The Global Tree C-Sink
Standard for tree-based carbon sinks

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Content

Acronyms

AGB	Above ground biomass
BGB	Below ground biomass
C	Carbon
CO_2	Carbon dioxide
CDR	Carbon dioxide removal
CSI	Carbon Standards International
dMRV	Digital monitoring, reporting and verification
FPIC	Free, Prior and Informed Consent
GHG	Greenhouse gas
ICS	Internal control system
IUCN	International Union for Conservation of Nature
MUR	Management Unit Report
NTFP	Non-Timber Forest Products
PDD	Project Description Document
PAC	Persistent aromatic carbon
t aCO_2e	Ton of annually stored carbon dioxide equivalent
t CO_2e	Ton of carbon dioxide equivalent
TTB	Total tree biomass
VVB	Validation / verification body

Glossary

Afforestation	Afforestation refers to the process of establishing a forest or stand of trees in an area that does not meet the forest definition at the time of project initiation. Suitable land may be selected irrespective of its canopy history - no minimum waiting period is required, provided the conditions outlined in **Section 5: Baseline Scenario** are met.
Agroforestry	Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used in the same management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence.
Allometric Equation	Mathematical expression, resulting from a regression analysis between tree diameter and/or height of a tree (independent variable) and its total above ground biomass, typically in volume or mass (dependent variable). Allometric equations are generated from empirical measurements. Eligible allometric equations must be peer-reviewed, species and climate zone specific, and endorsed by Carbon Standards International.
dMRV Provider	A dMRV Provider supports one or multiple C-Sink Managers in meeting standard requirements and submitting verification requests via the Global C-Sink Tool for issuance into the Global C-Sink Registry. Only one dMRV Provider can be assigned to one Project. If assigned by a C-Sink Manager, a dMRV Provider may: • Request verification requests on behalf of the C-Sink Manager • Access the verified C-Sinks of the C-Sink Manager • Transfer verified C-Sinks
Emission Portofolio	The Emission Portfolio refers to the GHG emissions associated with the establishment and management of a Tree C-Sink project, representing its carbon footprint. These emissions must be tracked and reported monthly using the Emission Portfolio template within the **Management Unit Report**. The data is then aggregated to calculate the total Project Emission Portfolio. This must be fully offset prior to the registration of the Tree C-Sink.
C-Sink	A C-Sink is the result of CO2-removal from the atmosphere, its transformation into a storable form and consecutive carbon storage for a verifiably duration. C-Sinks are classified depending on their C-sequestration curve (i.e., the time-dependent function, describing the amount of C being sequestered in the C-Sink). A C-Sink is described as temporary if carbon loss is expected in the first 1000 years after its establishment (e.g., trees or soil organic carbon). A C-Sink can be

	described as long-term if no carbon loss can be expected in the first 1000 years after its establishment. (e.g., the PAC fraction of biochar or geological C storage).
C-Sink Manager	Organization responsible for registering, coordinating, and monitoring tree planting projects, in accordance with the Global Tree C-Sink Standard. The C-Sink Manager is responsible to complete and submit all the relevant information for endorsement, validation / verification, as well as registration of the issued Tree C-Sinks. The organization must be a legally registered entity in the project's host country and hold a national tax ID. For international organizations not based in the project country, partnerships with local entities (e.g., NGOs) may be required to ensure effective on-the-ground implementation and community engagement.
Global C-Sink Registry	The public platform operated by CSI to display details of issued, transferred, retired, and revoked C-Sinks, as well as related project information.
C-Sink Unit	A C-Sink Unit refers to a specific area, spanning up to 10 hectares, which can form either a part or the entirety of a management unit. Data related to carbon accounting is collected and reported at this aggregation level.
Diameter at breast height (DBH)	A tree's diameter at 137cm height above ground. For trees on sloping ground, measured on the up-slope side of the tree.
Expected C-Sink curve	A predictive model of carbon storage over ten years, developed by the C-Sink Manager based on historical data and reference plots, adjusted with a security margin, and verified by the VVB. While these verified curves can be valued for pre-purchase agreements, they are not suitable for annual global cooling assessments or compensation greenhouse gas emissions.
Forest	Contiguous area spanning ≥0.5 hectares dominated by trees ≥ 5 meters presenting a canopy coverage of ≥30 percent. The forest definition does not include land that is under agricultural or urban land use. The forest definition employed is adapted from the Food and Agriculture Organization of the United Nations (FAO), though using an increased minimal canopy coverage. Any emergent vegetation below the stipulated thresholds is considered bushland eligible for conversion.
Temporary Offset	Temporary Offsets represents both the tangible climate mitigation impact and the financial commodity derived from dynamic C-Sinks. Unlike a CO_2 offset, which implies permanent removal, ensuring a comprehensive annulment of a distinct emission, a temporary offset offers compensation for the global warming caused by a specific emission over a defined period of time, usually for one year. These

	offsets are quantified using the metric of "t aCO_2" (pronounced "ton annually stored CO_2 equivalent" or "t CO_2 equivalent per annum"). As an illustration, if a forest retains 100t CO_2e and is maintained for a decade, it can neutralize the global warming effects of a 100t CO2 emission over that 10-year span.
Management unit	A management unit is a cohesive or closely associated tract of land that represents either the entire project area or a portion of it. Each management unit is limited to a maximum size of 50 hectares. For larger expanses, the area should be subdivided into multiple management units. It's essential for each management unit to be accurately mapped, with a georeferenced polygon detailing its boundaries readily available for certification purposes.
Project area	The project area refers to the designated space where a C-Sink Manager initiates and oversees tree planting activities. A single project area may encompass multiple, georeferenced management units.
Single Tree Tracking	Also referred to as Single Tree Monitoring, is a carbon accounting method that enables precise monitoring of key forest-related variables by tracking individual trees, rather than relying on random sampling and extrapolation.
Tonne annually stored CO_2 equivalent - t aCO_2e	A metric that represents the removal and storage of 1 tonne of CO_2 outside the atmosphere for one year.
Tree	A woody perennial plant with a defined crown and either a single main stem or, in the case of coppice, multiple stems. Includes bamboos, palms, and other species meeting these criteria.
Validation Verification Body	A Validation and Verification Body accredited by CSI to verify compliance before C-Sink issuance.

1 Introduction

Widespread afforestation initiatives could play a decisive role in mitigating climate change (CDRterra, 2024; Moustakis et al., 2024). The Global Tree C-Sink Standard offers an innovative certification framework for climate services generated by living tree biomass, through afforestation, natural regeneration, or other tree planting interventions, including urban forestry.

Version 2.0 of the Global Tree C-Sink Standard builds on recent developments in high-integrity carbon markets. It establishes an enhanced, science-based approach with a strong emphasis on digital Monitoring, Reporting, and Verification (dMRV) systems to ensure accuracy, transparency, and scalability for diverse project types and geographies.

This standard ensures:

i) Accuracy: High-resolution, data-driven carbon accounting supported by frequent, empirical measurements.
ii) Security: Independent third-party verification, annual aerial monitoring, and local biodiversity safeguards.
iii) Traceability: Each certified CO_2 unit is linked to a specific geolocation, down to the individual tree or C-Sink Unit where technically feasible.

Unlike permanent Carbon dioxide removal (CDR) technologies, such as BECCS, or DACCS, tree-based C-Sinks are time-dependent. As such, they are not used to offset fossil emissions permanently but instead provide measurable, temporary offsets over specific time periods (see **Box 01**). These services mitigate the short- to medium-term warming impact of emissions, offering a flexible and technology-inclusive alternative to traditional carbon credits.

Key innovations of the Global Tree C-Sink include:

- dMRV-driven certification for transparent, cost-effective carbon accounting.
- Dynamic valuation methods that reflect the temporary nature of biomass C-Sinks, ensuring fair pricing in voluntary markets.
- Biodiversity and community-focused criteria for sustainability.
- Eligibility and baseline determination criteria for avoiding land degradation.
- Improved guidance for Urban Tree and Plantation (Monoculture) projects.

The standard sets robust eligibility and sustainability criteria, incorporating biodiversity metrics, carbon expenditure tracking, and integration of conservation zones. Projects are managed by endorsed, local C-Sink Managers, verified annually, and generated C-Sinks recorded in the Global C-Sink Registry.

By leveraging the large global potential for tree planting and restoration, the Global Tree C-Sink enables immediate climate action, biodiversity gains, and scalable contributions to the global carbon budget.

Table 1. Difference between a carbon credit, also known as CO_2 offset, and a Temporary Offset (see also 8.7 – Temporary Offsetting) under the Global Tree C-Sink Standard

Carbon credit	Temporary Offset
Product (one time purchase)	Service (purchased for a duration of service)
Complete compensation of an equivalent emission	Compensation of an equivalent global warming effect of an emission, over a defined time horizon
Unit: t CO2e (t CO2 equivalent)	Unit: t aCO2e (ton annually stored CO2 equivalent)
Value proposition: Carbon market value for permanent removals (>1000 years persistence)	Value proposition: 1/50 value of permanent removals acquired on an annual basis
Scope: Only C-Sinks of proven >1000 years persistence	Scope: Flexible and inclusive mechanism for assessment and valuation of any C-Sink in function of the C-Sink lifetime

2 Global Tree C-Sink projects

2.1 Project types

The Global Tree C-Sink Standard, Version 2.0, applies to several project types involving active tree planting or support of natural and managed-natural restoration[1], promoting the afforestation of extensive land areas and including those with limited accessibility.

Improved management of existing forests and forest protection play equally a crucial role in carbon sequestration and emission avoidance but cannot be certified under the current standard.

The Global Tree C-Sink guideline distinguishes between five possible project scenarios, defined in Table 2 below.

Table 2. Eligible Project Types

Project Type	Description
Afforestation/ Reforestation	Actively planting forest with ≥2 species on land that is currently not covered by forest.
Plantation (Monoculture)	Planting of trees on land that is currently not covered by forest and where the plantation does not lead to an establishment of a forest but a form of tree cropping with low botanical diversity of no more than one species.
Agroforestry	Active planting of trees integrated in agricultural landscapes, e.g., alleys, windbreaks, hedges, riparian buffers, forest gardens, silvo-pastoral systems, etc.
Urban Forest	Active planting, or improved maintenance of trees urban areas. Trees are integrated into urban landscapes, including roadside trees, parks, micro-forests, rooftop trees, and other greenspaces.
Natural Restoration	Actively creating the enabling conditions for natural- or managed-natural restoration of forest on land that that is currently not covered by forest.

[1] Active tree planting is not always feasible, nor technical possible. However, the natural- or managed natural restoration of degraded land bears large potential. A project activity for the latter scenario creates the enabling conditions to facilitate natural restoration, e.g., by prevention of fire, management of grazing, catalyzation of seed germination, provision of alternative income to land users etc. Natural restoration relies on the soil's natural seedbank, while managed-natural restoration may modify the seedbank and manage the regrowth.

2.2 Spatial organization of projects

2.2.1 *Project Area*

A project area refers to the designated region where a C-Sink Manager initiates and oversees tree-planting endeavors. It functions as a reference point for both the C-Sink Manager and certifier, allowing for the strategic clustering of management units as needed. For instance, this can be based on differing local legislation across states or provinces, or on projects coordinated by distinct local organizations. The term ”Project area“ is not confined by any specific spatial definition or boundary.

