



BLUE CARBON METHODOLOGY

BCR0012

Methodology for Quantifying GHG Emission
Reductions and/or Removals from the
Conservation, Restoration and Sustainable
Management of Blue Carbon Ecosystems
*Applicable to mangroves, tidal marshes, and seagrass
meadows*

BIOCARBON CERT®

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BIOCARBON CERT

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Acronyms and abbreviations

ADC	Avoidance of Double Counting
AFOLU	Agriculture, Forestry and Other Land Uses
AGB	Aboveground biomass
BGB	Belowground biomass
CDM	Clean Development Mechanism
CF	Carbon fraction of the dry matter
CH ₄	Methane
CO ₂	Carbon dioxide
CO _{2e}	Carbon dioxide equivalent
FAO	Food and Agriculture Organization of the United Nations
FPIC	Free, Prior and Informed Consent
GHG	Greenhouse Gases
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
MRV	Monitoring, Reporting and Verification
N ₂ O	Nitrous oxide
QA/QC	Quality Assurance/Quality Control
RMSE	Root Mean Square Error
SDGs	Sustainable Development Goals
SDSs	Sustainable Development Safeguards
SOC	Soil organic carbon
SOP	Standard Operating Procedures
UNFCCC	United Nations Framework Convention on Climate Change
VCC	Verified Carbon Credit

1 Introduction

This methodology provides project holders with the normative requirements, procedures, models, parameters, and data necessary to quantify and monitor greenhouse gas (GHG) emission reductions and removals attributable to activities that conserve, restore, or sustainably manage Blue Carbon ecosystems. These ecosystems include mangroves, tidal marshes, seagrass meadows, and other intertidal wetlands that are characterized by high rates of carbon removals and long-term storage of carbon in biomass and soils.

The methodology covers aspects related to the definition of eligible Blue Carbon activities, spatial and temporal boundaries, agents and drivers of ecosystem degradation or conversion, identification of the baseline scenario and demonstration of additionality, quantification of emission reductions and removals, uncertainty management, risk and leakage management, non-permanence provisions, and compliance with social and environmental safeguards.

This methodology is globally applicable and has no geographical limitation, provided that the project area meets the applicability conditions defined in this document.

Project holders applying this methodology shall follow the requirements of the BIOCARBON STANDARD and its associated tools. Methodological deviations may be proposed, provided that they comply with the principles set forth in ISO 14064-2, applicable national legislation, and are approved by BIOCARBON prior to validation.

This methodology shall be used by Blue Carbon project holders to seek certification and registration under the BIOCARBON STANDARD.

2 Objectives

The objective of this methodology is to provide project holders with the requirements, procedures, and tools to:

- (a) Quantify greenhouse gas (GHG) emission reductions and removals generated by project activities in Blue Carbon ecosystems, including mangroves, tidal marshes, and seagrass meadows;
- (b) Establish a credible and conservative baseline scenario representing expected emissions and removals in the absence of the project;
- (c) Demonstrate additionality by proving that project activities go beyond legal obligations, common practice, and business-as-usual scenarios;

- (d) Ensure environmental integrity through the comprehensive accounting of relevant carbon pools (aboveground biomass, belowground biomass, and soil organic carbon), and where significant, non-CO₂ gases such as CH₄ and N₂O;
- (e) Address permanence risks by requiring risk assessment and the establishment of a reserve to compensate for potential reversals caused by natural or anthropogenic disturbances (e.g., sea-level rise, storms, or coastal erosion);
- (f) Identify and account for leakage that may result from the displacement of activities affecting other coastal ecosystems;
- (g) Provide monitoring, reporting, and verification (MRV) requirements that allow transparent, replicable, and conservative quantification of net GHG benefits;
- (h) Safeguard social and environmental co-benefits, including biodiversity conservation, coastal protection, and sustainable livelihoods for local communities;
- (i) Ensure consistency with the BIOCARBON STANDARD, the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, and the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* (hereinafter referred to as the *Wetlands Supplement*), as well as with national requirements;
- (j) Facilitate the articulation of the Project accounting with national accounting, if applicable;

3 Scope

This methodology applies to project activities that reduce greenhouse gas (GHG) emissions or enhance carbon removals by conserving, restoring, or sustainably managing Blue Carbon ecosystems, including mangroves, tidal marshes, and seagrass meadows. The scope of this methodology covers the following.

3.1 Ecosystem types

Mangrove forests (including both aboveground and belowground biomass and soils), coastal tidal marshes, seagrass meadows.

3.2 Project activities

- (a) Conservation of existing Blue Carbon ecosystems under threat of degradation or conversion;

- (b) Restoration of degraded ecosystems, including hydrological restoration, revegetation, and replanting; and,
- (c) Sustainable management practices that enhance long-term carbon storage and ecosystem resilience.

3.3 Carbon pools considered

- (a) Aboveground biomass, belowground biomass (roots), and soil organic carbon (SOC) (Mandatory);
- (b) Dead wood and litter, when significant and measurable (Optional).

3.4 GHGs included

- (a) Mandatory: CO₂;
- (b) Optional (where significant): CH₄ and N₂O, particularly in waterlogged soils and managed wetlands.

This methodology is applicable worldwide, with no geographical restriction, provided that the ecosystems meet the eligibility conditions and the project complies with the BIOCARBON STANDARD and applicable national regulations.

4 Version and validity

This document constitutes the Version 1.0. November 7, 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 Applicability conditions

This methodology is applicable to project activities that meet all of the following conditions:

5.1 Ecosystem type

- (a) The project area shall consist of Blue Carbon ecosystems, specifically mangroves, tidal marshes, or seagrass meadows;

- (b) The area shall be clearly mapped and georeferenced, with stratification by ecosystem type where applicable;

5.2 Project activities

Eligible activities include:

- (a) Conservation of existing ecosystems under threat of degradation or conversion;
- (b) Restoration of degraded ecosystems, including hydrological restoration, revegetation, and replanting;
- (c) Sustainable management practices that maintain or increase carbon stocks.

Project activities shall not involve large-scale conversion of ecosystems for other land uses, nor the introduction or promotion of alien, invasive, or potentially invasive species.

Conservation activities, as defined in Section 7, refer to the maintenance and continued protection of existing Blue Carbon ecosystems, such as mangroves, tidal marshes, and seagrass meadows, under demonstrable threat of degradation or conversion.

The conservation activities shall¹:

- (i) Address clearly identified threats or drivers of degradation or conversion, including but not limited to drainage, unsustainable harvesting, aquaculture expansion, or coastal development;
- (ii) Ensure legal and operational protection of the conservation area through management plans, community or co-management agreements, or other governance mechanisms consistent with applicable national or regional regulations; and
- (iii) Maintain or enhance the ecosystem's long-term capacity for GHG removals, biodiversity conservation, and coastal resilience through ongoing monitoring and adaptive management during the crediting period.

5.3 Baseline scenario

The project area shall be subject to an identifiable risk of degradation or loss (e.g., conversion to aquaculture, agriculture, urban infrastructure, or other non-wetland uses; hydrological alteration; unsustainable harvesting; erosion; pollution).

Areas where there is no plausible threat or risk of degradation are not eligible.

¹ These requirements are aligned with the IPCC 2013 Wetlands Supplement (Vol. 4, Ch. 4) and ISO 14064-2:2019, ensuring that conservation activities deliver measurable, additional, and durable climate-mitigation benefits.

5.4 Legal and regulatory compliance

- (a) Project activities shall not be mandated by law or regulation;
- (b) The project shall demonstrate secure rights to implement the activities and to claim the associated GHG benefits, including tenure, access, or formal agreements.

5.5 Projects in legally protected areas

The mere existence of a protected-area designation shall neither preclude project eligibility nor suffice to demonstrate additionality. Eligibility shall be established only where project activities materially exceed applicable legal requirements, where the competent authority participates in the project governance structure and provides explicit written consent, and where the resulting climate benefits are measurable, reportable, and verifiable.

In consequence, projects located within legally protected areas may be eligible provided that: (i) the project actions are not legally required or materially exceed any applicable legal obligations (regulatory surplus); (ii) the baseline scenario demonstrates ongoing or likely degradation or loss in the absence of the project; (iii) the competent authority confirms that the actions are not mandated and/or not funded as part of its statutory duties; and (iv) all other eligibility, additionality and MRV requirements of this Methodology and the BIOCARBON STANDARD are met. Credits intended for CORSIA or Article 6 use shall comply with program-specific rules (e.g., Host Party authorization, “inside/outside NDC”, and corresponding adjustments where applicable).

In this context, projects located within legally protected areas may be eligible provided that all of the following conditions are met:

- (a) Regulatory surplus: Project actions are not legally required or materially exceed any applicable legal obligations. The legal framework and the specific obligations applicable to the project area shall be identified and demonstrated in the Project Document;
- (b) Baseline credibility: The baseline scenario shows ongoing or likely degradation or loss in the absence of the project, supported by verifiable evidence (e.g., remote sensing, field reports, enforcement records, or peer-reviewed/lawful sources);
- (c) Authority participation and consent: The competent management authority of the legally protected area shall (i) participate in the project governance structure, contributing to decision-making during project formulation and implementation (without the obligation to provide financial resources), and (ii) provide an explicit written statement confirming its agreement with the implementation of the project;

- (d) Competent authority confirmation: A written statement (or equivalent official documentation) from the competent management authority confirms that the proposed actions are not mandated and/or not funded as part of its statutory duties, and that the project does not substitute existing committed public expenditure;
- (e) Additionality and MRV: All other eligibility, additionality, quantification, monitoring, and verification requirements of this Methodology and the BIOCARBON STANDARD are met, including leakage, permanence, and safeguards.

5.6 Environmental and social safeguards

- (a) The project shall not cause negative impacts o biodiversity, ecosystem services, or local livelihoods:
- (b) Activities shall comply with the BIOCARBON Sustainable Development Safeguards (SDSs) and national environmental and social regulations.

5.7 Carbon pools and GHGs

The methodology is applicable only where project activities maintain or enhance at least the following carbon pools: aboveground biomass, belowground biomass, and soil organic carbon.

Non-CO₂ gases (CH₄, N₂O) shall be included if significant, as determined by IPCC guidelines.

5.8 Exclusions

- (a) Projects that rely on draining wetlands, large-scale dredging, or other practices inconsistent with ecosystem integrity are excluded;
- (b) Projects that use non-renewable biomass or that generate significant leakage outside the project boundary are not eligible.

6 Normative references

The following documents are integral to the application of this Methodology.

All references shall be applied in their latest version in force at the time of project validation or verification, unless otherwise instructed by the BIOCARBON STANDARD.

In the event of future updates to these tools or standards, project holders shall adopt the revised versions as directed by BIOCARBON, including during baseline reassessment and revalidation stages.

6.1 Applicable Standards and Guidelines

The following external and internal references shall be used for the implementation of this methodology:

- (a) The BCR STANDARD;
- (b) IPCC Guidelines for National Greenhouse Gas Inventories (2006, 2019), Vol. 4 – AFOLU;
- (c) Applicable national GHG legislation and land-use regulations;
- (d) Relevant decisions from the UNFCCC, ICAO-CORSIA (ICAO, 2024)², and the Paris Agreement Article 6 mechanisms (UNFCCC, 2015)³;
- (e) ISO 14064-2 (ISO, 2019a) and ISO 14064-3 (ISO, 2019b), for project-level GHG quantification and verification.

6.2 BioCarbon Tools

Project holders shall apply, as applicable, the following tools and procedures developed under the BIOCARBON STANDARD. These are normative and binding for the quantification, monitoring, and registration of emission reductions under Blue Carbon activities:

- (a) Baseline and Additionality Tool;
- (b) Permanence and Risk Management Tool;
- (c) Monitoring, Reporting and Verification (MRV) Tool;
- (d) Conservative Approach and Uncertainty Management Tool;
- (e) Avoidance of Double Counting (ADC) Tool;
- (f) Sustainable Development Safeguards Tool (SDSs);
- (g) Sustainable Development Goals Tool (SDGs).

BIOCARBON may issue additional tools, technical guidance, or procedures that become mandatory upon publication. These shall be listed on the official BIOCARBON website and communicated to project holders.

² For use in the Carbon Offsetting and Reduction Scheme for International aviation (CORSIA), emission units shall comply with CORSIA program eligibility and vintage requirements as set by the BIOCARBON Rules.

³ Where mitigation outcomes are intended for international transfer under Article 6, the Project Document and Monitoring Reports shall include (i) Host Party authorization, (ii) indication of 'inside/outside NDC' scope, and (iii) evidence that corresponding adjustments will be applied by the Host Party, consistent with the BIOCARBON ADC Tool and registry procedures.

