



METHODOLOGICAL DOCUMENT

AFOLU SECTOR

BCR0001

AFFORESTATION, REFORESTATION, AND REVEGETATION

BIOCARBON CERT[®]

Public Consultation Version 5.0 | September 25, 2025

BIOCARBON CERT

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Table of contents

1	Introduction	8
2	Objective	8
3	Sources	9
4	Version and validity	10
5	Scope	10
6	Applicability conditions	11
7	Normative references	11
8	Terms and definitions	13
9	Carbon reservoirs and GHG sources	19
9.1	Carbon reservoirs.....	19
9.2	Emission sources and GHGs selected for accounting	20
10	Eligible areas for ARR activities	20
10.1	Requirements of geographic information for the eligibility analysis	21
11	Grouped projects and inclusion of new areas	21
12	Baseline scenario and additionality.....	22
12.1	Baseline	22
12.2	Additionality	23
13	Quantification of the GHG removals	23
13.1	Stratification.....	23
13.2	Baseline net GHG removals.....	24
13.3	GHG removals in the project scenario	25
13.3.1	Trees and shrubs	26
13.3.2	Deadwood and litter.....	28
13.3.3	Soil organic carbon (SOC)	31
13.4	Leakages.....	38

13.5	Net anthropogenic GHG removals	39
14	Leakage Management.....	40
14.1	Methodologies and sources of reference	40
14.2	Documentation and traceability	40
14.3	Verification and quality assurance	40
14.4	Uncertainty management	41
14.5	Integration in the net balance	41
15	Uncertainty management	41
15.1	Uncertainty Tool.....	41
15.2	Sampling design and measurements	42
15.3	Transparency and documentation.....	42
15.4	Updates and verifications	42
15.5	Principle of conservativeness	43
16	Permanence and reversal risk management.....	43
16.1	Complementary risk management instruments	44
17	Monitoring plan	45
17.1	Minimum technical requirements.....	45
17.2	Transparency and publication of information	46
17.3	Integration of continuous monitoring technologies (D-MRV).....	46
17.4	Monitoring procedures	46
17.4.1	Monitoring of the project boundaries	47
17.4.2	Monitoring of the implementation of project activities.....	47
17.4.3	Monitoring of biomass growth.....	48
17.4.3.1	Stratification and sampling design.....	49
	Stratification.....	49
	Sampling plots	49
	Size of plots or sampling units	49
	Sampling size	49
	Calculation of sample plots number	51

Allocation of sample plots	52
Monitoring frequency	52
Measuring and estimating changes in carbon contents	52
17.4.4 Monitoring of the quantification of project removals	53
17.5 Quality control and quality assurance procedures	54
17.5.1 Normative requirements	54
17.5.2 Recommended operational procedures	55
18 References	57
Annex 1. Continuous Monitoring Technologies (dMRV)	61

List of tables

Table 1. Carbon reservoirs selected for the accounting of carbon stock changes	19
Table 2. Emission sources and GHGs selected for accounting	20
Table 5. Parameters dead wood and litter	28
Table 6. Default values used for dead wood and litter	30
Table 7. Default reference SOC stocks (SOCREF) for mineral soils(tC ha ⁻¹ in 0-30 cm depth)	33
Table 8. Default factors for relative changes in organic C stocks due to crop management activities (net effective over 20 years)	35
Table 9. Relative stock change factors for different levels of nutrient input on cropland (net effect over 20 years)	36
Table 10. Relative stock change factors (f_{LU} , f_{MG} , and f_{IN}) for grassland management (net effect over 20 years)	37
Table 11. Variables to monitor sites establishment	48
Table 12. Parameters determined by the tool for sampling	51

Acronyms and abbreviations

AFOLU	Agriculture, forestry, and Other Land Use
ARR	Afforestation, Reforestation and Revegetation
AR-ACM	Afforestation/Reforestation Large-scale CDM Consolidated Methodology
CDM	Clean Development Mechanism
CH ₄	Methane
CLC	CORINE Land Cover
CO ₂	Carbon dioxide
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
N ₂ O	Nitrous oxide
SOC	Soil organic carbon
UNFCCC	United Nations Framework Convention on Climate Change
VCC	Verified Carbon Credits

Document for public consultation

1 Introduction

Afforestation, reforestation, and revegetation (ARR) activities are fundamental as global strategies for climate change mitigation and adaptation. In addition to their capacity to remove and store atmospheric carbon dioxide, ARR activities provide additional benefits by improving water quality and availability, protecting and restoring biodiversity, and maintaining key ecosystem services such as water regulation, soil protection, and the provision of habitat for native species. These co-benefits reinforce the value of ARR projects as nature-based solutions that contribute both to climate commitments and to sustainable development.

In this context, this Methodology provides project holders with a rigorous technical framework to transparently, verifiably, and conservatively quantify GHG removals derived from ARR activities.

The Methodology establishes the procedures for identifying the baseline scenario, demonstrating additionality, stratification, quantifying net removals and leakage, managing uncertainty, addressing permanence and reversal risks, as well as the monitoring requirements, quality assurance measures, and the optional use of continuous monitoring technologies (D-MRV). In this way, the Methodology ensures that results are consistent and comparable and that they fully reflect the contribution of ARR projects to environmental integrity..

2 Objective

This Methodology establish the technical and procedural requirements for the quantification, monitoring, and verification of net greenhouse gas (GHG) removals attributable to afforestation, reforestation, and revegetation (ARR) activities, ensuring consistency with the principles of conservativeness and the reporting of contributions to sustainable development..

In this context, the objective of this Methodology are to provide:

- (a) The applicability conditions and the eligibility criteria of the project areas, in coherence with the BIOCARBON STANDARD guidelines, the applicable national policies and regulations, and the priorities established by the host country;
- (b) The requirements for the identification of the baseline scenario and the demonstration of additionality;

- (c) The procedures for the estimation of GHG removals, including the identification, quantification, and management of relevant leakage, applying conservative and transparent criteria;
- (d) The conditions and methods related to the management of uncertainty, including the procedures for its identification, quantification, documentation, and conservative adjustment where applicable;
- (e) The conditions for the assessment and management of reversal risks, in order to support the permanence of the certified reductions and removals;
- (f) The monitoring, reporting, and verification (MRV) requirements, including the publication of key information, the georeferencing of project areas, and the traceability of the units issued in the BCR Standard registry;
- (g) The procedures for quality assurance and quality control (QA/QC) of the information collected and reported.

3 Sources

This Methodology is based on:

AR-ACM0003 A/R Large-scale Consolidated Methodology Afforestation and reforestation of lands except wetlands Version 02.0 UNFCCC (2013a).

AR-AM Tool 12. v3.1. A/R Methodological tool Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities UNFCCC (2015a).

AR-AM Tool 14. v4.2. Methodological tool Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities UNFCCC (2015b).

AR-AM Tool 15. v2.0. A/R Methodological tool Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity. UNFCCC (2013b).

AR-AM Tool 08. v4.0. A/R Methodological Tool Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity. UNFCCC (2011a).

AR-AM Tool 16. A/R Methodological Tool Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities UNFCCC (2011b).

AR-AM Tool 03. v2.1. A/R Methodological Tool Calculation of the number of sample plots for measurements within A/R CDM project activities. UNFCCC (2010).

AR-AM Tool 18. v01.0.1. A/R Methodological Tool Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities. UNFCCC (2012).

4 Version and validity

This document constitutes the Public consultation Version 5.0. September 25, 2025.

This methodological document may be updated periodically as part of the review and continuous improvement process. Intended users shall ensure the use of the most recent version of the document when initiating a new project or undergoing validation. Projects already registered may continue applying the version under which they were validated, unless they voluntarily decide to adopt a subsequent version officially published.

5 Scope

The scope of this Methodology covers afforestation, reforestation, revegetation, and those restoration, rehabilitation, and ecosystem recovery activities that result in verifiable increases in carbon stocks.

The Methodology establishes the procedures to quantify, monitor, and verify the net GHG removals derived from the increase of biomass and from changes in carbon stocks in aboveground biomass, belowground biomass, dead organic matter, and soil carbon, as well as the emissions associated with leakage attributable to project activities, including activity displacement, biomass diversion, market effects, and other relevant sources that may generate increases in GHG emissions outside the project boundaries.

The scope includes the application of the official BIOCARBON tools related to baseline and additionality determination, uncertainty management, reversal risk and permanence management, leakage control, and contribution to sustainable development.

Projects applying this Methodology shall identify and report their contributions to sustainable development using the BioCarbon Sustainable Development Goals (SDG) Tool. These results shall be documented in the Project Document and be subject to periodic verification as part of the monitoring reports.

This Methodology excludes activities implemented in wetlands, organic soils, or in areas where additionality cannot be demonstrated in a verifiable manner.

The temporal boundaries of projects applying this Methodology shall be defined in accordance with the quantification periods established in the BIOCARBON STANDARD.

6 Applicability conditions

This Methodology is applicable to afforestation, reforestation, revegetation, including the restoration, rehabilitation, and ecosystem recovery activities aimed at the capture and storage of carbon in biomass and soils, provided that the following conditions are met:

- (a) The areas in the project boundary shall not correspond to the forest category (according to the national definition adopted by the country in which the project activity is proposed), nor natural vegetation different to a forest, at the beginning of project activities and not five years before the project start date¹;
- (b) Project activities shall not generate transformation or conversion of natural ecosystems. Interventions that may cause a net loss of biodiversity, habitat degradation, reduction of water flows, significant loss of surface or groundwater, or any other irreversible negative environmental impact shall be excluded;
- (c) The areas within the geographic boundaries of the project shall not fall under the category of wetlands and shall not contain organic soils, thereby avoiding risks of additional emissions from drainage or degradation and ensuring the conservation of these sensitive ecosystems;
- (d) Project activities shall not employ flood irrigation or water management practices that generate permanent anaerobic conditions in soils, in order to avoid additional greenhouse gas emissions and to ensure the sustainability of water resources;
- (e) Project activities do not include the planting and/or management of species reported as invasive². It shall also be ensured that the species used do not generate loss of biodiversity, negative alterations in the hydrological cycle, or adverse impacts on ecosystems and local communities;
- (f) In the case of legally protected areas, project activities shall be eligible only if the project holder demonstrates that the restoration or management interventions generate additional and verifiable GHG removals beyond those required by the applicable regulations.