2.2.2 *Management Unit*

Every tree planting project must be organized into distinct management units. A management unit is a spatially contiguous, georeferenced (mapped) land area, spanning up to a maximum of 50 ha, designated for tree planting or regeneration. A cluster of closely associated, however not spatially contiguous, smallholder plots can likewise be registered as a management unit if subject to the same management plan and located all together in a radius of not more than 5 km. Each management unit must possess a unique ID and be associated with a specific project area. While the initial registration of a management unit may cover less than 50 ha, it can be updated and expanded at a later time. There's no restriction on the overall spatial extent of a tree planting project since project areas (as defined above) can consist of multiple management units, whether adjacent or dispersed.

2.2.3 *C-Sink Unit*

A C-Sink Unit is defined as a contiguous land area spanning up to a maximum of 10 ha, which forms part of a larger management unit. For instance, a 50 ha management unit would be subdivided into at least five separate 10 ha C-Sink units. Every C-Sink unit must be georeferenced (mapped), assigned a unique ID, and linked to its respective management unit. Consequently, also every tree assessed for its C-Sink capacity must be associated with the specific C-Sink unit ID. Serving as the primary unit for monitoring, reporting, and verification, the C-Sink unit will be certified and listed in the **Global C-Sink Registry.**

2.3 Spatial Organization for Urban Trees projects

2.3.1 *Urban Management Unit*

In urban tree projects, a Management Unit is defined as a georeferenced area that includes individual tree locations along streets, pathways, parks, cemeteries, and other small green spaces within the city or municipality boundaries. Unlike the other project types, trees within urban spaces are often distributed irregularly and in lower densities.

Therefore, the spatial boundaries in urban areas must be determined in function of the administrative boundaries. Smaller cities, multiple districts, or metropolitan areas may also be classified as a single management unit. Areas already designated as forests within urban spaces must be excluded from the project boundaries.

No maximum area limit is defined for Urban Management Units. Approval is subject to evaluation of the project's specific characteristics and the capacity of the dMRV system to ensure reliable monitoring at the planned scale.

2.3.2 *Urban C-Sink Unit*

A C-Sink Unit in urban tree projects corresponds to the subdivision of a management unit in function of its administrative boundaries. Districts, towns, or public spaces may be used as the subdivision of the Management Unit. The definition of the C-Sink Units must be done in function of the monitoring, reporting, and verification of the tree groups.

2.4 Project timeline

Projects under the Global Tree C-Sink Standard must adhere to the following definitions and deadlines:

- The official start date is defined as the date on which land preparation or tree planting activities begin. This may vary depending on the project type and prior land use conditions.
- The endorsement of the C-Sink Manager and project by Carbon Standards International (CSI) must be completed within two (2) years of the project start date. An extension to this period may be granted upon formal request and approval by CSI.
- Validation and verification are mandatory but are not tied to a specific deadline. However, projects with identified compliance risks during endorsement may be required to undergo early audits or provide supplemental documentation and monitoring evidence.
- To ensure the additionality of carbon removals, the following rules apply to the trees included in the project:
    - New Trees: Trees planted within three (3) years prior to project validation are eligible for retroactive certification of carbon stock.
    - Pre-existing Trees: Trees that were established more than three (3) years prior to validation are only eligible for carbon accounting of the additional biomass accumulated after validation. This applies in cases where the introduction of the project's improved management practices contributes to the conservation, protection, and healthy development of the trees.

2.5 Eligibility

To qualify under the Global Tree C-Sink Standard, projects must meet a set of core eligibility criteria that ensure measurable climate impact, ecological integrity, and social responsibility. These criteria include conditions related to project design, approved activities, land-use suitability, and compliance with work safety and social safeguard measures.
Only afforestation-based projects, defined as those that establish tree cover on land not classified as forest at the project start date, are eligible under this standard. Eligible project types include afforestation, monoculture plantations, agroforestry, urban tree planting, and natural restoration.

Projects focused exclusively on avoided deforestation, improved forest management, or conservation of existing tree cover are not eligible for accreditation under the Global Tree C-Sink Standard.

2.5.1 *Project design criteria*

All Global Tree C-Sink projects (See exceptions applied) must incorporate the following criteria into their spatial design. This includes specifications for species composition, spatial arrangement of planting plots, and the designation of conservation areas within each C-Sink Unit.

This criterion does not apply to Plantation (Monoculture) and Urban Tree project types. For further details, please refer to Section 2.5.2.

2.5.1.1 *Tree species composition*

C-Sink Units must meet the following minimum conditions:

i) Include at least two different tree species;

ii) Ensure no single species accounts for more than 80% of the total number of planted trees or more than 80% of the management units area; and

iii) Use either mixed-species plots or segregated blocks of different species.

2.5.1.2 *Invasive species control*

Tree species used in the project must comply with the following:

i) All planted species must be classified as non-invasive according to national regulations or guidelines.

This criteria does not apply to natural regeneration projects

2.5.1.3 *Chemical input regulations*

Use of agrochemical inputs must adhere to these rules:

i) Only chemical inputs that are legal in the host country are permitted;

ii) Pesticides listed as "Extremely Hazardous" or "Highly Hazardous" by the WHO (2019) are prohibited; and

iii) Application of inputs must follow the manufacturer's guidelines for safety and dosage.

2.5.1.4 *Native & naturalized species*

i) The dominant tree species must be native or naturalized to the project region.

2.5.1.5 *Conservation area*

i) A contiguous (non-fragmented) afforested area must be designated as a conservation area;

ii) This area must be protected from commercial logging for a minimum period of 30 years;

iii) Sustainable harvest of Non-Timber Forest Products (NTFPs) is permitted; and

iv) The conservation area must cover at least 10% of the total project management unit.

This criteria does not apply to agroforestry projects with management units smaller than 3 hectares

2.5.2 *Project design criteria for Monoculture and Urban Tree project types*

To ensure the Global Tree C-Sink Standard remains adaptable to the specific characteristics of each project type, the following spatial design criteria apply exclusively to Monoculture Plantation (see **Figure 1**) and Urban Tree projects.

2.5.2.1 *Plantation (Monoculture) projects*

2.5.2.1.1 Conservation area

i) At least 15% of the total project or management unit area must be designated as conservation, which may be distributed across multiple plots;

ii) Conservation areas must be distinct from firebreaks and ecological corridors; and

iii) At least 50% of the total designated conservation area must be spatially clustered. The remaining portion may be distributed in smaller patches based on expert ecological recommendations.

2.5.2.1.2 Ecological corridors

i) Ecological corridors must be established in addition to conservation areas and must:

a. Be spatially coherent, and non-fragmented;

b. Be protected from logging for a minimum of 30 years;

c. Permit the harvest of NTFPs;

d. Cover at least 10% of the management unit;

e. Be connected to conservation areas to ensure wildlife movement and habitat continuity; and

f. Be clearly distinguished from conservation areas, firebreaks, and access routes.

2.5.2.1.3 Plantation parcels

- Monoculture plantations must be arranged in spatially coherent parcels;
- A minimum of three separate parcels must be established per management unit; and
- Parcels should ideally have irregular shapes to promote ecological diversity and a more functional conservation layout.

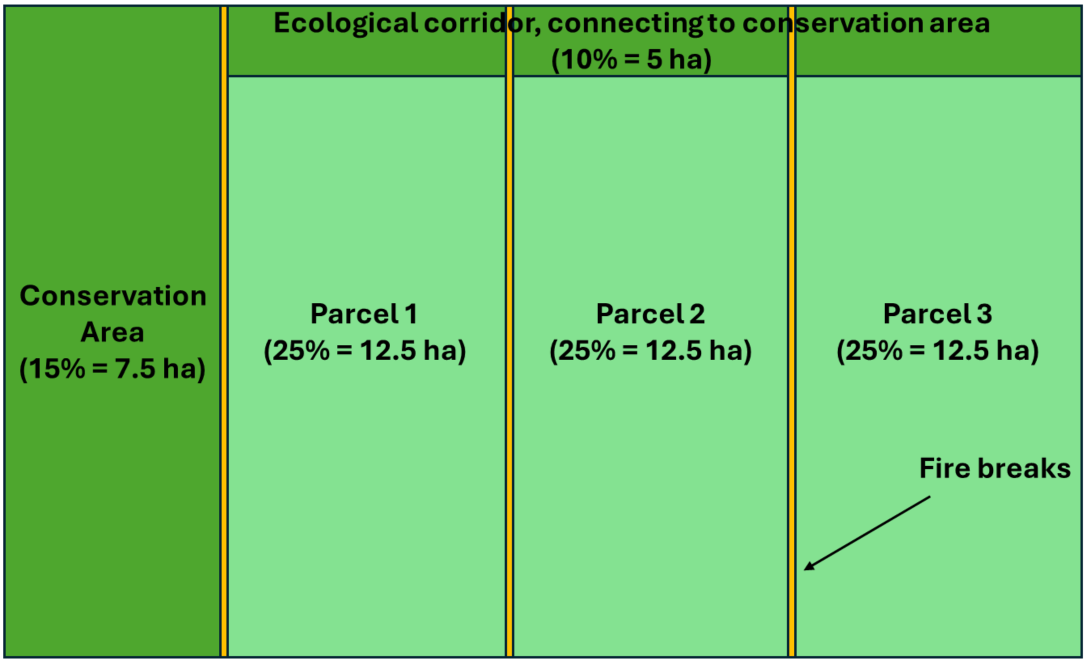


Figure 1. *Layout of a 50-hectare Management Unit (MU) in a Plantation (Monoculture) project. The design allocates 75% of the area across three production parcels, while 25% is designated for conservation, comprising a 15% clustered conservation zone and a 10% ecological corridor. Firebreaks are strategically positioned between the production parcels to enhance fire safety and landscape integrity.*

2.5.2.2 *Urban Tree projects*

2.5.2.2.1 Tree species composition

i) Each Management Unit must include a minimum of five distinct tree species or subspecies.

ii) No single species may comprise more than 30% of the total number of trees planted within the Management Unit.

2.5.2.2.2 Climate resilient design

i) At least 50% of the planted trees must be native or well-adapted species, selected based on their resilience to present and predicted local climate conditions and urban stressors.

ii) Species selection should consider tolerance to urban challenges such as soil compaction, limited rooting space, pollution, and heat stress.

2.5.2.2.3 Biodiversity support

i) A minimum of two tree species must be flowering or fruit-bearing to provide habitat and food sources for pollinators and urban wildlife.

2.5.2.2.4 Water retention and urban drainage

i) Tree planting must incorporate basic water retention principles and support integration with urban drainage systems to reduce runoff and enhance groundwater recharge.

2.5.2.2.5 Spatial configuration and planting design

i) Trees must be planted in configurations that consider urban infrastructure, ensuring adequate spacing for growth and maintenance.

ii) Designs should promote canopy connectivity to maximize ecological benefits and urban heat island mitigation.

2.5.3 ***Land-use criteria***

To ensure that the project generates climate benefits without causing negative effects on the environment and communities, the following land-use criteria must be fulfilled for eligibility of the land where the project will be developed.

This criterion does not apply to Urban Tree project types. For further details, please refer to Section 2.5.4.

