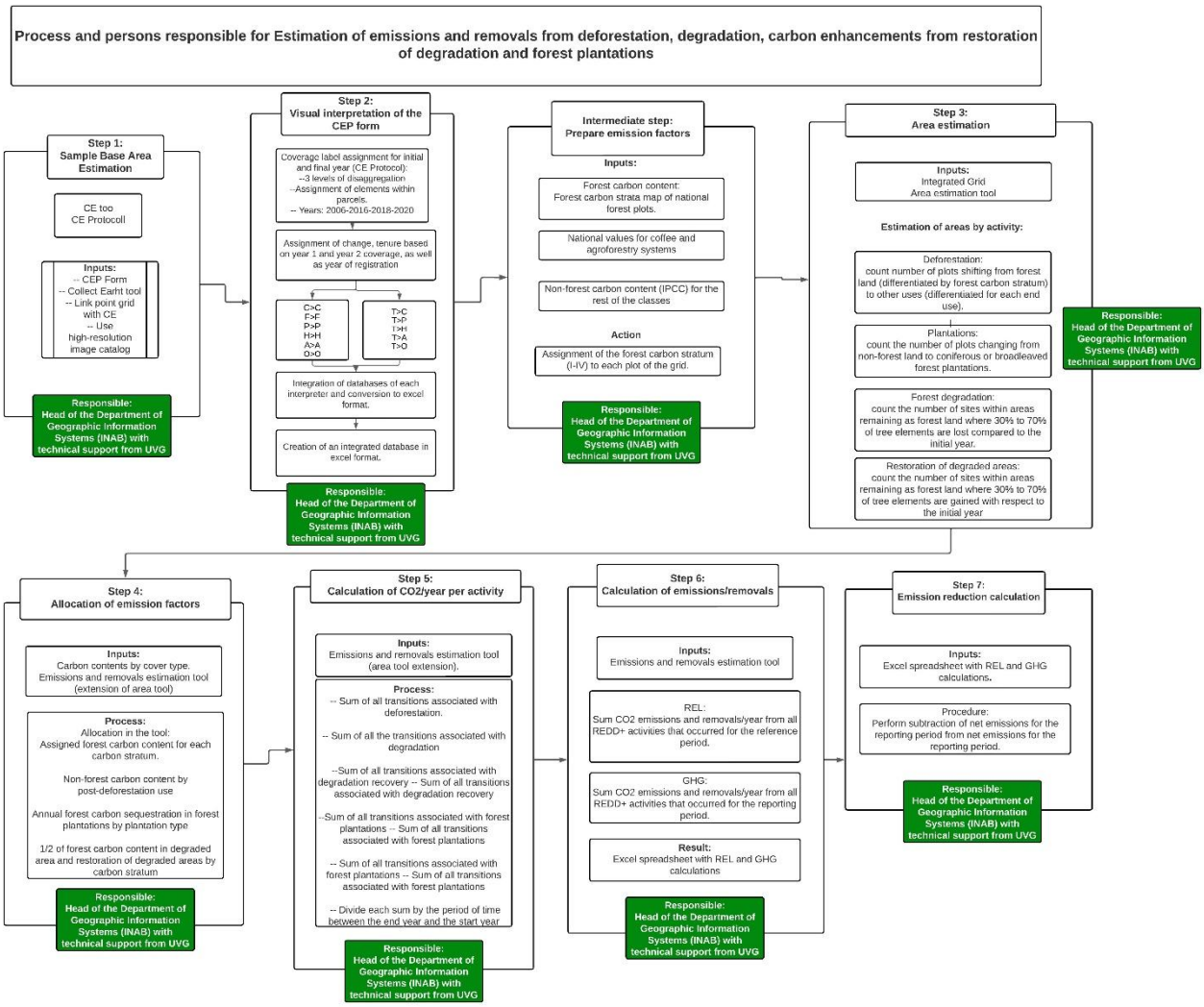

Figure 6. Components for calculating the program's emission reductions.

Calculation steps

The RL estimation may be found here, yet a description of the equations is provided below. RL was defined as the net annual average historical emissions [52]. Annual emissions or absorptions were estimated for all land transitions by REDD+ activity, and then adding the results for all selected REDD+ activities for each year.

The REDD+ activities that are included in the reference level for Guatemala are:

- Emissions from deforestation and forest degradation.
- Absorptions from increases in forest stock that may be due to recovery of forest degradation and forest plantations.

Equation:

[52] The Reference Level has 10 years because 2006 is considered the base year of the land cover status, and from 2007 onwards, emissions occurring from 2007 until 2016, which is considered the final year of the Reference Level, are reviewed and quantified, so when it comes to accounting, it is a total of 10 years.

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$$\mathbf{RL=(Def+deg)-(Incr)} = (\mathbf{E_{DEF}+E_{DEG}}) - (\mathbf{R_{rec}+R_{pla}}) = ((\mathbf{ADef} * \mathbf{FE}) + (\mathbf{ADdeg} * \mathbf{FE}) - (\mathbf{Rrec} * \mathbf{FA}) - (\mathbf{Rpla} * \mathbf{FA}))$$

Where:

RL	=	Reference Level
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from degradation
$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE	=	Emission factors for deforestation and degradation.
FA	=	absorption factors for carbon increases in forest biomass.

To determine the emissions of the reference level, the first step is to calculate the information from the activity data and then make the estimate in tons of CO_2 equivalent.

Below you will find the links to the files to estimate the activity data, as well as the emissions and removals of the reference level.

- File containing the estimates of emissions and removals for each of the REDD+ activities:
- File that contains the information of the point grid with its categories of land use:

3.2. Reference level activity data

3.2.1. Activity Data of deforestation

To determine the activity data, a random mesh was used consisting of 11,354 plots for the entire country and 10,414 plots for the program area. Each plot has a total of 25 elements and the use is determined by the coverage that predominates.

Equation 3:

$$AD_{def} = \left(\frac{N_{def}}{N_{Total}}\right) * T$$

Where:

AD_{def}	=	Data derived from deforestation
N_{def}	=	Number of plots that were interpreted as deforestation in the period studied and that are categorized according to the number of tree elements, and these categories are: • Primary forest: 20 to 25 trees per plot. • Degraded forest: 14 to 19 trees per plot. • Highly degraded forest: 8 to 13 trees per plot.
N_{Total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.2.2. Activity data for degradation

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Equation 4:

$$AD_{deg} = \left(\frac{N_{deg}}{N_{total}}\right) * T$$

Where:

AD_{deg}	=	Activity data derived from forest degradation
N_{deg}	=	Number of plots of forest remaining forest where Forest degradation occurring within the plots remaining as forest permanence and moving from primary forest to degraded forest, from primary forest to highly degraded forest, and from degraded forest to highly degraded forest is quantified.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.2.3. Forest degradation recovery activity data

Equation 5:

$$AD_{rec} = \left(\frac{N_{rec}}{N_{total}}\right) * T$$

Where:

AD_{rec}	=	Activity data derived from recovery from forest degradation
ND_{rec}	=	Number of plots of The recovery of forest degradation occurring within the plots that remain as forest permanence from degraded forest to primary forest, from very degraded forest to primary forest and from highly degraded forest to degraded forest is quantified
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.2.4. Increases for forest plantations

Equation 6:

$$AD_{pla} = \left(\frac{N_{pla}}{N_{total}}\right) * T$$

Where:

AD_{pla}	=	Activity data for reforestation through forest plantations
N_{pla}	=	Number of plots that goes from non-forest lands to forest plantations
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.2.5. Activity data for forest land maintained as forest land

Equation 7:

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$$AD_f = \left(\frac{N_f}{N_{total}}\right) * T$$

This formula is used to find out if the forest plots have undergone a degradation process or a degradation recovery process.
Where:

AD_f	=	Activity data for forest land maintained as forest land
N_f	=	Number of plots that are categorized as forest that remain as forest.
N_{total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

3.3. Reference level emission and removal data

3.3.1. Emissions from Deforestation

Equation 8:

$$\text{Edef} = \sum_{j,i} \left((C_{for} - C_{nofor}) \times \frac{44}{12} \times A(j,i) \right) / RP$$

Where:

Edef	=	Emissions caused by deforestation (tCO2 per year)
$\underline{A}_{(j,i)RP}$	=	Area from activity data that has been converted from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, Guatemala, the forests have a division based on four carbon strata: • Stratum I • Stratum II • Stratum III • Stratum IV Ten types of non-forest land are considered: • Cropland (C): What are annual crops, African palm, rubber and coffee. What are annual crops, African palm, rubber and coffee. • Agroforestry systems such as shade-grown coffee was separated. • Grassland (P); • Wetland (A); • Settlement (U); and • Other lands (O).
$\underline{C}_{for}$	=	Total forest carbon content of each strata j before conversion/transition, in tons of carbon per ha.
$\underline{C}_{nofor}$	=	Total non-forest carbon content of each non-forest land use i after conversion, in tons of carbon per ha.
44/12	=	Conversion of C to CO_2
RP	=	Years consisting of the reference period

The conversions identified for the reference level for Guatemala are the following:

Category	Activity

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Primary	Forest Land I to Settlements
Primary	Forest Land I to Other Land
Primary	Forest Land I to Grasslands
Primary	Forest Land I to Annual Crops
Primary	Forest Land I to Agricultural Land-Other
Primary	Forest Land I to Agricultural Oilland
Primary	Forest Lands I to agroforestry systems
Primary	Forest Lands II to Other Lands
Primary	Forest Lands II to Grasslands
Primary	Forest Land II to Annual Crops
Primary	Forest Land II to Agricultural Land-Other
Primary	Forest Land II to Agricultural Lands-Rubber
Primary	Forest Lands II to Agricultural Lands-African Palm
Primary	Forest Land II to agroforestry systems
Primary	Forest Land III a Settlements
Primary	Forest land III to Grasslands
Primary	Forest Land III to Crops-Annuals
Primary	Forest Lands III to agroforestry systems
Primary	Forest Lands IV to Other Lands
Primary	Forest Lands IV to Grasslands
Primary	Forest Land IV to Annual Crops
Primary	Forest Lands IV to Agricultural Lands-Coffee
Primary	Forest Land IV to Agricultural Land-Other
Primary	Forest Land IV to Agricultural Lands-Rubber
Primary	Forest Lands IV to Agricultural Lands-African Palm
Primary	Forest Lands IV to agroforestry systems
Degraded	Forest Land I to Grasslands
Degraded	Forest Land I to Agricultural Land-Other
Degraded	Forest Lands I to agroforestry systems
Degraded	Forest Lands II to Grasslands
Degraded	Forest Land II to Annual Crops
Degraded	Forest Land II to agroforestry systems
Degraded	Forest land III to Grasslands
Degraded	Forest Land III to Crops-Annuals
Degraded	Forest Lands III to agroforestry systems
Degraded	Forest Land IV to Settlements
Degraded	Forest Lands IV to Grasslands
Degraded	Forest Land IV to Annual Crops
Degraded	Forest Lands IV to Agricultural Lands-African Palm
Very degraded	Forest Land I to Annual Crops
Very degraded	Forest Land I to Agricultural Lands-Coffee
Very degraded	Forest Lands II to Grasslands
Very degraded	Forest Land II to Annual Crops

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Very degraded	Forest Land III a Settlements
Very degraded	Forest Lands II to Wetlands and Water Bodies
Very degraded	Forest Lands III to agroforestry systems
Very degraded	Forest Lands IV to Grasslands
Very degraded	Forest Land IV to Annual Crops
Very degraded	Forest Land IV to Agricultural Land-Other
Very degraded	Forest Lands IV to Agricultural Lands-African Palm
	Planting to pastures II
	Planting to pastures III
	Planting to pastures IV
	Planting to annual crops IV
	Plantation of coffee crops

The following tables show the forest carbon content as well as the content of other non-forest land uses. The origin of each of the values is shown in more detail in Chapter 3 and the respective sections of the report (Annex 4 and 5).

Forest carbon content

Stratum	Forest carbon content – Cfor-- (Ton/ha)
Forest I	107.6
Forest II	105.7
Forest III	87.1
Forest IV	83.6

Non-forest carbon content

Non forest land Use	Non forest carbon content – Cnofor-- (Ton/ha/yr)
Croplands (all classes not specified) and grasslands	4.7
Croplands-Coffee (intensive)	2.65
Croplands-African Palm	3.47
Croplands-Rubber	4.30
Non forest land Use	**Ton Carbon/ha/**
Agroforestry systems (shaded coffee)	20.1
Grasslands	6.73
Settlements	0
Wetlands	0
Other lands	0

3.3.2. Emissions from degradation

Equation 9:

$$Edeg = \sum_{\mathbf{j,i}} ((\mathrm{Cfor} - \mathrm{Cdeg}) \times \frac{44}{12} \times \mathrm{A(j,i)} \ ) / RP$$

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Where:

Edeg = Emissions caused by forest degradation in hectares per year

$\underline{A}_{(j,i)RP}$ = Activity data area that has undergone a degradation process within the forest cover during the reference period, in hectares per year. In the case of Guatemala, the analysis of forest degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Cfor = Total forest carbon content of each forest type j before conversion/transition, in tons of carbon per ha.

Cdeg = Forest carbon content of each degradated forest type j, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

3.3.3. Removals from forest degradation recovery

Equation 10:

$$Edeg = \sum_{j,i} ((\text{Cdeg} - \text{C}_{\text{for}}) \text{ x } \frac{44}{12} \times \text{A(j,i)})/RP$$

Where:

Rrec = Removals obtained from the recovery of forest degradation in hectares per year

$\underline{A}_{(j,i)RP}$ = Area that has had a recovery from degradation within the forest cover during the reference period, in hectares per year. In the case of Guatemala, the analysis of forest recovery degradation was made for the four strata that Guatemala has.

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Cdeg = Forest carbon content of each degradated forest type j, in tons of carbon per ha.

Cfor = Total forest carbon content of each forest type j before conversion/transition, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

3.3.4. Removals due to increased carbon through forest plantations

Equation 11:

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$$Rpla = \sum_{\mathbf{j,i}} ((AAI) \text{ x } \frac{44}{12} \times \text{A(j, i)} \ \ )/RP$$

Where:

Rpla = Removals obtained by the establishment of forest plantations in hectares per year

$A_{(j,i)RP}$ = Area that has been identified as forest plantation. In the case of Guatemala, two types of plantations are managed:

- Broadleaf Plantation
- Conifer plantation

AAI = Average annual increase that was identified for each of the types of forest plantations, in this case:

- Broadleaf plantations
- Coniferous plantations

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

Parameters to be monitored

Parameter:	Deforestation
Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 13
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	For deforestation, the land representation categories being used are those according to the IPCC categories. Table 61. Deforestation within the monitoring period and the reporting period

Category	Category	Ha	Ha/Year
Primary	Forest Land I to Settlements	-	-
Primary	Forest Land I to Other Land	959.92	479.96
Primary	Forest Land I to Grasslands	-	-
Primary	Forest Land I to Annual Crops	-	-
Primary	Forest Land I to Agricultural Lands-Coffee	-	-
Primary	Forest Land I to Agricultural Land-Other	-	-
Primary	Forest Land I to Agricultural Oilland	-	-
Primary	Forest Land I to Agricultural Land-African Palm	-	-
Primary	Forest Lands I to agroforestry systems	-	-
Primary	Forest Lands II to Settlements	-	-
Primary	Forest Lands II to Other Lands	-	-
Primary	Forest Lands II to Grasslands	3,839.67	1,919.84
Primary	Forest Land II to Annual Crops	-	-
Primary	Forest Land II to Agricultural Lands-Coffee	-	-
Primary	Forest Land II to Agricultural Land-Other	-	-
Primary	Forest Land II to Agricultural Lands-Rubber	-	-

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		Primary	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Primary	Forest Land II to agroforestry systems	-	-	
		Primary	Forest Land III a Settlements	-	-	
		Primary	Forest Land III to Other Land	-	-	
		Primary	Forest land III to Grasslands	5,759.51	2,879.75	
		Primary	Forest Land III to Crops-Annuals	959.92	479.96	
		Primary	Forest land III to agricultural land-coffee	-	-	
		Primary	Forest Land III to Agricultural Lands-Rubber	-	-	
		Primary	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Primary	Forest Lands III to agroforestry systems	959.92	479.96	
		Primary	Forest Land IV to Settlements	959.92	479.96	
		Primary	Forest Lands IV to Other Lands	1,919.84	959.92	
		Primary	Forest Lands IV to Grasslands	3,839.67	1,919.84	
		Primary	Forest Land IV to Annual Crops	959.92	479.96	
		Primary	Forest Lands IV to Agricultural Lands-Coffee	-	-	
		Primary	Forest Land IV to Agricultural Land-Other	-	-	
		Primary	Forest Land IV to Agricultural Lands-Rubber	-	-	
		Primary	Forest Lands IV to Agricultural Lands-African Palm	-	-	
		Primary	Forest Lands IV to agroforestry systems	-	-	
		Degraded	Forest Land I to Settlements	-	-	
		Degraded	Forest Land I to Other Land	-	-	
		Degraded	Forest Land I to Grasslands	1,919.84	959.92	
		Degraded	Forest Land I to Annual Crops	-	-	
		Degraded	Forest Land I to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land I to Agricultural Land-Other	-	-	
		Degraded	Forest Land I to Agricultural Oilland	-	-	
		Degraded	Forest Land I to Agricultural Land-African Palm	-	-	
		Degraded	Forest Lands I to agroforestry systems	-	-	
		Degraded	Forest Lands II to Settlements	-	-	
		Degraded	Forest Lands II to Other Lands	-	-	
		Degraded	Forest Lands II to Grasslands	1,919.84	959.92	
		Degraded	Forest Land II to Annual Crops	-	-	
		Degraded	Forest Land II to Agricultural Lands-Coffee	-	-	
		Degraded	Forest Land II to Agricultural Land-Other	-	-	
		Degraded	Forest Land II to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands II to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Land II to agroforestry systems	-	-	
		Degraded	Forest Land III a Settlements	-	-	
		Degraded	Forest Land III to Other Land	-	-	
		Degraded	Forest land III to Grasslands	2,879.75	1,439.88	
		Degraded	Forest Land III to Crops-Annuals	-	-	
		Degraded	Forest land III to agricultural land-coffee	-	-	
		Degraded	Forest Land III to Agricultural Lands-Rubber	-	-	
		Degraded	Forest Lands III to Agricultural Lands-African Palm	-	-	
		Degraded	Forest Lands III to agroforestry systems	-	-	
		Degraded	Forest Land IV to Settlements	-	-	
		Degraded	Forest Lands IV to Other Lands	-	-	
		Degraded	Forest Lands IV to Grasslands	1,919.84	959.92	
		Degraded	Forest Land IV to Annual Crops	-	-	

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Degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-
Degraded	Forest Land IV to Agricultural Land-Other	-	-
Degraded	Forest Land IV to Agricultural Lands-Rubber	-	-
Degraded	Forest Lands IV to Agricultural Lands-African Palm	-	-
Degraded	Forest Lands IV to agroforestry systems	959.92	479.96
Very degraded	Forest Land I to Settlements	-	-
Very degraded	Forest Land I to Other Land	-	-
Very degraded	Forest Land I to Grasslands	-	-
Very degraded	Forest Land I to Annual Crops	-	-
Very degraded	Forest Land I to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land I to Agricultural Land-Other	-	-
Very degraded	Forest Land I to Agricultural Oilland	-	-
Very degraded	Forest Land I to Agricultural Land-African Palm	-	-
Very degraded	Forest Lands I to agroforestry systems	-	-
Very degraded	Forest Lands II to Settlements	-	-
Very degraded	Forest Lands II to Other Lands	-	-
Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-
Very degraded	Forest Lands II to Grasslands	-	-
Very degraded	Forest Land II to Annual Crops	-	-
Very degraded	Forest Land II to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land II to Agricultural Land-Other	-	-
Very degraded	Forest Land II to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands II to Agricultural Lands-African Palm	-	-
Very degraded	Forest Land II to agroforestry systems	-	-
Very degraded	Forest Land III a Settlements	-	-
Very degraded	Forest Land III to Other Land	-	-
Very degraded	Forest Lands II to Wetlands and Water Bodies	-	-
Very degraded	Forest land III to Grasslands	1,919.84	959.92
Very degraded	Forest Land III to Crops-Annuals	-	-
Very degraded	Forest land III to agricultural land-coffee	-	-
Very degraded	Forest land III to agricultural land-other	-	-
Very degraded	Forest Land III to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands III to Agricultural Lands-African Palm	-	-
Very degraded	Forest Lands III to agroforestry systems	-	-
Very degraded	Forest Land IV to Settlements	-	-
Very degraded	Forest Lands IV to Other Lands	-	-
Very degraded	Forest Lands IV to Grasslands	-	-
Very degraded	Forest Lands IV a Wetlands and Water Bodies	-	-
Very degraded	Forest Land IV to Annual Crops	-	-
Very degraded	Forest Lands IV to Agricultural Lands-Coffee	-	-
Very degraded	Forest Land IV to Agricultural Land-Other	-	-
Very degraded	Forest Land IV to Agricultural Lands-Rubber	-	-
Very degraded	Forest Lands IV to Agricultural Lands-African Palm	959.92	479.96
Very degraded	Forest Lands IV to agroforestry systems	-	-
Total		**32,637.21**	**16,318.60**

For monitoring, a total of 35 deforestation points were identified, which is equivalent to a total of 32,637.21 and an annual deforestation rate of 16,318.60 for the reporting period.