7 Normative references

The following references are indispensable for the implementation of this Methodology:

¹ Except for cases in which the activities in the project correspond to restoration, rehabilitation and recovery.

² <https://www.gisp.org/>

- (a) The BIOCARBON STANDARD, including all program requirements, eligibility conditions, and applicable procedures for GHG mitigation activities;
- (b) The 2003, 2006, and 2019 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, or any subsequent revisions or updates thereof;
- (c) The applicable national legislation on GHGs and land-use regulations;
- (d) The relevant decisions of the UNFCCC, ICAO-CORSIA (ICAO, n.d.), and the mechanisms under Article 6 of the Paris Agreement (UNFCCC, 2015)³;
- (e) ISO 14064-2 and ISO 14064-3, for project-level GHG quantification and verification.

This Methodology shall be applied in conjunction with the BCR STANDARD (2025b) and all official tools issued by BIOCARBON that are applicable. The following tools are mandatory and shall be applied in their entirety, in accordance with the scope and characteristics of the project:

- (a) Baseline and Additionality Tool(2025d);
- (b) Permanence and Reversal Risk Management Tool (2025f);
- (c) Monitoring, Reporting, and Verification (MRV) Tool (2025e);
- (d) Uncertainty Assessment Tool (2025c);
- (e) Avoiding Double Counting (ADC) Tool (2025a);
- (f) Sustainable Development Safeguards (SDSs) Tool(2025h);
- (g) Sustainable Development Goals (SDG) Tool(2025i).

These tools form part of the regulatory framework of the BIOCARBON STANDARD. Their selective application or modification is not permitted. Through the Project Document, the project holder shall demonstrate the complete and consistent application of each tool, in its most recent version at the time of validation or verification. Failure to comply with these instruments shall result in ineligibility for certification, registration, or credit issuance.

³ When mitigation results are intended for international transfer under Article 6, the Project Document and the Monitoring Reports shall include: (i) the authorization of the Host Party, (ii) the indication of the scope “inside/outside the NDC,” and (iii) evidence that the Host Party will apply the corresponding adjustments, in accordance with the BioCarbon ADC Tool and the procedures of the registry.

BIOCARBON reserves the right to develop, approve, and publish additional tools, templates, or guidance documents that complement the BCR STANDARD and its methodologies. Any such instrument, once officially issued and published by the Program administrator, shall be considered binding and shall be applied by all project holders from its effective date, unless otherwise specified in transitional provisions.

8 Terms and definitions

Additionality

It is the effect of the project activity to reduce anthropogenic GHG emissions below the level that would have occurred in the absence of the GHG project or project activity.

In the AFOLU sector, for projects other than REDD+, additionality is the effect of the project activity to increase actual net GHG removals by sinks above the sum of carbon stock changes in carbon pools within the project boundary that would have occurred in the absence of the project activity.

Source: Adapted from CDM Glossary, UNFCCC (2015).

Afforestation, Reforestation and Revegetation activities

These are GHG mitigation actions in the AFOLU sector based on agricultural and forestry activities. These may include: silvopastoral systems (pastures and planted trees), agroforestry systems (agroforestry crops), commercial plantations (forest plantations), and other landscape management tools, as well as other crops, as long as they are developed in areas other than natural forest or natural vegetation cover other than forest.⁴

ARR activities may also include actions leading to the ecological restoration of degraded ecosystems, such as: (a) restoration, (b) rehabilitation and, (c) recuperation.

Agricultural lands

Agricultural territories are those lands dedicated mainly to the production of food, fiber, and other industrial raw materials, whether they are useful or not for cultivation, cattle grazing, crop rotation, or fallow. It includes areas devoted to permanent and temporary crops, pasture areas, and different agricultural zones, where livestock can occur with agriculture.

⁴ The names in parentheses correspond to the definitions contained in CORINE Land Cover. See Glossary of terms.

Agroforestry culture

Areas occupied by arrangements or combinations of crops of different species, with others of herbaceous, shrub, or tree habits, where the main characteristic of the coverage is that the increase in detail does not imply the subdivision into pure units because these share the same area, alternated by furrows or rows of trees with crops or trees with grasses.

AFOLU (Agriculture, Forestry and Other Land Use)

The sector comprises either greenhouse gas emissions or removals attributable to project activities in agriculture, forestry, and other land uses.

Baseline scenario

The GHG project scenario that reasonably represents the sum of changes in carbon stocks in the carbon pools within the project boundary that would occur in the absence of the GHG project.

Source: Adapted from CDM Glossary of Terms, Version 10.0.

Carbon fraction

Tons of carbon per ton of dry biomass. According to IPCC (2006), the default carbon fraction is 0.47.

Denitrification

It is the biological transformation of nitrate into nitrogen gas, nitric oxide, and nitrous oxide. Denitrification can occur in two ways. The first is the differentiated reduction of nitrate under anoxic conditions. The second is, under aerobic conditions, denitrification follows the assimilative or nitrogen accumulation pathway in biomass.

Ecological Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, in order to reestablish its integrity, health, and sustainability. According to the Society for Ecological Restoration (SER, 2019), this process seeks to recover the composition, structure, and functionality of the ecosystem, strengthen its resilience, and ensure the provision of ecosystem services, in harmony with the social, cultural, and economic context in which it takes place.

Eligible areas

Areas that meet the absence of forest or natural cover other than a forest, on the reference dates established by the BCR STANDARD.

Geographical limits of the Project's area are not in the forest category⁵, or natural cover other than the forest, neither at the beginning nor five years before the project starts.

For areas in which ecological restoration, ecological rehabilitation and ecological recuperation activities are proposed, eligible areas should be determined by land use analysis for the same reference dates. However, these should not necessarily demonstrate compliance with the forest definition.

If the eligibility analysis is included in the project boundary's total since the validation, the holder of the GHG project shall demonstrate the eligibility five years before and at the start date of the project activities.

If areas are subsequently included, which were not included in the initial analysis (in validation), the land cover for each plantation area shall be identified in every one of the dates on which activities in the forestry activities are established.

Forestry plantation

They are covers constituted by plantations of arboreal vegetation, made by the man's direct intervention with forest management aims. In this process, forest stands start by planting and, when applicable to seeding during the forestation or reforestation process to produce wood (commercial plantations) or environmental goods and services (protective plantations).

GHG Project (Greenhouse gas project)

activity or activities that alter the conditions of a GHG baseline and cause GHG emissions reductions or GHG removals.

[SOURCE: ISO 14064-3:2019(en), 3.4.1.]

GHG Project holder (greenhouse gas project proponent)

individual or organization that has overall control and responsibility for a GHG project.

Note 1 to entry: The term "project proponent" is also used synonymously in the text.

[SOURCE: ISO 14064-2:2019(en), 3.3.2]

Greenhouse gas reservoir (GHG reservoir)

component, other than the atmosphere, that has the capability to accumulate GHGs, and to store and release them.

⁵ In accordance with the national definitions of forest and natural vegetation cover other than forest

Note 1 to entry: The total mass of carbon contained in a GHG reservoir at a specified point in time could be referred to as the carbon stock of the reservoir.

Note 2 to entry: A GHG reservoir can transfer GHGs to another GHG reservoir.

Note 3 to entry: The collection of a GHG from a GHG source before it enters the atmosphere and storage of the collected GHG in a GHG reservoir could be referred to as GHG capture and GHG storage.

[SOURCE: ISO 14064-3:2019(en), 3.3.5]

Landscape management tools (LMT)

Landscape management tools are landscape elements that constitute or enhance habitat, increase functional connectivity, or simultaneously fulfill these functions for native biodiversity. Landscape management tools may include biological and conservation corridors and living fences.

Corridors (biological and conservation) are landscape management tools that encourage movement and genetic exchange between local populations spatially isolated because of habitat fragmentation and loss. They can be constituted following natural routes of dispersion and migration, such as watercourses or restoration strategies over open areas. Biological corridors can be remnant when the connection between preserved or restored forest patches when they are re-established.

Live fences are crucial for increasing structural connectivity, resource provisioning, and reducing fence maintenance costs. We seek to generate the most extensive and most efficient possible connections of forest fragments with living fences, such as in minimal areas, without altering existing productive activities on a large scale. Living fences reduce pressure on forests by decreasing the demand for fancy figured woods.

Land-use change

Land-use changes that constitute loss of natural cover. That is, changes caused by anthropogenic activities resulting in the conversion of forests or natural vegetative cover to other land uses.

For the purposes of this Methodology, the term land-use change also includes (where applicable) the degradation of natural vegetative cover. Likewise, when the land-use change involves the conversion of forest cover to another type of cover, it is referred to as deforestation.

Leakages

Increase in GHG emissions occurring outside the project boundary, attributable to its activities, including the displacement of agricultural or grazing activities, the diversion of biomass or inputs previously used, market effects, and other relevant sources such as transport or substitution of practices that generate additional emissions.

Natural Forest (Forest)

“Forest” is a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest⁶.

The GHG project holder must demonstrate the consistency of the eligibility analysis, in accordance with national forest definitions, following the criteria defined by the UNFCCC in its decision 11/COP.7 UNFCCC (2002).

Organic soils

According to the IPCC (2014) definition, organic soils are those with a high content of organic carbon, typically $\geq 12\%$ by weight, formed under poorly drained and water-saturated conditions, such as in peatlands, mangroves, and intertidal marshes. These soils store large amounts of carbon under anaerobic conditions and are highly vulnerable to GHG emissions when drained, degraded, or converted. For the purposes of this Methodology, organic soils shall be identified and accounted for in accordance with the IPCC Guidelines (2006).

Permanence

The condition resulting from project activities whereby the system established within the project boundaries continues over time, ensuring that the function of conserving carbon stocks is maintained.

Planted trees and crops

The area occupied by spatial arrangements combines crops and tree plantations (wood, firewood, fruit trees, resins, among others). Its main characteristic is that its increase in detail does not imply the subdivision into pure units, because they are combined in the same area, alternating trees' rows with crops.

⁶ UNFCCC. The Marrakesh Accords. Available in <https://unfccc.int/sites/default/files/resource/docs/cop7/13a01.pdf>

Planted trees and grasses

The area occupied by spatial arrangements combines pastures, destined for livestock, tree plantations destined for tree plantations (wood, firewood, fruit trees, resins, and others.). It is the so-called silvopastoral system. This coverage's main characteristic is that the increase in detail does not imply the subdivision into pure units because these shares the same area alternating by furrows or rows of trees with pastures.