2.5.3.1 *Non-forested lands*

i) Eligible lands must not be classified as forest at the project start (i.e. before land preparation for planting) according to the definition provided in the **Glossary**. See **Section 3.1 – Baseline demonstration**.

ii) If the project area was deforested within the 10 years preceding the project start date, the project may still be eligible, provided that the conditions established on **3.2.1 - Projects on deforested land**.

2.5.3.2 *No displacement of existing land uses*

i) Projects must not displace current settlements, agriculture, or pastoral systems.

ii) Degraded land or areas that have been unmanaged or abandoned should be prioritized for project implementation in order to promote ecological restoration and minimize the risk of displacement or leakage.

iii) Agroforestry, silvopasture, and integrated land-use systems are encouraged, provided they sustain local livelihoods and do not reduce food security.

2.5.3.3 *Protected areas and indigenous territories*

i) Project sites must not overlap with national parks, protected areas, or indigenous territories unless:
   a. The primary goal is ecological restoration; and
   b. Written consent is provided by the authority administrating the territory (e.g., government or community representatives).

ii) In such cases:
   a. Only native or naturalized species may be planted;
   b. Local communities must be empowered as stakeholders throughout the project lifecycle.

2.5.3.4 *Permanent Grasslands*

i) Projects in natural grasslands must meet a minimum premium biodiversity ranking of level II (See **Section 6.1 - Biodiversity Ranking**).

ii) Conversion to silvopastoral systems is permitted, provided that:
   a. Tree density does not exceed 200 trees/ha (adjustable based on local conditions);
   b. Biodiversity is maintained or enhanced; and
   c. Grazing activities remain viable.

2.5.3.5 *Wetlands and High-Carbon Soils*

i) Projects must not be established on Histosols or Gleysols, especially where drainage is required for tree planting. These soils contain high organic carbon stocks and must be protected from degradation.

ii) Drainage or prevention of rewetting is strictly prohibited.

iii) Rewetting and paludiculture approaches are encouraged.
iv) Mangrove restoration on coastal Gleysols may be considered on a case-by-case basis.

2.5.3.6 *Land Ownership and Legal Compliance*

i) Land tenure must be clearly defined and legally secure, with acceptable documentation including:
   a. Land ownership certificates; or
   b. Lease or concession contracts.

ii) Maximum lease durations:
   a. Up to 100 years (from state or enterprise); and
   b. Up to 60 years (from individuals or communities).

iii) All contracts must:
   a. Align with national legal frameworks;
   b. Specify benefit-sharing arrangements for landowners and project workers; and
   c. Clearly define the rights for use and valorization of carbon and co-benefits.

2.5.3.7 *Free, Prior, and Informed Consent (FPIC)*

i) For lands with customary or community tenure, FPIC is mandatory.

2.5.4 *Land-use criteria for Urban Tree projects*

To ensure the Global Tree C-Sink Standard remains adaptable to the specific characteristics of each project type, the following land-use criteria apply exclusively to Urban Tree projects.

2.5.4.1 *Urban trees pre-conditions*

i) Newly established trees must not be inside conservation areas (prohibiting tree removal), permanent green space mandates, and / or be part of compensatory tree planting mandated by law (e.g., trees planted to offset removal of small forest for road construction).

ii) The already established trees included in the project must not be part of ongoing municipal greening programs unless demonstrating that the Global Tree C-Sink project introduces improved practices and / or helps with financial gaps for their maintenance.

iii) The area must show no recent (<10 years) record of natural regeneration or voluntary greening efforts without carbon incentives.

2.5.5 *Project activities*

To prevent environmental degradation and enhance climate and ecosystem services, the Global Tree C-Sink defines a set of core activity requirements for tree planting and restoration projects. These must be fully integrated into the management plan within the Project Design Document (PDD).

This criterion does not apply to Urban Tree projects. For further details, please refer to Section 2.5.6

Table 3. Sustainable management activities for all project types

Sustainable management	Activities
Land preparation	- Soil must remain undisturbed; no draining, intensive tillage, burning, or slash-and-burn techniques. - Planting furrows and pits are allowed. - Burning of removed biomass is not permitted. - Moderate tillage may be allowed for natural seed bank germination.
Retaining remnant trees	- Preserve trees with DBH >10 cm (temperate/arid) or >25 cm (tropical), unless invasive. - Depending on the species and project type, remnant trees may be eligible for carbon accounting of additional biomass accumulated after project validation / verification. This will be evaluated on a project-specific basis and addressed during the endorsement phase by Carbon Standards International.
Mineral fertilization	- Preference for organic fertilizers. - Mineral fertilizers limited to the first 5 years post-planting, capped at 100 kg N ha^{-1} yr^{-1} and 100 kg P2O5 ha^{-1} yr^{-1}. - The attributed emissions must be included in the Emission Portfolio (see **Chapter 8**).
Permanent ground cover	- Maintain >75% soil cover year-round (litter, vegetation, or cover crops). - Introduced cover crops in natural forests are not permitted. - Agroforestry must include cover crops.
Irrigation	- Allowed for seedlings for up to 5 years. - No use of ground/river water after that period. - Fog-harvesting and renewable-powered desalination are favored.
Harvest practices	- No full clear-cutting allowed. - Minimum 40% carbon stock must be retained. - Harvested carbon must be documented. - Pruning and thinning are allowed without documentation.

Replanting after harvest	- Replanting must be immediate. - Soil must not be exposed for more than 3 months. - Tree density must equal or exceed pre-harvest levels. - Replanting species must align with the established planting plan for the MU.

2.5.6 *Project activities criteria for Urban Trees projects*

Due to the unique conditions of urban environments, urban tree projects must adopt specialized sustainability and planning practices to ensure ecological integrity and climate impact.

Table 4. Sustainable management activities for Urban Tree projects

Sustainable management	Activities
Inventory and monitoring	- A georeferenced tree registry must be maintained, documenting species, planting date, condition, and survival status. - Monitoring of tree health, growth, and maintenance interventions must be conducted. - Alignment with municipal databases is encouraged to ensure transparency and avoid double counting.
Improved management and protection	- A long-term maintenance plan must be compiled and implemented, including structured watering, pruning, soil maintenance, and protection against damages. - Tree removals must follow municipal law, with mandatory replacement of removed trees at equivalent or higher carbon value. - Public participation and involvement of local environmental groups in project oversight and monitoring is encouraged.

2.5.7 *Work safety and social safeguards*

Global Tree C-Sink projects must prioritize the protection of workers and uphold robust social and labor standards across all operations. This includes strict compliance with national labor laws and international labor conventions, the prevention of exploitative labor practices, and the promotion of fair, inclusive, and non-discriminatory workplaces.

In addition, projects must respect and safeguard the rights of indigenous peoples and local communities, especially in activities related to afforestation and forest restoration. Key elements such as Free, Prior, and Informed Consent (FPIC), secure land tenure, and participatory governance are essential to protecting livelihoods, building trust, and ensuring equitable climate benefits.

Projects must take a rights-based approach that values community agency, protects against exploitation, and fosters long-term partnerships rooted in mutual respect and transparency.

The following minimum criteria must be fulfilled to ensure social integrity and worker protection in all projects:

2.5.7.1 *Safe and healthy working conditions*

i) Projects must comply with all applicable national occupational health and safety regulations.

ii) All actors involved must ensure safe operating environments and implement fire prevention measures across all project activities.

2.5.7.2 *Training and personal protective equipment (PPE)*

i) PPE must be available and correctly used at all times.

ii) All personnel employed by the C-Sink Manager must receive training on:
   a. Safe handling of power tools;
   b. Fire prevention and emergency procedures;
   c. Proper use of PPE; and
   d. Pesticide handling, where applicable.

2.5.7.3 *Decent Work and Fair Treatment*

i) All workers must be treated with fairness and dignity.

ii) Discrimination based on gender, ethnicity, age, religion, or any protected status is strictly prohibited.

iii) Equal opportunities and fair wages must be ensured for all employees.

2.5.7.4 *Legal Employment Standards*

i) Projects must comply with national labor laws.

ii) Projects must uphold international labor standards, including ILO conventions.

2.5.7.5 *No child or forced labor*

i) Child labor and forced labor are strictly prohibited in all project activities and value chains.

2.5.7.6 *Equal opportunity and inclusive hiring*

i) Equal access to employment must be ensured, from field roles to leadership.

ii) Special consideration should be given to women, youth, indigenous peoples, and other marginalized groups.

2.5.7.7 *Community participation and benefit-sharing*

i) Local communities and indigenous peoples must participate in decision-making and planning.

ii) Projects must ensure fair access to:
   a. Forest products;
   b. Land lease agreements; and
   c. Climate service revenues and co-benefits.

2.5.7.8 *Free, Prior, and Informed Consent (FPIC)*

i) Projects must obtain FPIC from affected communities before implementing land-use changes.

ii) Consent must be inclusive, transparent, and documented, particularly with indigenous and marginalized groups.

2.5.7.9 *Grievance mechanism*

i) A transparent, accessible, and confidential grievance mechanism must be established.

ii) All workers and community members must have access to timely and fair redress procedures.

3 Baseline Scenario

The baseline scenario defines the most likely land-use pathway in the absence of the afforestation project. It establishes the reference conditions against which all climate, biodiversity, and socio-economic impacts of the project are measured. The baseline must be conservative, credible, and supported by robust data and documentation.

While most carbon standards only certify afforestation on land that has remained non-forested for 10 - 15 years, this delay often leads to prolonged land degradation, loss of biodiversity, and missed opportunities for early carbon capture. The Global Tree C-Sink standard intentionally breaks from this convention by also allowing immediate reforestation of recently deforested or degraded land, provided that the new forest achieves at least 30% of the regional average forest carbon stock before additional carbon sequestration will be certified.

This pragmatic threshold ensures that reforestation efforts genuinely contribute to additional carbon sinks without encouraging deforestation. It also accelerates climate action by restoring ecological function and carbon absorption capacity as soon as possible, rather than enforcing artificial waiting periods.

3.1 Baseline demonstration

To establish the baseline scenario, the project must first meet the corresponding general eligibility criteria outlined in **Section 2.5 - Eligibility** and must not be classified as forest at the time of project start.
The project proponent must then provide verifiable evidence that, in the absence of the project, no additional carbon removals would occur beyond those resulting from natural ecological processes. This includes demonstrating that the land is degraded or underutilized and would not regenerate significant biomass without intervention.

A comprehensive documentation of the land-use history over the past 10 years is required to verify the occurrence of land degradation or deforestation ≥ 10 years before project start with no regeneration of secondary forest until the project start. Accepted forms of evidence include:

- Satellite imagery (e.g., from platforms like Sentinel, Landsat), showing project area at least in year 1 and year 10 before project start;
- Aerial photographs showing project area at least in year 1 and year 10 before project start;
- Global Forest Watch excerpts (www.globalforestwatch.org), showing project area at least in year 1 and year 10 before project start;
- Logging permits or land-use licenses;
- Cadastral or tax records;
- Written land-use records or government registries; and
- Local testimonies, validated through a formal verification protocol.