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	For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Within the tab "Tables_PM_Report".
Source of data and description of measurement/calculation methods and procedures applied:	To generate the deforestation activity data, the Collect Earth platform was used to collect information on land cover and use in the years of interest. Guatemala uses the IPCC classification to determine land use in each plot, following a methodological protocol that hierarchizes land use into three levels. This protocol is available at the following link. Deforestation monitoring covered the state of land cover and use during 2018 and 2020, covering a two-year period, and was reported for the year 2020. During this time, high- and medium-resolution images were consulted. Plots were identified that, between 2018 and 2020, lost all their forest cover or suffered a degradation of more than 70% of their trees. Subsequently, the loss in hectares was calculated, annualizing it to obtain the 2020 data. After analyzing 11,354 sampling points nationwide, those that showed deforestation were filtered, identifying 35 plots equivalent to 32,637.21 hectares during the monitoring period, and 16,318.60 hectares annually for the reporting period. In addition, the number of trees per plot was counted to classify the forest into: • Primary forest: 20 to 25 trees per plot. • Degraded forest: 14 to 19 trees per plot. • Highly degraded forest: 8 to 13 trees per plot. Then, the carbon content was calculated based on the trees present. For example, a plot with 17 trees represents 68% of the total and, according to the stratum map, in Stratum I with 94 TonC/ha, it would have 60.16 TonC/ha. If the plot was converted to agricultural land with 4.7 TonC/ha, the carbon loss would be 55.46 TonC/ha. This method allows deforestation to be quantified proportionally, not only according to the carbon assigned by the strata map. Finally, the main deforestation changes were grouped
QA/QC procedures applied:	A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated. For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty for this parameter:	Table 62. Uncertainties for deforestation in the monitoring period **DEF-PM-HA-** **Median** 50,403

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	<table><tr><td>**Upper bound 90% CI** (Percentile 0.95)</td><td>65,211</td></tr><tr><td>**Lower bound 90% CI** (Percentile 0.05)</td><td>37,078</td></tr><tr><td>**Half Width Confidence Interval at 90% (B – C / 2)**</td><td>14,067</td></tr><tr><td>**Relative margin (D / A)**</td><td>**28%**</td></tr></table> The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

Parameter:	Degradation
Description:	Degraded forest land The following equations were used to calculate this parameter: Activity data: Equation 14
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	Table 63. Hectares that have been degraded within the 2016-2020 monitoring period and reporting period <table><tr><th>Category</th><th>Ha</th><th>Ha/Year</th></tr><tr><td>Forest Land I Primary A Degraded</td><td>23,997.95</td><td>5,999.49</td></tr><tr><td>Forest Land I Primary To Highly Degraded</td><td>4,799.59</td><td>1,199.90</td></tr><tr><td>Forest Land I Degraded to Very Degraded</td><td>3,839.67</td><td>959.92</td></tr><tr><td>Forest Land II Primary A Degraded</td><td>31,677.29</td><td>7,919.32</td></tr><tr><td>Forest Land II Primary To Very Degraded</td><td>3,839.67</td><td>959.92</td></tr></table>

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Forest Land II Degraded to Very Degraded	8,639.26	2,159.82
Forest Land III Primary A Degraded	23,997.95	5,999.49
Forest Land III Primary To Very Degraded	3,839.67	959.92
Forest Land III Degraded to Severely Degraded	11,519.01	2,879.75
Forest Land IV Primary A Degraded	46,076.06	11,519.01
Forest Land IV Primary to Very Degraded	9,599.18	2,399.79
Forest Land IV Degraded to Severely Degraded	8,639.26	2,159.82
Total	180,464.56	45,116.14

For forest degradation, a monitoring period was used corresponding to the state of land cover that persisted throughout 2016 and the state of land cover that persisted from the year 2020, which covers a period of 4 years and for purposes of reporting the data for the monitoring report the value corresponding to the year 2020 is taken. During this monitoring period, both high and medium resolution images available were consulted.

For forest degradation, a total of 180,464.56 hectares were counted for the period 2016-2020, while for the first reporting period corresponding to the year 2020, the amount of hectares degraded was **45,116.14 ha/year.**

For more information, see the file
"Archivo_Incertidumbres_Para_MonteCarlo_20mayo025_actualizado_"

And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg"

https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link

Within the tab "Tables_PM_Report".

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

To generate the information to quantify forest degradation, Collect Earth was used as a platform for the collection of information for land cover and land use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and land use to each of the plots, a methodological protocol was used that hierarchizes land cover and land use based on the land representation classification used by the IPCC, which can be consulted at the following link:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

To quantify forest degradation, it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered as forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is found, which can be:

- Primary forest: forest that conserves 20 to 25 tree elements within the plot.
- Degraded forest: forest that conserves 14 to 19 tree elements within the plot.
- Very degraded forest: forest that conserves between 8 to 13 tree elements within the plot.

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<table>
<tr><td></td><td>After this identification, the next step is to establish the forest carbon stratum, which is assigned through a map of carbon strata, which are 4 in total. The next step is to establish the amount of carbon that the plot has in a first moment, in this case the year 2016, and then establish the amount of carbon that the plot has in a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the number of tree elements in the plot, as this will establish the amount of carbon before degradation and the amount of carbon after degradation.

For example, a plot has 17 tree elements in a first moment, it is established that it is within a degraded forest, these 17 trees represent 68% of the plot that is in stratum I of the carbon map that has 94TonC/ha, and that in the plot there would be a total of 60.16 TonC/ha. In a second moment this plot goes from 17 tree elements to 12 tree elements, the plot changes its category to a very degraded forest, which represents 48% of the plot's cover and with a carbon content of 45.12 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a total of 15 TonC/ha that were lost due to a degradation process.</td></tr>
<tr><td>QA/QC procedures applied:</td><td>For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.</td></tr>
<tr><td>Uncertainty for this parameter:</td><td>Table 64. Uncertainties of degradation in the monitoring period

<table><tr><th colspan="2">DEG-PM-HA-</th></tr><tr><td>Median</td><td>187,322</td></tr><tr><td>Upper bound 90% CI (Percentile 0.95)</td><td>228,346</td></tr><tr><td>Lower bound 90% CI (Percentile 0.05)</td><td>147,866</td></tr><tr><td>Half Width Confidence Interval at 90% (B – C / 2)</td><td>40,240</td></tr><tr><td>Relative margin (D / A)</td><td>21%</td></tr></table>
The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_
Tab: Table-Report in Spanish.</td></tr>
<tr><td>Any comment:</td><td>To access the documents and calculations related to this activity, consult the following link:

For more information, see the file
“Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_”</td></tr>
</table>

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	And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg” https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

Parameter:	Forest Degradation Recovery
Description:	Land recovered from forest degradation The following equations were used to calculate this parameter: Activity data: Equation 15
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	Table 65. Hectares of forest increments through forest restoration for the monitoring and reporting period.

Category	Ha	Ha/Year
Forest Land I Highly Degraded to Degraded	5,759.51	1,439.88
Forest Land I Highly Degraded to Primary	9,599.18	2,399.79
Forest Land I Degraded to Primary	23,997.95	5,999.49
Forest Land II Highly Degraded to Degraded	19,198.36	4,799.59
Forest Land II Highly Degraded to Primary	12,478.93	3,119.73
Forest Land II Degraded to Primary	71,993.84	17,998.46
Forest Land III Highly Degraded to Degraded	30,717.37	7,679.34
Forest Land II Highly Degraded to Primary	14,398.77	3,599.69
Forest Land III Degraded to Primary	48,955.81	12,238.95
Forest Land IV Highly Degraded to Degraded	43,196.30	10,799.08
Forest Land IV Highly Degraded to Primary	21,118.19	5,279.55
Forest Land IV Degraded to Primary	90,232.28	22,558.07
Total	391,646.50	97,911.62

For forest degradation recovery, a monitoring period was used corresponding to the state of land cover that persisted throughout 2016 and the state of land cover that persisted from the year 2020, which covers a period of 4 years and for purposes of reporting the data for the monitoring report the value corresponding to the year 2020 is taken. During this monitoring period, both high and medium resolution images available were consulted.

For the recovery of degradation, a total of **391,646.50 hectares** were accounted for the period 2016-2020, while for the first reporting corresponding to the year 2020, the number of hectares recovered was **97,911.62 ha/year**.

For more information, see the file
“Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_”

And the point mesh file named: “NR_MallaPuntos_Escenario_7_MC2024_05_vg”

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	https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Within the tab "Tables_PM_Report".
Source of data and description of measurement/calculation methods and procedures applied:	To generate the information to quantify the recovery of forest degradation, Collect Earth was used as a platform for collecting information on land cover and use for the years of interest, which allows identifying the permanence and changes that occurred in these years. To assign each land cover and use to each of the plots, a methodological protocol was used that hierarchizes the land cover and use based on the land representation classification used by the IPCC, which can be consulted at the following link: To quantify the recovery of forest degradation, it is essential to first identify the plot as a forest permanence, because this phenomenon occurs within the plots that are considered forest. After identifying the plot as a forest permanence, it is important to establish the category in which the forest is located, which can be: • Primary forest: forest that conserves 20 to 25 tree elements within the plot. • Degraded forest: forest that conserves 14 to 19 tree elements within the plot. • Highly degraded forest: forest that conserves between 8 to 13 tree elements within the plot. After this identification, the next step is to establish the forest carbon stratum, which is assigned through a carbon stratum map, of which there are 4 in total. The next step is to establish the amount of carbon that the plot has at a first moment in this case the year 2016 and then to establish the amount of carbon that the plot has at a second moment, which in this case is the year 2020. To assign this amount of carbon, it is necessary to identify the amount of tree elements that the plot has, since with this we will establish the amount of carbon that there is before the process of recovery of forest degradation and the amount of carbon after the recovery of forest degradation. For example, a plot has 12 tree elements at first, it is established that it is within a very degraded forest, these 12 trees represent 48% of the plot that is in stratum I of the carbon map that has 94 TonC/ha, and that in the plot there would be a total of 45.12 TonC/ha. In a second moment this plot goes from 12 tree elements to 19 tree elements, the plot changes category, to a degraded forest, which represents 68% of the coverage of the plot and with a carbon content of 60.16 TonC/Ha, which applying the difference between moment 1 and moment 2 gives a carbon recovery of -15 TonC/ha. For the reporting period, a total of 351 plots were identified that were designated as forest degradation recovery, since the highly degraded forest became a degraded forest, from a highly degraded forest to a primary forest, and from a degraded forest to a primary forest.

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QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty for this parameter:	Table 66. Restoration uncertainties of degraded areas **RDEG-PM-HA-** **Median** 394,761 **Upper bound 90% CI** (Percentile 0.95) 456,693 **Lower bound 90% CI** (Percentile 0.05) 333,728 **Half Width Confidence Interval at 90% (B – C / 2)** 61,483 **Relative margin (D / A)** **16%** The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM

Parameter:	Increased Carbon Through Forest Plantations
Description:	Increased Carbon Through Forest Plantations The following equations were used to calculate this parameter: Activity data: Equation 1*6*
Data unit:	Hectares
Value monitored during this	Table 67. Hectares per year of carbon increases through forest plantations. **Category** | **Ha** | **Ha/Year**

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Monitoring/Reporting Period:	<table><tr><td>Plantations I conifers</td><td>959.92</td><td>959.92</td></tr><tr><td>Plantations of Broadleaf Plantations</td><td>-</td><td></td></tr></table> For forest plantations, a total of **959.92 hectares** were counted for the period 2018-2020, and for the year of the first reporting, the total number of hectares that were recovered through carbon enhancements through forest plantations was **959.92 ha/year.** For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Within the tab "Tables_PM_Report".
Source of data and description of measurement/calculation methods and procedures applied:	To generate the activity data for this parameter, Collect Earth was used as a platform for the collection of land use information for the years of interest, which allows us to identify the permanence and changes that occurred in these years. For the identification of these land uses, Guatemala uses the IPCC classification to establish the land use of the parcel being observed. To use the Collect Earth form, Guatemala has a methodological protocol for its use, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link For the case of forest plantations, a monitoring period covering the state of land cover that persisted during 2018 and the state of land cover that persisted during 2020 was used, which covers a period of two years and for reporting purposes the year corresponding to 2020 was also used. During this monitoring period, both high and medium resolution images were consult. The total number of interpreters who carried out the analysis of the images were three specialists: Ulises Armas, Claudia Saput and Melany Ramirez. Regarding the information on forest plantations, only one plot corresponding to coniferous plantations was identified. To obtain the data per hectare, the equation found in section 3.1.4 was used. Activity data and Calculation of hectares and emissions/absorptions https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link
QA/QC procedures applied:	For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 10% error.
Uncertainty for this parameter:	Table 68. Forest plantation uncertainties **PLANT-PM-HA-**

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		Median	1,709
		Upper bound 90% CI (Percentile 0.95)	4,365
		Lower bound 90% CI (Percentile 0.05)	182
		Half Width Confidence Interval at 90% (B – C / 2)	2,091
		Relative margin (D / A)	**122%**
	The uncertainty values of the activity data can be found at the following link: https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link Document: Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_ Tab: Table-Report in Spanish.		
Any comment:	To access the documents and calculations related to this activity, consult the following link: For more information, see the file "Archivo_Incertidumbres_Para_MonteCarlo_20mayo2025_actualizado_" And the point mesh file named: "NR_MallaPuntos_Escenario_7_MC2024_05_vg" https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV?usp=drive_link Tab: Cuadros_Informe_PM		

9.2 Organizational structure for measurement, monitoring and reporting

- Organizational structure

The MRV system of the forest sector has been built according to the capacities in the country to respond to the UNFCCC from the international point of view, and at the national level based on existing platforms, studies, data and processes, taking into account a diversity of governmental and non-governmental institutions, including academia, research centers and civil society organizations. In addition, it is based on the current legal frameworks: Forestry Law (Decree 101-96), Law of Protected Areas (Decree 4-89), and the Framework Law to Regulate the Reduction of Vulnerability, the Mandatory Adaptation to the Effects of Climate Change and Greenhouse Gas Mitigation (Decree 7-2013). These laws mandate the different government institutions to collect and process information according to their scope of action.

The MRV system for the Emission Reduction Program has been implemented through coordination by INAB, as the Executing Unit of the Program, with the support of technical staff from the GIS units and the climate change units/departments/ directorates of the institutions that make up CONAP, INAB, MARN and MAGA, as well as representatives of the Guatecarbon, Forests for Life and Local Networks (REDDES) REDD+ projects. The preparation of

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this report was complemented with the support of specialists from U*niversidad del Valle de Guatemala* [53]for carbon accounting.

All the information generated by the different institutions was integrated and systematized by INAB within the framework of the ERPA of the ER Program under the FCPF. In this sense, INAB has been an integrating unit and generator of the reports before the FCPF. It is in close coordination with MARN, as focal point before the UNFCCC, to ensure consistency between the information generated in the framework of the ERP and what is reported for other initiatives and commitments under the United Nations Framework Convention on Climate Change (UNFCCC), including GHG inventories for the LULUCF sector.

It is important to point out that each government institution of the Interinstitutional Coordination Group GCI[54] for the preparation of the First Emissions Reduction Monitoring Report has provided different inputs according to their competencies. A brief description of them is made in **Table 69** below.

Table 69. Participating institutions in the elaboration of the First Emissions Reduction Monitoring Report and the inputs provided.

Institution	**Inputs**
INAB / Emission Reduction Program Executing Entity (Coordinator, Technical coordinator, departments of GIS and Climate change)	Coordinate ER monitoring report integration
	Forest Cover Maps (in collaboration with CONAP).
	National Forest Inventory.
	List with information and maps/polygons on the areas subject to incentives by PINPEP, PINFOR, and PROBOSQUE.
	Data, maps and/or polygons linked to the use of firewood and legal and illegal selective logging.
	Estimation of average annual increments (AAI), and removals due to increased carbon stocks at the national level, through forest management and reforestation (management of natural forests, plantations, AFSs, forestry incentives) and natural regeneration.
	Emission factors for degradation and Removal factors for increases in carbon stocks.
	Participate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.
CONAP / Climate Change Unit and the Geospatial Analysis Directorate, Center for Evaluation and Monitoring (CEMEC) located in Petén.	Forest Cover Maps (in collaboration with INAB) Forest fires data Participate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.?

[53] Second monitoring report will be supported by UVG and a capacity building process will take place during 2023 for INAB to be full responsible of implementing the third MR with support from other institutions.
[54] GCI is the institutional governance body for REDD+ implementation in Guatemala.

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MAGA / Geographic, Strategic Information and Risk Management and Climate Change Unit.	Develop ancillary data such as vegetation cover and land use maps, for a potential estimate of carbon in the land uses. Support monitoring report integration.
MARN / Science and Metrics Department and the Mitigation Department of the Climate Change Unit, as well as in the Environmental Information and Climate Change Unit.	Reference Level of National Emissions for the Forest Sector and other land uses.
	Staff to standardize and ensure that there is consistency in the data presented in the ERP before the FCPF, the Greenhouse Gas Inventories (GHGIs), the reference level presented to the UNFCCC and the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions. Coordinate on visual interpretation of sample units of the national grid for generating LULUC Activity Data.
REDD+ Projects Guatecarbon, Forests for Life, Networks for Local Development (REDDES)	Technical staff
	Data from REDD+ projects, polygon activities, etc.
	Community monitoring data.
	Relevant scientific studies and research.
	Complaints linked to drivers of deforestation and forest degradation.
Universidad del Valle de Guatemala	Support on carbon accounting, data Processing Support on visual interpretation of sample units of the national grid for generating LULUC Activity Data. Support on ER monitoring report development. Support on uncertainty and sensitivity analysis.