Project Start date

The date on which the activities that will result in effective GHG emission reductions or removals commence. For GHG projects applying this Methodology, the start date corresponds to the date on which the implementation of project activities begins in order to generate emission reductions by avoiding land-use change in the eligible areas within the project boundaries. These activities may include, for example, agreements with stakeholders holding land-use rights and/or the initiation of management actions within the project boundaries..

Soil carbon

Organic carbon contained in mineral and organic soils (including peat) to a given depth chosen by the country and applied consistently throughout the time series. Live fine roots of less than 2 mm in diameter (or another diameter chosen by the country for belowground biomass) are included with soil organic matter when they cannot be empirically distinguished from it.

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories IPCC (2006b).

Soil organic matter

According to FAO (2019), “*soil organic matter comprises all organic materials of plant or animal origin, decomposed, partially decomposed, and undecomposed. It is generally synonymous with humus, although the latter is more commonly used to refer to well-decomposed organic matter, known as humic substances. Soil organic matter is a primary indicator of soil quality.*”

Vegetation cover, different from natural forest (Scrub and/or herbaceous vegetation Associations)

This coverage includes a vegetation group of a natural type and a natural succession's result, whose growth habit is shrubby and herbaceous, developed on different substrates and elevational levels, with little or no anthropic intervention. According to CORINE Land Cover legend, this class includes other cover types such as areas covered by mainly shrubby vegetation with an irregular canopy, shrubs, palms, vines, and low growing vegetation.

Wetlands

Wetlands are ecosystems that are permanently or seasonally saturated with water, including mangroves, intertidal marshes, and seagrass meadows, in which waterlogging creates anaerobic conditions that favor long-term carbon storage in soils and sediments. For the purposes of this Methodology, wetlands are defined in accordance with the Ramsar Convention (1987) and the IPCC Guidelines (2006, 2013 Wetlands Supplement, 2019 Refinement).

In the context of high mountain ecosystems, this definition applies specifically to high-Andean wetlands, high-Andean peatlands, peatlands, and other similar hydric systems..

9 Carbon reservoirs and GHG sources

9.1 Carbon reservoirs

The Intergovernmental Panel on Climate Change (IPCC) foresees the estimation of carbon stocks changes in the following reservoirs: above-ground biomass, below-ground biomass, deadwood, litter and soil organic carbon (SOC). However, the holders of GHG projects may choose not to consider one or more carbon pools as long as they provide transparent and verifiable information and do not increase GHG removals, quantified by the Project.

The selection of carbon reservoirs to quantify changes in carbon stocks at the project boundaries are shown in *Table 1*.

Table 1. Carbon reservoirs selected for the accounting of carbon stock changes

	Carbon reservoir	Selected (Yes/No)	Justification/Explanation
Baseline scenario	Above-ground biomass	Yes	In the baseline scenario, the expected changes in existing biomass in the absence of the project are considered .
	Below-ground biomass	Yes	They are included only if significant variation is expected in the absence of the project.
	Deadwood and litter	Optional	Shall be included where baseline conditions indicate measurable changes in these reservoirs .
	Soil organic carbon	Optional	Shall be included where baseline conditions indicate changes in soil organic carbon (SOC) .
Project scenario	Above-ground biomass		Carbon stock in this reservoir is expected to increase due to the implementation of the project activity.

	Carbon reservoir	Selected (Yes/No)	Justification/Explanation
	Below-ground biomass		An increase proportional to the growth of aboveground biomass is expected, based on root-to-shoot ratios.
	Deadwood and litter		Carbon stocks in this reservoir may increase as a result of biomass growth and the natural mortality of individuals.
	Soil organic carbon		May increase as a result of the accumulation of organic matter in the areas under intervention.

9.2 Emission sources and GHGs selected for accounting

The emission sources and associated GHGs selected for accounting are shown in *Table 2*.

Table 2. Emission sources and GHGs selected for accounting

	Source	GHG	Selected (Yes/No)	Justification/Explanation
Baseline scenario	Burning of woody biomass	CO ₂	No	CO ₂ is not accounted for in the absence of the project (assumed to be balanced with absorption).
		CH ₄	No	Not considered in the absence of project intervention.
		N ₂ O	No	Not considered in the absence of project intervention.
Project Scenario		CO ₂	No	CO ₂ emissions from burning are considered part of the biogenic cycle.
		CH ₄	Yes	If site preparation involves burning, these emissions shall be quantified.
		N ₂ O	Yes	If site preparation involves burning, these emissions shall be quantified.

10 Eligible areas for ARR activities

For activities other than restoration, recovery and rehabilitation, the holder of the GHG project shall demonstrate that the areas at the geographical boundaries of the Project do not correspond to the category of forest, nor to natural vegetation cover other than wood at the start of project activities, nor five years before the project start date.

This demonstration shall be by multi-temporal land cover analysis (on scales 1: 10,000 or higher) for the project start date and five years ago, (counting from the project start date), according to the land use and/or land cover classifications that apply for the country in which

the project activities are proposed. Additionally, land cover shall be identified for each planting date of the areas in the project, if the analysis was not developed for all areas in the project, at the validation time.

The cartographic inputs for the identification of land cover/use and the methodological process for the generation of information on land use changes should be based on reliable information, based on defined land use categories, for example, by the IPCC for national inventories of Greenhouse Gases -GHG. These, in turn, should be consistent with the land use categories applicable in the country in which the proposed GHG project is located.

To identify natural vegetation cover other than a forest, the GHG project holder shall use the CORINE Land Cover, or that applicable in the country in which the project is being developed.

On the other hand, for activities other than ecological restoration (including reclamation and rehabilitation), on behalf of the identification and selection of eligible areas, the holder of the project shall provide evidence that the land within the project boundaries, at the beginning of the Project and five years after the start date⁷:

- (a) it is not covered by forest or natural vegetation cover other than forest; and,
- (b) The land is not a part of a forest area that is temporarily unstocked due to human intervention (e.g., harvesting) or natural causes. It is not covered for young natural stands, which are not expected to reach the forest threshold values applicable to the host Party and the land is not expected to revert to a forest without human intervention.

10.1 Requirements of geographic information for the eligibility analysis

To demonstrate land eligibility, the GHG project holders shall carry out a multi-temporal analysis of satellite images, through which changes in land use coverage following the country's land cover analysis methodologies in which the project activities are proposed.

11 Grouped projects and inclusion of new areas

In the case of grouped projects, project holders may add new areas under the following conditions:

⁷ Adapted of CDM Tool "A/R Methodological tool Demonstration of eligibility of lands for A/R CDM project activities" Version 2.0. UNFCCC (2013c).

- (a) The project holder shall identify, during validation, the criteria and procedures for the inclusion of new areas, which shall be consistent with the requirements of the BioCarbon Standard and with this Methodology.
- (b) A new area may only be incorporated if it meets, at a minimum, the following criteria:
 - (i) Complies with the most recent version of the BCR STANDARD;
 - (ii) Meets all applicable requirements of this Methodology;
 - (iii) Corresponds exclusively to the validated project activities;
 - (iv) Implements ARR activities in accordance with the validated Project Document;
 - (v) Demonstrates that additionality, land tenure, and the baseline scenario are consistent with the descriptions in the Project Document;
 - (vi) Has a start date later than the areas initially validated;
 - (vii) Does not overlap with areas included in other registered AFOLU projects.
- (c) The inclusion of new areas shall take place within the framework of a verification event, and the Project Document shall be updated to reflect the areas incorporated.
- (d) The crediting period of the new areas shall not extend beyond the crediting period approved for the original project.
- (e) New areas shall be included within the first five (5) years following project registration, unless a different timeframe is established by national legislation or the competent authority.

12 Baseline scenario and additionality

To determine the baseline scenario and demonstrate additionality, the project holder shall apply the BioCarbon (2025c) Baseline and Additionality Tool, in its most recent version.

12.1 Baseline

The baseline scenario is the situation that reasonably and verifiably represents the greenhouse gas (GHG) emissions and removals in the absence of the implementation of the project. The identification of the baseline scenario shall comply with the following:

- (a) The scenario shall consider historical and current land uses, land cover change trends, socioeconomic dynamics, and applicable policies;

- (b) The assumptions, data, and parameters used shall be transparently documented, including information sources and technical justifications;
- (c) The baseline scenario shall be consistent with national and subnational land-use and climate change planning, and shall not contradict commitments already undertaken in the Nationally Determined Contributions (NDCs) or other official instruments.

12.2 **Additionality**

The project holder shall demonstrate additionality by applying the procedures established in the Baseline and Additionality Tool (2025C). The following criteria shall be met:

- (a) The activities implemented shall not be required by applicable regulations in the host country;
- (b) The project holder shall demonstrate the existence of financial, technological, institutional, or market barriers that prevent the implementation of the project in the absence of carbon finance;
- (c) The project shall be differentiated from prevailing practices in the region, demonstrating that without the proposed intervention, restoration, reforestation, or revegetation activities would not take place at a significant scale;
- (d) The project holder shall demonstrate that the revenues derived from the sale of carbon credits are decisive in overcoming the identified barriers and enabling its implementation.

13 **Quantification of the GHG removals**

13.1 **Stratification**

If biomass distribution within the project area (or as a result of project activities) is not homogeneous, stratification shall be applied to improve the precision of biomass estimation.

The project holder shall define different strata for the baseline scenario and for the calculation of mitigation results. This approach optimizes the precision in estimating GHG removals. In particular:

- (a) For the baseline scenario, it is usually sufficient to stratify the area according to land-use categories within the project area;
- (b) For the project scenario, stratification may be based on the crop establishment plans (species / year of planting).

13.2 Baseline net GHG removals

To consider GHG removals in the baseline scenario, the land cover in the project area (defined by the land use categories) should be considered.

According to what is established in the methodological tool to calculate changes in carbon stocks of trees and shrubs in afforestation and reforestation project activities⁸, the baseline carbon stock in trees can be accounted as zero if all of the following conditions are met:

- (a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the project horizon;
- (b) The pre-project trees do not suffer mortality because of competition from trees planted by the Project, or damage because of implementation of the project activity at any time during the project horizon;
- (c) The pre-project trees are not inventoried along with the project trees during carbon stocks monitoring.

