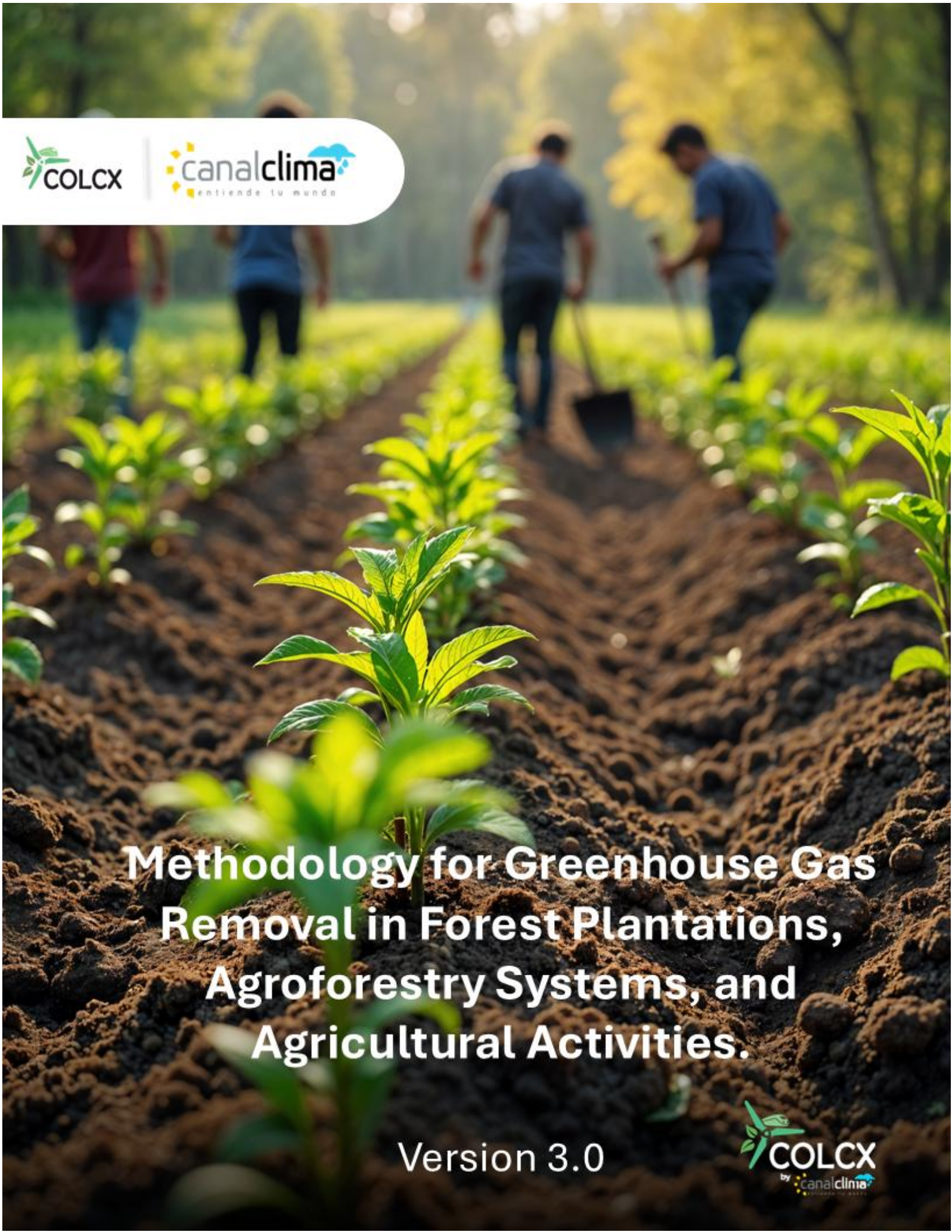

Methodology for Greenhouse Gas Removal in Forest Plantations, Agroforestry Systems, and Agricultural Activities.

Version 3.0

Methodology for Greenhouse Gas Removal in Forest Plantations, Agroforestry Systems, and Agricultural Activities

Version 3.0

CONTENT

TABLES

1 DEFINITIONS

- **Sustainable Forest Harvesting:** Silvicultural treatment consisting of the felling of trees in a way that ensures the continuity of timber resources for future generations. To be considered sustainable, forest harvesting must comply with technical and legal criteria, which vary depending on the forest type and the regulatory framework of the host country.
- **Land-Use Change:** The transformation of the current use of land associated with a particular land cover or area. This directly affects geographic, economic, political, social, demographic, and cultural factors.
- **Permanent Shrub Crops:** Land covers composed primarily of shrub-like crop species. Shrubs are understood as perennial plants with woody stems, ranging from 0.5 to 5 meters in height, and often exhibiting significant basal branching.[1]
- **Fruit Tree Crops:** For the purposes of this methodology, these are areas distinct from permanent shrub crops, where arboreal species predominate, including medium-sized trees such as cacao (*Theobroma cacao L.*), copoazú (*Theobroma grandiflorum (Wild. ex Spreng.) K. Schum.*), among others, which share similar characteristics (height and well-defined crown). These are mainly established for fruit production.
- **Oil Palm Crops:** The cultivation of African oil palm (*Elaeis spp.*) for oil production.
- **Afforestation:** The planting or sowing of tree species in areas with no historical presence of forest cover.
- **Forest Plantations:** Anthropogenic land cover composed of tree vegetation established for forest management purposes, with one or multiple production objectives (e.g., timber, non-timber forest products, or other ecosystem goods and services). They may be established in various areas, provided that the soil conditions are suitable. These plantations may consist of a single species or a mixture of species.
- **Oil Palm Replanting:** Activity aimed at improving crop productivity after factors such as plant height, reduced fruit bunch size and weight, or mortality caused by pests and diseases. These actions result in GHG emissions.
- **Reforestation:** The planting or sowing of trees in areas where forest cover (natural forest or forest plantation) previously existed but was removed due to other land uses.
- **Agroforestry Systems:** Areas with multipurpose arrangements (for the production of fiber, fodder, fruits, etc.) that combine forest species (trees or shrubs) with agricultural species of herbaceous, shrub, or tree types. These arrangements involve associations of permanent and semi-permanent crops (e.g., cacao, coffee, and fruit trees mixed with forest species) sharing the same geographical production area. Forest species in these systems may function as windbreaks, live fences, or shade for the shrub or herbaceous crops.
- **Organic Soils:** Soils with at least 12% organic carbon. These can be identified by the thickness of their organic horizon and the absence of water saturation.
- **Secondary Vegetation:** A type of land cover that emerges after the disturbance or destruction of natural forest, either by human intervention or natural causes. This cover is characterized by primary or secondary plant succession and may include elements such as remnants of dense or fragmented natural forest, degraded areas, or shrub vegetation covering less than 30% of the minimum mapping unit.