- **Differences with the original monitoring plan versus the current monitoring plan**

The original monitoring plan of the ERP was based on the fact that the data collection, calculation and analysis was to be carried out by GIMBUT, as one of its functions or activities was to support initiatives within the REDD+ framework. As the agreement55 expired in 2020, the first reporting was initiated in mid-2021, a year in which the agreement was no longer in force. To mitigate this gap left by GIMBUT, the inter-institutional coordination group in conjunction with the international cooperation through the World Bank, FAO and IDB have supported the Executing Unit to have sustainability for the collection of information for the first and second reporting. It is also important that during the year 2024, the Executing Unit was able to hire more staff to support everything related to the MRV of the program.

- **Selection and management of GHG related data and information**

Data selection and management was done to maintain consistency with the FREL included in the ERPD[56], and with the national FREL presented to UNFCCC[57]. This process was done by the GCI taking into consideration to use the best data available at the moment of generating the report which may also be available with the quality and in time to generate future reports. For the measurement and monitoring of activity data it is based on statistical sampling geo referencing

[55] https://drive.google.com/file/d/1wjxSDUdtmV1AWB0srcqT9eJiKzhuEYx9/view?usp=drive_link

[56] https://www.forestcarbonpartnership.org/system/files/documents/CLEAN%20ENGLISH%20Guatemala%20ERPD%2030%20-08-%202019%20ENGb.pdf

[57] https://redd.unfccc.int/files/niveles_referencia_emisiones_forestales_guatemala_070222.pdf

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of the territory using high and medium resolution sensors for the monitoring of forest cover, land use and land use change (LULUCF).

This approach is done by visual interpretation of samples, is easy to update for each monitoring period. Emission Factors are based on carbon strata map[58] which has been developed with the systematization and analysis of the best national data on carbon in the aerial and underground biomass of forests, from forest inventories in the country with different purposes and the first cycle of the National Forest Inventory of Guatemala, with the application of allometric models suitable for the country and its relationship with its bioclimatic variables.

The absorption factors (FA) are those estimated for the increase in carbon stocks by the annual growth of forest masses. They are obtained from the parcel system permanent sampling (PPM) established in the forestry incentive programs, with growth models applied to different species (pine and broadleaf).

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

The process of MRV in the ERP is implemented following the IPCC general equation of using Emission and Absorption Factors (related to forest inventory data) combined with Activity Data (related to remote sensing data) to estimate emissions and absorptions. A general approach of MRV in Guatemala is summarized in Figure 1**.**

[58] https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

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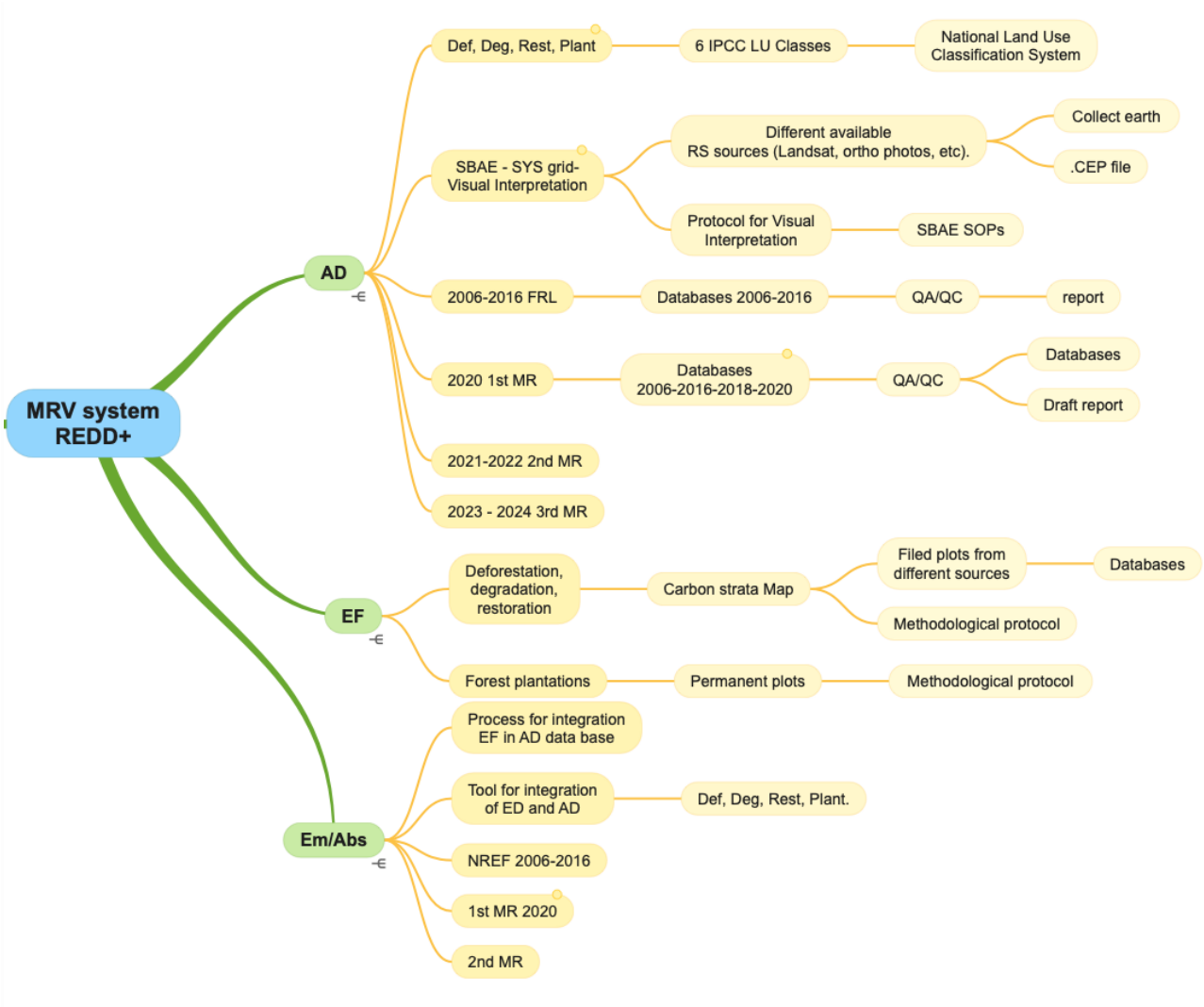

Figure 7. General approach for MRV for REDD+ in Guatemala ERP

- **Activity Data (AD)**

For the collection of activity data under the ERPA, the land use categories of the Intergovernmental Panel on Climate Change (IPCC) were used for the assignment of land cover for each of the plots.

Activity data for monitoring emission reductions in deforestation, degradation and carbon stock increases were monitored under the ERPA, reported using data generated using a Sample Based Area estimation through the use of a visually interpreted grid of sampling points developed with the Collect Earth platform[59] and using images available in high resolution (Digital globe, Planet, Aster, Sentinel, etc.), as well as medium resolution Landsat images (Table 2). This grid represents a geo-referenced statistical sampling of the territory and corresponds to a comprehensive approach to multi-temporal monitoring of forests and other land uses, which provides, during the ERP period, a specific and geographically-explicit analysis of the changes in the surfaces due to processes of deforestation, degradation and stock

[59] https://openforis.org/tools/collect-earth/
Access to the Guatemalan information collection form:
https://drive.google.com/drive/folders/1IhxjFz5gPGKg-qCbXXBwU9cDOSnQ0E5m?usp=drive_link

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increases. Its use ensures consistency with the Forest Reference Emission Level (FREL). Currently, the grid activity data is generated every two years and the monitoring sample is 10,414 points, corresponding to the subnational area of the FCPF program.

These new activity data generated with the Collect Earth Desktop tool will be used to generate the next GHG Greenhouse Gas Inventories that will be contained within the Biennial Reports and the new National Communications that will be generated in the future, the previous four GHG Inventories GHG Greenhouse Gases that have been generated in Guatemala were prepared with methodologies other than sampling.

The grid is part of a comprehensive monitoring system for forests and other land uses, since it is complemented with the maps generated every five years to improve the cartographic model and increase its thematic accuracy and change detection (reduces uncertainty) to provide national statistics and international reports, see Table 70 and Table 71.

Table 70*. Main activity data inputs of the MRV System for deforestation, degradation and increases.*

Inputs	Type of Information	Scale/Resolution/Sampling Unit	Frequency	Source/Protocols
Point sampling grid for forest monitoring	Geodatabase with variables of forest cover and land use dynamics	National grid of 3.1 X 3.1 km for visual interpretation in medium and high-resolution images (11,354 sampling points) for the entire country, regarding the FCPF program area, the total points correspond to a total of 10,414.	Multi-temporal evaluation of coverage and change of use every 2 years	GIMBUT, 2018
RS images	Collection of remote sensing images (Digital Glob, Airbus, INEG, AfriGIS, CNES) The orthophotos of Guatemala.	Median: 30 m (Landsat, 5,7 and 8) High: 1.24 m to 5 m (Spot, WorldView, Rapid eye, Quick Bird, Sentinel, etc.) High resolution: 0.3 meters.	Period of 15 days, Monthly, Annual Only one year corresponding to the months of October, November and December 2006.	Google Earth, Engine and Bing Maps with the use of the Collect Earth platform (FAO, 2015) http://ide.segeplan.gob.gt/cgi-bin/mapserv.exe?map=/ot_web/ot_overview_1.map&SERVICE=WMS&

- **Emission/Absorption Factors (EF/AF)**

Regarding emission factors, the same ones used in the FREL were used. These are based on the carbon strata map, which presents the best national data on biomass carbon in forests, as a result of a systematization and analysis of forest inventories for different purposes, allometric models and bioclimatic variables, combined with national and default (IPCC) values on the non-forest strata.

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The absorption factors used for the MRV are the same ones used for the increases in carbon stocks that come from permanent sites in forest plantations of forestry incentive programs (INAB) with growth models for different species and that are used for the estimation of emissions in areas where a change from other lands to forest lands due to a plantation is detected. The main inputs for the emission and absorption factors of the MRV system and their characteristics are described in Table 3.

Table 71. Main inputs of emission and absorption factors of the MRV System for deforestation, degradation and increases.

	Inputs	Type of Information	Scale/Resolution/Sampling Unit	Source/Protocols
Emission Factors	Carbon Strata Map	Raster and Vector Geodatabases	1 ha	GIMBUT, 2017; Gómez Xutuc 2017.
	Carbon density of land use in agriculture, livestock use and agroforestry systems	Databases and estimation process in the Quantification of carbon. Specific studies.	Districts of crop producers and agroforestry systems	ANACAFÉ 1998, Castillo 2006
	Non-forest carbon contents	Default emission factors	National/ By type of climatic region	IPCC, 2006; IPCC, 2019
Absorption Factors	Permanent plots	Databases	Plots in forest plantations	INAB, 2012. Samudio 2017.
	Growth models	Average annual increments and absorption factors	National (forest plantations)	INAB, 2012.
				Samudio 2017.

It is important to mention that the carbon strata map has the limitation of not being dynamic and depending on the availability of updating new forest measurement plots or remeasurements of the analyzed plots, which makes its long-term use very complex. Therefore, it is important to make a substantial improvement in the MRV for emission and removal factors in the medium term[60]. For this, a National Forest Inventory for multiple purposes has already been launched, where a network of 715 sites has been established where variables related to the carbon content of biomass above ground, below ground and of dead organic matter, with a design of three secondary sampling units will be collected.

Regarding the monitoring report, the Working Group for the Preparation of the First ER Report of Guatemala processes the information and results of the estimates resulting from the analysis of the activity data and emission

[60] Not to be implemented during the ERP period.

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factors during the period of the ER Program and then, subsequently transfers them to INAB so that it prepares the report to the FCPF (Figure 2). In turn, INAB transfers them to MARN for the report to the UNFCCC.

Role of users, beneficiaries and communities in forest monitoring system

Forest community monitoring in the country during the year 2020 due to COVID-19 has been constituted from the local perspective in the primary source of information on the state of the forest, the natural resources associated with the ecosystem and the social and economic conditions of the communities directly and indirectly linked to the use and exploitation of these resources.

The Government of Guatemala has worked on the construction of a computer tool that is part of an early warning system for the prevention and control of deforestation and forest degradation. This tool was developed in the MRV of the National Climate Change System of Information (*SNICC, for its acronym in Spanish*) and also in a mobile application for smartphones aimed at providing information in the field to different users with and without Internet access. The development of this tool also seeks to support the operationalization of this system through the participation of local governments under the operational scheme of community monitoring of the country's National REDD+ Strategy. This information is available at the following link: https://snicc.marn.gob.gt/MRV/SNMF

The community forest monitoring system contributes to the monitoring of social and environmental safeguards and the implementation of actions developed locally in the program. However, it does not participate in the monitoring of carbon variables. Below is a brief description of the role of community monitoring in 2020 in the different REDD+ Projects:

1. **Guatecarbon**: Through a community monitoring network made up of commissions for the control and protection of forest fires and a scientific commission on biodiversity, they have carried out monitoring of environmental and social issues in 11 communities of the Maya Biosphere Reserve, with a scope of at least 6,000 direct beneficiaries of the ERP.

2. **Forests for Life:** Through local workshops through community monitoring in the Sierra Lacandón Park, where the environmental and social issues of the ERP have been monitored, in at least three local communities and 120 direct beneficiaries of the program.

3. **Local Networks for Development (REDDES):** Actions were implemented to support the reduction of deforestation, degradation and increase of forest cover in 12 municipalities of the departments of Alta Verapaz, Quiché and Huehuetenango, to ensure the environmental goods and services that forests provide to indigenous communities and local organizations. These monitoring actions were carried out in at least 31 communities.

Community monitoring in the program is a process that is constantly being improved, since the participation of the local community has not yet been fully achieved. This is something that the government will work on in conjunction with the REDD+ Projects, to ensure that all activities are standardized and documented for the beneficiary communities. The Guatemalan MRV System will continue with the dynamic of empowering communities to gradually measure, monitor and report carbon stocks and, at the same time, that these activities contribute to local livelihoods and the conservation of forest biodiversity.

9.3 Relation and consistency with the National Forest Monitoring System

The MRV system for the carbon and emissions components in the LULUCF sector is part of the National Information System for GHG Emissions, Multiple Benefits, Other Impacts, Management and REDD+ Safeguards (*SIREDD+*), which represents the institutional proposal within the framework of the National REDD+ Strategy for

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Guatemala (2020-2050). SIREDD+, in turn, is part of the National GHG Inventory System (*SNIGT*), which is part of the SNICC (See Figure 10).

The SNICC aims to collect, systematize, analyze and present all the information related to climate change at the national level, including: Climate science, vulnerability, loss and damage; adaptation to climate change; GHG emissions and removals; and, mitigation measures. This information may be used for sectoral and territorial planning processes, monitoring and reporting of the country's progress, public investment programming and the formulation of public policies and application instruments on climate change. Therefore, the SNICC represents the set of data and information generated and analyzed, the necessary governance for the generation, analysis and reporting of this information and the virtual platforms that display it and make it public for the different users (Draft 1IBA, 2022).

All the country's climate change monitoring systems are incorporated under the SNICC, so that the order and quality of the information can be ensured. Since monitoring related to REDD+ is part of this structure, consistency is ensured both with the country's LULUCF sector monitoring system and with the entire national climate change monitoring scheme, including the Registry of Projects for the Removal or Reduction of Greenhouse Gas (GHG) Emissions (Figure 10).