If these conditions are not met, removals in the baseline scenario can be calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE_BSL,t} + \Delta C_{SHRUB_BSL,t} + \Delta C_{DW_BSL,t} + \Delta C_{LI_BSL,t} \quad \text{Equation (1)}$$

Where:

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year t; t CO ₂ -e
$\Delta C_{TREE_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO ₂ -e
$\Delta C_{SHRUB_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO ₂ -e
$\Delta C_{DW_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities"; t CO ₂ -e

⁸ UNFCCC (2015b).

$\Delta C_{LI_BSL,t}$ Change in carbon stock in baseline litter biomass within the project boundary, in year t , as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities"; t CO₂-e

13.3 GHG removals in the project scenario

GHG emissions resulting from the removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activities shall be considered insignificant and therefore accounted as zero.

Estimation of removals considers changes in carbon stocks in the project area, minus non-CO₂ GHG emissions at the project boundary resulting from project activities. GHG removals by sinks should be calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_t - GHG_{E,t} \quad \text{Equation (2)}$$

Where:

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals, in year t ; t CO₂-e

ΔC_t = Change in the carbon stocks in Project, occurring in the selected carbon pools, in year t ; t CO₂-e

$GHG_{E,t}$ = Increase in non-CO₂ GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t , as estimated in the tool "Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"⁹; t CO₂-e

Change in the carbon stocks in Project, occurring in the selected carbon pools in year t shall be calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t} + \Delta SOC_{A,t}$$

Equation (3)

⁹ Methodological Tool "Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity". UNFCCC (2011a).

Where:

- $\Delta C_{P,t}$ = Change in the carbon stocks in Project, occurring in the selected carbon pools, in year t; t CO₂-e
- $\Delta C_{TREE_PROJ,t}$ = Change in carbon stock in tree biomass in Project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"¹⁰; t CO₂-e
- $\Delta C_{SHRUB_PROJ,t}$ = Change in carbon stock in shrub biomass in Project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO₂-e
- $\Delta C_{DW_PROJ,t}$ = Change in carbon stock in deadwood in Project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities"; t CO₂-e
- $\Delta C_{LI_PROJ,t}$ = Change in carbon stock in litter in Project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities"; t CO₂-e
- $\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in Project, in year t, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities,"¹¹ as estimated in the same tool; t CO₂-e

13.3.1 Trees and shrubs

Carbon stock in shrubs at a point of time is estimated on the basis of shrub crown cover. The area within the project boundary is stratified by shrub crown cover. Those areas where the shrub crown cover is less than 5 per cent are treated as a single stratum and the shrub biomass in this stratum is estimated as zero.

For the strata with a shrub crown cover of greater than 5 per cent, carbon stock in shrubs is estimated as follows:

¹⁰ Methodological Tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". UNFCCC (2015b).

¹¹ Methodological Tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities". UNFCCC (2011b).

$$C_{SHRUB,t} = \frac{44}{12} \times CF_s \times (1 + R_s) \times \sum_i A_{SHRUB,i} \times b_{SHRUB,i} \quad \text{Equation (4)}$$

$$b_{SHRUB,i} = BDR_{SF} \times b_{FOREST} \times CC_{SHRUB,i} \quad \text{Equation (5)}$$

Where:

$C_{SHRUB,t}$ = Carbon stock in shrubs within the project boundary at a given point of time in year t; t CO₂-e

CF_s = Carbon fraction of shrub biomass; t C (t.d.m.)⁻¹.

A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.

R_s = Root-shoot ratio for shrubs; dimensionless

The default value of 0.40 is used unless transparent and verifiable information can be provided to justify a different value.

$A_{SHRUB,i}$ = Area of shrub biomass estimation stratum i; ha

$b_{SHRUB,i}$ = Shrub biomass per hectare in shrub biomass estimation stratum i; t d.m. ha⁻¹

BDR_{SF} = Ratio of shrub biomass per hectare in land having a shrub crown cover of 1.0 (i.e. 100 per cent) and the default above-ground biomass content per hectare in forest in the region/country where the A/R CDM project activity is located; dimensionless.

A default value of 0.10 should be used unless transparent and verifiable information can be provided to justify a different value.

b_{FOREST} = Default above-ground biomass content in forest in the region/country where the A/R CDM project activity is located; t d.m. ha⁻¹.

Values from Table 3A.1.4 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values.

$CC_{SHRUB,i}$ = Crown cover of shrubs in shrub biomass estimation stratum i at the time of estimation, expressed as a fraction (e.g. 10 per cent crown cover implies $CC_{SHRUB,i} = 0.10$); dimensionless

13.3.2 Deadwood and litter

The carbon in the deadwood and litter shall be estimated based on "AR TOOL 12 Estimation of carbon stocks and change in carbon stocks in dead Wood and litter in A/R CDM projects activities"¹².

This tool is based on the following assumptions:

- (a) The linearity of change of biomass in deadwood and litter over a time of period. Change of biomass in deadwood and litter may be assumed to proceed, on average, at an approximately constant rate between two points of time at which the biomass is estimated;
- (b) Appropriateness of root-shoot ratios: Root-shoot ratios appropriate for estimating below-ground biomass from above-ground biomass of living trees are also appropriate for dead trees.

The tool provides procedures to determine the parameters in Table 3.

Table 3. Parameters dead wood and litter

$C_{DW,i,t}$	Carbon stock in deadwood within the project boundary at a given point of time in year t; t CO ₂ e
$\Delta C_{DW,i,t}$	Change in carbon stock in deadwood within the project boundary in year t; t CO ₂ e
$C_{LI,i,t}$	Carbon stock in litter within the project boundary at a given point of time in year t
$\Delta C_{LI,i,t}$	Change in carbon stock in litter within the project boundary in year t; t CO ₂ e

Source: A/R Methodological Tool

¹² CDM-AR Tool 12 de la Metodología AR ACM0003. UNFCCC (2015a).

Estimates of carbon stocks in deadwood are based on a conservative value, then, is possible to use a default-factor based method described in this section. For all strata to which the default-factor based method is applied, the carbon stock in deadwood is estimated as:

$$C_{DW,i,t} = C_{TREE,i,t} \times DF_{DW} \quad \text{Equation (6)}$$

Where:

- $C_{DW,i,t}$ = Carbon stock in deadwood in stratum i at a given point of time in year t; t CO₂e
- $C_{TREE,i,t}$ = Carbon stock in trees biomass in stratum i at a point of time in year t, as calculated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO₂e
- DF_{DW} = Conservative default factor expressing carbon stock in deadwood as a percentage of carbon stock in tree biomass, percent
- i = 1, 2, 3. ... biomass estimation strata within the project boundary
- t = 1, 2, 3. ... years elapsed since the start of the project activity

In the case of not sampling based measurements for estimating C stock in the litter, it is necessary to use the default-factor-based method described below.

For all strata where the default method is applied, carbon stock in the litter is estimated as Equation 7:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI} \quad \text{Equation (7)}$$

Where:

- $C_{LI,i,t}$ = Carbon stock in litter in stratum i at a given point of time in year t; t CO₂e
- $C_{TREE,i,t}$ = Carbon stock in trees biomass in stratum i at a point of time in year t, as calculated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO₂e
- DF_{LI} = Conservative default factor expressing carbon stock in the litter as a percentage of carbon stock in tree biomass

i = 1, 2, 3 ... biomass estimation strata within the project boundary

t = 1, 2, 3 ... years elapsed since the start of the project activity

The conservative values of the default factors, which express the carbon stocks in dead wood and litter, as a percentage of the carbon stock in tree biomass, are presented in Table 4 below.

Table 4. Default values used for dead wood and litter

Data / Parameter	CF _{LI}			
Data unit	t C t ⁻¹ d.m			
Description	Carbon fraction of litter biomass			
Source of data	IPCC default value of 0.37 t C t ⁻¹ d.m. may be used			
Data / Parameter	DF _{DW}			
Data unit	Percentage			
Description	Conservative default factor expressing carbon stock in deadwood as a percentage of carbon stock in tree biomass			
Source of data	Defaults conservatively derived from Delaney et al. 1997 ¹³ , Smith et al. 2006 ¹⁴ , Glenday 2008 ¹⁵ , Keller et al. 2004 ¹⁶ , Eaton and Lawrence 2006 ¹⁷ , Krankina and Harmon 1995 ¹⁸ , and Clark et al. 2002 ¹⁹ :			
	Biome	Elevation	Precipitation	DF _{DW}
	Tropical	<2000m	<1000mm yr ⁻¹	2%
	Tropical	<2000m	1000-1600 mm yr ⁻¹	1%
	Tropical	<2000m	>1600 mm año ⁻¹	6%
	Tropical	>2000m	All	7%
	Temperate / Boreal	All	All	8%
Data / Parameter	DF _{LI}			
Data unit	Percentage			
Description	Default factor for the relationship between carbon stock in litter and carbon stock in living trees			
Source of data	Defaults conservatively derived from sources cited above:			
	Biome	Elevation	Precipitation	DF _{LI}
	Tropical	<2000m	<1000mm yr ⁻¹	4

¹³ Delaney, M., et al. (1997).

¹⁴ Smith, J. E., et al. (2006).

¹⁵ Glenday, J. (2008).

¹⁶ Keller, M., et al. (2004).

¹⁷ Eaton, J. M., & Lawrence, D. (2006).

¹⁸ Krankina, O. N., & Harmon, M. E. (1995).

¹⁹ Clark, D. B., et al. (2002)

		Tropical	<2000m	1000-1600 mm yr ⁻¹	1%	
		Tropical	<2000m	>1600 mm yr ⁻¹	1%	
		Tropical	>2000m	All	1%	
		Temperate / Boreal	All	All	4%	
Data / Parameter	R _j					
Data unit	Dimensionless					
Description	The root-shoot ratio for species j					
Source of data	Unless transparent and verifiable information can be provided to justify a different value, the value of R_j shall be calculated as: $R_j = \frac{e^{(-1,085+0,9256 \cdot \ln b)}}{b}$ Equation (8) <i>R_j</i> The root-shoot ratio for species j; dimensionless <i>b</i> Above-ground biomass per hectare (t d.m. ha⁻¹), <i>j</i> 1, 2, 3, ... specie Source: A/R Methodological Tool. "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" and [Table 4.A.4 of IPCC GPG-LULUCF 2003]					

Source: A/R Methodological Tool UNFCCC (2013a)

13.3.3 Soil organic carbon (SOC)

The estimation of change in carbon stock in soil organic carbon (SOC) is calculated according to the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", version 1.1.0.