7 Terms and definitions

The following terms are used throughout this Methodology. Unless otherwise specified, definitions are aligned with the BIOCARBON STANDARD, the IPCC Guidelines for National Greenhouse Gas Inventories (2006, 2019), and ISO 14064-2 (ISO, 2019a) and 14064-3 (ISO, 2019b). In case of conflict, definitions provided in the BIOCARBON STANDARD, and its associated tools shall prevail.

Activity data

Data representing the extent of human or natural activities that cause GHG emissions or removals. In Blue Carbon projects, activity data refers to measurable changes in the condition or extent of coastal ecosystems (e.g., mangroves, tidal marshes, or seagrass meadows), such as area gained or lost, restoration progress, or degradation levels. These data may be derived from satellite imagery, aerial photography, hydrological monitoring, soil and biomass sampling, or other verifiable sources.

Source: Adapted from IPCC Guidelines and BIOCARBON (2025d) MRV Tool.

Additionality

The characteristic of a GHG mitigation activity by which it generates emission reductions or removals that would not have occurred in the absence of the project. Additionality shall be demonstrated in accordance with the BIOCARBON Baseline and Additionality Tool.

Source: Adapted from ISO 14064-2 and CDM Glossary.

Agriculture, Forestry and Other Land Use (AFOLU)

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

Baseline scenario

A reference scenario that reasonably represents the expected changes in carbon stocks (emissions or removals) within the project area in the absence of the Blue Carbon project activity. The baseline shall reflect the most plausible trajectory of ecosystem loss, degradation, or non-restoration, based on historical evidence, identified drivers, and projected land- and seascape dynamics.

In Blue Carbon projects, the baseline scenario may include:

- (a) Conversion of mangroves, tidal marshes, or seagrass meadows to aquaculture, agriculture, or urban infrastructure;

- (b) Drainage or hydrological alteration leading to soil organic carbon (SOC) losses;
- (c) Progressive coastal erosion or land subsidence;
- (d) Continued unsustainable harvesting of mangrove wood or other resources;
- (e) Non-intervention in degraded wetlands, resulting in limited natural recovery.

The baseline shall be established using the BIOCARBON Baseline and Additionality Tool (BioCarbon Cert, 2025c) and in alignment with IPCC 2006 Guidelines, the 2013 Wetlands Supplement (IPCC, 2014), and the 2019 Refinement.

Blue Carbon

For the purpose of this methodology, Blue Carbon shall be defined as the carbon captured by living organisms in coastal ecosystems (e.g., mangroves, tidal marshes, and seagrass meadows) and marine ecosystems, and stored in biomass and sediments (IPCC, 2018; IPCC, 2022).

Carbon fraction

Tons of carbon per ton of dry biomass, in the case of AFOLU projects.

Carbon pools

The components of a coastal or marine ecosystem where carbon is stored. Relevant pools in this methodology include:

- (a) Aboveground biomass: carbon stored in living vegetation above the soil or sediment surface (e.g., mangrove trees, marsh grasses).
- (b) Belowground biomass: carbon stored in roots and rhizomes of mangroves, marsh plants, and seagrasses.
- (c) Soil organic carbon (SOC): carbon stored in soils and sediments, often the largest pool in Blue Carbon ecosystems.
- (d) Deadwood and litter: necromass and organic detritus, which may be significant in mangrove systems.

Carbon pools may be excluded only if their exclusion is technically justified and results in more conservative estimates of net GHG emission reductions and removals.

Source: IPCC 2006 Guidelines; IPCC 2013 Wetlands Supplement; BIOCARBON MRV Tool (2025d).

Conservation

Conservation refers to the maintenance and continued protection of existing Blue Carbon ecosystems, such as mangroves, tidal marshes, and seagrass meadows, that face a demonstrable risk of degradation or conversion. It involves proactive management, monitoring, and protective actions designed to prevent the loss of carbon stocks, soil organic carbon, and associated ecosystem functions and services.

Source: IPCC 2013 Wetlands Supplement; IPCC 2019 Refinement; ISO 14064-2:2019.

Eligible areas

Areas within the project boundary that consist of mangroves, tidal marshes, or seagrass meadows eligible under this methodology. Eligible areas shall be clearly georeferenced, demonstrate the presence or potential for restoration of Blue Carbon ecosystems at the start of project activities, and comply with all legal, ecological, and methodological requirements of the BIOCARBON STANDARD.

Emission factor

A coefficient that quantifies GHG emissions or removals per unit of activity data, typically expressed in tCO₂e per hectare. Emission factors shall be derived from credible sources such as peer-reviewed literature, national GHG inventories, or direct field measurements, and selected conservatively.

Emission factors are combined with activity data to calculate emissions and removals, consistent with IPCC guidance.

Source: IPCC 2019, ISO 14064-2 2019.

GHG Project (Greenhouse gas project)

Activity or activities that alter the conditions of a GHG baseline and which cause GHG emission reductions or GHG removal enhancements.

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

GHG emission reductions

The quantified decrease in anthropogenic greenhouse gas emissions attributable to the implementation of project activities, measured against a conservative and credible baseline scenario. Emission reductions shall be real, additional, measurable, permanent, and verified in accordance with the BIOCARBON STANDARD.

Leakages

A measurable and attributable increase in GHG emissions that occurs outside the project boundary as a result of the implementation of Blue Carbon project activities. Leakage may occur when human pressures or resource uses are displaced to other coastal or marine areas due to restrictions or interventions within the project area.

In Blue Carbon projects, potential sources of leakage include:

- (a) Displacement of aquaculture or agriculture to adjacent coastal zones or wetlands;
- (b) Increased harvesting of mangrove wood or non-timber resources in neighboring areas;
- (c) Shifts in fishing or resource extraction pressure to ecosystems outside the project boundary;
- (d) Relocation of coastal infrastructure or drainage works that negatively affect nearby ecosystems.

Leakage shall be identified, monitored, and quantified in accordance with the BIOCARBON MRV Tool. Where quantification is not feasible, conservative deduction factors shall be applied to ensure environmental integrity.

Source: Adapted from IPCC Guidelines and BioCarbon 2025d MRV Tool.

Legally protected area

A geographically defined space formally designated under national or subnational law for the conservation of biodiversity, ecosystems, or natural resources, where legally binding restrictions on land use, resource extraction, or management practices are established and enforceable by a competent authority.

The mere designation of a legally protected area does not in itself ensure effective conservation outcomes, and projects shall demonstrate compliance with all applicable requirements of this Methodology.

Mangroves

Mangroves are intertidal forests dominated by salt-tolerant tree and shrub species adapted to brackish and saline waters. They occur along sheltered tropical and subtropical coastlines, estuaries, lagoons, and river deltas, and are characterized by high productivity and substantial carbon storage in aboveground and belowground biomass and in waterlogged soils.

Source: IPCC, 2013 Wetlands Supplement; Ramsar Convention 1987.

Monitoring period

The monitoring period is the defined time interval during which data are collected and verified to quantify GHG emission reductions or removals from Blue Carbon activities, in accordance with the Project Document and the BIOCARBON STANDARD.

Organic soils

Organic soils are soils with high organic carbon content, typically $\geq 12\%$ by weight, formed under conditions of poor drainage and water saturation such as peatlands, mangroves, and tidal marshes. These soils store large amounts of carbon in anaerobic conditions and are highly vulnerable to GHG emissions when drained, degraded, or converted. For the purpose of this methodology, organic soils shall be identified and accounted for following the IPCC 2006 Guidelines and the 2013 Wetlands Supplement.

Permanence

Permanence refers to the long-term maintenance of GHG emission reductions and removals generated by Blue Carbon activities, ensuring that credited carbon stored in biomass and soils is not released back into the atmosphere due to natural or human-induced disturbances.

Project area

Geographic area under the legal authority or control of the project holder, within which Blue Carbon activities are implemented and where reductions of emissions and/or removals of GHGs are quantified and monitored.

The project area shall:

- (a) Consist of one or more eligible coastal ecosystems, including mangroves, tidal marshes, or seagrass meadows;
- (b) Be clearly delineated and georeferenced using GIS, satellite imagery, or equivalent spatial data;
- (c) Include restoration, conservation, or sustainable management activities that directly generate climate benefits;
- (d) Exclude areas where conservation is already legally mandated and where no additional mitigation outcomes can be demonstrated.

The project area may include multiple polygons, provided that each meets all eligibility criteria and is justified as part of the project scope.

Source: Adapted from BIOCARBON STANDARD and IPCC 2013 Wetlands Supplement.

Project boundary

The project boundary defines the geographic area, quantification period, and carbon pools and GHGs included in the assessment of Blue Carbon activities. It encompasses the mangroves, tidal marshes, or seagrass meadows under the project, documented with georeferenced maps; the temporal scope of monitoring and quantification; and the accounting of aboveground biomass, belowground biomass, soil organic carbon, and, where significant, CH₄ and N₂O, in accordance with the BIOCARBON STANDARD requirements and IPCC guidelines.

Project holder

The project holder is the legal entity or individual with operational control over the project area and the right to claim, register, and transfer GHG emission reductions or removals, demonstrating compliance with all applicable legal, technical, and programmatic requirements under the BIOCARBON STANDARD.

Project start date

The project start date is the moment when the first physical activity aimed at generating GHG emission reductions or removals in Blue Carbon ecosystems is implemented, such as hydrological restoration, replanting, or conservation interventions.

Quantification period

The quantification period is the timeframe over which GHG emission reductions or removals from Blue Carbon activities are calculated for credit issuance, aligned with the project start date and the validity of the baseline scenario, and may include multiple monitoring periods.

Rehabilitation

Rehabilitation refers to actions that improve ecosystem condition or functionality without necessarily returning it to its original state. In Blue Carbon projects, rehabilitation may include partial hydrological reconnection or assisted natural regeneration where full restoration is not feasible.

Source: IPCC 2013 Wetlands Supplement Section 4.4.2; IUCN Ecosystem Restoration Definition (2021).

Renewable Biomass

For the purpose of this methodology, Renewable Biomass shall be defined in accordance with the CDM Executive Board (EB23, Annex 18) as biomass that meets one of the following conditions:

- (a) Biomass originating from forest land where the land remains a forest, managed sustainably, and in compliance with national or regional forestry regulations.
- (b) Woody biomass from croplands and/or grasslands, where the land remains cropland or grassland (or reverts to forest), managed sustainably, and in compliance with applicable regulations.
- (c) Non-woody biomass from croplands and/or grasslands, where the land remains cropland or grassland (or reverts to forest), managed sustainably, and in compliance with applicable regulations.
- (d) Biomass residues, by-products, or waste streams from agriculture, forestry, and related industries, provided that their use does not decrease carbon pools (e.g., dead wood, litter, soil organic carbon) in the land areas where they originate.
- (e) The non-fossil fraction of industrial or municipal waste.

Note: This definition is included to ensure consistency in the treatment of biomass within the BIOCARBON STANDARD methodologies. It clarifies that only renewable biomass may be used in project activities, thereby preventing negative impacts on existing carbon pools (e.g., soil organic carbon, dead wood, litter) and avoiding leakage or non-permanence risks. For Blue Carbon projects, the requirement applies to any biomass used in restoration, conservation, or associated project activities.

Restoration

Restoration refers to the process of re-establishing the structure, function, and carbon storage capacity of degraded Blue Carbon ecosystems through hydrological, vegetative, and ecological interventions.

Restoration activities may include breaching dikes, re-establishing tidal exchange, sediment or hydrological management, and re-planting or re-vegetation with appropriate native species.

The objective is to return the ecosystem to a condition capable of sustained carbon removals and the provision of ecosystem services.

Source: IPCC 2013 Wetlands Supplement (Section 4.4.2); IPCC 2019 Refinement; Ramsar Convention (1987).

Safeguards

Safeguards are the social, environmental, and governance measures established to prevent adverse impacts and ensure that Blue Carbon project activities respect human rights, biodiversity, cultural values, and equitable benefit-sharing, in accordance with the BIOCARBON Sustainable Development Safeguards (SDSs) Tool.

Seagrass meadows

Seagrass meadows are submerged marine ecosystems formed by rooted, flowering plants (angiosperms) that develop dense underwater meadows in shallow coastal waters. They stabilize sediments, improve water quality, provide habitat for marine biodiversity, and store carbon mainly in their root and rhizome systems and associated sediments.

Source: IPCC, 2013 Wetlands Supplement; Ramsar Convention 1987.

Significant Leakage

Refers to greenhouse gas (GHG) emissions that occur outside the project boundary as a result of project activities and are sufficiently large to materially affect the project's net GHG benefits or environmental integrity.

Significant leakage shall be identified, quantified, and deducted from the verified emission reductions or removals in accordance with this methodology.

Source: Adapted from IPCC 2006 Guidelines for National GHG Inventories, Volume 4, Chapter 5; and ISO 14064-2:2019.