An extension of all terms related to this methodology can be found in the *Guide of Terms and Definitions COLCX.*

[1] IDEAM (2010). Leyenda Nacional de Coberturas de la Tierra. Methodology CORINE Land Cover adapted to Colombia Escala 1:100.000. Instituto de Hidrología, Meteorología y Estudios Ambientales. Bogotá, D. C., 72 p.

2 OBJECTIVES

Provide owners and proponents with a technical guide for the formulation and implementation of GHG Mitigation Projects (GHGMP) based on forest plantations, agroforestry systems and agricultural activities.

3 SCOPE

This methodology covers relevant criteria and procedures for performing:

1) Project eligibility analysis
2) Identification, quantification and monitoring of carbon sources, sinks and reservoirs
3) Determination of the baseline scenario
4) Additionality analysis
5) Quantification of GHG removals generated by the activities of the methodological scope
6) Definition of mechanisms for leakage control
7) Criteria for the monitoring of the GHGMP

This methodology can be applied by any type of entity, person or institution that intends to establish a project to mitigate the effects of climate change through GHG removal activities hereinafter referred to as GHGMP based on applicable activities. This methodology is applicable to Landscape Management Tools that are not located in forest areas, such as live fences, agroforestry systems and scattered trees in paddocks. In the case of forest enrichment, it can be used in conjunction with the ICR module of the REDD+ methodology in its current version.

4 APPLICABLE ACTIVITIES

This methodology allows the formulation and implementation of a GHGMP in the AFOLU sector, including at least one of the following activities, either monocultures or mixed crops:

- Timber, non-timber and/or multipurpose forest plantations
- Agroforestry systems
- Fruit Tree Crops
- Oil palm and other palm crops

Projects implementing this methodology must consider the specific requirements established by the host country's regulations.

5 APPLICABILITY CONDITIONS

This methodology is applicable under the following conditions:

- The owner(s) of the property(ies) are the legal owners of the total area where the GHGMP will be carried out, and who possess the right to use the land, free of legal or other disputes. The documents that can prove ownership, possession, and tenure must comply with the rights that demonstrate carbon ownership according to the legal context of each country.
- Activities that are developed in accordance with the legal requirements of each country and region, and present plans for the use or management of production that allow the traceability of the activity to be recognized.
- Areas whose land use suitability is related to the specific eligible activity (the specific activity refers to the type of crop). Official zonings made by the host country should be considered. Ecosystem maps in their recent official version from official national sources should be

considered. In case of edaphoclimatic differences in the project area with respect to zoning, information showing its suitability for use can be provided if it is specific to the area and is backed by a recognized source and endorsed by an expert in land use suitability.
- When Landscape Management Tools (LMT) are implemented that involve forest or remnant enrichment, the ICR Module of the current REDD+ methodology may be used.

This methodology is not applicable under the following conditions:

- Area with severe environmental impacts that cannot be managed
- Areas with applicable activities in areas that were previously secondary vegetation, some types of natural regeneration tending to be forest or natural forest.
- Areas in which there are plantations or ecological restoration, or compensation processes established by legal obligation.
- Projects that are already registered in other GHG programs or that have some type of financing for environmental services or other types of financing on account of ecosystem services.
- Establishment of activities applicable in areas dominated by natural ecosystems that are periodically flooded and/or have organic soils, for example: wetlands, paramos, mangroves, among others, which have soils with a high organic matter content.
- Places where there is a violation of the law
- Areas with plantings of species cataloged as invasive

6 ELEGIBILITY

For the eligibility of the area of a GHGMP, the following criteria must be taken into account:

- Demonstrate ownership by the proponents of the property, collective territory or properties, through legal documentation that shows that the owners are legal owners of the total land area where the GHGMP will be carried out or have the right to use the land, tenure or possession for the duration of the project; it must also be demonstrated that these properties do not have legal or other disputes that could jeopardize the GHGMP.
- Ten years prior to the project start date there was no forest or secondary vegetation cover according to official sources in each country. If no information is available, a multitemporal analysis can be carried out based on satellite images with a resolution level greater than 30 meters, considering the land cover classification of each country[2].
- Any type of activity in fragile or organic soils or establishment of any activity in ecosystems catalogued as strategic, protected areas or national parks is not eligible.

7 ADDITIONALITY

For the COLCX program the concept of additionality and the process for its evaluation is developed based on the Clean Development Mechanism (CDM). The mechanisms for demonstrating the additionality of a GHGMP are:

- Identification of alternative land use scenarios to GHGMP
- Investment Analysis and/or Barrier Analysis Selection

[2] For Colombia this classification is the CORINE Land Cover adapted by IDEAM.