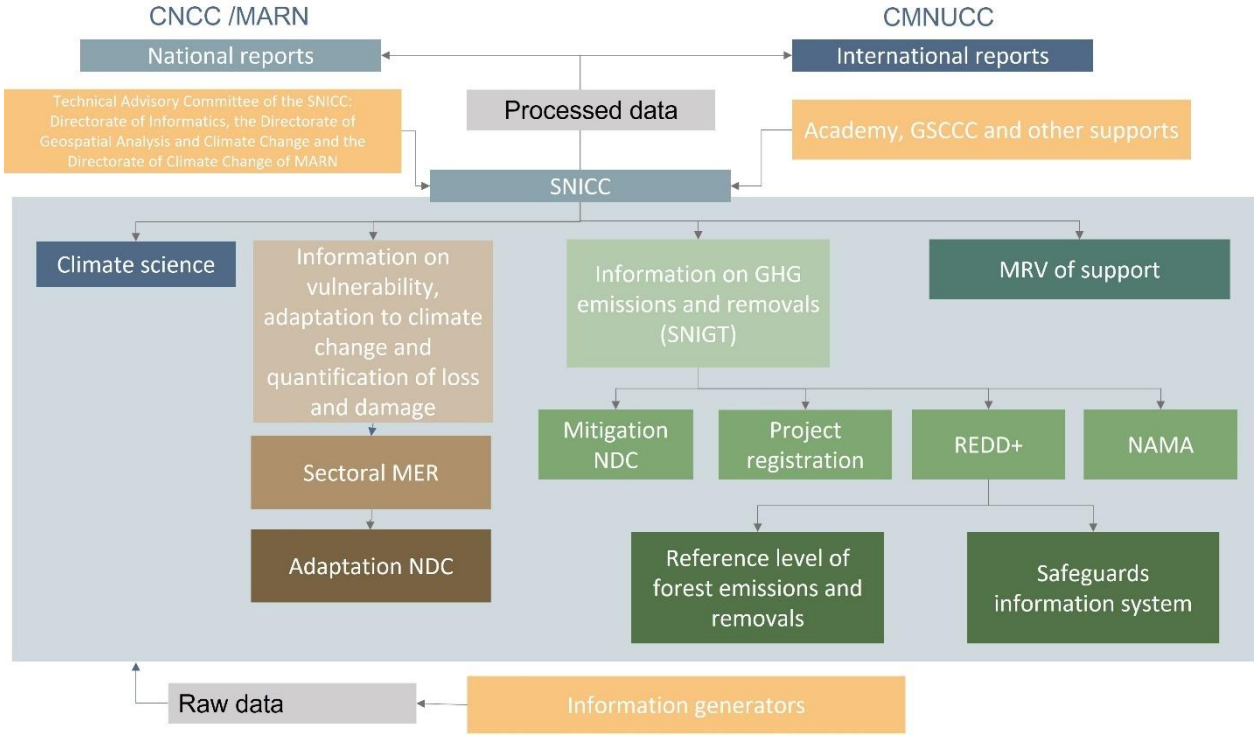

Figure 8. Operation and subsystems of the SNICC

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12 UNCERTAINTIES OF THE CALCULATION OF EMISSION REDUCTIONS

12.1 Identification and assessment of sources of uncertainty

Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
Activity Data						
Measurement	YES	YES	In the case of Guatemala, according to the sampling carried out for the generation of activity data, there may be sources of error associated with the quality and resolution of satellite images, the visual interpretation of samples, and sampling design. The error associated with the quality and resolution of the images could be considered low, since medium and high-resolution images have been used and the size of the analyzed plot (1ha) allows a correct visual interpretation of the images. In addition, the use of the Collect Earth tool allows to visualize the best images available on the dates of interest, ensuring to have images without clouds and with the requirements for their proper interpretation and reducing as much as possible the uncertainty that originates from this source.	High Bias and random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Another source of uncertainty comes from the main process for the estimation of the DA which is the visual interpretation of each of the points of the grid, for this part there has been a series of processes to minimize errors, with the choice of professional interpreters, who have gone through a training process on the use of the tools, an interpretation protocol has been developed which is the basis for the definition of classes. In addition, some scripts have been programmed to facilitate interpretation and avoid making mistakes during this process; a reliability value is even assigned to each of the data that is collected at each point in the mesh. Finally, a review of 5% of the samples is made by 3 interpreters and a comparative matrix of each evaluated point is made and a percentage of error is obtained in the interpretation of each of the original interpreters. For the measurement of the four REDD+ activities in Guatemala: A mesh composed of 11,354 samples points was used, which was used both at the reference level and in the first			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			reporting. With the sample mesh, the objective was to collect the land cover using the six IPCC classes and which were entered into a Collect Earth desktop form to display and interpret the high-resolution images for the year of study. Each plot on the Collect Earth form was made up of 25 elements for which coverage was assigned based on these elements, which could be trees, grasslands, agricultural land, bare soil, bodies of water and wetlands, as well as other land. In this way, each one of the interpreters was assigned a total of 3,700 plots (average) for each one to carry out the visual interpretation using the high-resolution images of Google Earth that were synchronized with Collect Earth. The imagery source was primarily high-resolution Google Earth imagery, followed by Planet, Sentinel, and Landsat imagery only when no imagery was available in Google Earth, or there were clouds or shadows in the Google Earth image. After the interpretation of the 11,354 sample points, the classes of change or permanence were identified with labels			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			to identify deforestation, degradation, and carbon increases through recovery from degradation and forest plantations. In this exercise, a review was made to assess the consistency of the coverage of the plot and whether it was coherent with the other dates. This process was carried out in an Excel sheet. After processing the labels, the total points for each of the four activities of the program were counted and then in another Excel tool to calculate hectares, total carbon and finally to be able to calculate the total number of CO2 emissions and absorptions. To reduce the error derived from visual interpretation, the Collect Earth methodological protocol was used to homogenize criteria among the interpreters, a forum was created in which the interpreters, when they had a sample with great difficulty, helped each other and how exercises were also done. To assess the degree of agreement between them as part of quality control. For the interpretation of the plots, 638 plots were interpreted and the information was cross-checked to obtain			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			the percentage of coincidence between the three interpreters. Due to the restrictions derived from the COVID-19 pandemic, the interpreters worked remotely, sending their results every 15 days to be reviewed. It is important to mention that among the interpreters there was communication with them to resolve doubts if the plot was too difficult to interpret. The temporal analysis was also done to identify possible incongruent transitions since having four points in time allowed to find out those non-logical changes that the plot could obtain. All this process was carried out using the Excel tool to process the information. When these non-logical changes were identified, the plot was reviewed again and the information was edited to ensure that the plot information was correct. Of the total of 638 samples for transitions and permanence that were identified for both the first reporting and the reference level that was reviewed. For deforestation and degradation, 48 and 42 samples were established, while for carbon increments through			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			degradation recovery and plantations, the samples were 56 and 18 respectively. These subsequent samples were chosen randomly and with a confidence interval of 95% and an error of 5%. Finally, it is important to mention that it can be considered that the interpreters do not have the same experience to interpret satellite images, so it is possible that the interpretation error is high. To reduce the error in the measurement/interpretation of the mesh of points, improvement points have been identified to implement in the following reporting, for example, the collect data form was tried to automate the entry of information through selection lists, as well as periodic review of the interpretation of the specialists.			
Representativeness	Yes	No	To detect areas of change due to emissions and removals from deforestation, degradation, and increases in carbon stocks, Guatemala used a multipurpose grid to collect information.	Low Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			This grid was prepared in the context of the second forest inventory of Guatemala, which seeks to be able to represent the soil cover with a sampling precision of 10% with a confidence interval of 95%, which is sufficient with 672 samples. With this information, Guatemala decided to use a 3.1x3.1 grid system using a non-aligned systematic sampling design, making the sample proportional to the country's area. Within each grid, a randomly located point was located, thus allowing the evaluation of the change in use of the land cover. The grid design generated a total of 11,354 sample points located randomly within each grid for the entire surface of the country. After locating the 11,354 sample points, a Collect Earth form was generated to collect the information using high-resolution images found in the Google Earth image catalog. In the event that a High-Resolution image is not available, images from the Landsat, Sentinel or Planet family are used depending on their availability.			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			This Collect Earth form asked about the six IPCC classes as well as other land cover based on the land cover mapping of Guatemala. If, in case, a change was detected, the form indicated what kind of coverage it went to, as well as the year and the sensor with which the information was captured. Within the actions to minimize the error due to the collection of information, Guatemala generated an interpretation protocol so that each specialist or interpreter could address it in case they had doubts when choosing the land cover. Monthly meetings were also held to resolve doubts that had a high degree of interpretation, but since most of the images are of high resolution, it can be considered that the protection against uncertainty due to the collection of information is low. Regarding land cover representativeness, interpretation protocols have been refined to facilitate interpretation in future reporting, in which the steps to choose the best land representativeness either by permanence or change have been detailed by means of decision trees.			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Operational processes have also been identified to achieve a better interpretation.			
Sampling	No	Yes	Regarding sampling error, this is the type of error that is quantified for its propagation in uncertainty, the sampling design is systematic with a mesh of 3.1 km x 3.1 km with a site located within each of the quadrants of the mesh. With the density of the sample you have, it is enough to capture the dynamics of the forests with an acceptable error. However, if you wanted to make an estimate of a smaller area, or for a specific type of change, this would require a densification of the mesh in those areas of interest. Because the grid of points used for collect earth is linked to the national forest inventory of Guatemala, it is considered that the choice of sampling points went through an adequate quality control process to ensure that the points can represent well the land cover area of Guatemala. The value used for uncertainty propagation is the sampling error that	High Random and bias	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			comes from the activity data for each of the transitions that are identified.			
Extrapolation	Yes	No	Extrapolation is not applied because Guatemala at no time used information to extrapolate activity data or emission factors. This is because Guatemala had information from the point grid, the carbon strata map and the IPCC default emission factors, as well as the non-forest carbon content. The data from the plots were not extrapolated so this source of uncertainty does not apply.	High Bias	Yes	No
Approach 3	Yes	No	This approach is applicable because the data collection was done by visual interpretation of land cover for the reference level and the reporting period. This approach does not apply to the case of Guatemala because Guatemala has a point grid that allows traceability of land use classes without the need to resort to other sources of information to identify land use.	High Bias	Yes	No
Emission Factor						
DBH measurement	Yes	Yes	The measurement of the DBH was measured directly since information	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			from different forest inventories that various projects in Guatemala have implemented over time was used. In Guatemala, a tree is defined as having a DBH greater than 10 centimeters at breast height. In the process of creating the emission factors, especially the forest carbon content, it is not clear what quality control process was used to measure the WTP. This is the reason why it was marked NO in QA/QC. However, when plots with DBH that were out of range were being purified, they were excluded in order to avoid errors in the calculations. It is considered that the error in the collection of information on the measurement factors is high because it comes from different sources of information that applied different methods and objectives at the time of collecting the information were different among the institutions and/or organizations that were in charge of generating the data. It is also considered high because it is not known if quality control methods were applied during and after the data analysis process.			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Being information coming from various sources of forest inventories, there is no estimate of random or systematic errors that can contribute to the total uncertainty, because what can be considered high contribution. It is expected that when the information from the second forest inventory of Guatemala is available, we will have better information on this value and seek to reduce the contribution to the total error of the calculation.			
H measurement	Yes	Yes	The allometric equations used to generate the carbon strata map do not use height to estimate carbon content. Within the process of creating the emission factors, especially the forest carbon content, it is not clear what quality control process was used when measuring the height of the trees within the plot. This is the reason why it was marked NO in QA/QC. However, when debugging plots with heights that were out of range, they were excluded in order to avoid errors in the calculations.	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			It is expected that when the information from the second forest inventory of Guatemala is available, we will have better information on this value and seek to reduce the contribution to the total error of the calculation.			
Plot delineation	Yes	Yes	There was no control over the size and shape of the plots, nor in the process of plot establishment. The use of plots of different origins and sizes leads to considerable errors, in addition to the fact that each group of plots has different purposes and therefore different types of sampling. This gives us an idea that EFS are one of the main sources of uncertainty in the estimation of emissions and removals. To use the data collected from these plots, Guatemala created a carbon strata map. This was done by, weighting the plots based on their size. In this process, modeling was done with the Monte Carlo and Bootstrap methods to better represent the distribution functions of the sample used. With this, the errors of each EF reported on the map became considerably low (see the FE section and the Carbon Strata Map protocol).	High Bias & Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Given that there are no specific QA-QC protocols for the plot delineation, the government of Guatemala decided to apply the highest uncertainty discount (15%). This approach serves as a conservative strategy to account for potential discrepancies and uncertainties inherent in the data. By applying the highest uncertainty discount, we aim to mitigate the risks associated with the lack of standardized quality measures, ensuring that any variability or errors in the inventory are adequately considered. This method provides a buffer against unforeseen inaccuracies, thereby safeguarding the integrity of the inventory's conclusions and facilitating more reliable decision-making. While this is not a substitute for comprehensive QA/QC processes, it is a necessary interim solution to address the current limitations and uphold the credibility of the forest inventory data. Yet, it is important to highlight that Guatemala is currently working on the second forest inventory. This inventory,			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			which is being elaborated between the National Forest Institute and FAO, as well as national and international experts, considers a much better sampling design that will help reduce the contribution to the overall error. The data from the 2nd NFI will be used in subsequent crediting periods (if any).			
Biomass allometric model	Yes	Yes	For the calculation of biomass, three allometric equations were used for natural forests, both broadleaf and coniferous, the latter was standardized through studies carried out by the Universidad del Valle de Guatemala: UVG (2018) for coniferous, UVG (2018) for broadleaf ; and for the northern lowlands the equation of Williams Arreaga (2002), with these the aerial biomass was calculated for each tree (includes from the stem to the branches), using only the DBH (diameter at height of 1.3 m). In the case of the mangrove forest, three equations were applied according to the species found (permanent sampling plots from the southern coast of Guatemala administered by INAB were used). In the process of creating the emission factors, especially the forest carbon	High Bias and Low Random	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			content, it is not clear what quality control process was used to create each of the formulas of the allometric model that was chosen for the calculation of the carbon content. This lack of information is mostly due to the fact that data was only collected from several sources. Given that there are no specific QA-QC protocols for the biomass allometric models, the government of Guatemala decided to apply the highest uncertainty discount (15%). This approach serves as a conservative strategy to account for potential discrepancies and uncertainties inherent in the data. By applying the highest uncertainty discount, we aim to mitigate the risks associated with the lack of standardized quality measures, ensuring that any variability or errors in the inventory are adequately considered. This method provides a buffer against unforeseen inaccuracies, thereby safeguarding the integrity of the inventory's conclusions and facilitating more reliable decision-making. While this is not a substitute for comprehensive QA/QC processes, it is a			

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			necessary interim solution to address the current limitations and uphold the credibility of the forest inventory data. It is anticipated that the data for estimating future emission factors will come from Guatemala's second national forest inventory. This improvement will apply the information to the surveys that have been used in Guatemala, which will help the error contribution of the allometric models to be reduced and not come from different sources of information. This information is integrated in the carbon strata map so that the error cannot be propagated. For this reason, the formula found in the FPCF uncertainty guidelines was applied to add an additional 10% to the emission factor error.			
Sampling	No	Yes	The sampling design for the calculation of forest carbon of the plots varies since there are data from plots with a size ranging from 0.02 to 1 hectare in size of the plot, this because the collection of more than 3,000 plots distributed in most of Guatemala and covering more than 203 thousand trees that were	High Bias and Random	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			inventoried. Derived from the fact that this information also comes from various information sources and it is not clear if there were quality control processes, this causes the contribution of sampling uncertainty to be high. For the propagation of the error, the probabilistic density function values were used for each of the carbon strata and for each of the different plot sizes with which the four strata of the carbon map were developed. Since the sample selected for the second forest inventory of Guatemala was elaborated between the National Forest Institute and FAO, as well as national and international experts, it is considered that the choice of sampling intensity for the second forest inventory of Guatemala was appropriate and it is considered that this information can help to reduce the contribution to the overall error.			
Other parameters (e.g., Carbon Fraction, roots-shoot ratios)	Yes	Yes	For the carbon fraction, the IPCC factor 0.47 was used, while to establish the belowground carbon fraction, the Mokany equation was used because it was established that this equation was	High Random and Bias	Yes	Yes

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			the most appropriate in proportion to the area biomass. Using the forest carbon content per hectare, the Mokany equation was applied to obtain the proportion of subterranean carbon. This information is integrated in the carbon strata map so that the error cannot be propagated. For this reason, the formula found in the FPCF uncertainty guidelines was applied to add an additional 10% to the emission factor error. Since this component of the emission factor is related to the information captured from forest plots, it is expected that with the second forest inventory in Guatemala, standard operating procedures will be applied to reduce bias and error in the aerial biomass.			
Representativeness	Yes	No	The map of carbon strata covers the entire territory since plots from different forest inventories in Guatemala were used to ensure that forest carbon is represented on the map. Also, as part of the review by the UNFCCC reference level, an analysis was	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			made on the correspondence of the map information with INAB's physical plots (document included in annexed folder 01.Datos_Fuentes/01. Carbono_forestal/Mapa Estratos de Carbono / 01_ControCalidad). Since the sample selected for the second forest inventory of Guatemala was elaborated between the National Forest Institute and FAO, as well as national and international experts, it is considered that the choice of sampling intensity for the second forest inventory of Guatemala was appropriate and it is considered that this information can help to reduce the contribution to the overall error.			
Wood density	Yes	Yes	The average wood density was obtained for broadleaved and coniferous forest. To do that, for each type of forest, the species in each community of trees were identified and the arithmetic mean was calculated. Wood density was used to transform cubic meters from mean annual increments to convert volume to carbon.	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			Since the information comes from the literature, in the short-term exercises should be carried out to corroborate these densities for species found in Guatemala, since there is no quality assurance control of the data on published data.			
Integration						
Model	Yes	No	There is an Excel file containing all the variables to estimate the uncertainty of the reductions. We will be working for the second reporting in a manual to perform this calculation. All sources of error were quantified in the activity data and emission factors, which were propagated in the integration, so it is assumed that the uncertainty calculation will be low. In addition, a logic function was performed within the tool to estimate emissions/removals to verify that the total area of the points coincides with the total area of the program. As for the Monte Carlo model, recommendations have been received to update the model, which is a process of continuous improvement to facilitate	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			its understanding in a sample and transparent manner.			
Integration	Yes	No	Emission factors were calculated for each forest stratum according to the location of the dot grid plots to ensure comparability between the transition classes of activity data and those of emission factors. This source of uncertainty is considered as one of the main sources of uncertainty. "Within the process of creating the emission factors, especially the forest carbon content, it is not clear the quality control process that was used at the time of the sample design of each of the plots in which the information was collected. This is the reason for the NO mark in QA/QC. This lack of information is mostly due to the fact that data was only collected from several sources." It is hoped that with the information from Guatemala's second forest inventory, as well as the implementation of standard operating procedures for visual interpretation, the integration of activity data with emission factors can be improved for subsequent monitoring to reduce or mitigate the impact of	High Bias	Yes	No

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Sources of uncertainty	Systematic	Random	Analysis of contribution to overall uncertainty	Contribution to overall uncertainty (High / Low)	Addressed through QA/QC?	Residual uncertainty estimated?
			possible sources of error in the calculation of uncertainty.			