Soil Organic Carbon (SOC)

Soil Organic Carbon (SOC) is the carbon component of soil organic matter, including carbon stored in decomposing plant and animal residues, soil organisms, and substances synthesized by soil biota. In Blue Carbon ecosystems, SOC represents the dominant carbon pool, stored in anaerobic and waterlogged sediments, and shall be quantified following the IPCC 2006 Guidelines, the 2013 Wetlands Supplement, and the 2019 Refinement.

Source, sink, or carbon pool

A source is any process or activity that releases GHGs into the atmosphere; a sink is any process, activity, or mechanism that removes GHGs from the atmosphere; and a carbon pool is a reservoir that stores carbon. In Blue Carbon projects, relevant pools include aboveground and belowground biomass, soil organic carbon in sediments, and, where applicable, dead organic matter.

Sustainable Management

Sustainable management refers to planned practices that maintain or enhance the carbon stocks and ecological functions of Blue Carbon ecosystems over time, ensuring that resource use does not exceed natural regeneration or compromise ecosystem integrity.

Examples include community-based harvesting of mangrove wood within sustainable limits, rotational closures of fishing grounds, or controlled grazing in salt marshes.

Sustainable management shall demonstrate long-term stability of carbon stocks, compliance with national environmental regulations, and measurable social and ecological co-benefits.

Source: IPCC 2006 Guidelines (Vol. 4 AFOLU, Ch. 4 Section 4.1.3); IPCC 2013 Wetlands Supplement; ISO 14064-2:2019.

Sustainable Use / Resource Utilization

Sustainable use refers to the utilization of natural resources within Blue Carbon ecosystems in a manner and at a rate that maintains their potential to meet the needs of present and future generations while conserving carbon stocks and ecosystem functions.

Source: Ramsar Convention (1987); CBD Article 2; IPCC 2013 Wetlands Supplement.

Tidal marshes

Tidal marshes are coastal wetlands located in the intertidal zone, periodically inundated by tidal waters, and dominated by herbaceous vegetation such as grasses, sedges, and rushes. They are highly productive ecosystems that accumulate organic matter and store large amounts of soil organic carbon under anaerobic conditions.

Source: IPCC, 2013 Wetlands Supplement; Ramsar Convention 1987.

Uncertainty

Uncertainty is the degree of imprecision associated with the quantification of GHG emissions or removals in Blue Carbon projects, arising from limitations in data, models, sampling methods, or measurement techniques, and shall be assessed and conservatively addressed in accordance with IPCC guidance and the BIOCARBON Uncertainty Assessment Tool.

Verified Carbon Credit (VCC)

A Verified Carbon Credit (VCC) is a serialized unit equivalent to one metric tonne of CO₂-equivalent emission reductions or removals that has been verified and issued under the BIOCARBON STANDARD, ensuring uniqueness, traceability, and environmental integrity.

Wetlands

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

8 Carbon pools and sources of emissions

This section describes the carbon pools and GHG emission sources that shall be considered for quantifying emission reductions and removals under this Methodology. The selection of carbon pools shall follow IPCC principles and be justified based on conservativeness and project-specific conditions.

8.1 Carbon pools

The selection of carbon pools shall be consistent between baseline and project scenarios. Any pool excluded from the baseline shall also be excluded from the project scenario, unless justified by risk of overestimation. The carbon pools to be quantified within the project boundary are presented in *Table 1*.

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

Carbon pool	Baseline Scenario	Project Scenario	Justification/Explanation
Aboveground biomass	Included	Included	Significant in mangroves and tidal marshes; mandatory in both scenarios.
Belowground biomass	Included	Included	Roots of mangroves, marshes, and seagrasses represent a substantial carbon pool; mandatory in both scenarios.
Soil Organic Carbon (SOC)	Included	Included	Dominant carbon pool in Blue Carbon ecosystems; required in both scenarios, measured following IPCC Wetlands Supplement (2013).
Deadwood and litter	Optional	Optional	Relevant mainly in mangroves; may be excluded if conservatively justified and demonstrated to be insignificant.

8.2 Source of emissions

The sources of GHG emissions considered under this Methodology are those resulting from the loss, degradation, or conversion of Blue Carbon ecosystems, as well as project-related

activities that may generate GHG emissions. These sources shall be consistently accounted for in both the baseline and project scenarios.

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	Whether selected (Yes/No)	Justification/Explanation
Drainage or hydrological alteration	CO ₂	Yes	Drained wetlands and altered tidal flows release SOC as CO ₂ .
Decomposition of disturbed soils/sediments	CO ₂ , CH ₄ , N ₂ O	Yes	Disturbance, erosion, or conversion mobilizes SOC and may generate CH ₄ and N ₂ O.
Biomass burning (if fire is present)	CH ₄ , N ₂ O	Yes	Although rare, fires in mangroves can emit CH ₄ and N ₂ O; shall be included when documented. CO ₂ is covered by carbon stock change.
Fuel use for project activities	CO ₂	Yes (if significant)	CO ₂ emissions from fossil fuel use in restoration, planting, monitoring, and transport activities shall be included if considered significant.
Leakage-related displacement	CO ₂ , CH ₄ , N ₂ O	Yes (if applicable)	Activity displacement (e.g., aquaculture, fuelwood harvest, fishing pressure) outside the project boundary

GHG emissions from each source shall be quantified using methods consistent with IPCC (2006 Guidelines, 2013 Wetlands Supplement, and 2019 Refinement) and the BIOCARBON MRV Tool (2025d). The most accurate available data shall be used, applying Tier 2 or Tier 3 methods when feasible, or applying conservative default values with proper justification when higher-tier data are not available.

Emission sources shall be included consistently in both the baseline and project scenarios. Any exclusion shall be conservative and justified in the Project Document.

Default values for SOC, CH₄, and N₂O may be taken from Annex 1 where project-specific data are not available

9 Spatial and temporal limits

This section defines the spatial and temporal boundaries within which GHG emission reductions shall be quantified under this Methodology. The boundaries shall be clearly documented and justified in the Project Document, following the definitions provided in Section 7.

9.1 Geographic boundaries

The geographic boundary shall include the full extent of the Blue Carbon ecosystem under the project, documented with georeferenced maps and coordinates. Project holders shall account for potential dynamic changes in the boundary caused by natural processes such as sea-level rise, erosion, accretion, or hydrological shifts, and describe how these are addressed in monitoring.

Projects involving transitional land–sea restoration, such as the reconnection of former aquaculture ponds or polderized areas, are eligible under this methodology. Project holders shall define geographic boundaries and hydrological stages consistent with the progressive restoration process and demonstrate how permanence and carbon accounting are maintained as the ecosystem transitions toward natural tidal conditions. The technical approach adopted shall be documented in the Project Document and assessed through the BIOCARBON Permanence and Risk Tool.

For eligibility and baseline credibility, project holders shall present a documented historical analysis of ecosystem extent and condition covering a minimum reference period of 10 years prior to the project start date. The analysis shall demonstrate historical trends in land or seascape dynamics, degradation processes, or conversion pressures relevant to the baseline scenario.

Data sources (e.g., official datasets, remote sensing time series, or peer-reviewed studies) and analytical methods shall be described in detail, ensuring consistency with the BIOCARBON Baseline and Additionality Tool.

This requirement supports eligibility under Section 5 and the credibility of the baseline scenario.

9.2 Temporal boundaries

The project start date shall be the date on which the first physical activity related to the conservation, restoration, or management of the Blue Carbon ecosystem is implemented. The quantification period shall be a maximum of twenty (20) years, renewable once for a total maximum project length of forty (40) years.

9.3 Carbon pools and GHGs

The following carbon pools and GHGs shall be considered within the project boundary:

- (a) Mandatory pools: aboveground biomass, belowground biomass, and soil organic carbon (SOC).
- (b) Optional pools: dead wood and litter, were significant.

- (c) Mandatory gas: CO₂.
- (d) Non-CO₂ gases: CH₄ and N₂O shall be included where they are significant, as determined in accordance with the 2006 IPCC Guidelines and the 2013 Wetlands Supplement.

10 Project activities

10.1 Description of activities

Project activities shall consist of interventions designed to conserve, restore, or sustainably manage Blue Carbon ecosystems, including mangroves, tidal marshes, and seagrass meadows.

For the purpose of this methodology, the term Blue Carbon ecosystems refer to coastal and marine ecosystems that are highly effective at sequestering and storing carbon in both biomass and soils. These ecosystems include mangroves, tidal marshes, and seagrass meadows, each defined below. Together, they represent the primary scope of this methodology and are recognized by the IPCC Wetlands Supplement (2013) and the Ramsar Convention (1987) as critical ecosystems for climate change mitigation, adaptation, and biodiversity conservation.

The Project Document shall describe in detail the type, location, and implementation plan of the activities, including the stakeholders involved and the expected impacts on greenhouse gas (GHG) emissions and removals.

10.2 Eligible activities

The following activities are eligible under this methodology:

- (a) Conservation of existing ecosystems under threat of degradation or conversion (e.g., preventing drainage of tidal marshes, restricting unsustainable logging in mangroves, avoiding loss of cover, or avoiding conversion of seagrass meadows to aquaculture);
- (b) Restoration, including:
 - i) Hydrological restoration, such as breaching dikes, removing barriers, or re-establishing tidal exchange to degraded wetlands,
 - ii) Revegetation and replanting of mangroves, marsh grasses, or seagrass meadows with appropriate native species,
 - iii) Sediment management where necessary to promote natural recolonization and stability.

- (c) Sustainable management, including practices that maintain or enhance long-term carbon storage, ecosystem health, and resilience, such as community-based harvesting of mangrove wood under sustainable limits, rotational closures of fishing grounds, or regulated grazing in salt marshes.

10.3 Excluded activities

The following activities are not eligible:

- (a) Conversion of wetlands or coastal areas to aquaculture, agriculture, or infrastructure;
- (b) Introduction or promotion of alien or invasive species, including native species that become invasive under altered ecological conditions;
- (c) Large-scale dredging, drainage, or activities that permanently reduce the capacity of the ecosystem to accumulate or store carbon.
- (d) Activities required by law or regulation that do not demonstrate additionality, that is, activities that would occur in any case to comply with a legal mandate, without generating additional GHG emission reductions or removals attributable to the project.

11 Analysis of drivers and agents

11.1 Requirement to identify drivers and agents

Project holders shall identify and analyze the direct and underlying drivers of degradation or loss in Blue Carbon ecosystems, as well as the agents responsible. This analysis shall provide the technical basis for the baseline scenario, additionality demonstration, and the assessment of leakage risks.

11.2 Direct drivers of degradation and loss

The following are common direct drivers affecting mangroves, tidal marshes, and seagrass meadows:

- (a) Conversion to aquaculture (e.g., shrimp or fishponds);
- (b) Agricultural expansion in coastal lowlands and drained wetlands;
- (c) Urbanization and infrastructure development, including ports, roads, tourism facilities, and industrial sites;

- (d) Hydrological alterations, such as diking, canalization, or drainage that restricts tidal flow and sediment deposition;
- (e) Overharvesting of wood and other resources from mangroves and marshes for fuel, charcoal, or construction;
- (f) Coastal erosion and sediment extraction (e.g., sand mining) leading to loss of soil organic carbon (SOC);
- (g) Pollution and eutrophication, especially nutrient loading from upstream agriculture and untreated wastewater;
- (h) Boat propeller scarring and dredging that damage seagrass meadows.

11.3 Underlying drivers

Underlying drivers that intensify pressures include:

- (a) Population growth in coastal areas;
- (b) Economic demand for aquaculture products and coastal land;
- (c) Weak enforcement of environmental regulations;
- (d) Lack of alternative livelihoods for coastal communities;
- (e) Climate change impacts, including sea-level rise and extreme weather events;

11.4 Agents responsible

The main agents associated with these drivers include:

- (a) Aquaculture operators (industrial and small-scale);
- (b) Agricultural producers extending into coastal wetlands.;
- (c) Developers and infrastructure companies (ports, tourism, urban expansion);
- (d) Local communities engaging in subsistence or commercial harvesting of mangrove wood, fish, and other resources;
- (e) Government or municipal authorities promoting drainage, land reclamation, or development in coastal areas.

11.5 Documentation

The Project Document shall:

- (a) Provide evidence (maps, satellite imagery, field surveys, literature, or government data) of the presence and impacts of drivers and agents;
- (b) Describe how these drivers and agents influence the baseline scenario and may contribute to leakage outside the project boundary;
- (c) Explain the extent to which project activities address or mitigate each driver.