  - *Investment Analysis:* Determine whether the activities proposed by the GHGMP are financially feasible, without considering COLCERs funding, and that these activities are less financially attractive compared to the consistent scenarios.
  - *Barrier analysis:* This can be performed in lieu of or as an extension of the investment analysis. If this step is used, determine whether the proposed project activity faces barriers that:
    - Avoid implementation of this type of proposed project activity without revenues from the sale of GHG credits; and
    - Do not prevent the implementation of at least one of the alternative land use scenarios.
- Common practice analysis: Determines that the alternative scenarios to the project have substantial differences with the project activities.
- Comparative Emissions and Carbon Analysis: Ensures that the selected baseline scenario is the one with the highest emissions and delimits that the project generates a positive impact with respect to baseline removals, reductions and emissions.

The proponent of the mitigation initiative must demonstrate the additionality of the project through the application of the *COLCX Guide to demonstrate additionality*, so that if the mitigation initiative meets the evaluation criteria defined in the referred instrument, it may be considered additional

8 TIME AND SPACE LIMITS

The temporal and spatial limits of GHGMP allow establishing the area and temporality in which COLCERs may be generated by the removal of GHGs. All geoprocessing performed by the developer must disclose in their attributes the area, type of coverage, year and description. The developer shall determine the most appropriate attributes.

8.1 Time Limits

The time limits of the project must be defined in the Project Design Document (PDD) and considering the following aspects:

8.1.1 Project Start Date

In the case of eligible activities, it is a date after or equal to the date of establishment of the activity. This must be supported by documents that objectively reveal its implementation. For example, establishment of seedlings, project idea documents and registration in the COLCX standard.

8.1.2 Retroactive period

The retroactivity period for ARR projects is a maximum of five (5) calendar years prior to the date of signature of the validation contract with a VVB.

8.2 Spatial Limits

The GHGMP must identify and delimit the areas that are subject to monitoring according to their activity. The project area corresponds to parcels or tracts of land over which the project proponent has the legal right of ownership of the land and can carry out mitigation activities. This right must be held by the proponent from the project start date and during the implementation of the GHGMP. The following criteria must be considered to identify the project area:

- Name or names of properties or areas
- Spatial delimitation of the project area. It must be presented in vector formats applicable in a GIS (e.g., shp., Geopackage, kml., among others)
- Current situation of land tenure and legal ownership of the territory.
- All participants and their roles within the GHGMP. Please note the company name, document number or NIT, contact number and e-mail address.

8.3 Grouped projects

For the GHGMP to be considered as grouped, an expansion area must be established that considers ecological and activity homogeneity criteria. The ecological homogeneity criteria are determined based on the similarity of living conditions in the environment, which must have been maintained at least during the historical reference period. The following is a list of the requirements that must be met to ensure ecological uniformity within the grouping area:

- **Similarity in land use and soil type**: soil characteristics, such as composition, use capacity and type, must be equivalent in all expansion polygons to ensure compatibility in terms of livestock management and conservation of soil carbon reservoirs.
- **Elevation**: the elevation ranges present in the expansion areas must be similar to those of the original project area, which is essential to maintain consistent ecological and climatic conditions.
- **Ecosystem similarity**: the predominant ecosystems in the expansion area must coincide with those of the project area, including the dominant vegetation and other ecological aspects that ensure continuity in environmental management. To determine this similarity, structural and functional ecological criteria should be considered. In addition, species richness and diversity indices, the presence of water bodies, and other key variables can be evaluated.
  At the landscape or polygon level, it is recommended to include environmental heterogeneity indices, considering the distribution of different vegetation types or phytophysiognomies. Polygons with greater environmental heterogeneity, characterized by high structural and functional diversity, should be prioritized for conservation and must not be considered for livestock expansion.
- **Similar slopes**: the areas selected for expansion should have similar slopes to the original project area, to avoid significant differences in soil management and sustainable livestock practices.
- **Adjacent political boundaries**: expansion areas should be within adjacent political boundaries, such as neighboring municipalities or departments, to facilitate administrative management and consistency in project implementation.
- **Environmental management conditions**: expansion areas must have been subject to practices similar to those of the original project area, including afforestation, restoration or carbon reserves enhancement practices.

A maximum variation of ±15% is allowed with respect to the original conditions of the project area, thus ensuring uniformity in its implementation and results.

The project has until its first verification to include the expansion areas identified by addition; after this verification, any inclusion of new areas will require a post-registration change of the project. If areas are subtracted for various reasons, the GHGMP will not need to be revalidated, and it will be sufficient to consult COLCX about this change. Expansion areas must allocate their entire area to these same activities. This approach ensures that the practices implemented are representative and

consistent with the objectives of the project, facilitating a proper evaluation of the impact and benefits generated.

It is essential that all homogeneity criteria are considered during the project's validation or first verification. The project developer must design the protocol that will guide this validation and clearly establish how each criterion is met, to allow a landholder to join a grouped project initiative.

9 APPLICABLE RESERVOIRS

The carbon reservoirs included in the different activities contemplated by this methodology will be those that can be measurable and significant with respect to the GHGMP baseline (minimum 5% to be considered). The selected reservoirs must be quantified both in the baseline scenario and in the formulation and implementation scenario. The following is a list of reservoirs that can be included in a GHGMP. For optional reservoirs, data from national or subnational GHG inventories or studies from indexed scientific journals can be used, if they apply to the climate, humidity and species implemented in the GHGMP.

Table 1 Reservoirs applicable to Afforestation, Reforestation and Revegetation activities.