3.2 Baseline Carbon Stock

If it is clearly demonstrated that the land was deforested at least 10 years prior to the project start and no secondary forest regeneration occurred during that time (in accordance with the criteria in **Section 3.1 – Baseline demonstration**), the business-as-usual scenario is assumed to result in no significant additional carbon removals.

In such cases, only natural processes such as the emergence of ground vegetation or scrub may occur. These land covers are not classified as forest, represent minimal carbon stocks, and have relatively fast carbon turnover rates.

Therefore, the baseline carbon stock is assumed as:

$$C - sink\ (Baseline)\ =\ 0\ tCO2e$$

3.2.1 ***Projects on deforested land***

If the project area was deforested within the past 10 years and previously covered by primary or secondary forest, the project can still be endorsed under the Global Tree C-Sink, but the following additional conditions apply:

i) Project proponents must quantify a non-zero baseline using one of the following recognized methods:
   a. A Tier 3 approach from the IPCC Guidelines for AFOLU (2019 Refinement) corresponding to the project type, or
   b. An equivalent approach approved by Carbon Standards International.

Baseline carbon stock changes must be estimated conservatively and justified with supporting documentation.

ii) A carbon penalty must be applied (see **Box 01**), requiring the newly established forest to reach at least 30% of the carbon stock of the former forest, calculated using IPCC regional benchmark values (refer to **Annex 2: Reference Values for Carbon Stock in Naturally Regenerated Forests**), before any additional carbon sequestration becomes eligible for certification; and

iii) The project must meet a premium ranking or level II (See **Section 6.1**).

Box 01. An example of the Carbon Penalty application

A C-Sink Manager in tropical Africa plans to afforestation a 1-hectare Management Unit (MU). The MU is situated on sloping land, and swift afforestation is crucial for the preservation of the topsoil. When verifying the land use history using satellite images and global forest watch data sets, it was revealed that until three years ago, the Management Unit was covered with young secondary forest.

As per the baseline land use regulations of the Global Tree C-Sink, the project can be endorsed and the C-Sink Manager can proceed immediately with the afforestation activities within the framework of a certified Tree C-Sink project. However, before an additional C-Sink can be registered, the project activity must recover 30% of the previously lost forest C-Stock.

A young (<20 years) secondary forest in a moist climate in Africa will store on average 100 t dry matter biomass per hectare (Annex 2), presenting a C-Sink of 183 t CO2e per hectare (100 t biomass* 50% C-content * (44/12) = 183 t CO2e).

The forest established by project intervention must reach 30% of this benchmark carbon stock, before all additional carbon sequestration can be registered. The first (183 t CO2e * 30% =) 55 t CO2e per hectare compensates for the loss of the former forest and must not be registered as an additional C-sink.

Once this benchmark is passed, the temporary offsets generated from the sequestration of the 56th t CO2e and beyond are accepted as additional and can be certified and valorized.

4 Additionality

The criteria for demonstrating additionality apply to all afforestation project types eligible under the Global Tree C-Sink Standard, as detailed in **Section 4.1**.

Given their unique implementation context, Urban Tree projects follow a separately set of criteria outlined in Section 4.2.

4.1 Additionality requirements for all project types

The additionality of a Global Tree C-Sink project must be demonstrated across all of the following three categories:

4.1.1 *Regulatory Additionality*

To prove that the project is not required under any national, regional, or local mandate, the project proponent must:

i) Review all applicable forestry, environmental, and climate-related laws and policies.

ii) Confirm that the tree planting and land management activities are not legally mandated.

iii) Provide evidence (e.g., law excerpts, permits, government correspondence).

4.1.2 *Carbon Removal Additionality*

To prove that the project leads to a net increase in carbon sequestration beyond what would happen in the "business as usual" baseline scenario, the project proponent must provide evidence of the potential carbon removals derived of the project activities. This is done by complying with the baseline scenario demonstration (**Section 4.1**) and completing the endorsement of the Expected C-Sink Curve (**Section 8.2.1**).

4.1.3 *Ecological Additionality*

Demonstrate that the project contributes ecological benefits beyond carbon removal and regulatory compliance.

The Global Tree C-Sink is dedicated to advancing afforestation initiatives that exhibit exceptional environmental integrity. Beyond ensuring carbon additionality relative to the baseline scenario, Global Tree C-Sink emphasizes and certifies the ecological additionality of each project.

To meet this criterion, projects must demonstrate additionality in at least one of the following aspects:

- The project exhibits a clear deviation from local customary practices by establishing more sustainable management systems (for instance, adopting agroforestry techniques in place of slash-and-burn methods).

- The tree planting initiative directly contributes to significant environmental improvements in the vicinity (examples include enhancing biodiversity through the introduction of diverse tree species, trees planted for water conservation, mitigating erosion, preventing landslides, or serving as firebreaks).

- Evidence suggests that, in the absence of the tree planting initiative, alternative undertakings detrimental to the environment would have transpired (such as the establishment of a monocultural palm oil plantation).

- Necessity for afforestation in specific areas, either to act as a protective buffer around national parks, to provide habitats or corridors for certain species (like gorilla sanctuaries), or to enhance various ecosystem services.

4.2 Additionality requirements for Urban Tree projects

Urban Tree projects face distinct constraints that differentiate them from afforestation and forest conservation projects in rural settings. The availability of land is limited, competition with infrastructure is high, and both planting and long-term maintenance require deliberate and costly interventions. Natural regeneration in such landscapes is nearly absent, and legal protections are often lacking. For these reasons, voluntary carbon incentives are essential to ensure the establishment, survival, and climate impact of urban trees.

Therefore, additionality in the context of Urban Tree projects is demonstrated by showing that the carbon market mechanism provides the necessary incentive for the protection of existing trees and/or the planting of new trees. These actions must result in additional carbon removals through improved management practices that would not have occurred under a business-as-usual scenario. To demonstrate this, the project must:

- Provide evidence of financial or regulatory gaps that hinder or prevent implementation in the absence of the financial incentives generated by the project.

- Document at least one of the following risk factors:

    - The project area is surrounded by infrastructure, buildings, or other non-green surfaces.

    - Tree establishment costs are unaffordable without external finance due to technical constraints (e.g., limited planting locations, irrigation systems, maintenance).

    - Land is at high risk of conversion to non-green uses based on zoning regulations and market trends.

5 Leakage

Carbon leakage refers to emissions caused by activities that were spatially replaced by the carbon project activity. For example, an afforestation project displaces cattle ranging to a place where forests are cut down to establish new pastures. Emissions from downstream deforestation are commonly considered leakage to the initial carbon project.

The key mechanism to avoid carbon leakage is to avoid displacement of settlements, agriculture, and pastoral activities.

To this end the Global Tree C-Sink guideline stipulates a list of conditions to be met by each project, minimizing the risk of leakage to an extended considered zero.

To minimize leakage risks, each Global Tree C-Sink project must demonstrate that:

- Is located on currently abandoned/ unutilized, degraded land;
- Did not displace settlements;
- Did not displace agricultural activities;
- Did not displace pastoral activities;
- Allows the landowner to access and trespass the project area;
- Encourages the use of non-timber forest products; and
- Promotes synergistic of agroforestry and silvo-pastoral systems harmonizing afforestation with community needs and benefits.

Carbon leakage can hardly be tracked and quantified empirically, as system boundaries are open, and causalities are unclear. Temporal boundaries to assess and document carbon leakage may extend beyond the lifetime of the actual Tree C-Sink project, while in a world of transborder trade in products, fuel, food, and feed, the spatial boundaries are global. Thus, if the above list of conditions are met:

$$Carbon\ \text{Leakage} = 0\ tCO2e$$

If the conditions stipulated above cannot be met, the calculation procedure for Carbon Leakage must be adapted from one the following approaches:

- A/R Methodological tool: Estimation of the increase in GHG emissions attributable to displacement of preproject agricultural activities in A/R CDM project activity Version 02.0.
- An equivalent approach approved by Carbon Standards International.

6 Voluntary Premium for enhanced biodiversity

Beyond carbon removal and climate mitigation, Global Tree C-Sink projects generate a wide range of co-benefits that support broader sustainability goals. These co-benefits play a key role in supporting the long-term impact of the project in the communities and ecosystems.

On the environmental dimension, Tree C-Sink projects have a great potential for delivering biodiversity and ecosystem benefits. By promoting native species planting, sustainable forest management, and the creation of conservation areas, these projects help enhance ecological integrity, support species diversity, and improve ecosystem services such as water regulation, soil stabilization, and pollination.

These criteria are applied voluntarily to demonstrate enhanced ecological value and to support sustainability claims and potential premium pricing for the Global Tree C-Sink project.

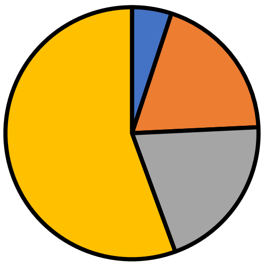
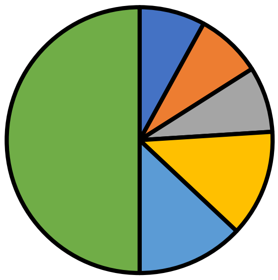
6.1 Biodiversity Ranking for all project types

The Global Tree C-Sink Standard integrates fundamental biodiversity and conservation principles into its basic project design criteria (see **Section 2.5.1 – Project Design Criteria**).

To further incentivize alignment with international sustainability goals, the standard provides additional criteria for achieving a biodiversity premium status. Therefore, projects that adopt more ambitious conservation and biodiversity-enhancing practices can qualify for a Biodiversity Ranking of Level II or Level III, represented respectively by two and three butterfly symbols (see **Table 5**).

- **To qualify for a Level II biodiversity premium, projects must fulfill the basic project design criteria for their type, as outlined in Section 2.5.1.**
- **To achieve a Level III classification, the project must meet both the Level II criteria and the additional requirements defined for Level III.**
- **Plantation (Monoculture) projects do not qualify for a biodiversity premium.**
- **Urban Tree projects are excluded from these criteria and may qualify for a biodiversity premium as indicated in Section 6.2: Biodiversity Ranking for Urban Tree Projects.**

Table 5. Biodiversity (B00) and nature conservation (C00) indicators for the Premium Levels II and III

Premium Level II Indicators additional to project design requirements		Premium Level III Indicators additional to level II	
B01	The management unit contains ≥ 4 tree species. The dominating tree species must cover less than 55% of the management unit or present less than 55% of the total number of trees planted in the management unit. Jointly, the **two dominating species** must represent less than 75%. To be recognized, each associate tree species must cover at least 3% of the management unit or present 3% of the total number of trees in the management unit. The project presents a minimal species composition as shown below:  It is not permitted to arrange the 4 species exclusively in segregated blocks. At least 30% of the management unit must constitute a mixed forest stand.	B04	The management unit contains ≥ 6 tree species. The dominating tree species must cover less than 50% of the management unit or present less than 50% of the total number of trees planted in the management unit. Jointly, the **three dominating species** must comprise less than 75%. To be recognized, each associate tree species must cover at least 3% of the management unit or present 3% of the total number of trees in the management unit. The project presents a minimal species composition as shown below:  It is not permitted to arrange the 6 species exclusively in segregated blocks. At least 60% of the management unit must constitute a mixed forest stand
B02	No synthetic pesticides are used in the management unit. (Herbicides, insecticides, fungicides, aborticides etc.)[2]. Organic pesticides are permitted. B02 is not applicable for agroforestry projects	B05	≥ 60% of the planted trees are native or naturalized to the region and regarded as climate resilient in the project area (referenced, scientific recommendation)
B03	In ≥10% of a management unit, trees are planted scattered, or in patterns other than straight lines, to improve protection from predators including humans. B03 is not applicable for agroforestry projects.	B06	≥5 % of the trees planted and maintained in a management unit represent endangered or near to threatened species according to the IUCN classification (red list). Eligible status: NT=Near Threatened, VU=Vulnerable, EN=Endangered, CR=Critically Endangered, EW=Extinct in the wild.
C01	The logging-protected area (defined in project design as conservation area) comprises at least 20% of the management	B07	In ≥30% of the project area, trees are planted scattered, or in patterns other than straight lines, to improve protection from predators