12 Quantification of GHG emission reduction from Blue Carbon activities

Quantification shall be conservative, transparent, and based on recognized scientific methods. All relevant carbon pools and GHGs identified in Section 9.3 shall be included, and the same pools and gases shall be accounted for in both baseline and project scenarios to ensure consistency and prevent overestimation.

12.1 Activity data

Activity data represent the quantitative extent of human or natural activities that cause GHG emissions or removals. In Blue Carbon projects, activity data shall include measurable changes in the extent, condition, or management of mangroves, tidal marshes, and seagrass meadows.

Acceptable forms of activity data include, but are not limited to:

- (a) Ecosystem area changes: hectares of ecosystem lost, conserved, or restored;
- (b) Restoration and management interventions: hectares replanted, hydrological barriers removed, tidal flows restored;
- (c) Condition indicators: canopy cover, vegetation density, seagrass shoot density;
- (d) Hydrological parameters: water level, salinity, inundation frequency;
- (e) Disturbance records: area affected by aquaculture conversion, erosion, storm damage, or unsustainable harvesting.

Activity data shall be derived from verifiable sources, including:

- (a) Remote sensing (satellite imagery such as Landsat, Sentinel, or Planet; aerial photography; drones, etc.);
- (b) GIS-based land cover and land use change analysis;
- (c) Field surveys (vegetation plots, soil sampling, hydrological monitoring);

- (d) Official records (permits, land tenure, management agreements);
- (e) Participatory and community monitoring systems.

All activity data shall be:

- (a) Georeferenced and documented in the Project Document;
- (b) Monitored consistently during each monitoring period;
- (c) Cross-checked with emission factors to calculate baseline and project emissions in accordance with IPCC 2006 Guidelines, the 2013 Wetlands Supplement, and the 2019 Refinement.

12.2 Stratification of the project area

The project area shall be stratified into relatively homogeneous units prior to quantification of greenhouse gas (GHG) emission reductions and removals. Stratification is a mandatory step to reduce sampling error, improve precision, and ensure representativeness of sampling efforts in accordance with IPCC Good Practice Guidance (IPCC, 2006; IPCC, 2013 Wetlands Supplement; IPCC, 2019 Refinement).

Each stratum shall be defined based on measurable and verifiable characteristics, which may include but are not limited to:

- (a) Ecosystem type: mangroves, tidal marshes, or seagrass meadows;
- (b) Biophysical characteristics: soil type (mineral or organic), salinity regime, hydrological conditions, geomorphological setting (deltaic, estuarine, lagoonal);
- (c) Vegetation condition: intact, degraded, or restored;
- (d) Management and disturbance history: conservation status, restoration activities, aquaculture conversion, harvesting intensity, or pollution levels.

12.2.1 Mapping and documentation

Strata shall be delineated using georeferenced maps, GIS analysis, and remote sensing data (satellite imagery, aerial photography, or other). Each stratum shall be clearly documented in the Project Document, including:

- (a) Boundary coordinates (latitude/longitude);
- (b) Area (hectares);

- (c) Stratification criteria applied;
- (d) Supporting spatial data sources and resolution.

When feasible, project holders are encouraged to report an accuracy assessment of land-use or land-cover classifications used for stratification (e.g., overall accuracy, confidence intervals $\geq 70\%$, or root mean square error – RMSE). This practice enhances transparency, comparability, and consistency with field sampling precision requirements established in Section 12.3.

12.3 Sampling design

Sampling for biomass, soil organic carbon (SOC), and non-CO₂ gases shall be allocated by stratum, following stratified random or systematic designs. Sampling intensity shall be proportional to the variability and the area of each stratum.

Higher variability strata (e.g., heterogeneous mangrove stands or areas with recent disturbance) require greater sampling effort to achieve the same confidence level as more homogeneous strata.

Minimum requirements include:

- (a) Stratification documented prior to field sampling;
- (b) At least 3 permanent sampling plots per stratum for biomass and vegetation parameters;
- (c) At least 3 soil cores per stratum for SOC estimates to 1 m depth, unless local regulations or IPCC guidance require deeper sampling;
- (d) Justification for sample size, with reference to statistical power and uncertainty assessment (Section 15).

The minimum requirement of three (3) permanent sampling plots per stratum for biomass and vegetation parameters, and three (3) soil cores per stratum for SOC estimates, is established to ensure long-term traceability and the ability to detect temporal changes in carbon stocks. These permanent plots and cores are additional to the temporary or rotating sampling plots that may be required to capture spatial variability within each stratum. Project holders shall design their sampling plans in accordance with statistical best practices and IPCC guidance, ensuring that both spatial representativeness (via temporary plots) and temporal consistency (via permanent plots) are adequately addressed.

To ensure the accuracy and reliability of the estimated emission factors, the sampling precision shall meet the following minimum requirement:

- ▲ A relative precision of $\pm 10\%$ at a 90% confidence level, calculated across the full population or stratum.

If this level of precision is not achievable due to practical limitations (e.g., access, cost, terrain), the project holders shall apply conservative emission factors and transparently document the reasons and implications.

Note: The target precision of $\pm 10\%$ at a 90% confidence level is mandatory under the BIOCARBON STANDARD and consistent with the ICVCM Core Carbon Principles (CCP 6.3 – Measurement, Monitoring and Data Quality). In cases where small strata, fragmented areas, or island contexts (SIDS) prevent achieving this target, project holders may apply adaptive or multi-stage sampling designs to improve representativeness. Any remaining uncertainty shall be transparently reported and addressed through conservative deduction as defined in Section 15.

12.4 Emission factors

The project holders may determine emission factors using data derived from field sampling plots or adopt regionally appropriate values from national or international sources, provided they are conservative and scientifically robust.

12.4.1 Field-Based estimation of emission factors

When emission factors are derived from sampling plots, the project holders shall follow the sampling requirements described by the Intergovernmental Panel on Climate Change (IPCC, 2006) Guidelines and subsequent refinements), including:

- (a) Sampling approach (e.g., random, stratified, or systematic sampling);
- (b) Sampling design parameters (e.g., plot size, shape, number, and distribution);
- (c) Sampling methods for area estimation (e.g., stratified random sampling using remote sensing data, area-weighted estimators);
- (d) Sampling methods for estimating emissions and removals of greenhouse gases;
- (e) Quantification and management of uncertainties in sample-based surveys.

Field data shall be collected in a manner that is statistically representative, independently verifiable, and spatially consistent with the strata or land classes used in the emission reduction estimates.

12.4.2 Use of published or default values

Where direct sampling is not feasible or data gaps exist, the project holders may use:

- (a) National emission factors published by the host country (e.g., in GHG inventories, NDCs, REDD+ FRELs), if consistent with IPCC Tiers 2 or 3 (2019);
- (b) Regionally relevant peer-reviewed literature or forest inventory databases;
- (c) IPCC 2019 default values (Tier 1) only if justified as conservative and no higher-tier data are available.

The selected emission factors shall:

- (a) Be consistent with the forest strata or land cover classes defined in the project;
- (b) Reflect the appropriate biomass components (e.g., aboveground, belowground, deadwood);
- (c) Be expressed in tCO₂e per hectare using applicable conversion factors and root-to-shoot ratios, as per IPCC 2019 guidance.

12.4.3 Documentation and validation

All emission factor sources, methodologies, assumptions, and calculations shall be:

- (a) Clearly described in the Project Document,
- (b) Supported by traceable datasets (field forms, calibration methods, equations, etc.), and
- (c) Subject to validation by an independent third party.

The uncertainty associated with emission factors shall be incorporated into the overall project uncertainty assessment as required under Section 15.

12.5 Spatial modelling criteria for baseline construction

- (a) Reference areas shall be representative of the biophysical conditions and of the drivers of degradation or conversion observed within the project area. Selection shall be based on explicit similarity criteria (ecosystem type, hydrological regime, salinity, tidal and wave exposure, accessibility, and anthropogenic pressures). Delineation and documentation shall rely on reproducible geospatial inputs consistent with the stratification and mapping requirements described in Sections 12.2 and 12.2.1,

including coordinates, data sources, and dates.

- (b) Official datasets and land, or seascape time-series from national or regional authorities shall be prioritized, complemented, when necessary, by peer-reviewed literature or other technically robust sources. All datasets shall include metadata and version control (date, spatial/temporal resolution, classification method) and be consistent with the BIOCARBON Baseline and Additionality Tool.
- (c) Ecosystem loss, degradation, or conversion dynamics shall be estimated using change-detection or transition-modelling techniques (e.g., classified time-series, transition matrices, trend analyses, and, where applicable, coastal hydrodynamic or geomorphological inputs). All assumptions, parameters, and validation procedures (e.g., accuracy assessment or performance metrics) shall be documented, and uncertainties quantified in accordance with Annex 3 – Guidance for the Assessment of Uncertainty.
- (d) The ex-ante baseline scenario shall provide spatially explicit maps and annualized or period-specific descriptions of the expected baseline trajectory. The ex-post monitoring shall apply the same methodology and resolution to ensure comparability. Any substantial divergence between ex-ante projections and ex-post observations shall be justified and, where relevant, trigger the revision procedures defined by the BIOCARBON STANDARD.
- (e) The modelling shall account for coastal processes (sea-level rise, erosion, accretion, subsidence) and describe how these are addressed within geographic boundaries and monitoring procedures, in coherence with Section 9.1 and mapping requirements in 12.2.1.
- (f) All spatial inputs (layers, scripts, parameters, processing workflows) shall be archived and remain reproducible for independent verification, consistent with the BIOCARBON MRV and Uncertainty Tools (Annexes 2 and 3 of this methodology).

12.6 Baseline emissions

Baseline emissions shall represent the expected loss of carbon stocks and associated GHG emissions in the absence of the project. Sources include:

- (a) Conversion of ecosystems to aquaculture, agriculture, or infrastructure;
- (b) Drainage or hydrological alteration of wetlands;
- (c) Ongoing unsustainable extraction of biomass;

(d) Coastal erosion or sediment removal.

The baseline emissions shall be calculated according to the Equation 1.

$$BE_y = \sum_{m=1}^M \sum_{i=1}^I \left(\Delta C_{i,m,BE,y} \times \frac{44}{12} \right) + \sum_{m=1}^M (E_{CH_4,m,BE,y} \times GWP_{CH_4}) + \sum_{m=1}^M (E_{N_2O,m,BE,y} \times GWP_{N_2O})$$

Equation 1

Where:

BE_y	=	Baseline emissions in year y; tCO ₂ e
$\Delta C_{i,m,BE,y}$	=	Change in carbon stock in pool i, for stratum m, under baseline; tC
$\frac{44}{12}$	=	Molecular weight ratio (C:CO ₂)
$E_{CH_4,BE,y}$	=	Baseline methane emissions; tCO ₂ e
GWP_{CH_4}	=	Global warming potential for CH ₄ ; dimensionless
$E_{N_2O,BE,y}$	=	Baseline nitrous oxide emissions; tCO ₂ e
GWP_{N_2O}	=	Global warming potential for N ₂ O; dimensionless
i, \dots, I	=	Carbon pool; dimensionless
m, \dots, M	=	Stratum; dimensionless
y	=	year

Where default emission factors are used, project holders shall apply those provided in Annex 1.

12.7 Project emissions

Project emissions include GHG releases resulting from project implementation, such as:

- (a) Biomass burning during site preparation;
- (b) Emissions from fuel use (transport, restoration);
- (c) Residual CH₄ and N₂O from restored wetlands (where significant).

The project emissions shall be calculated according to the Equation 2.

Equation 2

$$PE_y = \sum_{m=1}^M \sum_{i=1}^I \left(\Delta C_{i,m,PE,y} \times \frac{44}{12} \right) + \sum_{m=1}^M (E_{CH_4,m,PE,y} \times GWP_{CH_4}) + \sum_{m=1}^M (E_{N_2O,m,PE,y} \times GWP_{N_2O}) + \sum_{m=1}^M (E_{FF,m,PE,y})$$

Where:

PE_y	=	Project emissions in year y; tCO ₂ e
$\Delta C_{i,m,PE,y}$	=	Change in carbon stock in pool i, for stratum m, under project scenario in year y; tC
$\frac{44}{12}$		Molecular weight ratio (C:CO ₂); dimensionless
$E_{CH_4,m,PE,y}$		Project emissions of methane, in stratum m, in year y; tCH ₄
GWP_{CH_4}	=	Global warming potential for CH ₄ ; dimensionless
$E_{N_2O,m,PE,y}$	=	Project emissions of nitrous oxide, in stratum m, in year y; tN ₂ O
GWP_{N_2O}	=	Global warming potential for N ₂ O; dimensionless
$E_{FF,m,PE,y}$		Fossil fuel emissions, in stratum m, in year y; tCO ₂ e
i, \dots, I	=	Carbon pool; dimensionless
m, \dots, M	=	Stratum; dimensionless

12.8 Carbon stock changes

Carbon stock changes represent the difference in carbon stored in selected pools between the baseline and project scenarios. In Blue Carbon ecosystems, the most relevant pools are aboveground biomass (AGB), belowground biomass (BGB), and soil organic carbon (SOC). Dead wood and litter may also be included were significant and measurable.