Reservoir	Applicable	Description
Aerial biomass	Yes	This corresponds to the living biomass found on the soil (stems, branches, bark and foliage). This reservoir is expected to be maintained and increased as a function of ARR activity.
Belowground biomass	Yes	Includes the living biomass of roots. Excludes fine roots less than 2 mm in diameter. Expected to be maintained in conserved forest cover or increased in areas with new vegetation cover.
Dead Wood	Opt	Comprises dead woody biomass found on the surface either standing or fallen, parts of detached wood, or exposed roots of fallen trees. Must be significant and adequately accounted for, can be monitored.
Leaf litter	Opt	Includes all dead aboveground plant biomass less than 2 cm in diameter (leaves, branches and fruit shells). It must be justified as a significant reservoir and for its inclusion it must be possible to monitor it.
Soil Organic Carbon	Opt	It includes all organic carbon stored in the soil (including root ends smaller than 2 mm), the depth of estimation must be justified by the proponent being a minimum of 30 cm. It must be significant and adequately justified; it can be monitored.
Timber products	Opt	This relates to the timber products generated as a result of harvesting, extraction, transport and transformation of timber individuals, with the understanding that the harvesting of individuals does not generate the immediate release of stored carbon.

Where: ARR: Afforestation, Reforestation and Revegetation, Opt: Optional.

10 EMISSION SOURCES

All emission sources must be identified in the baseline scenario, for their inclusion it must be demonstrated that they are significantly increased and consistent with eligible activity. At a minimum, the sources in Table 2, must be evaluated and, if significant, must be monitored in the project scenario.

Emission sources that account for more than 5% of the total calculated emissions between the baseline and project scenarios should be included (see Table 2). Any non-significant GHG emissions should be conservatively excluded.

For the quantification of source emissions, the equations, factors and recommendations of the IPCC[3] [4], guidelines, host country GHG inventory methodologies or GHG inventories consistent with the project area can be used.

Table 2 Emission sources in ARR activities

Source	GHG	Applicable		Description
		LB	Proj	
Forest fires	CO_2	No	No	They are quantified within carbon reserves changes
	CH_4	No	Yes	Emissions resulting from uncontrolled fires are considered emissions. Not allowed in the baseline.
	N_2O	No	Yes	
Land-Use Change	CO_2	Si	Yes	Emissions caused by changes in pre-existing carbon reservoirs due to extraction.
	CH_4	No	No	GHG other than CO_2 are not considered because burning is not allowed for the preparation of the activities.
	N_2O	No	No	
Fertilization	CO_2	No	No	All emissions from the use of synthetic fertilizers or other pre-existing amendments and in the project, scenario must be quantified.
	CH_4	No	No	
	N_2O	Opt	Yes	
Forest Harvesting	CO_2	Si	Yes	Should be considered if selective logging, forest harvesting and losses due to pests or diseases occur during project implementation. All significant emissions from agricultural and forestry machinery for harvesting should be included.
	CH_4	No	No	
	N_2O	No	No	

Where: Opt: Optional

Where biogenic fires are recorded, these emissions are calculated according to IPCC guidelines [5]:

[3] IPCC. (2003). Orientación del IPCC sobre las buenas prácticas para UTCUTS. Available in: kutt.it/laZFfp
[4] IPCC. (2006). Directrices del IPCC de 2006 para los inventarios nacionales de gases de efecto invernadero. Agricultura, silvicultura y otros usos de la tierra. Available in: kutt.it/iLd1fY
[5] IPCC. (2003). Orientación del IPCC sobre las buenas prácticas para uso del suelo, cambio de uso del suelo y forestería. Available in: https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf

$$ECH4\ (CO2eq)_i = ECO2eq_i * \frac{12}{44} * TE * \frac{16}{12} * PCG\ (1)$$

$ECH4eq_i$: *Equivalent CH_4 - CO_2 emission from stratum i burned.*
$ECO2eq_i$: *CO_2e emission factor of stratum i.*
$\frac{12}{44}$: *C/CO2 ratio*
TE: *Methane emission rate*
$\frac{16}{12}$: *Methane to carbon dioxide molecular ratio*
PCG: *Global warming potential of methane*

$$EN2O(CO2eq)_i = ECO2eq_i * \frac{12}{44} * \frac{N}{C} * TE * \frac{44}{28} * PCG(2)$$

$EN2Oeq_i$: *N_2O- CO_2 emission from stratum i burning*
$ECO2eq_i$: *Emission factor of stratum i*
$\frac{12}{44}$: *C/CO2 ratio*
$\frac{N}{C}$: *Nitrogen-carbon ratio*
TE: *Methane emission rate*
$\frac{44}{28}$: *Molecular ratio of nitrous oxide and nitrogen*
PCG: *Global warming potential of methane*

11 BASELINE

The baseline is the existing sources, sinks and reservoirs of GHG emissions, prior to the implementation of the GHGMP as justified in Table 1 and Table 2.

The proponent should consider likely existing land uses in the absence of the mitigation initiative, justifying their presence with information appropriate to the context and host country where the initiative is established.

The selected scenario must comply with the normative and regulatory framework and use the conservative principle for the quantification of its associated emissions and its existence must be at least 10 years prior to the project start date.

For this reconstruction, information from official sources can be used, prioritizing from local, regional to national information. The availability and reliability of the source should also be supported if it comes from scientific articles, technical, economic or environmental concepts that may exist and fit the project area.

11.1 Emission factors

The emission factors used for the GHGMP can be based on official data from the host country, public studies or indexed journals applicable to the area of the GHGMP. Own surveys with sufficient technical support based on the best practices are also valid. Emission factors must be measurable and verifiable to allow for monitoring, reporting and verification.