[2] Chemical pesticides may only be used in rare instances, such as when the entire tree planting project is at risk. If they are used, the certification body must be notified immediately. However, these pesticides should never be part of the standard management plan or used to protect Non-Timber Forest Products (NTFPs).

	unit. C01 is not required for the certification of agroforestry projects and for management units < 3ha.		including humans. B11 is not applicable for agroforestry projects.
C02	If partial clear cuts occur, the non-logged areas (between the clear cuts) must be spatially coherent (connected) with each other or with the conservation area as per C01 This is to provide larger core areas and longer connective corridors. C02 is not applicable for agroforestry projects.	B08	No chemical synthetic commercial fertilizers are used in the management unit. Organic fertilizers such as manure, compost, or biochar-based fertilizers are permitted. B08 is not applicable for agroforestry projects.
C03	If partial clear cuts occur, habitat trees must be maintained at > 5 trees/ha in the logged areas.	C04	The logging-protected area (defined in project design as conservation area) comprises at least 30% of the project area and is referred to as the conservation area of the management unit. C05 is not required for the certification of agroforestry projects and for management units < 3ha.

6.2 Biodiversity Ranking indicators for Urban Trees projects

Urban trees play a vital role in enhancing biodiversity, supporting local wildlife, and contributing to climate resilience in urban areas. To ensure that urban tree projects promote ecosystem and climate services, a modified biodiversity ranking system with context-specific indicators (see **Table 6**) is established.

For this project type, the additional criteria can be adapted to achieve a Biodiversity Criteria of Level II, in addition to its specific basic project design criteria in **Section 2.5.2**.

Table 6. Criteria for biodiversity in Urban Tree projects

Premium Level II  Indicators additional to project design requirements	
UB01	The management unit contains ≥ 10 tree species. Each species should not be less than 5% of the total number of trees planted.
UB02	At least 70% of the trees are native or well-adapted, considering climate resilience.
UB03	Additional features like deadwood retention, insect hotels, or bird nesting aids are present in at least 30% of the Management Unit

UB04	At least five flowering tree species or fruit-bearing species are included to support biodiversity.
UB05	Species selection and planting density are optimized for climate regulation impact.
UB06	The project incorporates advanced water management techniques e.g. rainwater harvesting or natural infiltration.
UB07	The project enhances ecological connectivity by enabling species movement, resting or breeding. E.g. birds, pollinators, or other small animals.

7 Carbon accounting

The Global Tree C-Sink Standard does not prescribe specific technologies for monitoring tree growth. Instead, it sets performance criteria for accuracy and precision, encouraging technological innovation and allowing methods tailored to project-specific conditions. Approved carbon monitoring approaches may include, but are not limited to:

- Single-tree tracking;
- Digital twin modeling;
- Grid-cell–based monitoring of CO_2 fluxes via satellite data;
- Correlation of carbon stock with canopy elevation; and
- Light Detection and Ranging (LiDAR) techniques.

These and other technologies may be used individually or in combination, provided they meet the quality requirements and are verified by Carbon Standards prior to application.

Only monitoring approaches approved by Carbon Standards International are eligible for use in Global Tree C-Sink projects. A general description of the approved methods is provided on **Annex I – Accredited dMRV approaches for carbon accounting**.

The process of approval of a specific approach or technology and its authorized operation in a digital Monitoring, Reporting, and Validation (dMRV) system is completed through the Endorsement of dMRV Service Provider for Tree C-Sink Projects. More information is available in the guidance document for **Endorsement of a dMRV** by Carbon Standards International.

7.1 Basic requirements for the monitoring approach

Carbon monitoring approaches must meet the following requirements:

- **Context-Specific Accuracy**: Methods must yield results within ±10% accuracy across their validated spatial scale (e.g., tree, hectare, or grid cell) and must be calibrated against empirical ground data.
- **Digitalization**: To increase reliability and minimize human error, monitoring processes should be as automated and digitized as feasible. The use of digital Monitoring, Reporting, and Verification (dMRV) applications is required.
- **Full Spatial Coverage**: dMRV methods must monitor 100% of the project area. Extrapolation from sample plots is not permitted and all C-Sink certifications must be grounded in empirical measurements.

- **Minimum Temporal Resolution**: The method must provide the technical capability and economic feasibility to monitor the entire project area at least every 5 years. This could mean measuring the entire area every five years or evaluating, e.g., 20% of the area each year.

Each monitoring protocol must be submitted to Carbon Standards for approval and will undergo an annual renewal process. While proprietary technologies are protected, a general description of the measurement method and applications must be publicly disclosed.

7.2 Expected C-Sink Curve

The Expected C-Sink Curve is a key component of project planning under the Global Tree C-Sink Standard. It provides a scientifically grounded estimate of carbon sequestration (CO_2e) over time for a given project and is intended to support transparency, early-stage investment, and performance monitoring.

While the Expected C-Sink Curve does not generate certifiable carbon credits or tradable units, it constitutes a scientifically grounded projection of anticipated climate benefits, supporting informed decision-making and stakeholder engagement during the early stages of project development including pre-purchases.

Expected C-Sink Curves must be submitted for endorsement by Carbon Standards International and updated at least every five years, incorporating the latest empirical data collected through the dMRV system. This endorsement must be done in parallel to the endorsement of the dMRV system.

Once endorsed, the curve is entered into the Global C-Sink Tool and displayed in the C-Sink Registry for the first ten years of the project. These expected removals are labeled as the expected quantity (CO_2e) and are shown alongside actual certified carbon removals.

7.2.1 *General requirements for Expected C-Sink Curve endorsement*

To be eligible for endorsement, the Expected C-Sink Curve must:

- **Be project-specific and realistic** by reflecting actual conditions in the project's geographic and ecological context;

- **Be methodologically transparent** and provide clear documentation of the modeling assumptions and sources;

- **Provide calculations at the CSU level**, with an explanation of how the data is aggregated; and

- **Use verifiable data and equations** and provide enough information on allometric equations, tree species-specific growth models, and documented assumptions.

7.2.2 *Required technical documentation*

For the endorsement of the expected C-Sink curve, as supported by the dMRV system, the following documentation must be submitted:

i) A technical documentation or Standard Operating Procedure (SOP) describing:

   a. Aggregation of calculations in the Management Units (MU) and associated CSUs;
   b. Tree species composition;
   c. Planting density, and assumptions on mortality, harvest, and replanting;
   d. Modeling methods, including allometric equations with references;
   e. Data sources, model period, and any extrapolation techniques used;
   f. A flowchart of the calculation approach; and
   g. Justification of any security margins applied.

ii) Supporting files:
   a. Spreadsheets or software outputs showing detailed Expected C-Sink results; and
   b. Raw datasets and calculation scripts (where applicable).

For a consistent formatting, all files must be labeled according to the IDs assigned to the Project, MUs, and CSUs.

7.2.3 *Evaluation and Endorsement Process*

The endorsement of the Expected C-Sink Curve for the projects is completed in the following steps:

i) Submission of the Expected C-Sink Curve protocol and data by the -Sink Manager or dMRV provider;

ii) Review for methodological adequacy, data quality, and format compliance;

iii) Iterative feedback and correction if needed;

iv) A final endorsement audit, leading to the endorsement of the Expected C-Sink Curve;

v) An update of the calculations with empirical data every 5 years; and

vi) Re-endorsement of the Expected C-Sink Curve after update.

7.3 Soil organic carbon

If all requirements related to lang eligibility, project design, and sustainable managemnt are met, degradation of soil organic carbon (SOC) is not anticipated. Therefore, SOC monitoring is not mandatory.

SOC-based C-Sinks may become certifiable in the future, either as a separate Standard or integrated into tree-based dMRV systems.

Projects seeking SOC certification under third-party schemes must submit an authorization request to Carbon Standards.

7.3.1 *Net removal calculation*

The net removals of the project are calculated annually by assessing the change in certified carbon stock between two reporting years, and adjusting for leakage where applicable.

Under the Global Tree C-Sink Standard, the GHG emissions associated with project activities (see **Chapter 8**) must be fully offset by long-term geological carbon sinks acquired in the Global C-Sink Registry. Specifically, fossil CO_2 and N_2O emissions must be offset using long-term carbon storage solutions (e.g., the PAC fraction of soil-applied biochar), while significant CH_4 emissions can only be compensated by an equally sized global cooling effect. This ensures that emissions with a long-term impact are also compensated for by a permanent C-sink (See **Section 9.7**) before a temporary C-sink is registered.

The net removals in year *t* are then calculated using the following formula.

$$\boldsymbol{Net\ Removals\ t\ (tCO2e)} = [C_t - C_{t-1}] - L$$

Where:

- C_t = Carbon stock in year *t* (tCO_2e) determined by the accredited dMRV system
- C_{t-1} = Carbon stock in previous year *t* (tCO_2e) or considered zero in the year 0, if demonstrated, or calculated accordingly (see **Section 3.2 - Baseline Carbon Stock**).
- L = Leakage (tCO_2e) – emissions outside the project boundary caused by the project considered zero, if demonstrated, or calculated accordingly (see **chapter 5 - Leakage**).

Uncertainty in carbon stock measurement is accounted for through a conservative security margin, discounted from the carbon stock calculation in the monitoring approach.

8 Project GHG Emissions

Accurate accounting of project greenhouse gas (GHG) emissions is essential for determining the net climate impact of the Tree C-Sinks.

Project GHG emissions attributed to project-related activities must be tracked throughout the implementation period, calculated accordingly (See Table 7), and reported annually using the Emission Portfolio in the Management Unit Report (MUR). The GHG emissions associated with project activities must be fully offset by long-term geological carbon sinks acquired in the Global C-Sink Registry.

8.1 Project activities

The GHG emissions attributed to following activities must be monitored and recorded:

- **Land preparation**: If the project adheres to the land-use criteria outlined in **Section 2.5.3** and the sustainable management practices mentioned in **Section 2.5.5** (which includes the conversion of bushland, but no deforestation, no drainage, no inversive tillage, no burning, etc.), then significant emissions from land-use conversion are unlikely. The C-Sink Manager is only required to keep a record of fuel consumption (both diesel and gasoline) and electricity usage during the land preparation and planting stages. This also includes the transportation and handling of materials, such as seedlings, saplings, and debris.

The carbon content of removed biomass does not constitute a carbon expenditure.