For the purposes of this methodology, all carbon pools shall be estimated on a stratum basis, following the stratification requirements set out in Section 12.2. Within each stratum, carbon stock values shall be expressed as mean values per unit area (tC/ha), derived from statistically representative field sampling and laboratory analysis in accordance with IPCC 2006 Guidelines, the 2013 Wetlands Supplement, and the 2019 Refinement.

Changes in carbon stocks (ΔC) shall be calculated as the difference between mean carbon stocks at monitoring time t and at baseline (t_0), multiplied by the area of the stratum and,

where relevant, by the sampling depth (e.g., SOC). Total project-level carbon stock changes shall then be obtained as the area-weighted sum of all strata.

12.8.1 Aboveground and belowground biomass (mangroves and marshes)

Changes in biomass shall be calculated according to the Equation 3:

$$\Delta C_{B,y} = \left(\sum_{m=1}^M A_m \times (C_{B,m,t} - C_{B,m,0}) \right) \times \frac{44}{12}$$

Equation 3

Where:

$\Delta C_{B,y}$	=	Total carbon stock change in aboveground and belowground biomass, for stratum m , in year y ; tCO ₂ e
A_m	=	Stratum area; ha
$C_{B,m,t}$	=	Mean value of aboveground (AGB) and belowground (BGB) biomass carbon stock in stratum m at time t ; tC/ha
$C_{B,m,0}$	=	Mean value of aboveground (AGB) and belowground (BGB) biomass carbon stock in stratum m at time 0 ; tC/ha
$\frac{44}{12}$	=	Molecular weight ratio (C:CO ₂); dimensionless
m, \dots, M	=	Stratum; dimensionless

For the purpose of this methodology, $C_{B,m,t}$ shall represent the mean carbon stock per unit area (tC/ha) in stratum m at time t . The mean value shall be derived from field sampling (permanent or temporary plots) or equivalent verified data sources and shall be statistically representative of the stratum. Using mean values, rather than individual plot measurements, ensures consistency with IPCC Good Practice Guidance (IPCC 2006, Vol. 4; IPCC 2013 Wetlands Supplement; IPCC 2019 Refinement), improves representativeness, and prevents bias from atypical or extreme measurements.

12.8.2 Soil organic carbon (SOC) in sediments

SOC is the dominant pool in Blue Carbon ecosystems. Stock changes shall be calculated as:

$$\Delta C_{SOC,m,y} = \sum_{m=1}^M (SOC_{m,t} - SOC_{m,0}) \times A_m \times D \times \frac{44}{12} \quad \text{Equation 4}$$

Where:

- $\Delta C_{SOC,m,y}$ = Change in soil organic carbon stock in stratum m , year y ; tC
- $SOC_{m,t}$ = Mean value of SOC stock in stratum m at time t ; tC/ha
- $SOC_{m,0}$ = Mean value of SOC stock in stratum m at baseline ($t=0$); tC/ha
- A_m = Area of stratum m
- D = Depth of sampling (m), minimum 1 m (IPCC Wetlands Supplement, 2013).
- $\frac{44}{12}$ = Molecular weight ratio (C:CO₂); dimensionless
- m, \dots, M = Stratum; dimensionless

For the purpose of this methodology, soil organic carbon (SOC) shall be quantified separately for each stratum. $SOC_{m,t}$ and $SOC_{m,0}$ shall represent the mean value of SOC per unit area (tC/ha) in stratum m at time t and at baseline respectively, derived from soil core sampling, bulk density, and carbon fraction analysis, in accordance with IPCC (2006 Guidelines; 2013 Wetlands Supplement; 2019 Refinement).

The sampling depth (D) shall be at least 1 m unless otherwise justified by local soil conditions or regulations. Total project SOC change ($\Delta C_{SOC,y}$) shall be calculated as the area-weighted sum of changes across all strata.

SOC shall be monitored using stratified random sampling, with bulk density and carbon fraction measured in laboratory following standardized protocols.

12.8.3 Dead wood and litter

Dead wood and litter pools are considered optional in this methodology. Where included, they shall be quantified separately for each stratum, consistent with IPCC (2006 Guidelines, Vol. 4, Ch. 2; 2019 Refinement). $DW_{m,t}$, $DW_{m,0}$, $L_{m,t}$ and $L_{m,0}$ shall represent the mean carbon stock per unit area (tC/ha) for dead wood and litter in stratum m at time t and at baseline, respectively. Total project-level changes in dead wood and litter ($\Delta C_{DW+L,y}$) shall be calculated as the area-weighted sum of stratum-level changes. Where project holders exclude these

pools, exclusion shall be justified and shown to be conservative in accordance with Section 8.1.

Changes in dead wood and litter carbon stocks shall be calculated using Equation 5.

$$\Delta C_{DW+L,y} = \left(\sum_{m=1}^M A_m \times (DW_{m,t} + L_{m,t}) - (DW_{m,0} + L_{m,0}) \right) \times \frac{44}{12} \quad \text{Equation 5}$$

Where:

$\Delta C_{DW+L,y}$	=	Total carbon stock change in dead wood and litter, for stratum m , in year y ; tCO _{2e}
A_m	=	Stratum area; ha
$C_{DW,m,t}$	=	Mean value of dead wood carbon stock in stratum m at time t ; tC/ha
$C_{DW,m,0}$	=	Mean value of dead wood carbon stock in stratum m in baseline; tC/ha
$L_{m,t}$	=	Mean value of litter carbon stock in stratum m at time t ; tC/ha
$L_{m,0}$	=	Mean value of litter carbon stock in stratum m in baseline; tC/ha
$\frac{44}{12}$	=	Molecular weight ratio (C:CO ₂); dimensionless
m, \dots, M	=	Stratum; dimensionless

12.9 Non-CO₂ gases

Emissions of methane (CH₄) and nitrous oxide (N₂O) shall be quantified at the stratum level, since emission factors depend on ecosystem conditions such as salinity, hydrological regime, and nutrient inputs. Project holders shall use emission factors consistent with IPCC 2006 Guidelines, the 2013 Wetlands Supplement, and the 2019 Refinement, or more specific peer-reviewed or nationally approved data where available.

12.9.1 Methane (CH₄)

For drained or flooded soils, CH₄ fluxes shall be estimated as:

$$E_{CH_4,y} = \sum_{m=1}^M EF_{CH_4,m} \times A_m \times GWP_{CH_4} \quad \text{Equation 6}$$

Where:

- $E_{CH_4,y}$ = CH₄ emissions in the stratum m, in the year y; tCO_{2e}
- EF_{CH_4} = Emission factor for methane (kg CH₄/ha/year) from IPCC Wetlands Supplement (2013)
- A_m = Stratum area; ha
- GWP_{CH_4} = Global warming potential of methane (28, AR5 or updated value).

12.9.2 Nitrous oxide (N₂O)

Nitrous oxide (N₂O) emissions shall be estimated at the stratum level. Project holders shall apply one of the following approaches, depending on ecosystem conditions and data availability.

12.9.2.1 General default factor approach (Tier 1)

The N₂O emissions shall be estimated as:

$$E_{N_2O,m,y} = \sum_{m=1}^M EF_{N_2O,m} \times A_m \times GWP_{N_2O} \quad \text{Equation 7}$$

Where:

- $E_{N_2O,m,y}$ = N₂O emissions in the stratum m, in the year y; tCO_{2e}
- EF_{N_2O} = Default emission factor for nitrous oxide (kgN₂O/ha/year) from IPCC Wetlands Supplement (2013)
- A_m = Stratum area; ha
- GWP_{CH_4} = Global warming potential of nitrous oxide

12.9.2.2 Fertilization (managed input) approach

For fertilized or managed wetlands:

$$E_{N_2O,y} = \sum_{m=1}^M (EF_{N_2O} \times N_{input,m} \times 44/28) \times GWP_{N_2O} \quad \text{Equation 8}$$

Where:

- $E_{N_2O,y}$ = N₂O emissions in the stratum m, in the year y; tCO₂e
- EF_{N_2O} = Emission factor for N₂O; kg N₂O-N/kg N input
- $N_{input,m}$ = Nitrogen input per stratum; kg N/ha
- 44/28 = Molecular weight conversion from N-to-N₂O
- GWP_{N_2O} = Global warming potential of N₂O

12.10 Net GHG emission reductions and removals

Net GHG emission reductions and removals shall be calculated as:

$$ER_y = (BE_y - PE_y) - Lk_y \pm U_y \quad \text{Equation 9}$$

Where:

- ER_y = Net emission reductions and removals in year y; tCO₂e
- BE_y = Baseline emissions in year y; tCO₂e
- PE_y = Project emissions in year y; tCO₂e
- Lk_y = Leakage emissions in year y; tCO₂e
- U_y = Uncertainty deduction (tCO₂e), as per the BioCarbon Uncertainty Tool

Note: If the Project holders report results by stratum, they shall compute BE_y and PE_y using the stratified forms (area-weighted sums), then plug the aggregated values into the equation above.

12.11 Data, parameters, and quality assurance

All data and parameters shall be documented in the Project Document and default values may be used only when site-specific data are not available and shall follow IPCC 2006/2013/2019.

Quality assurance and control (QA/QC) procedures shall follow ISO 14064-2 (2019) and BIOCARBON MRV Tool.

Examples of parameter documentation tables are provided in Annex 3.

13 Leakage management

13.1 General requirements

Project holders shall identify and quantify, where significant, greenhouse gas (GHG) emissions that occur outside the project boundary as a result of project activities. Such emissions, referred to as leakage, shall be accounted for to ensure the environmental integrity of the Verified Carbon Credits (VCCs) issued under the BIOCARBON STANDARD.

13.1.1 Identification of potential leakage areas

Leakage areas shall be identified through spatial analysis of land- or seascape activities that could be indirectly affected by project implementation, such as displacement of biomass extraction, land-use conversion, or changes in management practices. These areas may include adjacent ecosystems, supply zones, or other locations where project activities could cause measurable increases in GHG emissions or decreases in removals outside the project boundary.

13.1.2 Ex-ante assessment

An ex-ante estimation of leakage shall be conducted prior to project validation. The assessment shall describe the expected drivers, magnitude, and spatial distribution of potential leakages, and shall provide a conservative quantification of anticipated emissions based on available baseline data or proxy indicators. The methodological approach and assumptions applied shall be transparently documented to allow verification.

13.1.3 Ex-post monitoring and verification

During each monitoring period, project holders shall verify the occurrence or absence of leakage using the same parameters, datasets, and spatial resolution applied in the ex-ante analysis. Any observed displacement of activities or emissions shall be quantified using a transparent and conservative approach consistent with this methodology and deducted from the verified GHG removals or emission reductions to ensure environmental integrity.

13.1.4 Consistency and transparency

All assumptions, data sources, and methods used for ex-ante and ex-post leakage assessment shall be documented in the Project Document and Monitoring Report. The procedures shall ensure transparency, reproducibility, and consistency with the BIOCARBON MRV and Uncertainty Tools.

13.1.5 No cross-methodological substitution

Leakage quantification under this methodology shall not rely on or reference other BIOCARBON methodologies (e.g., BCR001, BCR002, BCR004). Only the official BIOCARBON Tools listed in Section 6.2 may be used.

13.2 Sources of leakage in Blue Carbon ecosystems

Potential sources of leakage include, but are not limited to:

- (a) Displacement of aquaculture or agriculture: establishment or expansion of ponds, crops, or grazing areas in nearby coastal or wetland ecosystems as a result of project restrictions;
- (b) Fuelwood and timber extraction: increased harvesting in adjacent mangrove or coastal forests when access to project areas is restricted;
- (c) Fishing and resource use: increased pressure on neighboring areas due to restrictions on fishing, crab harvesting, or other extractive practices within the project boundary;
- (d) Infrastructure development: relocation of roads, drainage canals, or coastal works to nearby zones outside the project boundary.

13.3 Identification and monitoring of leakage areas

The project holders shall identify zones outside the project boundary where leakage risk is likely to occur, based on the mobility and behavior of the agents identified in the baseline scenario.

Such zones shall be georeferenced and described in the Project Document.

Monitoring shall include activity data and emissions from these areas using consistent methods applied to the project area, in line with IPCC 2006 Guidelines and the 2013 Wetlands Supplement.

13.4 Quantification of leakage emissions

Where leakage is significant, emissions shall be quantified using activity data, emission factors, and methodologies consistent with the treatment of the project area.