To determine the emission factors, calculations in carbon reservoirs should be taken into account through inventories that present an error of less than 10%, with a confidence level of 95%. Generate local data from GHG inventories. For the identification of these emission sources, methodological

reconstructions of the processes defined by GHG inventories or national inventories can be used, applicable to the GHGMP.

To determine the emission factors, consider the following formulas:

$$\boldsymbol{\Delta BA_{i,t} = (BA_{t1} - BA_{t2}) * \frac{44}{12} * FC} \quad (3)$$

ΔBA_i: Aerial biomass reservoir removal or emission factor in terms of Mg CO_2 per hectare of stratum i, in year t
BA_{t1}: Aerial biomass at initial time in terms of Mg biomass per hectare of stratum i
BA_{t2}: Aerial biomass at the final time in terms of Mg biomass per hectare of stratum i
$\frac{44}{12}$: Carbon dioxide and carbon dioxide molecular ratio constant
FC: Carbon fraction in biomass

$$\boldsymbol{\Delta BS_{i,t} = (BS_{t1} - BS_{t2}) * \frac{44}{12} * FC} \quad (4)$$

ΔBS_i: Removal or emission factor of the subway biomass reservoir in terms of Mg CO_2 per hectare of stratum i, in year t
BS_{t1}: Belowground biomass at initial time in terms of Mg biomass per hectare of stratum i
BS_{t2}: Belowground biomass at the final time in terms of Mg biomass per hectare of stratum i
$\frac{44}{12}$: Carbon dioxide and carbon dioxide molecular ratio constant
FC: Carbon fraction in biomass

$$\boldsymbol{\Delta MM_{i,t} = (MM_{t1} - MM_{t2}) * \frac{44}{12} * FC} \quad (5)$$

ΔMM_i: Removal or emission factor of the dead biomass reservoir in terms of Mg CO_2 per hectare of stratum i, in year t
MM_{t1}: Dead biomass at initial time in terms of Mg biomass per hectare of stratum i
MM_{t2}: Dead biomass at final time in terms of Mg of biomass per hectare of stratum i
$\frac{44}{12}$: Carbon dioxide and carbon dioxide molecular ratio constant
FC: Carbon fraction in biomass

$$\boldsymbol{\Delta LIT_{i,t} = (LIT_{t1} - LIT_{t2}) * \frac{44}{12} * FC} \quad (6)$$

ΔLIT_i: Leaf litter reservoir removal or emission factor in terms of Mg CO_2 per hectare of stratum i, in year t
MM_{t1}: Litterfall at the initial time in terms of Mg of biomass per hectare of stratum i
MM_{t2}: Litterfall at the final time in terms of Mg biomass per hectare of stratum i
$\frac{44}{12}$: Carbon dioxide and carbon dioxide molecular ratio constant
FC: Carbon fraction in biomass

$$\boldsymbol{\Delta COS_{20i,t} = \frac{(COS_{t1} - COS_{t2})}{20} * \frac{44}{12} * FC} \quad (7)$$

ΔCOS_{20i}: Soil organic carbon reservoir removal or emission factor in terms of Mg CO_2 per hectare of stratum i, in year t
ΔCOS_{t1}: Soil organic carbon at initial time in terms of Mg carbon per hectare of layer i
ΔCOS_{t2}: Soil organic carbon at the end time in terms of Mg carbon per hectare of stratum i
$\frac{44}{12}$: Carbon dioxide and carbon dioxide molecular ratio constant
FC: Carbon fraction in biomass

For this methodology, soil organic carbon is emitted gradually over a 20-year period.

The emission factor by stratum is presented below:

$$ECO2eq_i = (\Delta BA_i + \Delta BS_i + \Delta LIT_i + \Delta MM_i + \Delta COS_{20i}) \quad (8)$$

Where:

$ECO2eq_i$: *Emission factor of stratum i*
ΔBA_i: *Aerial biomass reservoir emission factor in terms of Mg per hectare*
ΔBS_i: *Belowground biomass reservoir emission factor in terms of Mg CO_2 per hectare*
ΔLIT_i: *Emission factor of the leaf litter reservoir in terms of Mg CO_2 per hectare*
ΔMM_i: *Emission factor of the dead biomass reservoir in terms of Mg CO_2 per hectare*
ΔCOS_{20i}: *Removal or emission factor of the soil organic carbon reservoir in terms of Mg CO_2 per hectare of stratum i, in year t.*

11.2 Baseline scenario

Once the baseline is defined, the baseline scenario is formulated, for which appropriate and reliable data sources must be considered. The project owner must justify the reasons for its choice and application. The timing of the data must consider the current technologies used in the territory and be as recent as possible.

The identification of the baseline scenario by the licensee shall be developed sequentially, starting from **¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.** and **¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.**.

12 FORMULATION SCENARIO

The following is a description of the project scenario based on assumptions and historical data called ex-ante, which is subject to validation.

12.1 Stratification

The stratification shall be applied in grouped projects and in those projects that present differences within their area in terms of the variables presented below.
To geographically represent the strata included within the grouped project, the cover will be georeferenced differentiating the type of cover, species planted, age and biomass volume.

12.1.1 Pre-stratification variables

The variables listed above should be reported for each stratum in the initiative formulation scenario.

12.1.1.1 Type of Coverage

The fundamental variable for stratification is the type of coverage implemented in the area, these must belong to one of the types of coverage of the applicable activities included in this methodology (see **¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.**).

12.1.1.2 Planted species(es)

The stratification of the areas with respect to the tree species planted within each project should be established to obtain a specific quantification for each type of cover, reducing uncertainty and highlighting the variations in capture for each species. In the case of mixed cover (more than one

species implemented within the same area), the identified stratum must be of the predominant tree species within the area.