- **Forest management:** The C-Sink Manager is obligated to record fuel consumption (diesel/gasoline) and electricity usage throughout forest management activities. This includes tasks such as trimming, pruning, thinning, liberation, mowing, spraying, irrigation, transportation/ travel, and monitoring surveys.

- **Fertilization:** The project needs to record the total quantity of mineral/synthetic nitrogen (N), phosphate (P), and potassium (K) – commonly referred to as NPK – fertilizers, as well as any lime applied within the project area.

- **Harvest:** The project is required to record the fuel consumption (diesel/gasoline) and electricity used during harvesting operations, which includes the operation of chainsaws, full harvesters, transport trucks, bulldozers for road construction, among others

- **Transportation:** Documentation is necessary for the transportation of workers to the project site, along with associated fuel (diesel/gasoline) consumption.

- **Electricity:** C-Sink Managers are urged to transition from fuel-powered machinery to those operated by electricity or renewable fuels. Any consumed electricity should ideally be sourced from renewable means, and evidence of its origin is essential. All electricity and renewable fuels consumed must be accurately documented, inclusive of their carbon footprint. The use of electricity generated from renewable sources, such as solar or wind, should be explicitly reported.

Table 7. Emission conversion factors for scope 1, scope 2 and fertilizer usage

Input	CO2 equivalent	Reference

1 l diesel	0.00269 t CO_2e	EPA (2023)
1 l gasoline	0.00235 t CO_2e	EPA (2023)
1 kg synthetic N (in N fertilizer)	0.01 t CO_2e	Walling and Vaneeckhaute (2020)
1 kg P2O5 (Ammonium phosphate)	0.0089 t CO_2e	Walling and Vaneeckhaute (2020)
1 kg P2O5 (single super phosphate)	0.001 t CO_2e	Walling and Vaneeckhaute (2020)
1 kg P2O5 (triple super phosphate)	0.0016 t CO_2e	Walling and Vaneeckhaute (2020)
1 kg K2O	0.0025 tCO2e	Walling and Vaneeckhaute (2020)
1 t industrial lime	0.45 t CO_2e	EEA (2016)
1 kWh	*variable* tCO_2e kWh^{-1}	Use national factor
1 t km transport	0.111 t CO2e t km^{-1}	UBA (2022)

When contractors are employed for the transportation or operation of heavy machinery, fuel consumption might not always be directly recorded. In such instances, documenting the operational hours is essential. As a reference, one hour of operation for a tractor or truck equivalent is estimated to consume 12 liters of diesel.

At the end of each reporting period, the C-Sink Manager must compile all fuel and electricity use, fertilizer application, and transportation records using supporting evidence such as logbooks, receipts, and operation hours. These inputs must then be integrated into the Emission Portfolio of the Management Unit Report (MUR).

8.2 Ex-post documentation and reporting of the project GHG emissions.

Once all activity inputs (see **Section 8.1**) are collected for a Management Unit, the project's Emission Portfolio (EP_{MU}) is calculated using the following equation:

$$EP_{MU}\ (\mathrm{tCO_2e\ year^{-1}}) = (\mathrm{annual\ scope\ 1} + \ \mathrm{scope\ 2\ emissions\ (tCO_2e)}) * 1.1$$

This calculation includes Scope 1 and Scope 2 emissions and applies a 10% safety margin to conservatively account for indirect or miscellaneous Scope 3 emissions.

The Emission Portfolios of each Management Unit (MU) must be aggregated to form the **Project Emission Portfolio**, which is submitted to Carbon Standards International as part of the Tree C-Sink registration process.

The entire emission documentation, including raw records, logs, and MURs, must be retained by the C-Sink Manager for a minimum of 10 years. This documentation is subject to review during validation and verification by the Validation and Verification Body (VVB).

All emission reported in the Project Emission Portfolio must be fully offset by long-term geological carbon sinks, such as the PAC fraction of biochar, as a precondition for C-Sink registration.

9 Monitoring, Reporting, and Verification

9.1 Monitoring Plan

The Tree C-Sink Manager is required to submit a monitoring plan during validation / verification. This plan must outline how tree planting activities, growth measurements, and associated project variables will be monitored throughout the project duration.

The monitoring plan should describe the frequency and methods for assessing tree survival, species composition, carbon stock development, and compliance with biodiversity and land-use requirements. It must also specify how monitoring will be implemented at the C-Sink Unit and Management Unit level.

The monitoring plan must include a clear schedule of field inspections, responsibilities of field staff or technical partners, and procedures for compiling and reviewing monitoring data before submission to Carbon Standards. Any anticipated challenges (e.g., seasonal access, poor internet connectivity) and how these will be addressed should also be explained.

The monitoring plan is evaluated by the Validation/Verification Body (VVB) during project validation and must be updated as needed throughout the project lifecycle.

The monitoring plan must be developed in alignment with the approach and technologies of the endorsed dMRV Provider for the Global Tree C-Sink project.

9.2 Internal Control System

An Internal Control System (ICS) is a key component of the project's quality management system. It ensures that all project activities are implemented according to the requirements of the Global Tree C-Sink Standard, and that data reported through the monitoring system is reliable, consistent, and verifiable.

The ICS serves as a supportive tool for Tree C-Sink Manager to implement internal checks and quality controls. The Validation/Verification Body (VVB) will evaluate the ICS during validation and verification along with the Project Description Document.

The Tree C-Sink Manager must develop and maintain an ICS that includes:

i) A description of internal roles and responsibilities;

ii) A system for regular internal inspections (including frequency and scope);

iii) Documentation procedures (e.g., plot registration, training records, and tree inventories);

iv) A list of producers and maps detailing all participating plots, tree species, planting years, and inspection history;

v) Protocols for identifying, documenting, and addressing non-conformities;

vi) A process for training internal inspectors and field staff;

vii) Data management procedures, including backups, version control, and security; and

viii) Procedures for record-keeping and updates to the Global C-Sink Registry;

A more complete guidance for integration of the ICS is provided by the VVB during the validation phase.

9.3 Project documentation

To ensure that Tree C-Sink projects are implemented in line with the principles of transparency and high integrity, two key documents must be submitted for completing the validation and verification processes: the Project Design Document (PDD) and the Management Unit Report (MUR).

9.3.1 *Project Design Document (PDD)*

The PDD provides a high-level overview of the entire project and forms the basis for its validation with the Global Tree C-Sink Standard. It compiles essential information about the project's design, objectives, and expected carbon removals, including:

i) Project type and spatial layout: including afforestation, urban trees, or agroforestry, alongside mapping and delineation of the Management Units (MUs) and their C-Sink Units (CSUs);

ii) Baseline and additionality assessment: clarifying how the project exceeds a "business-as-usual" scenario through ecological, regulatory, and carbon removal additionality;

iii) Management and monitoring plans: describing land preparation, fertilization, harvest and replanting strategies, safety measures, and social safeguards;

iv) Carbon accounting and dMRV system: detailing the digital Monitoring, Reporting, and Verification system used, its service provider, and integration with the Global C-Sink Registry;

v) Estimation of carbon removals: presenting the expected C-Sink Curve and standard equations used to estimate climate services; and

vi) Public consultation and stakeholder engagement: documenting stakeholder involvement and responses during the consultation period.

9.3.2 *Management Unit Report (MUR)*

The MUR serves as an annex to the PDD and offers a detailed overview of the important data for each Management Unit. This report is critical for operational validation and includes:

i) **Location-specific data:** GPS coordinates, size, land ownership documents, and Free, Prior, and Informed Consent (FPIC) where required;

ii) **Land eligibility and historical land use**: using satellite imagery and land classification to confirm the absence of recent forest cover and ensure suitability for afforestation;

iii) **Detailed planting and biodiversity plans:** outlining species composition, origin, planting density, biodiversity indicators, and ecological management practices at the unit level; and

iv) **Emission tracking and C-Sink accounting:** providing a template for data on activity emissions (Emission Portfolio), biomass accumulation, and expected carbon stock per CSU, aligned with dMRV outputs.

The dMRV provider may generate a custom export for individual MUs, provided it includes the same or more information as the MUR template.

9.4 Global C-Sink Registry (C-Sink Unit)

The relevant data for registration of carbon removals is reported at the C-Sink Unit (CSU) level, as defined on **Sections 2.2 and 2.3**. All C-Sink Units must be monitored using an endorsed dMRV system, which enables precise tracking of removals, centralized database management by the C-Sink Manager, and automated data exchange with the Global C-Sink Registry.

Each C-Sink Unit must meet the following registration and integration requirements:

iii) The maximum size of a C-Sink Unit is 10 hectares at the time of project initiation;

iv) Boundaries of each CSU must be clearly defined and mapped;

v) Each CSU must be assigned a unique certificate ID;

vi) The CSU must be linked to its corresponding Management Unit (MU), with boundaries and hierarchical relationships clearly established;

vii) All CSUs must be entered into the Global C-Sink Registry with accurate GPS coordinates and the total certified carbon removals (in tCO2e); and

viii) Each CSU must include a deep link (URL) to its corresponding entry in the dMRV system for reference by CSI and the Verification/Validation Body (VVB).

To ensure accurate data integration, the dMRV system must transmit the following parameters for each CSU during the defined monitoring period:

iii) Carbon removals (tCO2e), Carbon stock (t C), and Biomass (t);

iv) GHG emissions associated with project activities;

v) Updated Management Unit identification;

vi) Updated GPS coordinates (minimum 5 decimal places, e.g., 14.12345 / 8.12345); and

vii) Time stamps, including time zone, transaction ID, and other metadata

9.5 On-site Audit (Verification)

Following the successful validation of the Project Design Document (PDD), an on-site audit is required to verify that the project has been implemented in full compliance with the validated documentation.

An initial on-site audit is mandatory for the completion of the first verification cycle. For subsequent verification cycles, remote audits may be permitted at the discretion of the VVB, provided that:

i) High-quality monitoring data is available; and

ii) No irregularities or inconsistencies are identified in previous audits or reports.

After the initial verification, follow-up audits must be conducted at least once every five years for each individual MU.

9.6 C-Sink Certificate Issuance

For the issuance of certified C-Sinks, the following requirements must be met:

i) A random sample of at least 5% of the Management Units must be inspected annually;

ii) The C-Sink Manager must provide annual aerial imagery for all MUs. These must include timestamps and geolocation, captured by drone (or equivalent technology) at altitudes ≤100 meters above the canopy (see **Figure 2**);

iii) Visual records will be made publicly available in the Global C-Sink Registry;

iv) Upon successful verification, certified C-Sinks must be quantified ex-post using an accredited carbon accounting method via the endorsed dMRV system. These methods must be based on empirical data with high spatial and temporal resolution; and

v) Although the minimum verification frequency is once every five years, annual dMRV monitoring is strongly recommended to enable continuous certification and trading.

Figure 2. *Aerial photograph taken at 250 m altitude. The yellow square indicates an area of one hectare for reference. Retrieved from Google Earth (2023).*

9.7 Temporary Offsetting

The global warming effect of a discrete CO2 emission decreases exponentially. It is highest during the first 20 years, only 36% after 100 years, but still 15% after 1000 years and 5% after 10'000 years. The global warming effect of CO2 emissions persists for thousands to millions of years. It is something that cannot be undone except when actively removed from the atmosphere and sequestered forever, which means that it fossilizes or mineralizes in the realm of geology. To offset the global warming effect of a specific CO2 emission, an equal amount of CO2 must be removed from the atmosphere and stored without leakage for as long as humans participate in the making of history.