In cases where direct quantification is not feasible, the project holders shall apply a conservative deduction factor from the project's net GHG benefits.

Default deduction factors or conservative assumptions may be used if approved under the BIOCARBON STANDARD.

13.5 Mitigation of leakage

Project holders shall describe and implement measures to minimize leakage, which may include:

- (a) Supporting alternative livelihoods for communities previously dependent on mangrove fuelwood or aquaculture;
- (b) Establishing agreements with local stakeholders to prevent displacement of unsustainable practices;
- (c) Promoting sustainable use of coastal resources in adjacent areas.

13.6 Deduction from net emission reductions

All identified and quantified leakage emissions shall be deducted from the gross project benefits to determine the net GHG emission reductions and removals eligible for credit issuance.

13.6.1 Decision framework and conservative deductions

The BIOCARBON Leakage Tool provides a structured decision framework for identifying, assessing, and quantifying leakage. Project holders shall use this Tool to determine whether direct quantification is feasible and, where it is not, to apply conservative default deductions in a consistent manner. The Tool includes illustrative scenarios such as aquaculture displacement, fuelwood extraction, and shifts in fishing pressure, which support the transparent and conservative treatment of leakage across projects.

14 Permanence and reversal risk management

Ensuring the long-term permanence of GHG emission reductions and removals is critical in Blue Carbon projects, where carbon stored in biomass and soils remains vulnerable to reversal

due to human and natural risks. Project holders shall identify and assess all potential reversal risks, including coastal erosion, sea-level rise, extreme storms, hydrological alteration, illegal conversion to aquaculture or agriculture, land tenure insecurity, and institutional instability, throughout the quantification period and beyond.

14.1 Definition and scope of reversal

Project holders shall assess, mitigate, and manage the risk of reversal of GHG benefits generated through Blue Carbon activities. They shall ensure that all credited climate benefits are real, long-term, and durable.

A reversal refers to any intentional or unintentional event that results in the release of previously stored greenhouse gases (GHGs) or the loss of credited GHG emission reductions or removals. This may include:

- (a) Natural disturbances such as storms, flooding, erosion, or fires;
- (b) Human-induced degradation or conversion of restored or conserved ecosystems;
- (c) Policy or legal changes that compromise the protection of coastal ecosystems or carbon stock integrity;
- (d) Failure of long-term management or protection measures leading to renewed emissions, or project abandonment.

Due to their nature, Blue Carbon ecosystems are inherently exposed to both climatic and anthropogenic permanence risks that shall be systematically addressed throughout the quantification period and beyond.

14.2 Measures to enhance permanence

Project design and implementation shall include elements that strengthen the permanence of emission reductions and removals, such as:

- (a) Legal protection of the area (e.g., conservation easements, customary tenure recognition, community agreements);
- (b) Integration into jurisdictional or long-term coastal ecosystem governance frameworks;
- (c) Participatory forest monitoring and adaptive management practices;
- (d) Transparent benefit-sharing and full engagement of local and Indigenous communities;

- (e) Coastal defense, erosion control, and hydrological restoration to maintain ecosystem resilience;
- (f) Risk reduction strategies against extreme weather events and sea-level rise.

These measures shall be documented in the Project Document and assessed during validation and verification.

14.2.1 Benefit-sharing and governance integration

For guidance purposes, project holders may document transparent benefit-sharing and governance integration using optional indicators such as:

- (a) Percentage of project revenues allocated to local communities or conservation funds;
- (b) Number or type of formal agreements signed with local or regional institutions;
- (c) Implementation of measurable coastal defense or risk reduction measures (e.g., mangrove restoration, sediment stabilization, flood barriers);
- (d) Periodic disclosure of benefit-sharing outcomes or governance participation mechanisms.

These examples are illustrative and not mandatory. The documentation, monitoring, and verification of such social, economic, and environmental benefits shall be conducted in accordance with the BIOCARBON Sustainable Development Safeguards Tool (SDSs Tool), which provides the operational framework and indicators to ensure transparency, consistency, and traceability of benefit-sharing and governance outcomes.

14.3 Permanence and risk management tool

Project holders shall apply the BIOCARBON Permanence and Risk Management Tool to:

- (a) Evaluate the risk of reversal;
- (b) Assign a risk score using a structured methodology; and
- (c) Determine the required contribution to the BIOCARBON Reserve.

The tool includes a risk-weighted scoring system based on five categories:

The tool includes a risk-weighted scoring system based on five categories: ecological, natural disturbance, socio-economic, legal/policy, and management risks. Each category is scored on a 1 to 5 scale based on predefined criteria and guiding questions. The final score corresponds

to a reserve contribution of 10%, 20%, or 30% of the total verified emission reductions and removals. This amount is deducted prior to credit issuance.

Projects implementing planned shoreline migration or managed retreat as an adaptive strategy to sea-level rise remain eligible under this methodology, provided that governance, monitoring continuity, and carbon accounting are maintained throughout the process. Any carbon stock losses associated with managed retreat shall be transparently reported and managed within the framework of the BIOCARBON Permanence and Risk Tool, in coordination with the BIOCARBON STANDARD, to ensure that permanence obligations are maintained throughout the transition.

14.4 Risk assessment and monitoring requirements

Project holders shall:

- (a) Complete the full risk assessment as defined in Annex 1 of the BIOCARBON Tool;
- (b) Provide clear and auditable justification for each assigned score;
- (c) Update the risk assessment at each verification period;
- (d) Report any reversal events and classify them as avoidable or unavoidable in accordance with Section 4.1 of the tool.

In the event of a reversal:

- (a) The corresponding volume of credits shall be retired from the BIOCARBON Reserve;
- (b) For avoidable reversals, corrective actions and/or additional reserve contributions may be required.

15 Uncertainty assessment and conservative adjustment

Project holders shall assess and manage uncertainty in the quantification of GHG emission reductions and removals from Blue Carbon activities in accordance with the BIOCARBON Tool: Conservative Approach and Uncertainty Management. The application of this tool is mandatory for all Blue Carbon projects.

This requirement ensures that all Verified Carbon Credits (VCCs) issued under this methodology are based on transparent, conservative, and verifiable assumptions, in full alignment with IPCC good practice guidance and the integrity safeguards of the BIOCARBON STANDARD.

The tool applies to all relevant parameters that significantly influence the quantification of both baseline and project emissions or removals, including:

- (a) Activity data (e.g., area of mangrove, tidal marsh, or seagrass loss or restoration measured through remote sensing or field mapping);
- (b) Emission or removal factors (e.g., biomass carbon density, soil organic carbon stocks, CH₄ and N₂O emission factors under different salinity or hydrological conditions);
- (c) Sampling and measurement systems, including remote sensing, soil coring, and biomass plots;
- (d) Modeling assumptions, proxies, or expert judgment, where applied.

Project holders shall calculate combined uncertainty using one of the following approaches:

- ▲ Tier 1: Error propagation method (deterministic);
- ▲ Tier 2: Probabilistic method (e.g., Monte Carlo simulation), where applicable and supported by the data.

Where data availability and computational resources allow, project holders are encouraged to apply Tier 2 uncertainty assessment methods (e.g., Monte Carlo simulations or equivalent approaches) to better characterize combined uncertainties and confidence intervals. This enhances consistency with the IPCC 2019 Refinement and strengthens the robustness of project-level GHG estimates.

15.1 Required confidence level and adjustment rule

Uncertainty shall be expressed as a two-sided 90% confidence interval. The relative half-width of this interval shall determine the need for a conservative adjustment to the net emission reductions and removals:

- (a) If the relative half-width is $\leq 30\%$, no deduction is applied;
- (b) If the relative half-width exceeds 30%, the excess percentage shall be deducted from the net GHG benefits prior to credit issuance.

15.2 Data quality and discount factors

Where data sources are classified as lower quality (e.g., IPCC Tier 1 defaults, coarse-resolution land cover, global-average SOC values, 2019), project holders shall apply the data quality discount factors specified in Annex D of the BIOCARBON Tool: Conservative Approach and Uncertainty Management.

The highest applicable discount in the estimation chain shall be applied, unless:

- (a) Project-specific data have been used and validated during verification; or
- (b) Input parameters are fully consistent with national GHG inventory data of the host country (e.g., coastal wetlands data reported in FRELs, BURs, or National Inventory Reports).

For guidance purposes, project holders may illustrate the application of data quality adjustment factors through examples, such as combining high-resolution remote sensing data with lower-resolution ancillary datasets or integrating field measurements of varying precision. The adjustment shall remain conservative and consistent with the Uncertainty and MRV Tools of BIOCARBON.

15.3 Documentation and transparency requirements

Project holders shall document all uncertainty analyses and related assumptions in the Project Document and in each Monitoring Report. The documentation shall include, at minimum:

- (a) A parameter-by-parameter uncertainty table, indicating data type (input, model-derived, fixed);
- (b) The selected approach for uncertainty calculation (Tier 1 or Tier 2), including formulas or software used;
- (c) Any conservative adjustments applied to emission reductions and removals;
- (d) Rounding methods and final reported figures;
- (e) Supporting calculation files and spreadsheets enabling full replication by third parties.

Where expert judgment is used to fill data gaps or support assumptions, the elicitation process shall be documented in accordance with Annex G of the BIOCARBON Tool: Conservative Approach and Uncertainty Management.

An example of uncertainty tables and calculation procedures is provided in Annex 3.

15.4 Data management and version control

Project holders are encouraged to maintain digital archives of datasets (e.g., satellite imagery, GIS shapefiles, time-series data) with version control and standardized metadata. This practice enhances data traceability, facilitates independent verification, and aligns with the principles of digital MRV (Measurement, Reporting and Verification) under the BIOCARBON STANDARD.

16 Monitoring requirements

The purpose of the monitoring plan is to define the procedures, data sources, responsibilities, and quality assurance measures required to track the implementation of Blue Carbon activities, verify GHG emission reductions and removals, and ensure compliance with safeguards and permanence requirements throughout the project's quantification period.

16.1 Parameters to be monitored

The project holders shall monitor the following elements, as applicable:

- (a) Changes in ecosystem cover and condition within the project area (e.g., loss or gain of mangroves, marshes, or seagrass meadows);
- (b) Changes in ecosystem condition or cover in potential leakage areas;
- (c) GHG emissions and removals from relevant carbon pools (aboveground biomass, belowground biomass, soil organic carbon, and, where significant, CH₄ and N₂O);
- (d) Implementation progress of project activities (e.g., hydrological restoration, revegetation, sustainable management);
- (e) Compliance with environmental and social safeguards;
- (f) Risks to permanence and effectiveness of mitigation results.

The parameters to be monitored and reported shall be consistent with the requirements of the BIOCARBON MRV Tool and other applicable normative instruments.

Recommended monitoring frequencies and methods are provided in Annex 2.

16.2 Data sources and monitoring methods

The project holders shall describe the data sources, tools, and methods used for each parameter, which may include:

- (a) Remote sensing (satellite imagery, aerial photography, drones) for land and ecosystem cover;
- (b) GIS-based analysis for wetland dynamics, shoreline change, and erosion;
- (c) Field data collection (e.g., biomass plots, soil core sampling, hydrological monitoring);
- (d) Community monitoring, participatory diagnostics, or administrative records (for safeguards and activity implementation).

The same methodological approach, resolution, classification system, and spatial extent used for the baseline scenario shall be applied during monitoring to ensure consistency.

16.3 Monitoring frequency and reporting

Monitoring frequencies presented in this section are indicative and consistent with the BioCarbon MRV Tool. Project holders shall define and document the monitoring frequency for each parameter following the requirements and guidance established in the MRV Tool and the Standard Operating Procedures (SOP). The following intervals are indicative and may be adapted with technical justification, according to the project's specific conditions and data availability:

- (a) Carbon stock measurements. Typically, every 1 to 5 years, depending on ecosystem dynamics and accessibility;
- (b) Activity data and remote sensing assessments. Annually or biennially, consistent with data update cycles;
- (c) Leakage monitoring. At least once per crediting period or as required by the Leakage Tool;
- (d) Permanence and risk parameters. In accordance with the Permanence and Risk Tool requirements;
- (e) Socio-environmental indicators (SDSs/SDGs), as defined in the SDSs and SDGs Tools, or at least once per crediting period.

All monitoring results shall be documented and made available for verification in accordance with the BIOCARBON Validation and Verification Manual (2025e).

16.4 Monitoring of project activities and safeguards

The project holders shall establish and implement a monitoring plan to assess the execution and effectiveness of project activities, as well as to ensure continuous compliance with environmental and social safeguards.

The safeguard monitoring plan shall be aligned with the BIOCARBON Sustainable Development Safeguards Tool (SDSs Tool) and reflect the participatory processes established in the project design. Templates for activity and safeguard monitoring are provided in Annex 4.