12.1.1.3 Age of plantation

The age of the stratum must be reported in years, based on the time elapsed since its establishment and the time at which quantification is carried out. The age of each land cover must be determined according to the Establishment and Management Plan (EMP) of the plantation or crop and must be supported by the information provided in the official registration of the plantation with the relevant forestry and/or agricultural authority, where applicable.

12.1.2 Post-stratification variables

The variables listed above can be reported when the proponent deems it convenient to objectively illustrate the dynamics and behavior of the plantations involved.

12.1.2.1 Timber volume (optional)

The timber volume criterion (m^3) is not mandatory for stratification when the number of strata previously evaluated does not exceed 10. When there are grouped projects with more than 10 owners, this criterion must be reported.

Based on the identified strata and the indicated variables, an analysis of the volume variable should be carried out as follows:

a) The number of total m^3 belonging to the strata delimited on the basis of the variables mentioned above is identified with their corresponding sampled area.
b) The calculation of the volume per hectare for each stratum is made.
c) From the ordered data (from lowest to highest), the limiting index corresponding to each quartile is found as follows:

Even dataset

$$V_{Qk} = \frac{Kn}{4} \quad (9)$$

Odd dataset

$$V_{Qk} = \frac{K(n+1)}{4} \quad (10)$$

Where:
k = No. Quartile (1 to 3)
n = No. of data
V_{Qk} = Quartile limit index k

d) Considering the indexes belonging to each quartile, the strata are identified based on Table 3.

Table 3 Determination of strata according to the volume available in the project.

Category	Rank
I	Indices of volume data less than or equal to V_{Q1}
II	Volume data indices between V_{Q1} and V_{Q2}
III	Indices of volume data between V_{Q2} and V_3
IV	Indices of volume data greater than or equal to V_{Q3}

12.1.2.2 Stratification Results

Once the stratification has been carried out, the following results should be presented:

a) The EMF, with which the types of cover, age and species planted were identified
b) Procedure for calculating the quartiles and the subsequent classification of the final strata with the total variables (3 or as the case may be) when applicable
c) Stratification map for the project area
d) Report of the statistical analysis generated from the data obtained in the pre-sampling, determining the categorization ranges for the final stratification, including volume.

12.2 Quantification of GHG emissions

Emissions associated with the harvesting of timber for activities related to timber or palm extraction and those derived from the use of timber products according to their useful life are described in this chapter.

12.2.1 Emissions Caused by Forest Harvesting or Oil Palm Replanting Activities

12.2.1.1 Volume of Biomass Affected by Harvesting Activities

The determination of emissions associated with logging activities and the replanting of palm plantations must have a record of the individuals to be harvested per year (location and dendrometric data). Estimates of total volume and harvestable biomass derived from applicable local, regional or national allometric equations must be available. These equations must take into account at least the DBH and total height of the trees. Own allometric equations designed with a minimum of 10 individuals of at least 5 diameter classes per species are acceptable.

At least the volume of biomass affected by road construction and by the harvesting of forest individuals and/or replanting of palm crops for the activity must be identified. When there are activities such as the creation of firebreaks or other types of barriers that require the harvesting of individuals, these must also be quantified.

$$VT_{m,t} = \sum_{i=0}^{i}(\sum_{j=1}^{j}(\sum_{l=1}^{l}(VT_{l,j,i,t}))) \quad (11)$$

Where:
VT_m: *Total volume of biomass affected by activity m, in year t*
$VT_{lj,i,t}$: *Total biomass volume of tree l of species j in stratum i in* m^3, *in year t*
l : 1,2,3... sequence of individual trees
i : 1,2,3 ... M strata
j : 1,2,3 ... J tree species
t : year

Not all of the biomass that is affected is harvested; therefore, it has two components, the remaining biomass and the harvested biomass. In the case of harvested biomass, its volume is calculated as follows:

$$VC_t = \sum_{i=0}^{i}(\sum_{j=1}^{j}(\sum_{l=1}^{l}(VC_{l,j,i,t}))) \quad (12)$$

Where:
VC_t: *Total commercial volume harvested in* m^3, *in year t*

$VC_{l,j,i,t}$ = Commercial volume harvested of tree l of species j in stratum i, in m^3, in year t
l : 1,2,3... sequence of individual trees
i : 1,2,3 ... M strata
j : 1,2,3 ... J tree species
t : year

In the case of remaining wood, it is calculated as follows:

$$VR_t = (\sum_{m=0}^{m} VT_{m,t}) - VC_t \ (113)$$

VR_t= Remaining biomass volume in m^3, in year t
$VT_{m,t}$: Total volume of biomass affected by activity m, in year t
VC_t= Total commercial volume harvested, in year t
m = 1,2,3... silvicultural activity m
t = year

12.2.1.2 Emissions associated with forestry harvesting and palm replanting activities

Total emissions from forest harvesting and oil palm replanting are calculated under the assumption that they are generated outside the harvesting area; these may include:

- Emission from short-lived products: Includes products that are used for activities associated with the project area, whose emission takes place in the same year of harvesting. E.g., fuel wood, harvested residues.
- Emission from products with a moderate to long life: Includes products whose emission occurs in periods greater than 1 year and up to 100 years, depending on their useful life. E.g. paper, furniture and structural wood products.

Harvesting residues left on the site can be considered as dead matter and leaf litter inputs.