Temporary C-sinks that only persist for decades or centuries cannot fully offset CO2 emissions, or otherwise said, cannot make them unhappen. They can, however, temporarily offset the global warming effect of an emission for the years, decades or centuries that they persist. To avoid accelerating climate change, climate action must start immediately. Solely focusing on geological "forever" C-sinks to offset emissions once and forever would delay climate effects and risk trespassing the climate tipping points that render all future action more challenging.

Tree-based C-Sinks have a dynamic nature. Their carbon stock increases during their growth, but the accumulated carbon is vulnerable and can be released at any point due to unforeseen events such as fires, pests, natural disasters, or anthropogenic activities. Furthermore, post-harvest practices play a significant role in determining whether this carbon remains sequestered or is released back into the atmosphere.

Given the temporal nature of tree-based C-Sinks, guaranteeing long-term carbon sequestration exceeding centuries is not feasible. This inherent unpredictability renders tree-based C-Sinks unsuitable for fully offsetting CO2 emissions, or, in other words, for making the global warming effect of a CO2 emission disappear once and forever. Tree-based C-Sinks are temporary and can temporarily offset the global warming effect of an emission for the years, decades, or centuries that the C-sink persists.

Temporary C-sinks have, during their existence, the same climate effect as geological C-sinks of the same size. A C-sink that persists for only 10 years has, during these 10 years, a global cooling (= negative global warming) effect as large and efficient as a C-sink that may persist for a thousand years.

Tree-based C-Sinks provide immediate climate benefit and value in terms of climate regulation, ecosystem services, and as part of a comprehensive strategy towards a sustainable and resilient environment. However, the climate service ends immediately when the carbon captured from the atmosphere is released and emitted back into the atmosphere. In the concrete case of the certified tree, this would be the case when the tree burns in a forest fire or falls down in a storm and decays on the forest floor or is felled, chipped, and combusted for energy purposes.

Temporary offsetting is quantified in units of t aCO2e (pronounced as "ton annually stored CO2 equivalent"). To clarify, 1 t aCO2e signifies the physical sequestration of carbon corresponding to the removal of 1 t CO2e from the atmosphere, sustained over an annual period. Thus, a C-Sink sequestering 100 t CO2e over a decade possesses the capacity to offset the global warming effect of a 100 t CO2e emission for those ten years. After those ten years, the initially emitted CO2 continue to cause the same global warming effect if no other C-Sink is provided to offset the emission's warming effect (i.e. a harvested tree must be replaced by another equally sized tree).

Temporary carbon sinks are an essential component of climate change mitigation. They are more readily available, while long-term carbon sinks cannot yet be deployed at scale due to ongoing technological development and insufficient supply of renewable energy.
The Global Tree C-Sink certificates operate on evidence-based accreditation. Only after the CO2 has been conclusively extracted from the atmosphere, duly measured, and verified (ex-post), will the temporary offset be certified. This ensures the integrity of each certificate, safeguarding the trust of all stakeholders involved.

However, recognizing the financial constraints and challenges associated with afforestation and other C-Sink projects, provisions are available for C-Sink Managers. These managers can establish pre-purchase agreements or sell C-Sink Options linked to anticipated future C-Sink. Such arrangements can serve dual purposes: to secure the necessary initial capital for kick-starting the projects and to foster broader market engagement. It's a forward-looking approach that balances the immediate financial needs of projects with the overarching goal of carbon sequestration and global cooling.

9.8 C-Sink Options / Pre-Purchase Agreements

Pre-purchase agreements form a critical component of the financial scaffolding that can support the early stages and ongoing management of C-Sink projects.

Definition and Basis: Pre-purchase agreements are essentially contracts where the buyer agrees to purchase a certain amount of C-Sink Options from a C-Sink project at a predetermined price, even before the C-Sink has been certified. These agreements are based on "certified expected C-Sink curves," as outlined in **Section 7.2**, which provide a forecasted trajectory of how much carbon the project is anticipated to sequester over time.

Risk Management and Duration: The dynamic nature of tree-based C-Sinks brings inherent risks, as the amount of carbon sequestered can be influenced by various unforeseen factors such as pests, fires, or other natural hazards. To manage these uncertainties and safeguard both buyers and C-Sink Managers, the Global Tree C-Sink recommends a prudent approach: limiting the duration of these C-Sink Options to a maximum of 10 years into the future. This decade-long span strikes a balance between giving projects the forward-looking financial assurance they need and ensuring that the commitments remain within a reasonably foreseeable time-frame.

Benefits:

i) **Financial Security for Projects:** With funds secured in advance, projects can plan their activities better, ensuring the necessary resources are available for tree planting, maintenance, and monitoring.

ii) **Attractive for Investors:** Buyers or investors get the advantage of locking in prices today for future C-Sinks, potentially securing favourable rates while supporting climate action.

iii) **Enhanced Trust:** By sticking to a 10-year window, both parties can make more accurate predictions and commitments, building trust in the system.

In conclusion, while C-Sink Options provide an essential financial instrument for the growth and sustainability of C-Sink projects, they must be approached with caution, foresight, and mutual understanding of the associated risks and rewards.

10 References

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Annex 1: Accredited dMRV approaches for carbon accounting

A.1 The single tree tracking approach

The Global Tree C-Sink allows digital *single-tree tracking as a dMRV approach* for every certified project. An updated list of all technologies endorsed for this specific method is readily accessible online.

Single-tree tracking not only facilitates an empirical data-based evaluation of biomass-bound carbon stocks but also provides an unparalleled advantage in carbon stock tracking. It offers a high spatial resolution combined with a high temporal frequency, such as annual measurements. Using this approach, the computation of a C-Sink typically follows the methodology outlined in Figure A1 below.

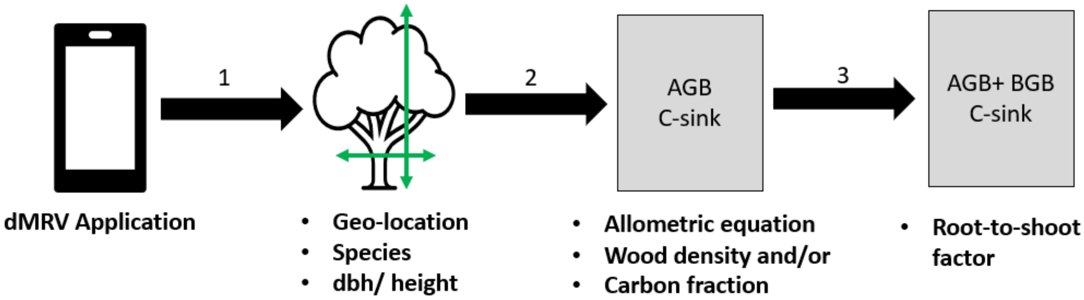

Figure A1. *Carbon sink calculation using dMRV applications for single-tree tracking. Step 1: An accredited dMRV application is utilized to monitor a single tree and calculate its current carbon sink. The dMRV application determines the trees' geolocation, species, and morphological parameters such as diameter at breast height and/or tree height. Step 2: The dMRV application employs the recorded morphological parameters in an allometric equation specific to the identified species and climate zone of the geolocation. The allometric equation calculates the trees' above-ground biomass in mass or volume. A further multiplication with the species-specific wood density (d) and/or carbon fraction (c) yields the C-Sink of the above-ground biomass. Some equations already calculate the trees' total biomass including below-ground biomass, these formulas are also permitted. In such cases, step 3 is omitted. Step 3: The calculated above-ground biomass is multiplied by a species-specific root-to-shoot factor (r), calculating the carbon sink of the total biomass (above-ground & below-ground biomass). Lastly, the total C-Sink can be translated into CO2e using a conversion factor of 44/12.*

Single-tree tracking approaches hinge on allometric equations. These equations are mathematical formulations derived from a regression analysis between tree morphology (the independent variable) and its biomass (the dependent variable). The outcomes of an allometric equation, that is, the tree biomass as the dependent variable, can be represented in either volume or mass. Such equations may utilize the tree's diameter at breast height (DBH) and/or its height as input parameters. Importantly, the units for DBH and height—whether in cm or m—should adhere to the original publication's specifications for the allometric equation in use. The resultant output of this equation can either be Above-Ground Biomass (AGB) or the Total Tree Biomass (TTB), which includes root biomass. For further standardized computations, as delineated in Table1 below, any output should be converted to t biomass or m^3 biomass as required.

Table A1. Overview of C-Sink calculations based on output from allometric equations

	Allometric equation calculating the AGB	Allometric equation calculating the TTB
Unit of equation output		
t biomass dry weight	$AGB * r * c * \frac{44}{12}$	$TTB * c * \frac{44}{12}$
m^3 biomass	$AGB * r * d * c * \frac{44}{12}$	$TTB * d * c * \frac{44}{12}$

AGB = Above ground biomass in m^3 or t calculated using an allometric equation.
TTB = Total tree biomass in m^3 or t calculated using an allometric equation.
r = Root to shoot factor (factor > 0) resolution: One decimal
d = Wood density in t m^3 (factor > 0) resolution: Two decimals
c = Carbon fraction (factor > 0 and <1) resolution: One decimal
44/12 = Factor converting t C in t CO_2e

Generally, the single tree tracking approach is technology open, not specifying how single-tree tracking based dMRV must be realized, yet it defines criteria that need to be met by the dMRV application facilitating data collection and C-Sink calculation as per the general formulas outlined above. Companies, NGOs, or other entities can apply at Carbon Standards International for the accreditation of their single tree tracking technology to be employed under the Global Tree C-Sink.

A.2 Operating principles

Emerging dMRV tools enable the cost-effective monitoring of individual trees, even in spatially large projects. Single-tree tracking approaches under the Global Tree C-Sink require tracking of each single tree established by the project in the project area. Only C-Sinks from empirical measurements can be certified. The sampling and extrapolation from sampling plots or reference areas are not permitted.

Single-tree tracking is based on digital applications (smartphones, drones, satellites, etc.) that:

i) Automatically or manually localize an individual tree and record its GPS coordinates (usually based on georeferenced smartphone photographs)[3].
ii) Automatically or manually[4] identify the tree species.
iii) Automatically assess relevant morphological data of each single tree (diameter and/or height).
iv) Automatically employ the assessed morphological data in an allometric equation, specific to the tree's geolocation (climate zone) and botanic species to calculate the tree volume/mass.

[3] **Automatically:** Trees are located using supervised classification algorithms, which interpret data sources such as drone imagery. **Manually:** Individuals in the field physically locate and record trees using a dMRV application. In either approach, GPS coordinates must be automatically assigned to each tree.

[4] Automatically = automatic classification by supervised algorithms interpreting, e.g., tree bark pattern. Manually = manual input of tree species (or selection form list) in dMRV application interface.

v) Automatically calculate the tree's AGB (or TTB) and consecutively the C-Sink based on volume/mass and species-specific wood density and wood carbon content as stored in an associated database.
vi) Automatically calculate the TTB including the below-ground biomass (BGB) using species and climate zone-specific root-to-shoot factors (only applicable if allometric equation calculates only AGB).
vii) Automatically enter the tree and the calculated C-Sink time- and georeferenced data into a project database linked to the correct C-Sink unit ID. The C-Sink Manager must retain the single tree data for at least 10 years.
viii) Once per year, the aggregated C-Sink values for each C-Sink unit must be reported through an API Interface to the Swiss Carbon Registry. This data transfer also includes C-Sink type, geolocation, and time-stamp of measurement.