In addition, to quantify the organic carbon in the soil, the following shall be fulfilled:

- (a) Litter remains on-site and is not removed from the project area; and,
- (b) Soil disturbance attributable to the project activity, if any, is:
 - By appropriate soil conservation practices
 - Limited to site preparation before planting and is not repeated in less than twenty years;

It is assumed that implementing a project activity increases the lands' SOC content to a level that is equal to the steady-state SOC content under native vegetation. Also, the SOC content in the project scenario takes place at a constant rate over 20 years since the planting year.

The applicability conditions of the tool, to estimate the land change in SOC stock in the project scenario, are stratified according to:

- (a) Climate region and soil types in Table 5
- (b) Pre-project management activities on croplands in Tables 8 and 9; and
- (c) Pre-project management activities on grasslands (Table 8)

The initial SOC stock at the start of the Project is estimated as follows²⁰:

$$SOC_{INITIAL,i} = SOC_{REF,i} \times f_{LU,i} \times f_{MG,i} \times f_{IN,i} \quad \text{Equation (9)}$$

Where:

$SOC_{INITIAL,i}$	=	SOC stock at the beginning of the project activity in stratum i of the areas of land; t C ha ⁻¹
$SOC_{REF,i}$	=	Reference SOC stock corresponding to the reference condition in native lands (i.e., non-degraded, unimproved lands under native vegetation forest) by climate region and soil type applicable to stratum i of the areas of land; t C ha ⁻¹
$f_{LU,i}$	=	Relative stock change factor for baseline land-use in stratum i of the areas of land; dimensionless
$f_{MG,i}$	=	Relative stock change factor for baseline management regime in stratum i of the areas of land; dimensionless
$f_{IN,i}$	=	Relative stock change factor for baseline input regime (e.g., crop residue returns, manure) in stratum i of the areas of land; dimensionless
i	=	1, 2, 3, strata of areas of land; dimensionless

The values of $SOC_{REF,i}$, $f_{LU,i}$, $f_{MG,i}$ y $f_{IN,i}$ are taken from Tables 5 - 8, unless transparent and verifiable information can justify different values.

²⁰ Equation in CDM-AR Tool¹⁶ UNFCCC (2011b).

For each stratum subjected to total area soil disturbance due to project activity, if disturbed area over and above in the baseline is greater than 10% of the area of the stratum, the following carbon loss is accounted as:

$$SOC_{LOSS,i} = SOC_{INITIAL,i} * 0,1 \quad \text{Equation (10)}$$

Where:

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable to the project activity, in stratum i of the areas of land; t C ha⁻¹; t C ha⁻¹

$SOC_{INITIAL,i}$ = SOC stock at the beginning of the project activity in stratum i of the areas of land; t C ha⁻¹

0,1 = The approximate proportion of SOC lost within the first five years from the year of site preparation

i = 1, 2, 3, strata of areas of land; dimensionless

Table 5. Default reference SOC stocks (SOCREF) for mineral soils²¹ (tC ha⁻¹ in 0-30 cm depth)

Climate region	HAC ^(a) soils	LAC ^(b) soils	Sandy soils ^(c)	Spodic soils ^(d)	Volcanic soils ^(e)
Boreal	68	NA	10	117	20
Cold temperate, dry	50	33	34	NA	20
Cold temperate, moist	95	85	71	115	130
Warm temperate, dry	38	24	19	NA	70
Warm temperate, moist	88	63	3	NA	80
Tropical, dry	38	35	31	NA	50
Tropical, moist	65	47	39	NA	70
Tropical, wet	44	60	66	NA	130
Tropical montane	88	63	34	NA	80

(a) Soils with high activity clay (HAC) minerals are light to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols);

(b) Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols);

²¹ Adapted from 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Climate region	HAC ^(a) soils	LAC ^(b) soils	Sandy soils ^(c)	Spodic soils ^(d)	Volcanic soils ^(e)
(c) Includes all soils (regardless of taxonomic classification) having > 70% sand and < 8% clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments); (d) Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification Spodosols); (e) Soils derived from volcanic ash with allophonic mineralogy (in WRB classification Andosols; in USDA classification Andisols)					

Source: A/R Methodological Tool UNFCCC (2013a).

In the project scenario, the rate of change in SOC stock until the steady-state SOC content reached is estimated as follows:²²

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20 \text{ years}} \text{ for } t_{PREP,i} < t < t_{PREP,i} + 20$$

Equation (11)

Where:

$dSOC_{t,i}$ = The rate of change in SOC stock in stratum i of the areas of land, in year t; t C ha⁻¹ yr⁻¹

$SOC_{REF,i}$ = Reference SOC stock corresponding to the reference condition in native lands (i.e., non-degraded, unimproved lands under native vegetation forest) by climate region and soil type applicable to stratum i of the areas of land; t C ha⁻¹

$SOC_{INITIAL,i}$ = SOC stock at the beginning of the A/R CDM project activity in stratum i of the areas of land; t C ha⁻¹

$SOC_{LOSS,i}$ = Loss of SOC caused by soil disturbance attributable to the A/R CDM project activity, in stratum i of the areas of land; t C ha⁻¹

$t_{PREP,i}$ = The year in which first soil disturbance takes place, in stratum i of the areas of land

²² CDM-AR Tool16. UNFCCC (201b).

i = 1, 2, 3, ... strata of areas of land; dimensionless

t = 1, 2, 3, ... years elapsed since the start of the project activity

The default factors for relative changes in carbon stocks for different management activities in crop areas are presented in Table 6.

Table 6. Default factors for relative changes in organic C stocks due to crop management activities (net effective over 20 years)

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Land use, f_{LU}	Long-term cultivated	Temperate/Boreal	Dry	0,80	The area has been continuously managed for crops for more than 20 years
			Moist	0,69	
		Tropical	Dry	0,58	
			Moist/Wet	0,48	
		Tropical montane	n/a	0,64	
Land use, f_{LU}	Short-term cultivated (< 20 yrs) or set aside (< 5 years)	Temperate/Boreal and Tropical	Dry	0,93	The area has been managed for crops for less than 20 years, or it is cropland in a fallow state for less than five years at any point during the last 20 years
			Moist	0,82	
		Tropical montane	n/a	0,88	
Management, f_{MG}	Full tillage	All	Moist / Wet	1,00	Substantial soil disturbance with full inversion or frequent (within-year) tillage operations. At planting time, residues cover little of the surface (e.g., <30%)
Management, f_{MG}	Reduced tillage	Temperate/Boreal	Dry	1,02	Primary or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion).
			Moist	1,08	
		Tropical	Dry	1,09	
			Moist / Wet	1,15	
		Tropical montane	n/a	1,09	

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
					Typically leaves the surface with >30% coverage by residues at planting

Source: A/R Methodological Tool UNFCCC (2013a).

Table 7. Relative stock change factors for different levels of nutrient input on cropland (net effect over 20 years)

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Input, f_{IN}	Low	Temperate/Boreal	Dry	0,95	There is residues removal (via collection or burning), or frequent bare-fallowing, or production of crops yielding low residues (e.g., vegetables, tobacco, cotton), or no mineral fertilization or N-fixing crops
			Moist	0,92	
		Tropical	Dry	0,95	
			Moist/Wet	0,92	
		Tropical montane	n/a	0,94	
	Medium	All	Moist/Wet	1,00	All crop residues are returned to the field. If residues are removed, then supplemental organic matter (e.g., manure) is added. Additionally, mineral fertilization or N-fixing crop rotation is practiced
	High without manure	Temperate/Boreal and Tropical	Dry	1,04	Represents significantly greater crop residue inputs over medium C input cropping systems due to additional practices, such as the production of high residue yielding crops, use of green manures, cover crops, improved vegetated fallows, irrigation, frequent use of perennial
			Moist/Wet	1,11	
		Tropical montane	n/a	1,08	

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
					grasses in annual crop rotations, but without manure applied

Source: A/R Methodological Tool UNFCCC (2013a).

Table 8. Relative stock change factors (f_{LU} , f_{MG} , and f_{IN}) for grassland management (net effect over 20 years)

Factor type	Level	Climate regime	Factor	Description
Land use, f_{LU}	All	All	1,00	All permanent grassland is assigned a land-use factor of 1
Management, f_{MG}	Non-degraded grassland	All	1,00	Non-degraded and sustainably managed grassland, but without significant management improvements
Management, f_{MG}	Moderately degraded grassland	Temperate / Boreal	0,95	Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs
		Tropical	0,97	
		Tropical montane	0,96	
Management, f_{MG}	Severely degraded	All	0,70	Lands are identified as degraded lands using the "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities."
Input, f_{IN}	Low/Medium	All	1,00	All grassland without the input of fertilizers is assigned an input factor of 1
	High	All	1,11	Grasslands with direct application of fertilizers - organic or inorganic

Source: A/R Methodological Tool UNFCCC (2013a).

Taking into account uncertainties and inherent precision limitation of a factor-based estimation by this tool, value of the rate of change of SOC stock is not accounted as more than $0.8 \text{ t C ha}^{-1} \text{ yr}^{-1}$, that is:

$$\text{If } dSOC_{t,i} > 0.8 \text{ t C ha}^{-1} \text{ yr}^{-1}, \text{ then } dSOC_{t,i} = 0.8 \text{ t C ha}^{-1} \text{ yr}^{-1}$$

SOC stock change for all strata of the areas of land, in year t, is calculated as:

$$\Delta SOC_{AL,t} = \frac{44}{12} \times \sum_i A_i \times dSOC_{t,i} \times 1\text{year} \quad \text{Equation (12)}$$

Where:

$\Delta SOC_{AL,t}$ = Change in SOC stock in areas of land meeting the applicability conditions of the A/R Tool16, in year t; $\text{t CO}_2\text{-e}$

A_i = The area of stratum i of the areas of land; ha

$dSOC_{t,i}$ = The rate of change in SOC stocks in stratum i of the areas of land; $\text{t C ha}^{-1} \text{ yr}^{-1}$

i = 1, 2, 3, ... strata of areas of land; dimensionless

13.4 Leakages

Leakage is defined as the increase in greenhouse gas (GHG) emissions occurring outside the project boundary as a direct or indirect result of its activities. The project holder shall identify, document, and quantify all relevant sources of leakage, applying conservative and transparent criteria.