12.2 Quantification of uncertainty in Reference Level Setting

Parameters and assumptions used in the Monte Carlo method

Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Land I to Settlements	97.22	118.05	107.65	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	97.22	118.05	107.65	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	89.71	112.26	100.88	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	92.12	113.53	102.97	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	92.12	113.53	102.97	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	94.20	115.09	104.65	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Lands I to agroforestry systems	53.06	107.09	84.21	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	95.42	115.96	105.66	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	87.98	110.20	98.91	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	90.31	111.69	100.94	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	90.31	111.69	100.94	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	92.42	113.00	102.65	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	60.95	72.24	64.07	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	51.04	105.11	82.15	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	81.41	92.81	87.13	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	73.18	87.39	80.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	75.92	88.84	82.40	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Lands III to agroforestry systems	33.83	84.89	63.81	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	75.68	91.34	83.49	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	67.94	85.75	76.79	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	70.53	87.18	78.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	70.53	87.18	78.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	70.53	87.18	78.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	72.66	88.39	80.49	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	73.24	88.98	81.08	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	29.59	82.24	60.04	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	54.18	78.64	66.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	55.98	78.10	67.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Lands I to agroforestry systems	17.83	72.79	49.57	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	53.51	76.59	65.04	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	55.98	78.10	67.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	16.85	71.40	48.35	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	41.74	63.36	52.71	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	44.23	64.96	54.66	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	4.90	58.51	35.86	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	47.31	66.36	56.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	39.81	60.42	50.15	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	42.15	62.06	52.21	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	44.83	64.00	54.52	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Land I to Annual Crops	33.86	51.51	42.60	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	36.05	56.17	46.12	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	33.60	54.56	44.10	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	36.05	56.17	46.12	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land II a Settlements	41.17	60.50	50.85	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	32.46	51.33	41.89	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	24.76	45.40	35.10	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	24.62	42.23	33.41	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	27.05	43.91	35.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	27.05	43.91	35.50	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	29.80	45.73	37.76	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Planting to pastures II	36.60	65.93	51.22	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures III	36.60	65.93	51.22	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures IV	36.60	65.93	51.22	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to annual crops IV	36.60	65.93	51.22	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantation of coffee crops	36.60	65.93	51.22	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary A Degraded	19.05	49.95	34.46	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary To Highly Degraded	47.19	73.64	60.31	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Very Degraded	11.60	40.01	25.86	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary A Degraded	19.02	48.83	33.86	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary To Very Degraded	40.91	69.25	54.87	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Very Degraded	6.81	35.31	21.17	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Land III Primary A Degraded	16.40	39.48	27.99	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary To Very Degraded	34.06	56.45	45.32	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Severely Degraded	3.34	31.25	17.35	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary A Degraded	14.19	39.35	26.69	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary to Very Degraded	32.25	54.81	43.47	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Severely Degraded	3.98	29.43	16.83	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degraded plantations	6.35	21.89	14.12	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Degraded	(40.02)	(11.54)	(25.79)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Primary	(73.88)	(47.04)	(60.36)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Primary	(49.70)	(18.91)	(34.61)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Degraded	(35.54)	(7.18)	(21.16)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Emisson Factors						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Land II Highly Degraded to Primary	(69.47)	(40.94)	(55.09)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Primary	(48.86)	(19.02)	(33.96)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Highly Degraded to Degraded	(31.28)	(3.58)	(17.43)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	(56.46)	(33.97)	(45.25)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Primary	(39.24)	(16.03)	(27.68)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Degraded	(29.26)	(4.51)	(16.88)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Primary	(55.07)	(32.41)	(43.61)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Primary	(39.07)	(14.18)	(26.82)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations I conifers	(14.56)	(3.91)	(9.23)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations of Broadleaf Plantations	(22.05)	(6.51)	(14.28)	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Deforestation						
Forest Land I to Settlements	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	77.29	7,602.05	3,839.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	13,830.24	32,245.82	23,038.03	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Land II to Annual Crops	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	43,059.43	72,130.72	57,595.07	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	593.30	9,005.87	4,799.59	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Lands III to agroforestry systems	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	41,382.64	69,967.84	55,675.24	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	2,996.93	14,281.59	8,639.26	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	593.30	9,005.87	4,799.59	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	77.29	7,602.05	3,839.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Land I to Annual Crops	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Grasslands	1,742.92	11,695.93	6,719.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	77.29	7,602.05	3,839.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Land III a Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	10,791.35	27,605.37	19,198.36	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to Agricultural Lands-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	6,403.18	20,474.52	13,438.85	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	1,742.92	11,695.93	6,719.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Land IV to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	(378.71)	6,138.21	2,879.75	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Other Land	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Grasslands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Annual Crops	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Lands-Coffee	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-Other	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Oilland	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I to Agricultural Land-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands I to agroforestry systems	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Other Lands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	Range or standard deviations		Parameter values	Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Assumptions
	Lower	Upper				
Forest Lands II to Grasslands	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Annual Crops	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Land-Other	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Agricultural Lands-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II to agroforestry systems	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III a Settlements	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Other Land	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands II to Wetlands and Water Bodies	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to Grasslands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Crops-Annuals	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest land III to agricultural land-other	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Lands III to Agricultural Lands-African Palm	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands III to agroforestry systems	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Settlements	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Other Lands	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Grasslands	593.30	9,005.87	4,799.59	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV a Wetlands and Water Bodies	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Annual Crops	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-Coffee	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Land-Other	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV to Agricultural Lands-Rubber	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to Agricultural Lands-African Palm	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Lands IV to agroforestry systems	-	-	-	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures II	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to pastures III	77.29	7,602.05	3,839.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Planting to pastures IV	(740.80)	4,580.48	1,919.84	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Planting to annual crops IV	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantation of coffee crops	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degradation						
Forest Land I Primary A Degraded	15,374.94	34,540.79	24,957.86	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Primary To Highly Degraded	4,321.82	16,796.38	10,559.10	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Very Degraded	1,151.96	10,367.06	5,759.51	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary A Degraded	45,582.20	75,367.45	60,474.83	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Primary To Very Degraded	13,063.79	31,092.43	22,078.11	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Very Degraded	2,996.93	14,281.59	8,639.26	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary A Degraded	28,961.89	53,591.05	41,276.47	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Primary To Very Degraded	7,116.48	21,681.06	14,398.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Land III Degraded to Severely Degraded	10,791.35	27,605.37	19,198.36	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary A Degraded	69,476.02	105,229.03	87,352.53	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Primary to Very Degraded	14,600.70	33,395.19	23,997.95	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Severely Degraded	22,483.06	44,711.19	33,597.13	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Degraded plantations	(921.52)	2,841.36	959.92	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Increases in carbon stocks (Hectares)						
Forest Land I Highly Degraded to Degraded	77.29	7,602.05	3,839.67	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Highly Degraded to Primary	593.30	9,005.87	4,799.59	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land I Degraded to Primary	19,295.89	40,219.01	29,757.45	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Degraded	7,116.48	21,681.06	14,398.77	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Highly Degraded to Primary	1,742.92	11,695.93	6,719.43	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land II Degraded to Primary	33,068.08	59,084.04	46,076.06	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Highly Degraded to Degraded	3,651.90	15,546.45	9,599.18	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

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Activity Data						
Parameter included in the model	**Range or standard deviations**		**Parameter values**	**Error sources quantified in the model (e.g. measurement error, model error, etc.)**	**Probability distribution function**	**Assumptions**
	Lower	**Upper**				
Forest Land II Highly Degraded to Primary	4,321.82	16,796.38	10,559.10	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land III Degraded to Primary	36,378.99	63,452.47	49,915.73	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Degraded	10,791.35	27,605.37	19,198.36	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Highly Degraded to Primary	5,004.68	18,033.35	11,519.01	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Forest Land IV Degraded to Primary	50,652.80	81,815.87	66,234.33	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations I conifers	10,791.35	27,605.37	19,198.36	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.
Plantations of Broadleaf Plantations	5,698.89	19,258.97	12,478.93	Error due to different sizes of forest stands used to calculate carbon content.	It comes from the sampling error and is assumed to have a normal distribution.	The probability density function values obtained from the carbon strata map were used.

Quantification of the uncertainty of the estimate of the Reference level

	Deforestation	**Forest degradation**	**Enhancement of carbon stocks**
	(TonCO2eq/year)	**(TonCO2eq/year)**	**(TonCO2eq/year)**

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A	**Median**	7,925,854	3,741,959	-2,916,333
B	**Upper bound 90% CI** (Percentile 0.95)	9,179,547.12	4,610,617.10	-2,277,453.25
C	**Lower bound 90% CI** (Percentile 0.05)	6,701,261.38	2,921,024.97	-3,634,569.05
D	**Half Width Confidence Interval at 90% (B – C / 2)**	1,239,143	844,796	678,558
E	**Relative margin (D / A)**	16%	23%	-23%
F	**Uncertainty discount**	4%	4%	4%

The Montecarlo model can be accessed through the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

The file is called: Archivo_Incertidumbres_Para_MonteCarlo_02mayo2025_actualizado_ And in the tab "Cuadro_Informe"" you can find the statistics.

***Guatemala proposes to use the maximum discount for the uncertainty buffer of 15% for the following reasons:

1. within the process of creating the emission factors, especially the forest carbon content it is not clear what quality control process was used during the information gathering process for each of the plots where the field information (forest inventory) was collected. This is the reason for the NO mark in QA/QC. This lack of information is due to the fact that in the absence of data from a complete and nationally implemented national forest inventory, forest inventory data from various sources were used, including forest inventory sites from forest concessions, research data, and partial data from the first national forest inventory.

2. Since the country does not yet have the main information to obtain the conservation status of forests (primary, degraded and very degraded), the best available information was used, in this case the grid of points to obtain statistical information on carbon content associated with canopy cover in order to model the emission factors in the Monte Carlo model and the Sensitivity analysis.

3. It has not been possible to propagate all the errors in the Monte Carlo uncertainty, because the EFs are associated with a carbon strata map that reports carbon above and below ground in a combined form and during the process the conversion of biomass to carbon is done without reporting separately the carbon fraction. Therefore, neither the stem-root error nor the carbon fraction error has been propagated.

4. An additional 10% error has been propagated in the forest carbon due to the fact that the errors of the allometric models used cannot be propagated.

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Sensitivity analysis and identification of areas of improvement of MRV system

The Sensit module of the SimVoi program was used to perform the sensitivity analysis, and the results are shown in Table 72:

The sensitivity analysis of the Guatemala baseline shows how different land use categories 79.8% have changed in percentage terms. Here is a summary of the most salient results:

The sensitivity analysis that 16 elements of the reference level emissions and removals calculation contribute 95.1% of the uncertainty of the reductions. Of these elements, degradation contribute 56.3%, while 29.2% come from forest degradation restoration emission factors. Finally, emission factors from deforestation contribute the remaining 9.6%.

Table 72. Senility analysis of reference level

The dimensionals for the activity data (DA) are hectares while for the emission factors are (FE). They are not shown in the table because the values are mixed.

Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEG-Forest Land IV Primary to Degraded	14.19	21.95	39.35	7,188,884.24	7,413,032.36	7,916,086.00	727,201.76	22.2%
NR-FE-DEG-Forest Lands II Primary A Degraded	19.02	27.80	48.83	7,237,514.93	7,413,032.36	7,834,011.31	596,496.38	15.0%
NR-FE-RDEG-Forest Lands IV Degraded to Primary	- 39.07	- 21.19	- 14.18	7,020,952.10	7,413,032.36	7,566,677.53	545,725.43	12.5%
NR-FE-RDEG-Forest Lands II Degraded to Primary	- 48.86	- 26.17	- 19.02	7,067,003.51	7,413,032.36	7,522,011.69	455,008.19	8.7%
NR-FE-RDEG-Forest Lands III Degraded to Primary	- 39.24	- 22.98	- 16.03	7,144,509.24	7,413,032.36	7,527,848.33	383,339.09	6.2%
NR-FE-DEF-Primary-Forest Land IV to Grasslands	67.94	74.42	85.75	7,293,766.06	7,413,032.36	7,621,836.72	328,070.65	4.5%
NR-FE-DEG-Forest Lands III Primary A Degraded	16.40	19.44	39.48	7,371,497.95	7,413,032.36	7,686,685.86	315,187.91	4.2%
NR-FE-RDEG-Forest Lands I Degraded to Primary	- 49.70	- 28.33	- 18.91	7,202,596.53	7,413,032.36	7,505,822.54	303,226.01	3.9%
NR-FE-DEG-Forest Land IV Degraded to Very Degraded	3.98	16.25	29.43	7,276,609.49	7,413,032.36	7,559,570.18	282,960.69	3.4%
NR-FE-DEF-Primary-Forest Land III to Grasslands	73.18	77.06	87.39	7,339,150.75	7,413,032.36	7,610,055.52	270,904.77	3.1%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEG-Forest Land I Primary A Degraded	19.05	28.15	49.95	7,337,872.70	7,413,032.36	7,593,051.07	255,178.38	2.7%
NR-FE-DEG-Forest Land II Primary A Very Degraded	40.91	47.63	69.25	7,363,923.47	7,413,032.36	7,571,027.77	207,104.31	1.8%
NR-FE-DEG-Forest Land IV Primary To Very Degraded	32.25	40.81	54.81	7,345,081.35	7,413,032.36	7,524,236.82	179,155.47	1.3%
NR-FE-DEG-Forest Land III Degraded to Very Degraded	3.34	16.72	31.25	7,327,994.88	7,413,032.36	7,505,312.40	177,317.52	1.3%
NR-FE-DEF-Primary-Forest Lands II to Grasslands	87.98	96.72	110.20	7,346,397.58	7,413,032.36	7,515,819.26	169,421.68	1.2%
NR-FE-RDEG-Forest Land IV Heavily Degraded to Degraded	- 29.26	- 13.21	- 4.51	7,311,057.23	7,413,032.36	7,468,306.98	157,249.75	1.0%
NR-FE-DEF-Degraded-Forest Land III to Grasslands	41.74	51.28	63.36	7,352,476.17	7,413,032.36	7,489,799.78	137,323.61	0.8%
NR-FE-RDEG-Forest Land II Highly Degraded to Degraded	- 35.54	- 16.07	- 7.18	7,320,266.23	7,413,032.36	7,455,395.51	135,129.28	0.8%
NR-FE-DEG-Forest Land III Primary To Very Degraded	34.06	44.36	56.45	7,363,929.97	7,413,032.36	7,470,645.22	106,715.24	0.5%
NR-FE-DEG-Forest Land I Primary A Very Degraded	33.35	46.58	59.80	7,366,819.29	7,413,032.36	7,459,245.42	92,426.13	0.4%
NR-FE-DEF-Degraded-Forest Lands IV to Grasslands	39.81	46.08	60.42	7,385,184.33	7,413,032.36	7,476,814.96	91,630.62	0.4%
NR-DA-DEF-DEF-Plantation to pastures III	77.29	3,839.67	7,602.05	7,368,311.24	7,413,032.36	7,457,753.47	89,442.23	0.3%
NR-FE-RDEG-Forest Land III Highly Degraded to Degraded	- 31.28	- 10.80	- 3.58	7,347,967.55	7,413,032.36	7,435,956.01	87,988.46	0.3%
NR-FE-RDEG-Forest Land IV Heavily Degraded to Primary	- 55.07	- 40.98	- 32.41	7,359,300.80	7,413,032.36	7,445,674.26	86,373.46	0.3%
NR-FE-DEG-Forest Land II Degraded to Very Degraded	6.81	15.04	35.31	7,389,502.53	7,413,032.36	7,470,996.41	81,493.88	0.3%
NR-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 56.46	- 40.22	- 33.97	7,356,294.62	7,413,032.36	7,434,890.45	78,595.82	0.3%
NR-DA-DEF-DEF-Plantation to coffee crops	- 921.52	959.92	2,841.36	7,374,331.65	7,413,032.36	7,451,733.06	77,401.41	0.3%
NR-DA-DEF-DEF-Plantation to pastures II	- 921.52	959.92	2,841.36	7,376,871.94	7,413,032.36	7,449,192.78	72,320.84	0.2%
NR-FE-PLANT-Conifer Plantations I	- 8.56	- 3.24	2.08	7,379,226.73	7,413,032.36	7,446,837.99	67,611.26	0.2%
NR-FE-DEF-Primary-Forest Lands IV to agroforestry systems	29.59	60.18	82.24	7,374,160.98	7,413,032.36	7,441,063.75	66,902.77	0.2%
NR-FE-DEF-DEF-Plantation to pastures III	14.44	35.92	65.93	7,385,740.71	7,413,032.36	7,451,169.52	65,428.81	0.2%
NR-FE-PLANT-Plantation establishments	- 9.53	- 1.76	6.01	7,380,949.41	7,413,032.36	7,445,115.30	64,165.89	0.2%
NR-FE-RDEG-Forest Land II Heavily Degraded to Primary	- 69.47	- 54.38	- 40.94	7,379,492.02	7,413,032.36	7,442,916.79	63,424.76	0.2%
NR-FE-DEG-Forest Land I Degraded to Very Degraded	11.60	13.63	40.01	7,409,164.09	7,413,032.36	7,463,310.99	54,146.90	0.1%
NR-FE-DEF-Primary-Forest Lands I to agroforestry systems	53.06	87.54	107.09	7,380,178.82	7,413,032.36	7,431,666.93	51,488.10	0.1%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEF-Degraded-Forest Lands II to Grasslands	53.51	61.55	76.59	7,395,149.39	7,413,032.36	7,446,468.82	51,319.44	0.1%
NR-DA-DEF-DEF-Plantation to Grasslands IV	- 740.80	1,919.84	4,580.48	7,387,910.61	7,413,032.36	7,438,154.11	50,243.50	0.1%
NR-FE-RDEG-Forest Land I Heavily Degraded to Primary	- 61.90	- 46.50	- 31.10	7,388,578.65	7,413,032.36	7,437,486.07	48,907.42	0.1%
NR-FE-DEF-Primary-Forest Land IV to Crops-Annuals	70.53	78.93	87.18	7,389,024.63	7,413,032.36	7,436,624.90	47,600.27	0.1%
NR-FE-DEF-Degraded-Forest Land IV to Crops-Annuals	42.15	47.87	62.06	7,400,312.89	7,413,032.36	7,444,592.77	44,279.88	0.1%
NR-DA-DEF-DEF-Planting to annual crops IV	- 921.52	959.92	2,841.36	7,394,003.90	7,413,032.36	7,432,060.82	38,056.92	0.1%
NR-FE-RDEG-Forest Land I Very Degraded to Degraded	- 40.02	- 27.99	- 11.54	7,397,740.36	7,413,032.36	7,433,930.76	36,190.40	0.1%
NR-FE-DEF-Degraded-Forest Lands II to agroforestry systems	16.85	51.80	71.40	7,390,825.00	7,413,032.36	7,425,483.23	34,658.23	0.1%
NR-FE-DEF-Degraded-Forest Lands III to agroforestry systems	4.90	45.31	58.51	7,387,358.20	7,413,032.36	7,421,419.83	34,061.63	0.0%
NR-FE-DEF-Grassland Planting IV	13.87	28.53	65.93	7,403,714.82	7,413,032.36	7,436,793.77	33,078.94	0.0%
NR-FE-DEF-Primary-Forest Land I to Grasslands	89.71	100.91	112.26	7,398,808.13	7,413,032.36	7,427,451.27	28,643.14	0.0%
NR-FE-DEF-Degraded-Forest Land II to Crops-Annuals	55.98	64.03	78.10	7,402,799.77	7,413,032.36	7,430,901.71	28,101.94	0.0%
NR-FE-DEF-Very Degraded-Forest Land IV to Grasslands	24.62	30.74	42.23	7,403,315.24	7,413,032.36	7,431,283.95	27,968.71	0.0%
NR-FE-DEF-Primary-Forest Lands IV to Agricultural Lands-African Palm	73.24	76.82	88.98	7,407,356.40	7,413,032.36	7,432,349.84	24,993.44	0.0%
NR-FE-DEF-Primary-Forest Land III to Crops-Annuals	75.92	77.52	88.84	7,410,493.58	7,413,032.36	7,431,009.47	20,515.89	0.0%
NR-FE-DEF-Primary-Forest Land I to Agricultural Land-Other	92.12	102.94	113.53	7,402,724.81	7,413,032.36	7,423,121.56	20,396.75	0.0%
NR-FE-DEF-Primary-Forest Land II to Crops-Annuals	90.31	101.04	111.69	7,402,800.29	7,413,032.36	7,423,175.50	20,375.22	0.0%
NR-FE-DEF-Degraded-Forest Land III to Crops-Annuals	44.23	53.36	64.96	7,404,326.13	7,413,032.36	7,424,086.34	19,760.21	0.0%
NR-FE-DEF-Degraded-Forest Lands IV to Agricultural Lands-African Palm	44.83	45.60	64.00	7,412,302.12	7,413,032.36	7,430,571.90	18,269.78	0.0%
NR-FE-DEF-Degraded-Forest Lands I to Agroforestry Systems	17.83	48.79	72.79	7,403,197.25	7,413,032.36	7,420,658.00	17,460.75	0.0%
NR-FE-DEF-Primary-Forest Lands II to agroforestry systems	51.04	85.64	105.11	7,402,039.77	7,413,032.36	7,419,217.07	17,177.31	0.0%
NR-FE-DEF-Primary-Forest Lands III to agroforestry systems	33.83	67.00	84.89	7,402,497.88	7,413,032.36	7,418,716.97	16,219.09	0.0%
NR-FE-DEF-Degraded-Forest Lands I to Grasslands	54.18	60.01	78.64	7,409,329.48	7,413,032.36	7,424,868.08	15,538.60	0.0%
NR-FE-DEF-Primary-Forest Lands IV to Other Lands	75.68	78.05	91.34	7,410,771.08	7,413,032.36	7,425,693.12	14,922.05	0.0%
NR-FE-DEF-Primary-Forest Land I to Crops-Annuals	92.12	100.79	113.53	7,407,528.38	7,413,032.36	7,421,126.21	13,597.83	0.0%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-Other	90.31	101.04	111.69	7,406,210.98	7,413,032.36	7,419,794.46	13,583.48	0.0%
NR-FE-DEF-Primary-Forest Land I to Agricultural Land-Rubber	94.20	103.34	115.09	7,407,228.70	7,413,032.36	7,420,497.75	13,269.04	0.0%
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-Rubber	92.42	95.10	113.00	7,411,333.54	7,413,032.36	7,424,405.23	13,071.68	0.0%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Coffee	70.53	80.98	87.18	7,406,394.89	7,413,032.36	7,416,972.73	10,577.84	0.0%
NR-FE-DEF-DEF-Plantation to pastures II	36.60	58.08	65.93	7,406,209.88	7,413,032.36	7,415,527.41	9,317.53	0.0%
NR-FE-DEF-Planting to annual crops IV	15.90	30.56	45.23	7,408,373.59	7,413,032.36	7,417,691.12	9,317.53	0.0%
NR-FE-DEF-Plantation to coffee crops	36.60	62.16	65.93	7,404,913.81	7,413,032.36	7,414,231.35	9,317.53	0.0%
NR-FE-DEF-Very Degraded-Forest Land IV to Agricultural Land-Other	16.98	25.41	43.91	7,410,354.29	7,413,032.36	7,418,911.60	8,557.31	0.0%
NR-FE-DEF-Primary-Forest Land II to Agricultural Land-African Palm	96.74	102.28	107.82	7,409,512.66	7,413,032.36	7,416,552.06	7,039.40	0.0%
NR-FE-DEF-Degraded-Forest Lands I to Agricultural Lands-Others	55.98	59.88	78.10	7,411,792.21	7,413,032.36	7,418,817.69	7,025.49	0.0%
NR-FE-DEF-Very Degraded-Forest Lands II to Grasslands	33.60	48.26	54.56	7,408,377.68	7,413,032.36	7,415,034.36	6,656.68	0.0%
NR-FE-DEF-Primary-Forest Land I to Other Lands	97.22	107.64	118.05	7,409,722.49	7,413,032.36	7,416,339.74	6,617.25	0.0%
NR-FE-DEF-Very degraded-Forest Lands III to agroforestry systems	7.90	18.22	28.54	7,409,754.93	7,413,032.36	7,416,309.79	6,554.86	0.0%
NR-FE-DEF-Primary-Forest Land II to Other Lands	95.42	105.74	115.96	7,409,753.23	7,413,032.36	7,416,276.75	6,523.52	0.0%
NR-FE-DEF-Very degraded-Forest Land I to Agricultural Land-Coffee	36.05	49.02	56.17	7,408,913.53	7,413,032.36	7,415,303.29	6,389.76	0.0%
NR-FE-DEF-Very Degraded-Forest Land II to Crops-Annuals	36.05	50.29	56.17	7,408,510.34	7,413,032.36	7,414,900.10	6,389.76	0.0%
NR-FE-DEF-Very Degraded-Forest Land III to Settlements	41.17	41.81	60.50	7,412,831.92	7,413,032.36	7,418,970.62	6,138.69	0.0%
NR-FE-DEF-Degraded-Forest Lands IV to Settlements	47.31	50.18	66.36	7,412,122.71	7,413,032.36	7,418,172.67	6,049.95	0.0%
NR-FE-DEF-Very degraded-Forest Lands II to Wetlands and Water Bodies	32.46	38.32	51.33	7,411,170.29	7,413,032.36	7,417,163.17	5,992.87	0.0%
NR-FE-DEF-Very degraded-Forest land I to crops-annuals	33.86	46.97	51.51	7,408,867.41	7,413,032.36	7,414,475.71	5,608.31	0.0%
NR-FE-DEF-Very Degraded-Forest Land IV to Crops-Annuals	27.05	38.79	43.91	7,409,304.98	7,413,032.36	7,414,661.12	5,356.14	0.0%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Other	70.53	78.93	87.18	7,410,364.83	7,413,032.36	7,415,653.75	5,288.92	0.0%
NR-FE-DEF-Very degraded-Forest Land IV to agricultural land-African palm	29.80	40.02	45.73	7,409,785.91	7,413,032.36	7,414,844.48	5,058.57	0.0%
NR-FE-DEF-Primary-Forest Land IV to Agricultural Land-Rubber	72.66	79.33	88.39	7,410,915.23	7,413,032.36	7,415,912.47	4,997.24	0.0%
NR-FE-DEG-Degraded plantations	20.48	28.18	35.88	7,410,586.36	7,413,032.36	7,415,478.36	4,892.00	0.0%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-FE-DEF-Primary-Forest Land III a Settlements	81.41	87.10	92.81	7,411,225.58	7,413,032.36	7,414,847.17	3,621.59	0.0%
NR-DA-DEF-Primary-Forest Lands I to Settlements	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land I to Other Lands	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land I to Grasslands	77.29	3,839.67	7,602.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land I A Crops-Annuals	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land I to Agricultural Land-Other	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land I to Agricultural Land-Rubber	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Lands I to agroforestry systems	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Other Lands	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Grasslands	13,830.24	23,038.03	32,245.82	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Crops-Annuals	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-Other	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-Rubber	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land II to Agricultural Land-African Palm	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Lands II to agroforestry systems	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land III a Settlements	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land III to Grasslands	43,059.43	57,595.07	72,130.72	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land III to Crops-Annuals	593.30	4,799.59	9,005.87	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Lands III to agroforestry systems	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land IV to Other Lands	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Lands IV to Grasslands	41,382.64	55,675.24	69,967.84	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land IV to Crops-Annuals	2,996.93	8,639.26	14,281.59	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Coffee	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Other	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-Rubber	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-DA-DEF-Primary-Forest Land IV to Agricultural Land-African Palm	593.30	4,799.59	9,005.87	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Primary-Forest Lands IV to agroforestry systems	77.29	3,839.67	7,602.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands I to Grasslands	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land I to Agricultural Land-Other	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands I to Agroforestry Systems	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands II to Grasslands	1,742.92	6,719.43	11,695.93	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land II to Annual-Crops	77.29	3,839.67	7,602.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands II to agroforestry systems	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land III to Grasslands	10,791.35	19,198.36	27,605.37	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land III to Crops-Annuals	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands III to agroforestry systems	- 740.80	1,919.84	4,580.48	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands IV to Settlements	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land IV to Grasslands	6,403.18	13,438.85	20,474.52	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Land IV to Crops-Annuals	1,742.92	6,719.43	11,695.93	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Degraded-Forest Lands IV to Agricultural Lands-African Palm	- 378.71	2,879.75	6,138.21	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very degraded-Forest land I to annual crops	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land I to Agricultural Land-Coffee	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Lands II to Grasslands	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land II to Annual-Crops	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land III to Settlements	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very degraded-Forest Lands II to Wetlands and Water Bodies	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very degraded-Forest Lands III to agroforestry systems	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land IV to Grasslands	593.30	4,799.59	9,005.87	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land IV to Crops-Annuals	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEF-Very Degraded-Forest Land IV to Agricultural Land-Other	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-DA-DEF-Very degraded-Forest Land IV to Agricultural Land-African Palm	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land I Primary A Degraded	15,374.94	24,957.86	34,540.79	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land I Primary A Very Degraded	4,321.82	10,559.10	16,796.38	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land I Degraded to Very Degraded	1,151.96	5,759.51	10,367.06	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land II Primary A Degraded	45,582.20	60,474.83	75,367.45	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land II Primary To Very Degraded	13,063.79	22,078.11	31,092.43	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land II Degraded to Very Degraded	2,996.93	8,639.26	14,281.59	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Lands III Primary to Degraded	28,961.89	41,276.47	53,591.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land III Primary A Very Degraded	7,116.48	14,398.77	21,681.06	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land III Degraded to Very Degraded	10,791.35	19,198.36	27,605.37	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Lands IV Primary to Degraded	69,476.02	87,352.53	105,229.03	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land IV Primary A Very Degraded	14,600.70	23,997.95	33,395.19	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Forest Land IV Degraded to Very Degraded	22,483.06	33,597.13	44,711.19	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-DEG-Degraded plantations	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land I Highly Degraded to Degraded	77.29	3,839.67	7,602.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land I Heavily Degraded to Primary	593.30	4,799.59	9,005.87	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land I Degraded to Primary	19,295.89	29,757.45	40,219.01	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Lands II Very Degraded to Degraded	7,116.48	14,398.77	21,681.06	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land II Heavily Degraded to Primary	1,742.92	6,719.43	11,695.93	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Lands II Degraded to Primary	33,068.08	46,076.06	59,084.04	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land III Heavily Degraded to Degraded	3,651.90	9,599.18	15,546.45	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land II Heavily Degraded to Primary	4,321.82	10,559.10	16,796.38	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land III Degraded to Primary	36,378.99	49,915.73	63,452.47	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land IV Heavily Degraded to Degraded	10,791.35	19,198.36	27,605.37	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-RDEG-Forest Land IV Heavily Degraded to Primary	5,004.68	11,519.01	18,033.35	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%