The monitoring of safeguards shall be carried out in accordance with the requirements of the SDSs Tool. This tool provides the mandatory indicators, monitoring methods, documentation requirements, and stakeholder engagement processes applicable to each safeguard. The

safeguard monitoring results shall be included in each Monitoring Report and subject to independent verification.

Monitoring results shall also be made available to affected stakeholders upon request.

Each project activity implemented shall have a corresponding set of indicators to track its implementation status and outcomes, including:

- (a) Identification of each activity (Activity ID and description);
- (b) One or more indicators associated with the activity (Indicator ID);
- (c) Definition of target values, measurement units, and expected results;
- (d) Methodology and tools used to monitor the indicator;
- (e) Frequency of data collection and responsible entity;
- (f) Documentation to support the reported results.

16.5 Monitoring of safeguards

The project holders shall monitor the implementation and compliance of safeguards throughout the duration of the project. These include, at a minimum:

- (a) Full and effective participation of stakeholders, including Indigenous Peoples and local communities;
- (b) Respect for land tenure and customary rights;
- (c) Conservation of biodiversity and ecosystem services;
- (d) Enhancement of social and environmental benefits;
- (e) Transparent governance and grievance mechanisms.

For each safeguard, the project holders shall define specific indicators, monitoring methods, and documentation procedures. Templates for activity and safeguard monitoring are provided in Annex 4.

16.6 Data quality and management

All monitored data shall be:

- (a) Complete and representative of the project area;
- (b) Supported by documentation (e.g., photos, field forms, remote sensing outputs);

(c) Validated through internal QA/QC procedures;

(d) Stored for a minimum of 10 years or two quantification periods, whichever is longer.

Where sampling is used, it shall be based on statistically robust approaches (e.g., stratified random sampling, IPCC-compliant SOC sampling).

If digital monitoring technologies (e.g., drones, LiDAR, automated sensors) are used, methods shall be validated and reproducible.

16.7 Monitoring of reversal risk and permanence conditions

Project holders shall monitor and report any changes that may affect the permanence of credited outcomes, including:

(a) Signs of illegal activity, drainage, or conversion;

(b) Natural disturbances (hurricanes, cyclones, tsunamis, storm surges, erosion, pests);

(c) Changes in legal status, governance, or stakeholder agreements;

(d) Effectiveness of applied risk mitigation measures (e.g., restoration structures, erosion barriers, community involvement).

Such data shall be used to update the Permanence and Risk Management Tool at each verification period and to support the classification of any potential reversal event as avoidable or unavoidable.

16.8 Data and record keeping

Project holders shall establish and maintain a data and record-keeping system that ensures the transparency, traceability, and accessibility of all information used in the design, implementation, monitoring, and verification of Blue Carbon activities.

This system shall support the independent verification of GHG emission reductions, the assessment and management of permanence risk, the monitoring of safeguards, and compliance with all applicable requirements of the BIOCARBON STANDARD.

Project holders shall retain all relevant records and supporting documentation for a minimum of ten (10) years after the end of the last quantification period or for two (2) full verification cycles, whichever is longer. Records shall be:

(a) Accurate, complete, and consistent with the Project Document and monitoring plan;

(b) Archived in a secure, retrievable format;

- (c) Made available to accredited Conformity Assessment Bodies (CABs) during validation and verification;
- (d) Made available upon request for review by BIOCARBON or its designated representatives.

Minimum documentation to be retained includes:

- (a) GIS files and maps of project boundaries, stratification, and monitoring plots;
- (b) Biomass measurements, SOC sampling data, hydrological monitoring data, and raw field data;
- (c) Satellite imagery, aerial or drone outputs used for monitoring;
- (d) Legal documentation: land titles, project authorization, community agreements;
- (e) Monitoring and verification reports, field inspection records, data analysis files;
- (f) Evidence of stakeholder consultations, grievance redress logs, and benefit-sharing documentation;
- (g) Risk assessment scores and justifications from the Permanence Tool;
- (h) Documentation related to reversals, loss events, or leakage incidents, including mitigation actions and corrective measures.

Project holders shall implement systems for QA/QC and version control, including:

- ▲ Consistent versioning of datasets and methodological inputs across reporting periods;
- ▲ Change logs for any corrections, updates, or revisions;
- ▲ Backups and audit trails with recorded date and time.

Project holders shall apply the BIOCARBON Sustainable Development Safeguards (SDSs) and Sustainable Development Goals (SDGs) Tools to document social, environmental, and economic co-benefits in a consistent manner. At minimum, the Project Document and Monitoring Report shall include the indicators and evidence required by these Tools, using the templates provided by the BIOCARBON STANDARD to ensure comparability across projects.

17 Quality Assurance and Quality Control (QA/QC)

Project holders shall implement a structured QA/QC system to ensure the accuracy, consistency, and transparency of all data, calculations, and procedures used in the

quantification and monitoring of GHG emission reductions and removals under this methodology.

This section establishes the requirements for implementing a robust Quality Assurance and Quality Control framework to ensure that:

- (a) All data and estimates are reliable, transparent, and verifiable;
- (b) Errors, omissions, and inconsistencies are minimized;
- (c) Monitoring, reporting, and verification (MRV) processes meet the highest standards of integrity;
- (d) Claims of emission reductions and removals are defensible before third-party audits, host country authorities, and international market mechanisms.

The QA/QC procedures shall apply to both ex-ante and ex-post estimations and shall be documented in the Project Document and in each Monitoring Report.

Standardized templates for documenting QA/QC procedures are included in Annex 4.

17.1 Quality Assurance (QA)

Quality assurance refers to procedures implemented to prevent errors and ensure that data collection, processing, and reporting conform to methodological requirements. QA shall be proactive, focusing on accuracy and methodological rigor.

QA procedures shall include, as applicable:

- (a) Independent review of stratification, sampling design, and monitoring protocols (e.g., SOC coring, biomass plots, hydrological monitoring);
- (b) Validation of field crew training and calibration of measurement instruments, including GPS, soil augers, coring devices, and laboratory equipment;
- (c) Cross-checks of input data, sources, and emission/removal factors against IPCC values, national inventories, or peer-reviewed literature;
- (d) Peer review of emission reduction and removal calculations prior to submission;
- (e) Documentation of data sources, assumptions, and justifications, with clear references and version control.

17.2 Quality Control (QC)

Quality control refers to routine technical activities that verify the integrity of data and calculations. QC is applied continuously during data collection, processing, and reporting.

QC measures shall include:

- (a) Spot-checks or remeasurement of a statistically significant subset of sample plots, soil cores, or monitoring stations;
- (b) Verification of field forms, GPS coordinates, geotagged photos, and data entries;
- (c) Consistency checks across datasets, years, and versions to detect anomalies;
- (d) Use of version control and audit trails for any modification of values or assumptions;
- (e) Demonstration of reproducibility of results using documented methods, equations, and tools.

17.3 Corrective actions and traceability

Any detected errors, inconsistencies, or deviations shall be corrected in a transparent manner and documented. The QA/QC system shall ensure that:

- (a) All data used in calculations can be traced to original records (field notes, laboratory results, raw satellite data);
- (b) Changes in data or assumptions are justified, version-controlled, and reviewed;
- (c) Results presented for verification are reproducible by an independent third party using the same datasets and procedures.

17.4 Documentation and archiving

All QA/QC actions shall be documented and archived. All monitored data shall be recorded in a transparent manner and archived in digital format.

At a minimum, the following shall be retained:

- (a) Raw monitoring data, laboratory results, and processing scripts or spreadsheets;
- (b) Version-controlled emission reduction and removal calculations;
- (c) Field survey protocols and original field notes, including geotagged evidence;
- (d) Copies of external reports, assessments, calibration certificates, and reviews;

- (e) Documentation of all revisions, corrections, or updates to the methodology application.

All information shall be stored for a minimum of 15 years or two full quantification periods, whichever is longer, and made available upon request by the BIOCARBON STANDARD or accredited third-party verifiers.

17.5 Continuous improvement

Project holders are encouraged to periodically review and update the QA/QC system, incorporating:

- (a) Lessons learned from previous monitoring, verifications, or audits;
- (b) Technological advancements (e.g., new remote sensing platforms, LiDAR, AI-assisted classification of wetlands, blockchain traceability tools);
- (c) Feedback from stakeholders, verifiers, and host country authorities;
- (d) Updates to the BIOCARBON STANDARD, IPCC guidelines, or best practices in carbon accounting and wetland science.

18 Document status and publication format

18.1 Status

This methodology has been prepared in accordance with the BIOCARBON STANDARD procedures for the development and revision of methodological documents. This Version 1.0 incorporates the results of the public consultation process and has been approved for official use under the BIOCARBON STANDARD.

18.2 Version

Version 1.0. November 7, 2025

Approved by: Technical Committee of BIOCARBON

Supersedes: N/A

18.3 Publication Format

This methodology is published in digital format (PDF) on the official website of BIOCARBON. Any printed copies or unofficial reproductions shall be cross-checked against the version available in the official site. In case of discrepancy, the digital version in force shall prevail.

Project monitoring reports and VCC issuance/retirement data shall be publicly accessible via the registry website.

19 References

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20 Annexes

The following annexes form an integral part of this methodology. They provide technical guidance, default values, and standardized templates to ensure the consistent application, monitoring, and verification of Blue Carbon projects.

Project holders shall apply the annexes in conjunction with the BIOCARBON STANDARD. Where project-specific or higher-tier data are available, they shall take precedence over Tier 1 default values included in these annexes.

Annex 1 – Default emission factors and parameters: Tier 1 default values from the IPCC 2013 Wetlands Supplement and the 2019 Refinement.

Annex 2 – Monitoring guidance: Recommended parameters, frequencies, and methods for Blue Carbon ecosystem monitoring.

Annex 3 – Guidance for the Assessment of Uncertainty: Procedures for quantifying and addressing uncertainty.

Annex 4 – Templates for Monitoring and Reporting: Standardized formats to ensure transparency and replicability in reporting.

Annex 1 – Default emission factors and parameters

This annex provides default values from the IPCC 2013 Wetlands Supplement and the 2019 Refinement, which may be used where project-specific data are not available. These values are Tier 1 defaults and shall be applied conservatively. Where higher-tier data (Tier 2/3) exist, project holders are encouraged to use those values.

A.1 Soil Organic Carbon (SOC) stock values (0–1 m depth)

Ecosystem type	Soil type	Default SOC stock (tC/ha)	95% Confidence Interval	Source
Mangroves	Mineral	286	247 – 330	IPCC 2013, Table 4.11
Mangroves	Organic	471	436 – 510	IPCC 2013, Table 4.11
Tidal marshes	Mineral	226	202 – 252	IPCC 2013, Table 4.11
Tidal marshes	Organic	340	315 – 366	IPCC 2013, Table 4.11
Seagrass meadows	Mineral	108	84 – 139	IPCC 2013, Table 4.11

A.2 Default emission factors for rewetting and drainage of coastal wetlands (IPCC 2013 Wetlands Supplement)

Activity / Ecosystem	EF (tC/ha/year)	95% CI (tC/ha/year)	Range (tC/ha/year)	n	EF (tCO ₂ /ha/year)	95% CI (tCO ₂ /ha/year)	Range (tCO ₂ /ha/year)
Mangrove	-1.62	1.3-2.0	0.10-10.2	69	-5.94	4.77-7.33	0.37-37.40
Tidal marsh	-0.91	0.7-1.1	0.05-4.65	66	-3.34	2.57-4.03	0.18-17.05
Seagrass meadow	-0.43	0.2-0.7	0.09-1.12	6	-1.58	0.73-2.57	0.33-4.11
Drainage (tidal marshes & mangroves)	7.9	5.2-11.8	1.2-43.9	22	28.97	19.07-43.27	4.40-160.97

Notes:

- Emission factors (EFs) are expressed as tonnes of carbon per hectare per year (tC/ha/year). Conversion to CO₂-equivalent (tCO₂/ha/year) was performed by multiplying by 44/12.
- Negative values indicate removals.

3. Values are Tier 1 defaults from the 2013 IPCC Wetlands Supplement, Volume 4, Chapter 4: Coastal Wetlands, Tables 4.12 and 4.13.
4. For drainage, Tier 1 provides an aggregate factor for tidal marshes and mangroves; further disaggregation by climate or soil type requires Tier 2/3 data at national or regional level.