According to AR-ACM0003, leakage analysis shall apply the methodological tool AR-TOOL15, A/R Methodological Tool, Version 02.0 (Estimation of the increase in GHG emissions attributable to the displacement of pre-project agricultural activities) UNFCCC (2013b).

The tool is not applicable if the displacement of agricultural activities is likely to cause, directly or indirectly, drainage of wetlands or peatlands.

As described in the tool, the displacement of agricultural activities itself does not result in leakage. Leakage occurs when the displacement of agricultural activities generates an increase

in GHG emissions as a result of the project activities implemented within the project boundary.

Leakage attributable to the displacement of agricultural activities shall be considered insignificant and may be accounted as zero under the following conditions:

- (a) Animals are displaced to existing grazing land, and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;
- (b) Animals are displaced to existing non-grazing grassland, and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;
- (c) Animals are displaced to cropland that has been abandoned within the last five years;
- (d) Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;
- (e) Animals are displaced to a zero-grazing system.

In all other cases, the lands within the project boundary from which the pre-project agricultural activities are displaced shall be delineated and their area estimated. Leakage emission resulting from the activities displacement is estimated as follows:

$$LK_t = LK_{AGRIC,t} \quad \text{Equation (13)}$$

Where:

LK_t = Leakages t ; t CO₂-e

$LK_{AGRIC,t}$ = Leakage emission resulting from agricultural activities displacement in year t ; t CO₂-e

13.5 Net anthropogenic GHG removals

The net anthropogenic GHG removals shall be calculated as follows:

$$\Delta C_{PROJ,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \quad \text{Equation (14)}$$

Where:

$\Delta C_{PROJ,t}$ = Net anthropogenic GHG removals by sinks, in year t ; t CO₂-e

- $\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year t ; t CO₂-e
- $\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks, in year t ; t CO₂-e
- LK_t = GHG emissions due to leakage, in year t ; t CO₂-e

14 Leakage Management

In addition to the quantification of leakage established in Section 13.4, this Section defines the requirements for the identification, documentation, verification, and management of leakage attributable to project activities.

The purpose of this Section is to ensure that all relevant sources of leakage are considered systematically and transparently, and that, in case of uncertainty, conservative approaches are applied. In this way, the environmental integrity of certified reductions and removals is guaranteed, beyond their simple accounting in the net GHG balance.

14.1 Methodologies and sources of reference

Leakage shall be quantified based on recognized methodologies and reliable reference sources (IPCC 2006, 2019; methodologies and tools under the CDM; and the official tools of the BioCarbon Standard), using emission factors consistent with the best available information and always applying the principle of conservativeness.

14.2 Documentation and traceability

Leakage shall be documented in a complete and transparent manner in the Project Document, including:

- (a) The description of the leakage source considered,
- (b) The assumptions applied,
- (c) The estimation methods used,
- (d) The parameters and data employed, and
- (e) The justification of the relevance or insignificance of each leakage source.

14.3 Verification and quality assurance

Leakage shall be subject to periodic verification as part of the Monitoring Report. The project holder shall retain and make available all supporting documentation, databases, and technical

evidence underlying the estimations, in accordance with the traceability and quality assurance requirements established in the BCR Standard.

14.4 Uncertainty management

In cases of significant uncertainty, conservative adjustments shall be incorporated to ensure that emissions from leakage are not underestimated. Such adjustments shall be based on recognized statistical procedures (e.g., confidence intervals defined in the BioCarbon Uncertainty Tool) and shall be systematically applied in all leakage calculations.

14.5 Integration in the net balance

Leakage shall be reported in a consolidated manner in the estimation of the project's net GHG removals, ensuring consistency between baseline calculations, project scenario, and permanence.

The application of these leakage management procedures ensures that all indirect emissions attributable to the project are identified, quantified, and reported transparently, under principles of conservativeness and traceability. In this way, leakage is integrated consistently into the estimation of the project's net GHG removals, and the basis is established for the application of the uncertainty requirements described in Section 15 of this Methodology.

15 Uncertainty management

Uncertainty management is a central element to ensure transparency, credibility, and environmental integrity of the GHG removals reported under this Methodology. All estimations shall be carried out so that results are statistically robust, verifiable, and consistent with the principle of conservativeness.

15.1 Uncertainty Tool

All calculations of uncertainty shall be performed using the BioCarbon Uncertainty Tool BioCarbon Standard. (2025c), in its most recent version. The use of alternative methodologies or unauthorized adaptations shall not be permitted.

15.2 Minimum levels of confidence and precision

The minimum statistical confidence level shall be 90%, applying two-sided confidence intervals.

The maximum acceptable margin of error shall be $\pm 10\%$ with respect to the value of net GHG removals.

In line with good practice, such as that indicated by the IPCC (2006), a 90% confidence level and a maximum error of 10% are considered an appropriate balance between statistical rigor and practical feasibility in mitigation projects based on forest and soil sampling.

This level ensures that estimates are statistically robust, conservative, and verifiable, avoiding overestimation of removals and guaranteeing comparability of results across projects.

Where the error exceeds this threshold, the project holder shall apply a mandatory conservativeness deduction, proportionally reducing the reported removals in accordance with the BioCarbon Standard Uncertainty Tool.

15.2 Sampling design and measurements

The project holder shall:

- (a) Apply a statistically representative sampling design (stratified or systematic),
- (b) Justify the choice of sample size and sampling intensity,
- (c) Document the use of allometric equations, expansion factors, and default parameters, and
- (d) Demonstrate that such values are applicable to the species and local conditions.

15.3 Transparency and documentation

All information used in the estimation of uncertainty shall be fully documented in the Project Document, including:

- (a) Statistical assumptions and input parameters,
- (b) Sampling methods and data processing,
- (c) Calculated confidence intervals,
- (d) Uncertainty results obtained, and
- (e) Application of conservativeness deductions, where applicable.

15.4 Updates and verifications

The uncertainty assessment shall be updated in the following cases:

- (a) Each verification cycle,
- (b) Inclusion of new project areas,

- (c) Modification of the sampling design, or
- (d) Incorporation of new carbon pools or methodologies.

The Conformity Assessment Body shall verify the consistency in the application of the Uncertainty Tool, as well as the traceability of the calculations and the conservativeness deductions applied.

15.5 Principle of conservativeness

In cases of doubt, insufficient data, or inability to apply robust measurements, the project holder shall apply conservative factors to ensure that net GHG reductions or removals are not overestimated.

The application of these uncertainty management requirements ensures that the results of net GHG removals are statistically robust, verifiable, and conservative, avoiding overestimation of climate benefits. This reinforces transparency and comparability across projects and establishes the basis for the application of the permanence and reversal risk management provisions described in Section 16 of this Methodology.

16 Permanence and reversal risk management

The activities eligible under this Methodology shall guarantee the permanence of the GHG reductions and removals attributable to project activities. For this purpose, the following provisions are established:

- (a) Reversal risks shall be identified and assessed, including natural risks (fires, droughts, pests, diseases), anthropogenic risks (land-use change, economic activities, social or tenure pressures), and regulatory risks;
- (b) The project holder shall define and document the management, monitoring, and mitigation measures adopted to reduce such risks, including sustainable management practices, fire prevention and control plans, governance agreements, and community management mechanisms;
- (c) All projects shall contribute a percentage of the credits generated to a non-permanence reserve administered by the operator of the registry of BIOCARBON. This reserve shall act as a collective guarantee against potential carbon losses caused by reversal risks;

- (d) In the event of a reversal, whether partial or total, compensations shall be applied from the reserve, in accordance with the BIOCARBON STANDARD procedures, to cover the magnitude of the reported loss;
- (e) Permanence monitoring shall remain active throughout the project crediting period and shall be subject to periodic verification by Conformity Assessment Bodies.

The evaluation shall be conducted by applying the Permanence and Risk Management Tool (2025f), in order to:

- (a) Classify the risk profile by factor and at an aggregate level;
- (b) Quantitatively estimate the residual risk;
- (c) Determine the mandatory contribution percentage to the non-permanence reserve;
- (d) Establish mitigation and contingency measures with designated responsibilities and timelines.

The risk assessment and mitigation plan shall be updated at each verification and whenever material events occur (e.g., fires, pest outbreaks, tenure conflicts), maintaining documentary evidence and traceability.

Sustained and verifiable reduction of the risk profile may be reflected in an adjustment of the reserve percentage in accordance with the BioCarbon Standard criteria.

16.1 **Complementary risk management instruments**

All projects shall contribute a fixed 10% of certified reductions or removals to the non-permanence reserve as a minimum guarantee. In the case of AFOLU projects, in addition to this 10%, the Risk Tool (2025f) shall be applied. The result of the tool will determine the additional percentage of contribution to the reserve, based on the risks identified and the mitigation measures implemented by the project holder.

Project holders may voluntarily employ complementary financial or contractual instruments, such as parametric insurance, business interruption policies, or financial guarantees. These instruments do not replace the obligation to contribute to the non-permanence reserve nor reduce the mandatory percentage, but they may be recognized as additional risk management measures, provided that:

- (a) They remain valid throughout the entire crediting period,
- (b) They cover the risks identified as relevant in the tool, and

- (c) They are issued by insurance or financial entities duly recognized in the corresponding jurisdiction.

Project holders shall provide documentary evidence of the existence, coverage, and validity of such instruments, and shall report any change in their condition during each verification.

17 Monitoring plan

The monitoring plan shall ensure the systematic collection, secure storage, and traceability of all data necessary to verify compliance with this Methodology and with the BIOCARBON STANDARD.

Project holders shall describe the procedures for tracking project activities and GHG emission reductions or removals within the project boundary. The monitoring objectives are:

- (a) Verify that applicability conditions and eligibility criteria are met throughout the project period;
- (b) Measure and estimate changes in carbon stocks in the selected reservoirs;
- (c) Quantify emissions associated with the project and relevant leakage, applying conservative criteria in cases of uncertainty;
- (d) Document the management of reversal risks and permanence;
- (e) Report the contributions to sustainable development of project activities, in accordance with the BIOCARBON SDG Tool;
- (f) Report the environmental and social outcomes of project activities.