Emissions from timber harvesting and replanting are calculated using the following formulas[6]:

$$\Delta EP_{T,t} = E_{p,t} + E_{s,t} (14)$$

$\Delta EP_{T,t}$: Total emissions due to sustainable forest harvesting and/or replanting of palm crops
$E_{p,t}$: Emissions due to quick release products, in Mg CO_2 equivalent, in year t
$E_{s,t}$: Emissions due to moderate to slow-release products, in Mg CO_2 equivalent, in year t
ETp,t: Emissions due to activities with machinery or animals on the farm, in Mg CO_2 equivalent, in year t

Given the differences in GHG release associated with timber products, these should be calculated considering three categories[7]. The first category is that which is broken down into the first three years of harvesting. This is calculated as:

$$E_{p,t} = (VR_t + Vp_t) * \frac{44}{12} * FC \ (125)$$

$E_{p,t}$: Emissions due to quick release products, in Mg CO_2 equivalent, in year t.
VR_t: Remaining biomass volume, in year t.
Vp_t: Volume of short-lived timber products (1 to 3 years), in year t.

[6] Consider IPCC guidelines on Harvested Wood Products (HWP) for volume determination https://www.ipcc-nggip.iges.or.jp/public/2006gl/spanish/pdf/4_Volume4/V4_12_Ch12_HWP.pdf

[7] Define the useful life of each identified product type and based on this, quantify the corresponding progressive emissions. Consider the IPCC *guidance on harvested wood products*.

$\frac{44}{12}$: *Carbon dioxide and carbon dioxide molecular ratio constant*
FC: *Carbon fraction in biomass*
t = *year.*

The second category is wood that has a life span of 3 to 100 years. This category is estimated on a linear decomposition of 20 years.

$$E_{s,t} = Vst * \frac{44}{12} * FC \quad (136)$$

Es: Emissions due to moderate release products in Mg CO_2 equivalent, in year t
Vst: *Wood volume of medium-lived products (4 to 100 years), based on 20-year linear decomposition, in year t*
$\frac{44}{12}$: *Carbon dioxide and carbon dioxide molecular ratio constant*
FC: *Carbon fraction in biomass*
t = *year*

For the third category, corresponding to those products with a life of more than 100 years, it is assumed that their carbon reserves are permanently conserved.

12.2.2 Emissions from the use of wood harvesting and processing machinery

The machines used for wood harvesting and processing must be identified, and the fuel volume, type and corresponding emission factor for each machine and/or means of transport must be considered. This is calculated as follows:

$$\Delta ETp_t = E_{harvesting} + E_{minor\ transport} + E_{major\ transport} + E_{processing} \quad (147)$$

ΔETp: *Emissions due to activities associated with harvesting machinery in Mg CO_2 equivalent, year t*
$E_{harvesting}$: *Total emissions due to the use of machinery associated with harvesting in Mg CO_2 equivalent, year t*
$E_{major\ transport}$: *Total emissions due to minor timber transport in Mg CO_2 equivalent; in year t*
$E_{processing}$: *Emissions due to electricity consumption at the sawmill in Mg CO_2 equivalent, in year t*

For the calculation of emission factors associated with CO_2, CH_4 and N_2O related to fossil fuels, you can use the IPCC guidelines[8]. For the electricity used, use the emission factors of the host country.

12.3 Calculation of projected removals

The formulation scenario is based on projections derived from the modeling of increased GHG removals. Secondary or internal studies showing trends in reservoir increases may be used as reference. This multitemporal modeling, by crop type, must be conducted for the entire lifetime of the project.
In equation 18 replace the efficiency factor (EF) by supporting it as a function of the activities generated by the proponent for the performance of the reservoirs. The removals and the factor ($1 + Ef$) should be multiplied year by year according to the total projected removals.

[8] IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/spanish/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

$$\Delta FRR_{ACTUAL,t} = (\Delta CP_{T,t} - \Delta EP_{T,t})(1 + Ef) \quad (158)$$

Where:

$\Delta FRR_{ACTUAL,t}$ *(tCO_2e): Projected net CO_2 removals, by sinks at year t*
$\Delta CP_{T,t}$ *(tCO_2e): Projected carbon removals in sinks at year t* [9]
$\Delta EP_{T,t}$*: Total emissions due to logging and replanting of palm plantations*
Ef*: Project efficiency ratio*

In any case, the modeling of the stock changes must be done for each applicable reservoir considering the following equation:

$$\Delta \boldsymbol{CP_{T,t}} = (\boldsymbol{\Delta BA_{i,t}} + \boldsymbol{\Delta BS_{i,t}} + \boldsymbol{\Delta LIT_{i,t}} + \boldsymbol{\Delta MM_{i,t}} + \boldsymbol{\Delta COS_{20i,t}}) \quad (169)$$

Where:

$\Delta CP_{T,t}$*: Projected carbon removals in sinks at year t*
$\Delta BA_{i,t}$*: Aerial biomass reservoir emission factor in terms of Mg per hectare, year t*
$\Delta BS_{i,t}$*: Belowground biomass reservoir emission factor in terms of Mg CO_2 per hectare, year t*
$\Delta LIT_{i,t}$*: Emission factor of the leaf litter reservoir in terms of Mg CO_2 per hectare, in year t*
$\Delta MM_{i,t}$*: Emission factor of the dead biomass reservoir in terms of Mg CO_2 per hectare, year t*
$\Delta COS_{20i,t}$*: 20-year soil organic carbon reservoir emission factor in terms of Mg CO_2 per hectare, in year t*

Once the projection of the increase in removals in the formulation scenario has been estimated, the COLCERs are estimated, using the following formulas:

- For ARR compartment:

$$COLCERSDef_t = \Delta FRR_{ACTUAL,t} * FFR * \%RNP \quad (20)$$

Where:

$COLCERS_{FRR}$*: Projected certificates that are attributable to ARR activities, in year t.*
FFR*: Correction factor for the measurement of emissions from ARR activities.*
$\%RNP$*: Risk of non-permanence*

13 IMPLEMENTATION SCENARIO

The calculations for the implementation scenario are the same as for the formulation scenario, except for the values for each carbon reservoir.