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Input Variable	Corresponding Input Value			Output Value			Percent	
	Low Output	Base Case	High Output	Low	Base	High	Swing	Swing^2
NR-DA-RDEG-Forest Land IV Degraded to Primary	50,652.80	66,234.33	81,815.87	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-PLANT-Conifer Plantations I	10,791.35	19,198.36	27,605.37	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
NR-DA-PLANT-Plantation establishments	5,698.89	12,478.93	19,258.97	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
PM-DA-DEF-Primary-Forest Land I to Other Land	- 921.52	959.92	2,841.36	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%
PM-FE-DEF-Primary-Forest Land I to Other Lands	97.22	107.64	118.05	7,413,032.36	7,413,032.36	7,413,032.36	-	0.0%

To access the table and data used in the sensitivity analysis, click on the following link:
https://drive.google.com/drive/folders/1BaUk_CGtA1LJffUdGT8FIrjkzuIW2GWb?usp=drive_link

The file is called " Archivo_Sensibilidad_RE_22mayo2025_actualizado_NR_bueno_ Inside the excel file tab called: AS_NR_junio

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ANNEX 5: ER MONITORING REPORT (ER-MR) ON THE AREA OUTSIDE THE SCOPE OF ER PROGRAM ACCOUNTING AREA

This annex was prepared as part of the Government's commitment to monitor and report in parallel the annual reduction of emissions in the area outside the scope of the Emissions Reduction Program located in Triángulo de la Candelaria, Laguna del Tigre.

5.1 Carbon pools, sources and sinks

5.1.1. Description *of Sources and Sinks selected*

Sources/Sinks	**Included?**
Emissions from deforestation	Yes
Emissions from forest degradation	No
Enhancement of carbon stocks	No
Sustainable management of forests	No
Conservation of carbon stocks	No

5.1.2. Description *of carbon pools and greenhouse gases selected*

Carbon Pools	**Selected?**
Above Ground Biomass (AGB)	Yes
Below Ground Biomass (BGB)	No
Biomass in non-woody vegetation	No
Dead organic matter	No
Soil Organic Carbon (SOC)	No

GHG	**Selected?**
CO2	Yes
CH4	No
N2O	No

5.2 REFERENCE LEVEL

5.1.3. Reference Period

The reference period is 2006-2016.

5.1.4. Forest definition used in the construction of the Reference Level

According to the national definition, the forest is the continuous area with dominant tree cover with a minimum canopy cover of 30%, forming a stand of a minimum of 0.5 hectares and a minimum width of 60 meters (GIMBUT 2018b). Forests and other land uses are defined below in the consistent representation of land with its classification criteria, to provide greater clarity in the quantification of the FREL, as well as in the characterization of the forest land dynamics processes that are identified from REDD+ activities in the FREL.

The definition of forest used differs from that used in the Forest Report Assessment (FRA) 2015, which is as follows: Forest land or land without any use that extends over 0.5 hectares, endowed with trees that reach a height greater than 5 m and a canopy cover greater than 10 percent. The term specifically excludes tree stands used in agricultural production systems, for example fruit plantations and agroforestry systems. The term also excludes trees that grow in urban parks and gardens.

On the other hand, the GHGI presented in the Third National Communication on Climate Change does not include a definition of forest, nor does it include the input used to detect deforestation. However, it can be assumed that operationally it should be similar due to the forest classifications identified, as well as to the other uses that are reported.

Although there could be differences in the definitions, operationally the definition has remained constant, since the classifications and figures reported in terms of the amount of forest, both in the FRA and in the National Communication are similar, and the differences can be attributed to the use of different inputs and methodologies, rather than to a difference in definition. In addition, the definition presented in this document will be used in the next official reports to the UNFCCC.

5.1.5. Average annual historical emissions over the Reference Period

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

The land use approach, in the three REDD+ activities of deforestation, degradation and increases in forest carbon stocks (IPCC, 2006). CO_{2eq} emissions and removals were obtained by multiplying the activity data corresponding to the area converted from forest land to other land for deforestation, the forest land that remains as forest land that loses coverage due to degradation, and the other land that is converted to forest land, through the recovery of degraded areas and the establishment of forest plantations to increase carbon stocks, by emission and absorption factors (Equation 8, which corresponds to the calculation section).

$$\mathbf{RL=(Def+deg)-(Incr)} = \mathbf{(E_{DEF}+E_{DEG})} - \mathbf{(R_{rec}+R_{pla})} = ((\mathbf{ADef} * \mathbf{FE}) + (\mathbf{ADdeg} * \mathbf{FE}) - (\mathbf{Rrec} * \mathbf{FA}) - (\mathbf{Rpla} * \mathbf{FA}))$$

Where:

RL	=	Reference Level
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from degradation
$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE	=	Emission factors for deforestation and degradation and absorption factors for carbon increases in forest biomass.
FA	=	Emission factors for absorption for carbon increases in forest biomass.

To determine the emissions of the reference level, the first step is to calculate the information from the activity data and then make the estimate in tons of CO_2 equivalent.

Below you will find the links to the files to estimate the activity data, as well as the emissions and removals of the reference level.

- File containing the estimates of emissions and removals for each of the REDD+ activities:
- File that contains the information of the point grid with its categories of land use:

Guatemala does not consider the annual loss of biomass due to forest removal (harvesting), the collection of fuel wood and other losses caused by disturbances, storms, insects and forest and diseases. The estimates for each activity are made separately with specific assumptions based on the information available, and their methods of obtaining activity data and their emission and absorption factors.

1.1.2 Activity data and emission factors used for calculating the average Annual historical emissions over the Reference Period

Activity data

Parameter:	Deforestation
Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 3 Additionally, to convert the data to emissions we used equation 8.
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	To generate the activity data for this parameter, Collect Earth was used as a platform for the collection of land use information for the years of interest, which allows us to identify the permanence and changes that occurred in these years. For the identification of these land uses, Guatemala uses the IPCC classification to establish the land use of the parcel being observed. To use the Collect Earth form, Guatemala has a methodological protocol for its use, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link The interpreters who performed the interpretation and after labeling the 11,354 sample points and labeling the change, a filter was made to identify those points that were deforestation within the program area. A total of 27 points were identified within the program area, to then use the equation found in section 2.1.1 to obtain the data on hectares of deforestation. The table 6*8* of applied values shows the main transitions caused by deforestation. The total number of hectares deforested at the reference level was 23,944.28 ha. The information corresponding to the activity data can be found in the excel file called "Estimacion_ Emisiones_Guatemala_NRF_MR_2daRonda_05agosto2024". In the tab called “AreaExterna” In the NR Program tab and column E of the deforestation section (Rows 7-9) is the information corresponding to the activity data of the reference level. The information in this column is not divided into the year’s corresponding to the reference level.
Value applied	For deforestation, the land representation categories being used are those according to the IPCC. Table 73. Deforestation in the reference level

Classification	(Ha)
Forest I to cropland	957.77

<table>
<tr><td></td><td></td><td>Forest I to grasslands</td><td>23,944.28</td><td></td></tr>
<tr><td></td><td></td><td>Forest I to other lands</td><td>957.77</td><td></td></tr>
<tr><td>QA/QC procedures applied:</td><td colspan="4">A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated.

For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td colspan="4">Table 74. Uncertainties for deforestation for the reporting period

<table><tr><th>Classification</th><th>Deforestation ((TonCO2/year))</th></tr><tr><td>Median</td><td>2,440,861</td></tr><tr><td>Average</td><td>2,582,319</td></tr><tr><td>Deviation</td><td>1,603,825,524,163</td></tr><tr><td>CI – lower limit</td><td>985,818</td></tr><tr><td>CI – upper limit</td><td>4,499,796</td></tr><tr><td>%</td><td>72</td></tr></table></td></tr>
<tr><td>Any comment:</td><td colspan="4">To access the documents and calculations related to this activity, consult the following link:
To check the grid of points for the activity data, please click on the following link: https://drive.google.com/drive/folders/1tEoT1GJPzitSpmoW3nLxhi5entlqBUAo

To check the emissions and removals estimation tool, please click on the following link: https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV</td></tr>
</table>

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

Accreditation period year *t*	**Annual average of historical emissions derived from deforestation during the Reference Period (tCO_{2eq}/year)**	**If applicable, annual average of historic emissions from forest degradation during the Reference Period (tCO_{2eq}/year)**	**If applicable, annual average of historical removals by sinks during the Reference Period (tCO_{2eq}/year)**	**Adjustment, if applicable (tCO_{2eq}/year)**	**Reference level (tCO_{2eq}/year)**
2020	**1,096,058.92**				**1,096,058.92**
2021	**1,096,058.92**				**1,096,058.92**
2022	**1,096,058.92**				**1,096,058.92**
2023	**1,096,058.92**				**1,096,058.92**
2024	**1,096,058.92**				**1,096,058.92**

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5.3 Estimated reference level

ER Program Reference level

The reporting period covered in this report covers a full calendar year, therefore the application of Guideline number 3 of the Methodological Framework is not necessary.

Accreditation period year *t*	Annual average of historical emissions derived from deforestation during the Reference Period (tCO_{2eq}/year)	If applicable, annual average of historic emissions from forest degradation during the Reference Period (tCO_{2eq}/year)	If applicable, annual average of historical removals by sinks during the Reference Period (tCO_{2eq}/year)	Adjustment, if applicable (tCO_{2eq}/year)	Reference level (tCO_{2eq}/year)
2020	1,096,058.92				1,096,058.92
2021	1,096,058.92				1,096,058.92
2022	1,096,058.92				1,096,058.92
2023	1,096,058.92				1,096,058.92
2024	1,096,058.92				1,096,058.92

5.3 MONITORING AND REPORTING PERIOD

5.3.1 Measurement, monitoring and reporting approach

Line Diagram

The following diagram (Figure 11) shows the different components of the MRV System of the emission reduction program under the FCPF, where the main activities related to the generation of activity data, the estimation of emission/removal factors and the calculation of emissions and removals to obtain the emission reductions for the year of interest are presented. This line diagram is complemented by Figure 3, which details those responsible for the preparation of carbon accounting, safeguards, benefit sharing plan and non-carbon variables. The line diagram shows the step by step (seven steps in total) of each of the steps that are needed to have as a result the emission reductions for the monitoring period.

For the process of calculating emissions reductions, the line diagram is intended to show the different processes from the generation of activity data, the allocation of carbon content, obtaining the emission and removal factors to obtain the emissions and removals of the reference level and the first monitoring. These processes are in charge of the head of the Geographic Information Systems unit of INAB with technical support from UVG.

Each step of the line diagram is described below:

- Step 1 sample Base Area Estimation:

Consists of the use of the collect earth tool which allows us to use the high-resolution images available in the Google Earth catalog. The tool also has external support to consult Planet, Sentinel and Landsat images, as well as to consult vegetation indexes. The document can be accessed:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

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- Step 2 Visual interpretation of the CEP form:

In this step the visual interpretation of the 11,354 sample points that are randomly distributed in Guatemala is performed. The collect earth form allows to establish the coverage and use for the current year, as well as to establish the coverage of the previous year. It also assigns whether the plot is a permanence or change in use, in addition to recording the date of the images used. The database is then exported and transformed from a comma-separated format to an Excel file. The form can be accessed through this link:

Methodological protocol:
https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link

Point grid:
https://drive.google.com/drive/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC

CEP: https://drive.google.com/drive/folders/1IhxjFz5gPGKg-qCbXXBwU9cDOSnQ0E5m?usp=drive_link

- Intermediate step Prepare emission factors:

In this step we proceed to assign to each of the plots in Guatemala, the forest content stratum to the plots this with the objective of identifying the plots that had a change of use and to know the carbon content prior to deforestation or degradation.