17.1 Minimum technical requirements

For monitoring to be comprehensive and meet the objectives of tracking project activities, it shall at a minimum:

- (a) Ensure that all project areas are georeferenced and registered in a Geographic Information System (GIS), with unique identifiers for each plot or parcel;
- (b) Document the location of sampling plots with GPS coordinates and maintain them in the project file;
- (c) Apply sampling methodologies consistent with the official tools of BIOCARBON and with the IPCC Guidelines (2006, 2019).

17.2 Transparency and publication of information

The project holder shall publish, in the project's public registry, at least one summary of monitoring results for each reporting period, including:

- (a) Monitored area;
- (b) Survival and growth rates;
- (c) Changes in carbon stocks;
- (d) Leakage identified and quantified;
- (e) Results of permanence and risk assessments.

17.3 Integration of continuous monitoring technologies (D-MRV)

Methodologies under the BioCarbon Standard may integrate continuous monitoring technologies (D-MRV), such as remote sensing, real-time carbon flux measurements, or blockchain, provided that:

- (a) Methodological equivalence is demonstrated with approaches accepted by IPCC, CDM, and the BioCarbon Standard;
- (b) Results are subject to validation and verification by an accredited Conformity Assessment Body; and
- (c) Transparency, traceability, and public availability of relevant information are ensured.

The specific conditions for the application of these technologies are detailed in Annex 1 of this Methodology.

17.4 Monitoring procedures

Project holders shall describe the procedures for monitoring project activities and GHG emission reductions or removals within the project boundary.

Leakage monitoring shall include, where applicable, verification of possible displacement of activities, diversion of biomass or inputs, market effects, and any other significant indirect sources of emissions, applying conservative criteria in cases of uncertainty.

The monitoring plan shall include:

- (a) Monitoring of project boundaries;
- (b) Monitoring of the implementation of project activities;

- (c) Monitoring of biomass growth for forest and other crops; and
- (d) Monitoring of the quantification of the project's net removals.

The information related to the data required for carbon estimations shall be established using commonly accepted principles and practices for forest crop and other crop management.

17.4.1 Monitoring of the project boundaries

The geographical limits of the Project, consisting of the eligible areas²³ on which the project activities are developed, shall be included in a Geographic Information System (GIS), georeferencing each of the planted areas with their respective ID, coverage at the reference dates for each of the areas in each of the crops, among others.

In this way, monitoring of project activities is carried out for each of the geographic areas included in the Project. Periodic verification of the project boundaries should be carried out by evaluating satellite images, consistent with the eligibility analysis of the areas in the Project.

17.4.2 Monitoring of the implementation of project activities

Following practices in the Agriculture, Forestry, and other land-use sectors, the monitoring activities for the implementation of project activities shall be as follows:

- (a) Confirm that soil preparation and site selection are carried out as described in the establishment and management plans and the project document;
- (b) Annually review and update planted areas by species and strata;
- (c) Determine plantations survival, and biomass decreases in the areas or events that determine them.

²³ Eligible areas refers to the areas that comply with the condition of absence of forest or natural covers, on the reference dates established by the BCR STANDARD.

Table 9. Variables to monitor sites establishment

Variable	Unit of measurement	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Coverage / Other measurements or number of data collected	Observations
ID - Ref.GIS	alphanumeric	Defined	Continuously	100%	Each stratum and crop established, associated with an alphanumeric identifier.
Localization	geographic coordinates	m	Continuously	100%	Using GPS to identify the geographic coordinates of each lot included in the Project.
A_{ikt}	hectare	c	Continuously	100%	Polygons of the areas planted during time t, by stratum i, by model k (by species or date).
Site preparation	hectare	M	At the beginning of each establishment	100% of the planted areas	Intervened area for crop establishment.
Planted species for each stratum	NA	Defined	Annually	100%	Species planted by each stratum within the project boundaries.
Survival of i, j, k.	Trees ha^{-1}	m, c	Three months after planting and annual verification	100% of the planted area	The survival rate per hectare established, for stratum i, species j, and forest system k is calculated.
Planting date	alphanumeric	m	Start date of each establishment	100%	Date of the planting of each project site.

17.4.3 Monitoring of biomass growth

For the purpose of ensuring crop quality and confirming that activities have been implemented in accordance with the descriptions provided in the Project Document, the following monitoring activities shall be carried out in relation to crop management:

- Assessment of the permanence and growth of planted plots within the project boundaries, through the measurement of growth plots.
- Identification and assessment of disturbance events affecting the planted areas. This shall include the date, location, coordinates, affected species, type of event (fire, pests,

windthrow, floods, etc.), corrective measures implemented, and changes in project boundaries.

The project holder shall establish a protocol for the measurement of growth plots, as described below.

17.4.3.1 Stratification and sampling design

As established in section 13 of this document, the defined strata should be evaluated and under appropriate statistical methodological procedures.

Stratification

The defined strata shall be assessed in accordance with Section 13 of this document and following appropriate statistical methodological procedures.

Sampling plots

Temporary sampling plots are required, which depends on the number of strata present in the project boundaries. These plots allow for monitoring changes in above-ground biomass. All plots shall be adequately numbered, georeferenced, and located within a map of areas established within the project boundaries.

NOTE: If permanent plots are available in the project area, they can be used for sampling. However, it is considered good practice to establish temporary plots.

Size of plots or sampling units

It is recommended to establish a plot size according to individuals' density in the plantation or crop. In general, circular plots can be used, with an area of 250 or 400 m².

Sampling size

In order to obtain the information required²⁴ for calculating the number of plots needed for monitoring, preliminary sampling should be carried out. The number of plots for preliminary sampling is defined by the number of strata and the selected sampling intensity.

The sample size (n) is estimated with the following equation:

$$n = \frac{A_i \times 10.000 \times \text{Sampling intensity}^{25}}{PS} \quad \text{Equation (15)}$$

²⁴The approximate value of the variance of the biomass reserves, in each stratum and/or lot.

²⁵ The project holder shall select the sampling intensity, depending on the planted areas (it can be 0.5% or 0.1%, in relation to the size of the planted area).

Where:

n Number of plots required for biomass estimation; dimensionless

A_i Size of each stratum i ; ha

PS Plot size (constant for all strata); ha.

To calculate the number of sampling plots, the CDM Methodological Tool: A/R Methodological Tool is used. "Calculation of the number of sample plots for measurements within A/R CDM Project activities."²⁶ The scope, assumptions, parameters, and procedure for the calculation, defined in the tool, are detailed next.

Scope

- (a) The tool can be used to calculate the number of sample plots required for estimation of biomass stocks from sampling-based measurements in the baseline and project scenarios.
- (b) The tool calculates the number of required sample plots based on the specified targeted precision for biomass stocks to be estimated.
- (c) For this tool's purpose, all parameters used in calculating plot-level biomass stock (e.g., biomass expansion factors, root-shoot ratios) are considered fixed constants. Similarly, all models used to calculate plot-level biomass stock (e.g., volume tables or equations, allometric equations) are considered to be exact.

Assumptions

- (a) The approximate area value of each stratum within the project boundary is known;
- (b) The approximate variance of biomass stocks value in each stratum is known from a preliminary sample, existing data related to the project area, or existing data related to a similar area.
- (c) The project area is stratified into one or more strata.

Parameters

The tool provides the steps to estimate the following parameters:

²⁶ UNFCCC (2010)

Table 10. Parameters determined by the tool for sampling

Parameter	Unit	Description
n	Dimensionless	Number of sample plots required for estimation of biomass stocks within the project boundary
n_i	Dimensionless	Number of sample plots allocated to stratum i for estimation of biomass stocks within the project boundary

Source: A/R CDM methodological tool. UNFCCC (2013a).

Calculation of sample plots number

The required sample plots number for the estimation of biomass stocks in a carbon reservoir depends on the targeted precision and the variability of the estimated biomass stock. Targeted precision is specified by the Methodology applying the tool.

The project area is stratified based on the variability of estimated biomass stock and area of each stratum. If the biomass stock being estimated is the sum of biomass stocks in two or more pools, then stratification is carried out on the basis of the variability of the dominant reservoir (i.e., the reservoir containing the most considerable amount of biomass stock).

For the tool, biomass stock variability is expressed as the standard deviation of biomass stock in the stratum. The approximate value of the standard deviation of biomass stock in each stratum at the time of estimation is either known from existing data applicable to the project area or existing data related to a similar area or estimated based on a preliminary sample and expert judgment.

The number of sample plots required for estimating biomass stocks within the project boundary is calculated iteratively. In the first iteration, it is calculated as:

$$n = \frac{N * t_{VAL}^2 * (\sum_i w_i * s_i)^2}{N * E^2 + t_{VAL}^2 * \sum_i w_i * s_i^2} \quad \text{Equation (16)}$$

Where:

n Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

N Total number of possible sample plots within the project boundary (i.e., the sampling space or the population); dimensionless

t_{VAL}	Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence level; dimensionless
w_i	The relative weight of the area of stratum i (i.e., the area of the stratum i divided by the project area); dimensionless
s_i	The estimated standard deviation of biomass stock in stratum i; t d.m. (or t d.m. ha ⁻¹)
E	Acceptable margin of error (i.e. one-half the confidence interval) in the estimation of biomass stock within the project boundary; t d.m. (or t d.m. ha ⁻¹), i.e., in the units used for S_i
l	1,2, 3, ... biomass stock estimation strata within the project boundary

Allocation of sample plots

The establishment of the sampling units is done randomly or systematically. In random sampling, with randomly selected points, the plot centre's subjective location (plot center, plot reference points, or movement of the plot center to a more "convenient" position) should be avoided, following the principle of randomness.

GPS should be used for their location and georeferencing in the field, thus allowing easy access and location. The sampling plots shall be identified with alphanumeric code series, and the information of their geographic position (GPS geographic coordinates), the location of the sampling unit, and the strata shall be recorded and archived.

Monitoring frequency

The GHG project holder shall establish a monitoring frequency according to the needs of verification and certification.