A.3 Default emission factors for methane (CH₄) in flooded land and constructed waterbodies (IPCC 2019 Refinement, Ch. 7)

System / Zone	EF (kg CH ₄ /ha/year)	Notes	Source
Flooded Land Remaining Flooded Land			
Boreal	13.0	Tier 1 default for natural flooded land (wetlands)	IPCC 2019, Table 7.9
Temperate	220.0	Tier 1 default for natural flooded land (wetlands)	IPCC 2019, Table 7.9
Tropical	1400.0	Tier 1 default for natural flooded land (wetlands)	IPCC 2019, Table 7.9
Constructed waterbodies (ponds, canals, reservoirs)			
Freshwater/brackish ponds	1050.0	Includes aquaculture ponds, non-saline constructed	IPCC 2019, Table 7.12
Saline ponds	230.0	Constructed ponds with salinity ≥20 ppt	IPCC 2019, Table 7.12
Notes: Emission factors (EFs) are expressed in kg CH ₄ /ha/year. For consistency with carbon accounting, values shall be converted to tCO ₂ e/ha/year using the applicable Global Warming Potential (GWP) for CH ₄ (e.g., 28 under IPCC AR5 or 27 under AR6). Where project-specific or nationally determined emission factors exist (Tier 2 or 3), those shall take precedence over the Tier 1 defaults.			

A.4. Emission Factor (EF_F) for N₂O emission from aquaculture use in mangroves, tidal marshes and seagrass meadows

Default EF	95% CI ¹	Reference
0.00169 kg N ₂ O-N per kg fish produced	0, 0.0038	Hu et al., 2012 (IPCC 2013, Table 4.15)
¹ 95% CI of the geometric mean. Note: Approach used by Hu et al. (2012) using N in feed to fish biomass: Hargreaves, 1998; Protein content of fish biomass: USDA nutrient database for Standard Reference Nutrient Data Laboratory; N content of protein: Nelson and Cox, 2013; N to N ₂ O conversion: Hu et al., 2013; Kong et al., 2013; Kampschrew et al., 2008; Ahn et al., 2010 (refer to Annex A.4.5)		

For the purposes of this Methodology, nitrous oxide (N₂O) emissions shall only be included where significant anthropogenic sources of nitrogen are present within the project boundary. In particular:

- (a) Aquaculture: Where aquaculture is practiced within mangroves, tidal marshes, or seagrass meadows, N₂O emissions shall be quantified using the default emission factor provided in the 2013 IPCC Wetlands Supplement (Table 4.15), or higher-tier factors where available.
- (b) Other activities: In the absence of aquaculture or other relevant nitrogen inputs (e.g., fertilizer application, industrial discharge), N₂O emissions from natural tidal wetlands are considered negligible at Tier 1 and shall not be included, unless project-specific or nationally determined Tier 2/Tier 3 data demonstrate significant fluxes.

A.5 Global warming potentials (GWPs)

Gas	AR5 100-year GWP	AR6 100-year GWP (optional)
CO ₂	1	1
CH ₄	28	27.0
N ₂ O	265	273

Note: BioCarbon projects shall apply the most recent IPCC GWPs in force at the time of validation.

Annex 2 – Monitoring guidance

This annex provides guidance on the monitoring of parameters required under this Methodology. It is intended to support consistency, transparency, and replicability of monitoring systems in Blue Carbon projects. Project holders shall apply the BioCarbon MRV Tool in all cases; where project-specific designs differ, justification shall be provided.

A.2.1 Parameters and monitoring frequency

Parameter	Unit	Monitoring frequency	Monitoring methods / data sources	Notes
Ecosystem cover and condition (mangroves, marshes, seagrass meadows)	ha, % cover	At least once every monitoring period (1–5 years); recommended annually via remote sensing	Satellite imagery (Landsat, Sentinel, Planet), aerial photography, drones; GIS-based change detection	Mandatory; stratification by ecosystem type required
Aboveground biomass	tC/ha	Every 5 years or at each verification	Field plots, allometric equations, LiDAR, national forest/wetland inventory data	Default root-to-shoot ratios may be used if local equations unavailable
Belowground biomass	tC/ha	Every 5 years or when aboveground biomass is updated	Root-to-shoot ratios, field coring, IPCC defaults	Applies to mangroves, marshes, and seagrass
Soil Organic Carbon (SOC)	tC/ha	Minimum once every 10 years	Stratified random soil coring, density, analysis in laboratory bulk %C in	1 m depth (IPCC Wetlands Supplement 2013 (IPCC, 2014)); deeper if justified

Parameter	Unit	Monitoring frequency	Monitoring methods / data sources	Notes
CH₄ fluxes (tidal wetlands)	tCO ₂ e/ha	Once per monitoring period or when management alters hydrology	Flux chambers, eddy covariance, or IPCC default EF by salinity	Required when salinity <18 ppt or evidence of emissions
N₂O fluxes (fertilized/managed wetlands)	tCO ₂ e/ha	Once per monitoring period or when fertilizers are applied	IPCC default EF; field measurements where feasible	May be excluded if de minimis and justified
Hydrological parameters (water level, salinity)	m, ppt	Continuous or at least quarterly	Piezometers, salinity probes, hydrological models	Important for SOC stability and CH ₄ /N ₂ O flux estimation
Leakage drivers (aquaculture, fuelwood harvest, fishing pressure)	Qualitative / ha	At each verification period	Field surveys, interviews, stakeholder consultations, GIS	Required if risk of displacement exists
Safeguard indicators	Qualitative / quantitative	Annually or biennially	SDSs Tool participatory monitoring, surveys, administrative records	Shall align with BioCarbon SDSs Tool (BioCarbon Cert, 2025f)
Permanence risk indicators (erosion, extreme events, land tenure, governance)	Qualitative / ha	Reviewed at each verification period, or immediately following a reversal	Project-specific records, field inspections, disaster reports	Used in Permanence and Risk Tool (BioCarbon, 2025g)

A.2.2 Documentation requirements

- (a) All monitored data shall be archived in digital format, georeferenced where applicable, and retained for at least 10 years after the last quantification period or two full verification cycles, whichever is longer.
- (b) QA/QC procedures shall include cross-checks of data, calibration of instruments, and reproducibility of calculations.
- (c) Where expert judgment is applied, the process shall be documented according to the BioCarbon MRV Tool.

Annex 3 – Guidance for the Assessment of Uncertainty

This annex provides guidance on how to apply the BIOCARBON Uncertainty Assessment Tool in Blue Carbon projects. It sets out the minimum requirements for documenting, calculating, and applying conservative adjustments when uncertainty affects the quantification of GHG emission reductions and removals.

A.3.1 Confidence level and adjustment rule

- (a) Uncertainty shall be expressed as a **two-sided 90% confidence interval**.
- (b) The **relative half-width (RH)** of this interval shall determine the conservative adjustment applied to net emission reductions and removals:

$$RH = \frac{(Upper\ CI - Lower\ CI)}{2 \times Mean} \times 100$$

Adjustment rule

If $RH \leq 30\%$: no deduction is applied.

If $RH > 30\%$: The excess percentage above 30% shall be deducted from net emission reductions/removals prior to credit issuance.

A.3.2 Uncertainty sources

Project holders shall consider and document uncertainty in the following parameters:

- (a) **Activity data**
 - Area of ecosystem change (loss, restoration, management).
 - Derived from remote sensing, GIS, field mapping.
- (b) **Emission/removal factors**
 - Biomass expansion factors, root-to-shoot ratios, SOC densities.
 - IPCC defaults or project-specific data.
- (c) **GHG fluxes**
 - CH₄ and N₂O emission factors (salinity, fertilization).
 - Measurement or IPCC defaults.
- (d) **Sampling and measurement systems**
 - Biomass plots, soil coring, bulk density, %C analysis.
- (e) **Modeling assumptions, proxies, expert judgment**

- Hydrological modeling, interpolation of data.

A.3.3 Calculation approaches

Project holders shall apply one of the following approaches:

- **Tier 1 – Error propagation method** (deterministic):

$$Var(Y) = \sum \left(\left(\frac{\partial f}{\partial x_i} \right)^2 Var(x_i) \right)$$

Applied when uncertainty estimates for input parameters are available.

- **Tier 2 – Probabilistic methods** (e.g., Monte Carlo simulation):
 - Applied when data quality and variability justify stochastic approaches.
 - Requires at least 5,000 iterations and explicit documentation of distributions used.

A.3.4 Example of parameter-by-parameter uncertainty table

Parameter	Data type	Mean value	Uncertainty (± %)	Source
Area of mangrove loss (ha)	Remote sensing	500	±10%	Landsat/Sentinel imagery, 95% CI
AGB carbon stock (tC/ha)	Input (field plots)	120	±15%	Field inventory, allometric equations
SOC stock (tC/ha, 0–1 m)	Input (soil cores)	286	±20%	Soil coring, lab analysis
CH ₄ EF (tCH ₄ /ha/year)	Default factor	0.011	±50%	IPCC 2013 Wetlands Supplement
Fossil fuel use (tCO ₂)	Administrative	200	±5%	Fuel records

Net uncertainty is calculated by combining individual contributions via error propagation or Monte Carlo.

A.3.5 Documentation requirements

- (a) A parameter-by-parameter uncertainty table shall be included in each Monitoring Report.

- (b) All assumptions, formulas, software, and input distributions (for Monte Carlo) shall be documented.
- (c) Expert judgment shall follow elicitation procedures in Annex G of the BIOCARBON Tool.
- (d) Supporting calculation files (Excel, R, Python, etc.) shall be archived and made available for verification.

Annex 4 – Templates for Monitoring and Reporting

This annex provides standardized templates to support the documentation and reporting of monitoring results in Blue Carbon projects. Project holders shall adapt these tables to their project context and include them in each Monitoring Report submitted for verification.

Monitoring data and results shall be submitted following the templates provided in this Annex and in accordance with the BIOCARBON MRV Tool and Registry requirements. Structured and machine-readable formats (e.g., CSV, JSON) are encouraged to facilitate data traceability and digital MRV integration.

For clarity and transparency, the calculation of GHG benefits shall follow the stepwise process described in Sections 12 to 15 (stratification, sampling, parameter estimation, aggregation, uncertainty deduction). The uncertainty deduction shall be applied after aggregation and prior to credit issuance. Projects combining parameters of different Tier levels shall document the Tier classification, data sources, and methods used in the Monitoring Report.

A.4.1 Project activities monitoring template

Activity ID	A1
Activity description	Hydrological restoration of degraded mangrove
Indicator ID	IND-01
Indicator name	Area restored
Target value	100
Measurement unit	ha
Methodology/tool	Remote sensing + field verification
Monitoring frequency	Annual
Responsible entity	Project holders and community monitors
Results (current period)	95 ha restored
Supporting documents	GIS shapefiles, photos
Observations	Slight delay due to weather conditions

A.4.2 Safeguard compliance monitoring template

Safeguard ID	S ₁
Indicator ID	SAF-01
Indicator name	Effective participation of Indigenous Peoples and local communities
Type (quant./qual.)	Qualitative
Target	Evidence of FPIC process
Methodology/tool	SDSs Tool participatory monitoring
Frequency	Biennial
Responsible entity	Project holders and community representatives
Results (current period)	FPIC process completed
Supporting documents	FPIC records, meeting minutes
Observations	Grievance log maintained

A.4.3 Permanence and reversal risk monitoring template

Risk category	Natural disturbances
Indicator	Shoreline erosion rate
Measurement unit	m/year
Baseline risk score	2
Updated risk score	3
Method/tool	Piezometer data, GIS shoreline change analysis
Corrective actions	Additional erosion barriers installed
Supporting documents	Field survey reports, drone imagery

A.4.4 Uncertainty assessment template

Parameter	SOC stock (0–1 m depth)
Data type	Field sampling
Mean value	286 tC/ha
Uncertainty ($\pm\%$)	$\pm 20\%$
Source	Soil coring, lab analysis
Method (Tier 1/Tier 2)	Tier 1 (error propagation)
Final adjustment applied	-2% deduction

A.4.5 Leakage monitoring template

Leakage driver	Displacement of aquaculture
Potential impact	Conversion of adjacent marsh to ponds
Indicator	Area converted (ha)
Monitoring method	Remote sensing + field visits
Frequency	Annual
Mitigation action	Provide alternative livelihood support
Results (current period)	0 ha converted
Supporting documents	Satellite imagery, stakeholder interviews

Document history

Type of document. Methodological Document for Blue Carbon projects

Version	Date	Nature of the review
Public Consultation Version	September 3, 2025	Initial version - Document submitted for public consultation
Version 1.0	November 7, 2025	Comprehensive technical and editorial revision following the public consultation process. Updates include: Clarification of transitional land-sea restoration boundaries; managed retreat eligibility; Spatial modelling criteria (Section 12.5); Adaptive sampling and precision note (Section 12.3); Leakage assessment framework (Section 13.6.1); Governance and benefit-sharing integration (Section 14.2.1); Permanence clarification (Section 14.3); and, Uncertainty and digital MRV enhancements (Sections 15-16 and Annex 4).