The carbon layer map can be accessed through this link:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view
(Open with ArcGIS)

The methodological protocol document can be accessed through this link:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Step 3 Area estimation:

For the area estimation, each plot was weighted with the total number of plots in the country, and then the WI weight was multiplied with the total area of Guatemala to obtain hectares. After this, dynamic tables can be made to know the areas for each of the REDD+ activities that Guatemala has. The area can be found in the file "NR_MallaPuntos_Escenario_7_MC2025_05", in the BL column.

The document can be accessed through this link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvaIYzd_1HnDqkaPYCV

- Step 4 Allocation of emission factors:

To establish the emission factors, forest strata were used to categorize the plot into primary forest, degraded forest and highly degraded forest based on the number of elements in the plot. Once the stratum is identified, the carbon content is established based on the forest stratum in which it is located and the stratum of the carbon map in which the plot is located. Additionally, the non-forest carbon content is also established in case there is a change in land use. The carbon calculation is found in column BQ for the year 2006, column BU for the year 2016 and column CA for the year 2020. The file to consult this information is called "NR_MallaPuntos_Escenario_7_MC2025_05".

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvaIYzd_1HnDqkaPYCV

- Step 5: Calculation of CO2/year per activity

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To calculate the CO2 per year for each activity, the excel file called “NR_MallaPuntos_Escenario_7_MC2025_05” is used and the BW column contains the tons of CO2 per year for the reference level and the CE column contains the tons of CO2 per year for the first reporting period.

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV

- Step 6 Calculation of emissions/removals:

For the calculation of emissions and removals we proceed to create a pivot table using the data from the “Malla” tab of the excel file “NR_MallaPuntos_Escenario_7_MC2025_05” using the columns in which the REDD+ activities that Guatemala monitored were identified. The next step is also to create a dynamic table for the first reporting period of Guatemala also using the "Malla" tab and accounting the emissions for this reporting period. These calculations can be found in the tab "TablaD"

The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV

- Step 7 Emission reduction calculation:

After the pivot tables are created, a table is created by subtracting the reference level REDD+ activities minus the REDD+ activities of the first reporting period to obtain the total reductions. These calculations can be found in the "Table D" tab.
The excel file can be consulted at the following link:
https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV

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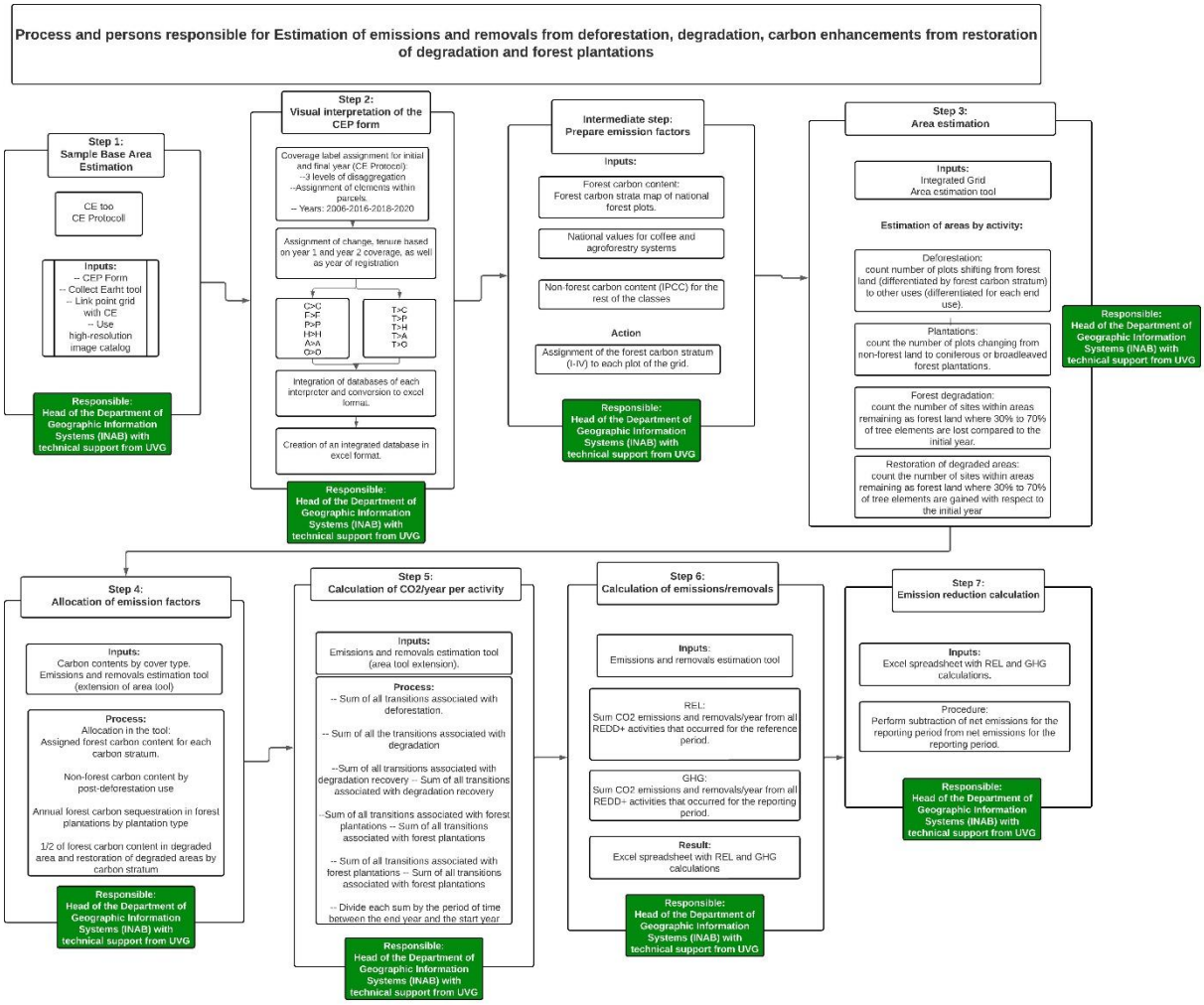

Figure 9. Components for calculating the program's emission reductions.

Calculation

Emission reduction (ER)

$$ER_{ERP} = RL_T - GHG_T \qquad \text{Equation 1}$$

Where:

ER_{ERP}	=	Emission Reductions under the ER Program in year t ($tCO_2e*year^{-1}$)
RL_T	=	Gross emissions of the RL from deforestation over the Reference Period ($tCO_2e*year^{-1}$). Net annual average emissions of the RL due to deforestation and degradation and the absorptions due to the increases in carbon during the reference period(($tCO_2e*year^{-1}$) This is sourced from Annex 4 to the ER Monitoring Report and equations are provided below.
GHG_T	=	Monitored gross emissions from deforestation at year t ($tCO_2e*year^{-1}$) Annual net emissions from deforestation and degradation and the absorptions due to increase in carbon in the monitoring period ($tCO_2e*year^{-1}$)

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T		Number of years during the monitoring period; dimensionless

4. Reference Level (RL)

The RL estimation may be found is provided below [61]. RL was defined as the net annual average historical emissions. Annual emissions or absorptions were estimated for all land transitions by REDD+ activity, and then adding the results for all selected REDD+ activities for each year.

The REDD+ activities that are included in the reference level for Guatemala are:

- Emissions from deforestation and forest degradation.
- Absorptions from increases in forest stock that may be due to recovery of forest degradation and forest plantations.

Equation 2:

$$\mathbf{RL=(Def+deg)-(Incr) = (E_{DEF}+ E_{DEG}) - (R_{rec}+ R_{pla}) = AD * FE/FA}$$

Where:

RL	=	Reference Level
$\mathbf{E_{DEF}}$	=	Emissions from Deforestation
$\mathbf{E_{DEG}}$	=	Emissions from degradation
$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE/FA	=	Emission factors for deforestation and degradation and absorption factors for carbon increases in forest biomass.

To determine the emissions of the reference level, the first step is to calculate the information from the activity data and then make the estimate in tons of CO_2 equivalent.

Below you will find the links to the files to estimate the activity data, as well as the emissions and removals of the reference level.

- File containing the estimates of emissions and removals for each of the REDD+ activities:
- File that contains the information of the point grid with its categories of land use:

4.1. Reference level activity data

4.1.1. Activity Data of deforestation

[61] The Reference Level has 10 years because 2006 is considered the base year of the land cover status, and from 2007 onwards, emissions occurring from 2007 until 2016, which is considered the final year of the Reference Level, are reviewed and quantified, so when it comes to accounting, it is a total of 10 years.

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To determine the activity data, a random mesh was used consisting of 11,354 sample points for the entire country and 10,414 plots for the program area. Each plot has a total of 25 elements and the use is determined by the coverage that predominates.

Equation 3:

$$AD_{def} = \left(\frac{N_{def}}{N_{Total}}\right) * T$$

Where:

AD_{def}	=	Data derived from deforestation
N_{def}	=	Number of plots that were interpreted as deforestation in the period studied and that are categorized according to the number of tree elements, and these categories are: • Primary forest: 20 to 25 trees per plot. • Degraded forest: 14 to 19 trees per plot. • Highly degraded forest: 8 to 13 trees per plot.
N_{Total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

4.2. Reference level emission and removal data

4.2.1. Emissions from Deforestation

Equation 8:

$$\text{Edef} = \sum_{j,i} \left(\left(C_{for} - C_{nofor}\right) \text{x} \frac{44}{12} \times A(j,i) \right) / RP$$

Where:

Edef = Emissions caused by deforestation (tCO2 per year)

$\underline{A}_{(j,i)RP}$ = Area from activity data that has been converted from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, Guatemala, the forests have a division based on four carbon strata:

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Ten types of non-forest land are considered:

- Cropland (C): What are annual crops, African palm, rubber and coffee. What are annual crops, African palm, rubber and coffee.
- Agroforestry systems such as shade-grown coffee was separated.
- Grassland (P);
- Wetland (A);
- Settlement (U); and
- Other lands (O).

$\underline{C_{for}}$ = Total forest carbon content of each ~~forest carbon content~~ strata j before conversion/transition, in tons of carbon per ha.

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C_{nofor} = Total non-forest carbon content of each non-forest land use i after conversion, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the reference period

The conversions identified for the reference level for Guatemala are the following:

Forest to croplands

- Forest I to cropland lands

Forest to grasslands

- Forest I to grasslands

Forest to other lands

- Forest I to other lands

The following tables show the forest carbon content as well as the content of other non-forest land uses. The origin of each of the values is shown in more detail in Chapter 3 and the respective sections of the report (Annex 4 and 5).

Forest carbon content

Stratum	Forest carbon content -Cfor- (Ton/ha)
Forest I	94.40

Non-forest carbon content

Non forest land Use	Non forest carbon content -Nofor- (Ton/ha)
Croplands (all classes not specified) and grasslands	4.7
Grasslands	6.73
Other lands	0

5. Reporting period (GHG)

Net emissions during the reporting period[62] in the accounting area are estimated by subtracting carbon emissions and carbon removals.

Equation 12:

$$\mathbf{GHG=(Def+deg)-(Incr)} = \mathbf{(E_{DEF}+E_{DEG})} - \mathbf{(R_{rec}+R_{pla})} = ((\mathbf{ADef} * \mathbf{FE}) + (\mathbf{ADdeg} * \mathbf{FE}) - (\mathbf{Rrec} * \mathbf{FA}) - (\mathbf{Rpla} * \mathbf{FA}))$$

Where:

GHG = Reporting period

$\mathbf{E_{DEF}}$ = Emissions from Deforestation

$\mathbf{E_{DEG}}$ = Emissions from degradation

[62] The monitoring period has 4 years for degradation and recovery of degradation because the year 2016 cannot be quantified again so the years 2017,2018,2019 and 2020 are used for the monitoring period and reported for the year 2020. For deforestation, the total number of years is two because 2018 is taken as the base year and from 2019 to 2020 monitoring is carried out and reported for 2020.

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$\mathbf{R_{rec}}$	=	Removals from forest degradation recovery
$\mathbf{R_{pla}}$	=	Removals due to increased carbon through forest plantations
AD	=	Activity data for conversion of forest lands to other lands (Deforestation), permanent forest lands with forest cover loss (Degradation), other lands that become forest lands and degraded permanent forest lands that increase their forest cover and establishment of forest plantations (Increases).
FE/FA	=	Emission factors for deforestation and degradation
FA	=	Absorption factors for carbon increases in forest biomass.

The first step to calculate the net emissions of the monitoring period is the calculation of the activity data.

Activity data of the monitoring period

5.1. Activity Data of deforestation

To determine the activity data, a random mesh was used consisting of 11,354 sample points for the entire country and 10,414 plots for the program area. Each plot has a total of 25 elements and the use is determined by the coverage that predominates.

Equation 13:

$$AD_{def} = \left(\frac{N_{def}}{N_{Total}}\right) * T$$

Where:

AD_{def}	=	Data derived from deforestation
N_{def}	=	Number of plots that were interpreted as deforestation in the period studied and that are categorized according to the number of tree elements, and these categories are: • Primary forest: 20 to 25 trees per plot. • Degraded forest: 14 to 19 trees per plot. • Highly degraded forest: 8 to 13 trees per plot.
N_{Total}	=	Total number of parcels found in the program area
T	=	Surface area of the program expressed in hectares

5.2. Reporting period emission and removal data

Equation 18:

5.2.1. Emissions from Deforestation

$$\text{Edef} = \sum_{\mathbf{j,i}} ((C_{for} - C_{nofor}) \text{ x } \frac{44}{12} \times A(j,i) \ ) / RP$$

Where:

Edef	=	Emissions caused by deforestation (tCO2 per year)

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$\underline{A}_{(j,i)RP}$ = Area from activity data that has been converted from forest type j to non-forest type i during the Reference Period, in hectares per year. In this case, Guatemala, the forests have a division based on four carbon strata:

- Stratum I
- Stratum II
- Stratum III
- Stratum IV

Ten types of non-forest land are considered:

- Cropland (C): What are annual crops, African palm, rubber and coffee. What are annual crops, African palm, rubber and coffee.
- Agroforestry systems such as shade-grown coffee was separated.
- Grassland (P);
- Wetland (A);
- Settlement (U); and
- Other lands (O).

$\underline{C}_{for}$ = Total forest carbon content of each strata j before conversion/transition, in tons of carbon per ha.

$\underline{C}_{nofor}$ = Total non-forest carbon content of each non-forest land use i after conversion, in tons of carbon per ha.

44/12 = Conversion of C to CO_2

RP = Years consisting of the monitoring period

Forest to grasslands

- Forest I to grasslands

Forest carbon content

Stratum	Forest carbon content (Ton/ha)
Forest I	94.40

Non-forest carbon content

Non forest land Use	Non forest carbon content (Ton/ha)
Grasslands	6.73

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5.3.2. Data and parameters

Fixed Data and Parameters

Parameter:	Forest carbon content (Cfor)
Description:	Forest carbon content of four carbon strata before conversion to non-forest land Used in equations: 8,9,10,11 and 18,19,20,21.
Data unit:	Ton of carbon 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):	The information generated in the carbon strata map of Guatemala was used to establish biomass above and below ground for forest information. To obtain the carbon content, a study was carried out in which a total of 2,364 forest plots were analyzed, which was prepared by the National Council of Protected Areas with the support of GIMBUT. For more details and explanation of how the value was obtained for the four strata of forest carbon in Guatemala you can consult the report that was made, which is in the following link: https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view To obtain greater clarity on how the forest carbon content in Guatemala was constructed, the documents, databases and spatial data have been placed in the section of any comments. The criteria for data cleaning started with individual trees, identifying atypical data with respect to DBH, height was applied only where trees with inconsistent heights were identified; however, in the other sources of information it was only used as a reference. Plot debugging consisted of missing coordinate information and inconsistent locations". The most significant pool includes above-ground biomass carbon from trees greater than 10 cm in diameter (Trees greater than 10 cm DBH[63] are included, because for Guatemala it is the definition of a tree). measured at 1.3 m (DBH). Lianas and palms were not considered as part of the aboveground or belowground biomass as part of the emission factors, since there is no information available. The data of this pool is modeled in the carbon strata map at the national level, which was prepared from 2,306 plots of forest inventories, from different projects, which were systematized, refined, standardized, and analyzed to obtain the value of biomass for each individual greater than 10 cm DBH[64]. General allometric equations were applied, differentiating between broadleaf forests in Petén, coniferous forests, broadleaf forests and mangrove forests. In the latter, three

[63] For Guatemala, the following definition for a tree is used:
Woody plant with a defined stem and crown with secondary growth that, when mature, reaches a minimum height of 5 meters and a minimum diameter of 10 cm. Bamboos and palms are excluded.

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species-specific equations were used. The factor 0.47 was used to convert biomass to carbon and the result per hectare was standardized by dividing the result by the plot size.

The second pool, which is related to the previous one, includes below-ground biomass (roots). To estimate below-ground biomass, an above-ground biomass ratio equation was used for all plots (Mokany, Raison & Prokushkin 2006)[65], except for the Mangrove Forest plots, where an equation was used (Komiyama et al. 2008)[66].

The following (see

The equations that appear in table 5 for coniferous and deciduous forests were generated for these specific forest types. They were not made for tree species.

Table 5) shows the equations used to calculate the biomass above and below ground for the Petén, conifers, broadleaves and three mangrove species forests, which take into consideration the relationship in function of the proportion of aerial biomass for the below-ground biomass. It is important to mention that all the allometric equations are implemented at the tree level, not at the level of an entire plot.

Additionally, in the "Methodological report for the elaboration of the carbon strata map" in chapter 4.3 and 4.4 Allometric equations for broadleaved and coniferous forests, it is explained how the allometric equations were applied, depending on the location of the plots (page 7).
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

A regional equation is used for the vegetation types of northern Peten (Arreaga) and is applied for all trees in Peten. For the rest of the country, two equations are used that are assigned by vegetation type (coniferous and broadleaf), and three species-specific equations for mangrove trees (Rhizophora mangle L., Laguncularia racemosa (L.) Gaertn.f., Avicennia germinans (L.)L.).

Table 75. Allometric equations used.

Mangrove species	Equation	Source	r2	N	Dmax
Rhizophora mangle L.	0.178*DBH^2.47	Imbert and Rollet (1989)a	0.98	17	Unknown
Laguncularia racemosa (L.) Gaertn.f.	0.1023*DBH^2.50	Fromard et al. (1998)	0.97	70	10
Avicennia germinans (L.) L.	0.14*DBH^2.4	Fromard et al. (1998)	0.97	25-45	42.4
Conocarpus erectus L.[67]	0.1023*DBH^2.50	Fromard et al. (1998)			
Types of vegetation by region	**Equation**	**Source**	**r2**	**N**	**Dmax**

[65] https://drive.google.com/file/d/1kM2ZLN0ftJHTO4due1jyJx1s4_DuATA4/view?usp=drive_link
[66] https://drive.google.com/file/d/15PmlsvBZefff7-2b_GBZhMvry4y7sp2u/view?usp=drive_link
[67] This equation is the same as the one used for the Mangrove species "Laguncularia racemosa (L.)".