- For aboveground biomass and the calculation of $\Delta CP_{T,t}$ the Increase of Carbon Reserves (ICR) module and the methods described for the determination of carbon assets should be taken as a reference. In addition, from the CDM AR-TOOL14 tool.
- In the case of the variable $\Delta EP_{T,t}$, the proponent must keep a GHG inventory of all associated variables, including emissions caused by the impact on GHG reservoirs, direct emissions due to forest harvesting and/or renewal of palm cultivation, and emissions due to the use of machinery.

[9] *Changes in the reservoirs, as well as their uncertainty, should be applied following the guidelines of A/R TOOL 14. (See* ar-am-tool-14-v4.2.pdf (unfccc.int)).

- Emissions should follow the same equations of the formulation scenario, applying the actual values. These should be supported with fuel inventories, technical specifications of the machinery, among others.
- For reservoirs other than aboveground biomass, methodologies endorsed by the CDM or from national GHG inventories, research institutes or scientific methods published in indexed scientific journals can be used.

14 MONITORING PLAN

The GHGMP proponent must monitor the activities implemented in the ARR initiative from the start date, generating an adequate follow-up of the GHG reductions and/or removals achieved because of its performance. The monitoring plan must define as a minimum the evaluation of variables associated with:

- Increase in carbon reservoirs
- GHG emissions associated with the activity
- Emission leakage (when applicable)
- Reversion and non-permanence risks
- Generation of no net harm and socio-environmental safeguards
- Contribution to the Sustainable Development Goals (SDG)

14.1 Data and parameters to monitor

This section presents the factors to be taken into account by the proponent in the reporting and monitoring of each related variable, covering the categories listed below.

Data / Parameter	Measured parameter (e.g. Area)
Unit of measure	(e.g. Hectare – ha)
Value applied	Indicate the value used in the analysis
Description	Characteristics of the measured parameter
Frequency of monitoring	Measurement timing
Responsible for monitoring	Actor related to parameter reporting
Source of information	Indicate where the information will be obtained from
Quality control and quality assurance activities	Mechanisms to ensure traceability and consistency of the information used
Additional information	Additional data explaining the parameter used

A monitoring plan should be proposed, including a general description of its content, follow-up mechanisms, data to be collected, data collection mechanisms, procedures to ensure the management and quality of the information.

To ensure traceability of the GHGMP, all information used, calculated and generated by the developer or reference must be documented and archived during the GHGMP crediting period under the responsibility of the proponent.

All mandatory monitoring variables on carbon sources, sinks and reservoirs must be verified at least every monitoring period.

14.2 Monitoring mechanisms

Information on aboveground biomass increment can be monitored through on-site data collection (e.g. forest inventories, censuses, sampling, etc.) or in combination with digital cover monitoring, meeting the thresholds of certainty and accuracy required by the methodology.

15 REVERSION RISK MANAGEMENT, NON-PERMANENCE RISKS

The analysis of non-permanence and reversal risks consists of monitoring strategic indicators that allow identifying the integrity of carbon stocks in the long term. The Non-Permanence Risk analysis shall be developed in accordance with the *ColCX Guide for the identification of non-permanence risks* in its most updated version.

16 UNCERTAINTY

The following considerations must be considered by the proposer:

- Uncertainties will be calculated based on the IPCC guidelines for each carbon reservoir on forest land [10] in addition to uncertainty issues[11].
- Errors from carbon reservoirs must be clearly identified and described.
- The proponent must demonstrate that year to year for any given emissions estimate, the calculated uncertainty is less than 10%.
- A statement of uncertainty should be made, conceptualizing the measurements and ways of measuring the different variables involved in carbon accounting.
- The proponent must report on the field data collection methods, measurement instruments, technical specifications and the ways in which measurement errors are expected to be reduced, such as calibration methods, training, among others.
- The proponent should make an identification of the uncertainty related to the models used in the analysis of alternatives for the construction of the baseline scenario. The uncertainty in the models should be key leading to the choice of the most appropriate one.
- Always ensure that the absolute percentage error (MAPE) is as low as possible.
- For activity data, the proponent must produce confusion matrices, identify confidence intervals for each category based on commission and omission errors, and ensure they are below 10%. Uncertainty in activity data must be calculated annually.
- In the case of areas without information, the proponent must have a protocol for the treatment of these areas.
- The criteria of conservatism, accuracy and completeness must always be considered.

The GHGMP for uncertainty should follow the guidelines defined in the most recent version of the "*ColCX Guide for the management of reversal risks, non-permanence risks and uncertainty*".

17 CONTRIBUTION TO THE SDG

The project proponent must indicate how the project activities contribute to the achievement of the Sustainable Development Goals (SDG) targets proposed by the 2030 Agenda. If the country where the initiative is developed has an adaptation of the SDG targets, the proponent may demonstrate its alignment with the specific objectives of the territory.

The project must consider the criteria and guidelines defined by the *COLCX Guide for Reporting Contributions to the SDGs* in its most updated version.

[10] https://www.ipcc-nggip.iges.or.jp/public/2006gl/spanish/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

11 https://www.ipcc-nggip.iges.or.jp/public/2006gl/spanish/pdf/1_Volume1/V1_3_Ch3_Uncertainties.pdf

—

History of the document

Version	*Date*	*Description*
1.0	August 10, 2023	Development initial version
2.0	July 22, 2024	Adjustments to the version 1.0
3.0	May 08, 2025	Adjustments to the version 2.0