Measuring and estimating changes in carbon contents

The increase in above-ground biomass is measured. Therefore, each tree's individual growth shall be monitored in the sampling plots. Changes in carbon content in other components of the above-ground (branches and leaves) and below-ground (roots) biomass of individuals in each plot shall be estimated by expansion factors or by adjusting allometric biomass equations, if available for the species.

17.4.4 Monitoring of the quantification of project removals

The estimate of actual removals considers the changes in carbon stocks in the project area, minus the estimate of non-CO₂ GHG emissions at the project boundaries resulting from the implementation of project activities.

According to the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities,"²⁷ the change in carbon stocks in trees is estimated using the following steps:

- (a) Use appropriate equations to estimate tree carbon stocks (in living, above-ground, and below-ground biomass). Using expansion factors - Biomass Expansion Factor (BEF), or specific biomass allometric equations that do not require expansion factors.
- (b) Use appropriate equations to estimate carbon stocks in trees. Using volume tables or equations used to convert wood volume (in forestry activities) from stem to above-ground biomass, or using expansion factor that relates root biomass to total above-ground biomass.

In this way, the biomass of trees of species j can be estimated as:

$$B_{TREE,j,i,t} = V_{TREE,j,i,t} \times D_j \times FEB_j \times (1 + R_j) \quad \text{Equation (17)}$$

Where:

$B_{TREE,j,i,t}$	Biomass of trees of species j in sample plot p of stratum i at a point of time in year t ; t d.m
$V_{TREE,j,i,t}$	Stem volume of trees of species j in sample plot p of stratum i at a point of time in year t , estimated by using the tree dimension(s) as entering data into a volume table or volume equation; m ³
D_j	Basic wood density of tree species j ; t d,m; m ⁻³
BEF_j	Biomass expansion factor for conversion of stem biomass to above-ground tree biomass, for tree species j ; dimensionless
R_j	The root-shoot ratio for tree species j ; dimensionless
j	Tree species

²⁷ UNFCCC (2015b)

The biomass $B_{TREE,j,p,i,t}$, maybe estimated for species and stratum using the annual volume per hectare. The annual volumes for each species are taken from the data resulting from the inventories at the date of monitoring.

In the case of other crops, biomass equations can be used to represent site conditions.

According to annex 24, EB 67 (A/R Methodological Tool "Demonstrating appropriateness of volume equations for estimation of above-ground tree biomass in A/R CDM project activities")²⁸ *"A species-specific or group-of-species-specific volume table or volume equation derived from trees growing in edapho-climatic conditions similar to those in the project area is considered appropriate, and hence can be used for ex-post estimation of tree stem volume"*²⁹. In all cases, the data used shall meet this condition.

The holder of the GHG project shall include the sources of the equations used. For example, published volume or biomass equations that are reasonably applicable to the species and site, or equations developed by the proponent for which the proponent can demonstrate their origin and applicability. Besides, the QA/QC process should consider verifying the validity of the equations.

Finally, with the field measurements results, the carbon stocks (total of tons of CO_{2e} at the date of the inventory) are calculated in the carbon pools included in the Project, according to the Methodology applied (AR-ACM0003).

17.5 Quality control and quality assurance procedures

17.5.1 Normative requirements

The project holder shall design and implement a comprehensive QA/QC system that ensures the reliability, consistency, and traceability of all information used in the quantification of GHG removals. This system shall include, at a minimum:

(a) Normative integration

The QA/QC system shall be consistent with the Monitoring, Reporting and Verification (MRV) Tool of the BioCarbon (2025e).

Partial or modified application of this tool shall not be accepted.

(b) Field data verification

²⁸ UNFCCC (2012)

²⁹ if at least one of the 3 conditions is satisfied

A representative fraction of plots (10–20%) shall be remeasured by a team independent from the main sampling team.

Differences greater than 5% shall be documented, corrected, and reported.

(c) Review of data processing

The data collected shall be reviewed by at least a second analyst before being included in the final estimations.

A record of all reviews conducted shall be maintained, including errors detected and corrections applied.

(d) Data recording and archiving

QA/QC procedures shall be documented, including field data verification, information processing, and secure digital archiving.

QA/QC procedures shall also apply to the data and assumptions used for leakage estimation, ensuring consistency, traceability, and transparency of the reported information.

All field forms, databases, metadata, and intermediate results shall be archived in secure digital format with redundant backup.

(e) Version control and corrections

Any subsequent update, correction, or modification in the data or calculations shall be recorded through version control systems, ensuring complete traceability of changes.

(f) Availability for external verification

All information collected shall be made available for review and verification by the Conformity Assessment Body and by the administrator of the BIOCARBON GHG Program, during and after the crediting period.

17.5.2 Recommended operational procedures

To strengthen the reliability of the data, the project holder shall apply the following procedures:

(a) Remeasurement of plots

Remeasurements of plots shall be carried out, with a random selection covering between 10% and 20% of the total number of plots established in the initial sampling. The remeasurements,

when compared with the initial measurements, shall not show deviations greater than 5%. Any errors found shall be corrected and reported.

(b) Measuring instruments

Field measurements shall be conducted with instruments of similar characteristics to those used in the initial sampling. This includes periodic calibration and the use of standardized protocols.

(c) Field protocols

The establishment and measurement of plots shall follow the same technical protocols defined in the sampling design.

Changes to location, plot center, or measurement procedures for operational convenience shall not be permitted.

(d) Data entry verification

Field records shall be reviewed in at least 10% of entries, selected randomly.

The maximum allowed error in data entry is 10%. If this threshold is exceeded, 100% of the data shall be reviewed and the necessary corrections implemented.

(e) Information comparison

The information obtained in follow-up measurements shall be compared with the initial records.

Inconsistencies, errors, and omissions shall be identified.

In cases of errors greater than 5%, the sampling shall be repeated for all plots.

(f) Data recording and archiving

All field forms, databases, intermediate calculations, GIS maps, and reports shall be retained in both physical and digital formats.

The information shall be archived in an organized and secure manner for at least two (2) years after the closure of the last crediting period.

18 References

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Document for public consultation

Annex 1. Continuous Monitoring Technologies (dMRV)

This annex establishes provisions for the voluntary integration of digital and continuous monitoring technologies (dMRV) in the implementation of afforestation, reforestation, and revegetation (ARR) projects under the BioCarbon Standard.

(a) Scope

Continuous monitoring technologies may include, among others:

- (i) In situ carbon flux sensors (e.g., net ecosystem exchange, NEE),
- (ii) Airborne or terrestrial LiDAR scanning,
- (iii) Satellite Earth observation systems,
- (iv) Automated digital MRV platforms,
- (v) Data tokenization and blockchain for traceability and record security.

(b) Conditions of application

The use of dMRV technologies is optional and may be employed to complement or partially substitute conventional sampling plot measurements, provided that:

- (i) Methodological equivalence is demonstrated with approaches accepted by IPCC, CDM, and the BioCarbon Standard (Tier 2 or higher);
- (ii) Results are validated and verified by an accredited Conformity Assessment Body, in accordance with the procedures of the BioCarbon Standard;
- (iii) Transparency, traceability, and public accessibility of relevant data are ensured, in line with the publication requirements of the BioCarbon registry;
- (iv) The integration of these technologies, the assumptions applied, and the quality assurance protocols are documented in the Project Document.

(c) Minimum requirements

Project holders shall retain verifiable data series for at least fifteen (15) years after the last verification.

All information shall be reported in digitally auditable formats.

dMRV systems shall be certified or independently validated regarding the reliability of their algorithms and data capture processes.

(d) Use of results

Results generated through continuous monitoring technologies may be used in the calculation of the project's net GHG removals, provided that they are integrated consistently with the procedures established in this Methodology and with the official tools of the BioCarbon Standard (baseline and additionality, uncertainty, permanence, and leakage).

(e) Principle of equivalence

The use of dMRV technologies does not exempt compliance with the principles of conservativeness, verifiability, and consistency. Where discrepancies exist between dMRV results and conventional measurements, the most conservative value shall be applied for credit issuance.

(f) Pilot character

This annex applies exclusively to afforestation, reforestation, and revegetation (ARR) projects under the BioCarbon Standard, on a pilot basis. The inclusion of continuous monitoring technologies in other BioCarbon methodologies will be evaluated subsequently, based on the experience gained and the independent validation of their effectiveness and methodological equivalence.

Document for public consultation

Document history

Version	Date	Type of document	Nature of the review
1.0	December 10, 2019	Methodological Document sectoral GHG projects in the	Initial version – Document submitted to public consultation
2.0	March 27, 2020	Methodological Document sectoral GHG projects in the AFOLU sector	Updated version – After public consultation
2.1	August 27, 2020	Methodological Document sectoral GHG projects in the AFOLU sector	Adjusted version Minor editorial changes
2.2	October 19, 2020	Methodological Document sectoral GHG projects in the AFOLU sector	Updated version Adjustments in the section Uncertainty Management
2.3	November 25, 2021	Quantification of GHG Emission Reductions from GHG projects. GHG REMOVAL ACTIVITIES.	Updated version Change of title to specify that it does not apply only to sectoral GHG projects. Clarifications on eligible projects. Definition of GHG projects. Adjustments to the applicability conditions. Adjustments in section 6. Normative references
3.0	April 13, 2022	Quantification of GHG Emission Reductions. GHG Removal Activities	Updated version Adjustment of scope and normative references Adjustment of additionality analysis. Updated uncertainty analysis.
4.0	February 9, 2024	Quantification of GHG Removals. Afforestation, Reforestation and Revegetation.	Updated version Change in the name of the methodology Adjustment of objective Adjustment of Additionality (Tool reference) Copyright BioCarbon Cert

Version	Date	Type of document	Nature of the review
5.0	September 25, 2025	BCR0001 Afforestation, Reforestation, and Revegetation	Updated version Strengthening of additionality and baseline through the mandatory application of the official BioCarbon tool. Explicit inclusion of restoration, rehabilitation, and recovery activities within the scope. Adjustments on permanence: 10% reserve + application of the Reversal Risk Tool + recognition of complementary financial instruments. Expansion of the leakage definition: displacement of activities, diverted biomass, market effects, transport, and other relevant sources. Establishment of uncertainty rules: $\pm 10\%$ at 90% confidence, with mandatory conservativeness deductions. New monitoring plan: strengthened transparency,