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Broadleaf vegetation of northern Peten	10^ (-4.09992+(2.57782*LOG10(DBH))) *1000	Arreaga, 2002	95	139	130
Broadleaf vegetation	0.13647*DBH^2.38351	UVG,2018	0.939	100	79.9
Coniferous vegetation	0.15991 * DBH^2.32764	UVG,2018	0.966	80	82

With the biomass data for each individual, the conversion of tons of biomass to carbon is made, multiplying by the fraction of 0.47 and the value for one hectare is extrapolated, according to the size of each plot. The values are added for each of the plots, and results in a standardized value of tons of carbon per ha in each of them.

Each plot has geographic location data, and these were stratified bioclimatically, as an indirect measure of primary productivity, based on the ombrothermal indices generated for Guatemala, which were constructed with data obtained from the World Clim digital page, using the monthly precipitation and temperature averages. This climatic classification has been widely used in Guatemala as a basis for regional planning and for the integration of other variables of interest to forest services or biological conservation (CONAP, 2015).

The plots with their carbon content were in 6 ombric horizons, and data (the carbon content data of the analyzed plots) distribution tests were carried out for each of them, finding that none presented normality in the data distributions. Therefore, to carry out the stratification according to the ombric horizons, a comparison test of k samples (Kruskal-Wallis) was carried out, where statistically differentiated groups were detected as shown below (See Table 6).

Table 76. Grouping categories according to climatic regime.

Ombric Horizon	Frequency	Sum of ranks	Average Ranges	Groups	
8a. Hyperhumid Lower	381	559995.000	1469.803	A	
7b. Wet top	578	684020.500	1183.426	B	
6b. Upper sub-humid	172	203487.000	1183.064	B	
6a. Lower sub-humid	633	725451.000	1146.052	B	
8b. Hyper-humid superior	43	49152.500	1143.081	B	C
7a. Wet Bottom	556	570960.000	1026.906		C

As shown below, from the statistical grouping, four strata were determined at the national level according to the amount of carbon and the zones of ombric horizons (See Table 7). The groups that are observed in table 8, indicate those ombric indices that are statistically related to each other. That is why the result is four groups.

Table 77. Groups in which climatic regimes are classified.

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Ombric Horizon	Groups			Final stratum
8a. Hyperhumid Lower	A			I
7b. Wet top		B		II
6b. Upper sub-humid		B		II
6a. Lower sub-humid		B		II
8b. Hyper-humid superior		B	C	III
7a. Wet Bottom			C	IV

With these data, the values were assigned to those areas whose ombric horizon did not have enough plots to be represented (e.g., Dry type), leaving the final stratification as detailed in Table 8, with which the national coverage is achieved.

Table 78. Strata assigned to horizons with insufficient values.

Stratum	Ombric Type	Ombrian horizon
I	8. Hyper-humid	8a. Hyperhumid Lower
	4. Semi-arid	4b. Upper semi-arid
	5. Dry	5a. Lower Dry
		5b. Superior dry
II	6. Sub-humid	6a. Lower sub-humid
		6b. Upper sub-humid
	7.Wet	7b. Wet top
	9. Ultra-Hyperhumid	9. Ultra-Hyperhumid
III	8. Hyper-humid	8b. Hyper-humid superior
IV	7. Wet	7a. Wet Bottom

To have more consistent data in the estimation of tons of carbon per hectare and per stratum, descriptive statistics were made for each group and the resulting carbon content ranges were compared. Due to the great variability of the data according to the size of the plots and sampling designs, calculations of carbon density were made with the median and the weighted mean was also calculated for the four strata according to the proposal of Thomas and Rennie, 1987, who define that variance is a good estimator of the mean. Due to the variability of sampling designs for different purposes, data distribution (non-normal) and plot sizes, the probability density function (PDF) of the data by plot size and by stratum through goodness-of-fit tests was identified (Gómez Xutuc, 2017). Once the PDFs have been identified, it performs simulations of the carbon content per hectare, (Figure 6).

Thus, 10,000 simulations were run, truncating distributions according to the minimum and maximum of each data (tC/ha) by plot size and by stratum, respectively. The median was used for the analysis, since these are data that do not present a normal distribution.

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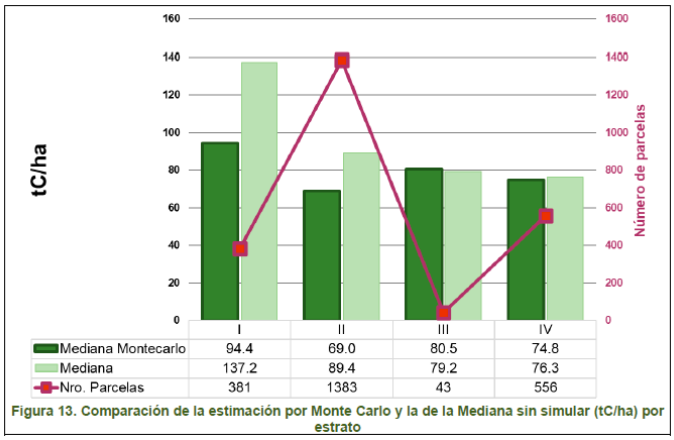

Figure 10. Estimated values for the carbon map.

Value applied:

The final values of forest biomass above and below ground were as follows.

Table 79. Carbon values obtained for each stratum.

Strata	Median	Standard deviation	Uncertainty (%)
I	94.43	27.919	58.0%
II	68.98	20.353	57.8%
III	80.46	9.049	22.0%
IV	74.78	38.023	99.7%

QA/QC procedures applied

Review and evaluation of atypical data for its depuration. Due to the variability in the sources of information, different procedures were carried out in the debugging of the information. For most of the plots, the previously described process was applied (see figure 2), with the exception of the inventory base, for which the following steps were followed. Methodological Document (page 6).
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

A constraint was made to limit the height of the trees in the equations so that heights well outside the range would bias the results. Additionally, plots with inadequate georeferencing were removed from the analysis.

Additional analysis was done to check the accuracy of the map against the plots of the project inventories. Since the country also submitted a reference level to the United Nations Convention on Climate Change, we proceeded to review whether the correspondence of the map's carbon layers was in line with reality. Therefore, INAB proceeded to perform an analysis to evaluate the quality of the carbon layers map, which can be found in the folder in this link:
https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view

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<table>
<tr><td></td><td>Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.</td></tr>
<tr><td>Uncertainty associated with this parameter:</td><td>Table 80. Uncertainty of the carbon strata after applying the Monte Carlo method.

<table><tr><th>Strata</th><th>Median (TonC/ha)</th><th>Uncertainty (%)</th></tr><tr><td>I</td><td>94.43</td><td>58.0%</td></tr><tr><td>II</td><td>68.98</td><td>57.8%</td></tr><tr><td>III</td><td>80.46</td><td>22.0%</td></tr><tr><td>IV</td><td>74.78</td><td>99.7%</td></tr></table>
The values found in
Table 10 are the result of the modeling for the carbon strata for the calculation of the uncertainty of the emission reduction.

Slope correction is a practice that is performed when taking data from forest plots, however, it is not certain if all the plots used in the carbon strata map of Guatemala have applied this good practice, which may represent a systematic error. This error is not propagated because there is a risk that this adjustment was not actually implemented.</td></tr>
<tr><td>Any comment:</td><td>To access the documents and calculations related to this activity, consult the following link:

Methodological report:
https://drive.google.com/file/d/1zLvJIbThxMOW_QFFZu4E29xBkb6wOfyx/view

Database to build the carbon strata of Guatemala:
https://drive.google.com/file/d/12c8ozxbj3VcquPhLeKNXHVcYPxK8KNTl/view

Shapefile:
https://drive.google.com/file/d/12daIACdM77zRz474dsfPL0u3D7b16aI8/view

For the National Forest inventory:

https://www.sifgua.org.gt/SIFGUAData/PaginasEstadisticas/Recursos-forestales/inventario-forestal.aspx and for the rest of the plots, they are based on the permanent sampling plots and inventory plots: https://mangomap.com/desarrollo-forestal/maps/103965/parcelas-permanentes-de-medici-n-forestal-ppmf-?preview=true#.

It is important to mention that for the elaboration of the carbon strata map there was no consolidation methodology that fulfilled this objective, however, the task of compiling information from plots from natural forests was carried out, which is why there is information of different sampling sizes.</td></tr>
</table>

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<table>
<tr><td>Parameter:</td><td>Non forest carbon content (Cnofor)</td></tr>
<tr><td>Description:</td><td>Non-forest carbon content after conversion of forest land to non-forest land
Used in the equations: 9 and 19</td></tr>
<tr><td>Data unit:</td><td>Tons of carbon/ha</td></tr>
<tr><td>Source of data or description of the method for developing the data, including the spatial level of the data (local, regional, national or international):</td><td>In order to have an estimation of the emissions that is closer to reality and to assign a biomass existence value after deforestation, depending on the type of activity that is carried out, in addition to the data obtained for the country for agroforestry systems, the general default values were used for land converted to cropland during the year following conversion, from the 2006 IPCC Guidelines for Wet Tropical Annual and Perennial Crops and their associated error range found in IPCC Table 5.9 (2006). The values for these other non-forest use categories were used as described below (See Table 81):
Table 81. Carbon in biomass after conversion due to deforestation.

Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Monitoring Period results in the process of rebuilding the estimation of reductions.
<table>
<tr><th>Other land uses</th><th>Ton Carbon/ha/year</th><th>Range of error and/or uncertainty</th><th>Source</th></tr>
<tr><td>Croplands (all classes not specified)</td><td>4.7</td><td>±75%</td><td>IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)</td></tr>
<tr><td>Croplands-Coffee (intensive)</td><td>2.65</td><td>1.35%</td><td>Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the coffee agroecosystem in Guatemala. PROMECAFE</td></tr>
<tr><td>Croplands-African Palm</td><td>3.47[68]</td><td>±75%</td><td>IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands) Above-ground</td></tr>
<tr><td>Croplands-Rubber</td><td>4.30[70]</td><td>±75%</td><td>IPCC 2019 (Volume 4, Table 5.3Table 5.3, chapter 5 Croplands, annual croplands) Above-ground</td></tr>
</table>
</td></tr>
</table>

[68] modified by applying the Mokany equation

[69] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

[70] modified by applying the Mokany equation

[71] The default assumption is that there is no change in below-ground biomass of perennial trees in agricultural systems

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Other land uses	Ton Carbon/ha/	Range of error and/or uncertainty	Source
Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the coffee agroecosystem in
Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)
Settlements	0.00	N/A	IPCC 2006
Wetlands	0.00	N/A	IPCC 2006
Other lands	0.00	N/A	IPCC 2006

Value applied:

Other land uses	Ton Carbon/ha/year	Range of error and/or uncertainty	Source
Croplands (all classes not specified)	4.7	±75%	IPCC 2019 (Volume 4, Table 5.9, chapter 5 Croplands, annual croplands)
Croplands-Coffee (intensive)	2.65	1.35%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the
Croplands-African Palm	3.47[72]	±75%	IPCC 2019 (Volume 4, Table 5.3, chapter 5 Croplands, annual croplands)
Croplands-Rubber	4.30[73]	±75%	IPCC 2019 (Volume 4, Table 5.3Table 5.3, chapter 5 Croplands, annual croplands)

[72] modified by applying the Mokany equation

[73] modified by applying the Mokany equation

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Other land uses	Ton Carbon/ha/	Range of error and/or uncertainty	Source
Agroforestry systems (shaded coffee)	20.1	1.34%	Alvarado J, López D, Medina B. Estimated quantification of carbon dioxide fixed by the
Grasslands	6.73	±75%	IPCC 2006 (Table 6.4, chapter 6 Grasslands)
Settlements	0.00	N/A	IPCC 2006
Wetlands	0.00	N/A	IPCC 2006
Other lands	0.00	N/A	IPCC 2006

Note: Since there are national values, it is suggested to leave this table to have all the non-forest carbon content values so that it is easier to replicate the Reference Levels and the Reporting Period results in the process of rebuilding the estimation of reductions.

QA/QC procedures applied

Does not apply because they are default values taken from the IPCC Guidelines.

Uncertainty associated with this parameter:

Table 82. Uncertainty of carbon content in non-forest land

Classification	Agriculture	Coffee	Palm	Rubber	Agroforestry	Grasslands
Mean (TonC/ha)	4.7	2.6	2.4	3.0	20.3	6.7
Average (TonC/ha)	4.7	2.7	2.4	3.0	20.2	6.8
Deviation (TonC/ha)	3.1	0.3	0.2	0.0	361.6	55.8
CI – lower limit (TonC/ha)	1.22	1.64	1.44	2.63	-16.72	-7.78
CI – upper limit (TonC/ha)	8.15	3.70	3.35	3.38	57.12	21.51
%	73.43	38.93	39.83	12.58	181.82	218.33

Any comment:

To access the documents and calculations related to this activity, consult the following link:

Chapter Croplands for Croplands:

	https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch05_Cropland.pdf Chapter Croplands for African Palm and Rubber: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_05_Ch5_Cropland.pdf Chapter Grasslands https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_06_Ch6_Grassland.pdf Data for intensive coffee and Agroforestry systems (shaded coffee): https://drive.google.com/file/d/1kXI5Pxr_iUJOffJJTfVBTjF2iWihs3tq/view?usp=drive_link https://docs.google.com/presentation/d/1JjSan9z5CYySzZuhCwRWxW9c1tR2nyww/edit?usp=drive_link&ouid=115188584703966598135&rtpof=true&sd=true

Monitored Data and Parameters

Parameter:	Deforestation
Description:	Forest land converted to non-forest uses The following equations were used to calculate this parameter: Activity data: Equation 13 Additionally, to convert the data to emissions we used equation 18.
Data unit:	Hectares
Value monitored during this Monitoring/Reporting Period:	<table><tr><th>Category</th><th>Ha</th></tr><tr><td>Forest I to grasslands</td><td>3,831.08</td></tr></table>
Source of data and description of measurement/calculation methods and procedures applied:	To generate the activity data for this parameter, Collect Earth was used as a platform for the collection of land use information for the years of interest, which allows us to identify the permanence and changes that occurred in these years. For the identification of these land uses, Guatemala uses the IPCC classification to establish the land use of the parcel being observed. To use the Collect Earth form, Guatemala has a methodological protocol for its use, which can be consulted at the following link: https://drive.google.com/drive/folders/1uAYrJ4GdtwBOeVxW3fVWufGJnj_TRY7f?usp=drive_link The total number of interpreters who carried out the analysis of the images were three specialists: Ulises Armas, Claudia Saput and Melany Ramirez. For the identification of deforestation, plots were identified in which, during the 2018-2020 period, they lost their entire forest cover or suffered a degradation process greater than 70% loss of the elements corresponding to trees.

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	After interpreting the 11,354 sample points and labeling the change, a filter was made to identify those points that were deforestation. 27 points were identified within the external area of the program (Laguna del Tigre) to then use the equation found in section 3.1.1 to obtain the data on hectares of deforestation. For monitoring, a total of 27 deforestation points were identified, which is equivalent to a total of 25,859.82 ha. After the identification of the deforested plots, the forest stratum was identified for each of the plots and the carbon content was assigned. Then, the non-forest cover to which the plot passed was identified and the carbon content for this use was assigned. The information corresponding to the activity data can be found: https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV In the tab "AreaExterna" column E, in the section corresponding to Deforestation is the information corresponding to the activity data for the m*onitoring* period. The information in this column is not divided into the year's corresponding to the monitoring.
QA/QC procedures applied:	A review of the non-logical changes was made and the information corresponding to the land cover that did not match was updated. For quality control, the criterion of using 5% of the sample corresponding to the total deforestation points was used, with a 90% confidence interval and an expected 5% error.
Uncertainty for this parameter:	Table 83. Uncertainties for deforestation for the reporting period **Classification** / **Deforestation** Median (TonC) / 44,951.1 Average (TonC) / 45,032.8 Deviation (TonC) / 42,905,355.4 CI – lower limit (TonC) / 32,024.6 CI – upper limit (TonC) / 58,084.9 % / 29.0
Any comment:	To access the documents and calculations related to this activity, consult the following link: Activity data: https://drive.google.com/drive/folders/12VcqmE16an7EKVeHXpsZkqqtFYS5MhGC In the tab "AreaExterna" column E, in the section corresponding to Deforestation is the information corresponding to the activity data for the reporting period. The information in this column is not divided into the year's corresponding to the monitoring.

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	Calculation of hectares and emissions/absorptions https://drive.google.com/drive/folders/1W5iqLKV7iCR-jcvalYzd_1HnDqkaPYCV

5.4 QUANTIFICATION OF EMISSION REDUCTIONS

5.4.1 Reference level for the Monitoring / Reporting Period covered in this report

Year of Monitoring/Reporting g period *t*	Average annual historical emissions from deforestation over the Reference Period (tCO2-e/yr)	If applicable, average annual historical emissions from forest degradation over the Reference Period (tCO2-e/yr)	If applicable, average annual historical removals by sinks over the Reference Period (tCO2-e/yr)	Adjustment, if applicable (tCO2-e/yr)	Reference level (tCO2-e/yr)
2020	1,096,058.92	-	-	-	1,096,058.92
Total	**1,096,058.92**	**-**	**-**	**-**	**1,096,058.92**

5.4.2 Estimation of emissions by sources and removals by sinks included

Year of Monitoring/Reporting g Period	Emissions from deforestation (tCO2-e/yr)	If applicable, emissions from forest degradation (tCO2-e/yr)*	If applicable, removals by sinks (tCO2-e/yr)	Net emissions and removals (tCO2-e/yr)
2020	809,616.71	-	-	809,616.71
Total	**809,616.71**	-	-	**809,616.71**

5.4.3 Calculation of emission reductions

Total Reference Level emissions during the Reporting Period (tCO2-e)		**1,096,058.92**
Net emissions and removals under the ER Program during the Reporting Period (tCO2-e)	**2020**	**809,616.71**
Emission Reductions during the Reporting Period (tCO2-e)	**2020**	**286,442.21**

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5.5 UNCERTAINTY OF THE ESTIMATE OF EMISSION REDUCTIONS

Uncertainty of Reference Level emissions during the reporting period (%)		71.46
Uncertainty of net emissions and removals under the ER Program during the for the reporting period (%)	**2020**	77.65
Uncertainty of Emission Reductions during the reporting period (%)	**2020**	77.65

Document history

Version	Date	Description
1	June 2022	The initial version moved for approval by Carbon Fund Participants during a three-week no-objection period.

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Document history

Version	Date	Description
2.4	May 2022	• Page 1 and section 8 have been adjusted to reflect the dentition of Total ERs
2.3	December 2021	• Section 5.2 was adjusted to allow the reporting of the uncertainty estimates for both the reporting period and the crediting period. • Section 8 has been adjusted to clarify that countries can also report ERs jointly and not only in separate calendar years.
2.2	August 2021	• Cross-references have been corrected • Information about the start date of the crediting period has been requested in annex 4.
2.1	November 2020	Aspects on uncertainty analysis were revised based on the guidelines on uncertainty analysis.
2	June 2020	Version approved virtually by Carbon Fund Participants. Changes made: • Update to consider the changes made to the Methodological Framework (Version 3.0) and Buffer Guidelines (Version 2.0) • Update to consider the changes made to the Validation and Verification Guidelines
1	January 2019	The initial version approved by Carbon Fund Participants during a three-week non-objection period.