Tree identification, including their species, can be either manually entered by individuals into a digital application or automatically determined using artificial intelligence. Specifically, this involves sophisticated algorithms designed for supervised classification. Beyond identification, all subsequent steps — assessing tree morphology and calculating its C-Sink — are fully automated. This minimizes potential human errors. Digital documentation, calculation, data storage, and transmission are crucial components of this process.

For areas that are remote or situated in hilly terrains where traditional network reception may be unreliable, alternative solutions such as Starlink, Kuiper, or IRIS2 can be utilized. Another option is to store data locally and delay its transmission. Similarly, in these regions, if there's difficulty accessing GPS, Glonass, Baidou, or IRNESS signals, a rover or a reference antenna positioned at a known location can be employed.

A.3 Required functionalities.

Geolocation

The geolocation of an individual tree must be captured with an accuracy of less than 10 meters, adhering to the World Geodetic System (WGS1984). For improved accuracy, Galileo is recommended over GPS. All trees must be located within the polygon that defines the C-Sink unit. This polygon, outlining the project management unit or C-Sink unit should be demarcated with an accuracy of less than 5 meters. In dense forest areas, achieving this precision might necessitate the use of internal GPS systems or reference antennas[5].

Individual trees must be trackable and re-identifiable in the field. This can be achieved through various means:

i) Achieving high GPS accuracies, for instance, by using a rover.
ii) Combining tree mapping with pattern recognition algorithms.
iii) Implementing tree labeling methods such as paint, lables, QR codes, RFID, NFC, AirTag, etc.

From the fifth year following the initial tree planting in any project, it's imperative that each tree can be tracked and re-identified. However, for the initial four years, recording (or counting) all trees as stipulated by the dMRV application suffices, without the specific need for single-tree tracking.

[5] Used in, e.g., CTFS global forest plots: http://ctfs.si.edu/ctfsweb/index.php/auth/login

It's crucial to note that any trees recorded outside the designated polygon marking the boundaries of the project area or its sub-management unit will not be eligible for certification.

Allometric equations - Conditions for the accreditation and ranking of allometric formulas.

Allometric equations must be sourced from scientific, peer-reviewed literature. Any relevant literature should be submitted to Carbon Standards for verification. If the equation is taken from secondary literature or a database, it's essential to cross-reference with the original publication and make corrections if necessary.

Should there be a need to create new allometric formulas, they should strictly adhere to guidelines provided in the "Manual for building tree volume and biomass allometric equations: From field measurement to prediction" (accessible at [http://www.globallometree.org/]) or any other manual approved by Carbon Standards. It's essential that all primary data used in constructing an allometric equation undergoes a thorough plausibility check.

Furthermore, the allometric equation must specifically relate to a tree species, identified both by its genus and species epithet. Additionally, the equation must have a defined range of validity for its independent variable, detailing the minimum and maximum values for DBH or height. These boundaries are determined based on the empirical dataset from which the equation is derived[6]. It's of utmost importance that the dMRV application strictly adheres to these specified ranges of validity.

The following table distinguishes three quality levels of allometric formula precision:

[6] If a tree with DBH < min. DBH is recorded the recorded DBH must be automatically corrected to 0, implying a C-Sink of 0 tCO_2e. If a tree with DBH > max. DBH is recorded the DBH must be automatically corrected to max. DBH before further calculation of the C-Sink.

Table A2. Quality levels of allometric formula precision.

			
Geographic/ climatic calibration range.	The allometric equation is generated as per paired samples from the same climate zone[7] as the project location.	The allometric equation is generated as per paired samples from the same county as the project location.	The allometric equation is generated as per paired samples from the project location.
Training Dataset	Comprises ≥ 10 paired samples. The independent variable follows a normal distribution or is systematically covering a range.	Comprises ≥ 15 paired samples. The independent variable follows a normal distribution or is systematically covering a range.	Comprises ≥ 20 paired samples. The independent variable follows a normal distribution or is systematically covering a range.
Regression coefficient (or equivalent measure of statistical error)	≥0.90	≥0.90	≥0.95

Training of supervised classification algorithms

If algorithms are used for automatic tree identification, as opposed to manual classification by qualified operators, they must be rigorously trained and verified.

Machine learning that facilitates supervised classification, specifically to discern tree species from features like bark patterns or canopy reflectance curves (spectroscopy), requires robust validation. This validation should be anchored against field data for each species, with a minimum of n=100 replicates, and must achieve an accuracy exceeding 90% for correct species determination. This is paramount even in diverse forest compositions.

For greater flexibility and accuracy, it's permissible to employ a hybrid approach. This would entail automatic classification for more prevalent species combined with manual classification for those that are rarer, especially in instances where there aren't enough samples to effectively train the algorithm.

Validation of tree morphology measurements

Machine learning algorithms used to compute morphological tree parameters, such as DBH and/or height, must be cross-validated against field data. For each species, this validation should involve no fewer than n=100 replicates, and the accuracy should fall within a range of -10% to +5% when compared to manually measured tree diameters or heights.

[7] Differentiating between main climate zones according, e.g., to the Köppen-Geiger, FAO, or WWF classification system.

When reporting results, DBH should be presented in cm with one decimal point, and height should be expressed in meters with two decimal points where relevant.

A.4 Wood density, wood carbon content, and root-to-shoot factor

Just like the allometric equations, values for wood density, wood carbon content, and root-to-shoot ratios need to be tailored to the species and climate zone of the project context. These values should be derived from peer-reviewed scientific literature or from publicly accessible and well-referenced official databases. If neither is available, using the IPCC standard values is acceptable.

Additionally, as an alternative, a C-Sink Manager has the option to engage a Carbon Standards -accredited laboratory[8] to carry out analyses of wood densities and carbon contents. To ensure reliability, species-specific wood densities and carbon contents should be determined based on the average values from a minimum of 5 sampled trees per species and climate zone.

Root biomass

Below-ground biomass (BGB) carbon can be included in accounting and certification processes if monitoring systems utilize an allometric equation that accounts for total biomass. Alternatively, a species and climate zone-specific factor derived from scientific, peer-reviewed literature can be used to estimate the root-to-shoot ratio[9]. New root-to-shoot ratios can be derived from empirical measurements involving a minimum of five sampled trees for each species and climate zone. If these methods are not feasible, relying on the IPCC standard values for root-to-shoot ratios is acceptable.

It's important to note that when a tree is cut down, its BGB carbon count is reset to zero. This is due to the current limitations in accurately tracking the decay of BGB over time.

Documentation of tree harvesting

Any application designed for single tree tracking must incorporate a feature to document harvesting operations, ensuring accurate recording of the number of trees and associated carbon being removed[10]. Before felling a tree, operators use this feature to register/scan the tree.

The processes for tree registration, identification, and C-Sink calculations are consistent with those previously described. Once this function is used, the documented trees are excluded from the project's registry. Additionally, the total carbon value associated with these trees is subtracted from the value of the relevant C-Sink unit.

[8] Laboratories can contact CSI for further information on laboratory accreditation. A list of accredited laboratories will be provided online.

[9] IPCC values must be adequately referenced. The most case specific IPCC values must be used, i.e., don't use a global mean if there is a regional or species specific factor available.

[10] Given that regulatory C monitoring can occur at 5-year intervals, a distinct documentation process for harvesting operations is essential. Without this separate recording, trees that have been harvested might persist as "ghost trees" in the registry for up to five years, inaccurately reflecting cooling potentials that no longer exist.

This feature plays a pivotal role in:

i) Monitoring the carbon that has been removed (or remains) within a management unit;

ii) Reporting harvesting operations, which involves noting any reduction in a C-Sink unit's value to the Swiss Carbon Registry promptly (within a maximum of one month post-harvest); and

iii) Setting the base for tracking biomass bound carbon to its down-stream C-Sink, such as in certified biochar or buildings.

Box A1. Generic examples for single tree tracking dMRV approaches

Smartphone-based single tree tracking

A company managing a mixed afforestation project in Asia has introduced a smartphone-based application for individual tree tracking. When using this dMRV app, the field operator captures a photo of the tree trunk at breast height. During this process, the operator places a standardized reference plastic card against the tree trunk. The app, by comparing the relative size of the reference card in the foreground to the tree trunk in the background, automatically deduces the tree's diameter. Additionally, the tree's bark pattern aids the app in identifying the specific tree species.
Subsequently, the application employs the deduced tree diameter in a species-specific allometric equation to estimate the C-Sink. This computed C-Sink, paired with the identified species, is then linked with the tree's geolocation and a timestamp marking the moment of measurement. These recorded metrics are saved within a project-specific database which, in turn, connects to the Global Carbon Registry.

Drone-based single tree tracking

An enterprise has pioneered a dMRV system that harnesses a supervised classification algorithm, interpreting data from both multi-spectral imagery and LiDAR (Laser Imaging, Detection, and Ranging). This information is gathered annually by drones, which are deployed to map and consistently monitor the project's expanse.

Using LiDAR technology, the drone scans the project area's canopy, subsequently creating a detailed digital elevation model (DEM) of the terrain. Within this DEM, every local maximum (or peak) signifies a tree's crown. By referencing the position of the crown in this georeferenced dataset, the precise location of each individual tree can be ascertained and recorded. Moreover, by juxtaposing the height of these local maxima against a known ground reference point, the system can effectively compute the height of every individual tree.

The digital elevation model is synchronized with a multispectral image that encompasses near-infrared bands, captured by a different drone. This sophisticated classification algorithm can discern the spectral reflectance pattern characteristic of each tree crown, enabling it to correctly identify and assign a tree species to every distinct local maximum.

Following this, the deduced height of the identified tree is utilized within a species-specific allometric equation. This equation calculates the tree's C-Sink, and this computed value, in conjunction with the measurement date and precise geolocation, is securely stored in the project database.

Annex 2: Reference values carbon stock in naturally regenerated forests

Annex 3 A.1 of the IPCC Good Practice Guidance for LULUCF (IPCC 2003)

TABLE 3A.1.2
ABOVEGROUND BIOMASS STOCK IN NATURALLY REGENERATED FORESTS BY BROAD CATEGORY **(tonnes dry matter/ha)**

(To be used for Bw in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in Cropland section and for $L_{conversion}$ in Equation 3.4.13. in Grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3)

Tropical Forests [1]						
	Wet	**Moist with Short Dry Season**	**Moist with Long Dry Season**	**Dry**	**Montane Moist**	**Montane Dry**
Africa	310 (131 - 513)	260 (159 – 433)	123 (120 - 130)	72 (16 - 195)	191	40
Asia & Oceania:						
Continental	275 (123 - 683)	182 (10 – 562)	127 (100 - 155)	60	222 (81 - 310)	50
Insular	348 (280 - 520)	290	160	70	362 (330 - 505)	50
America	347 (118 - 860)	217 (212 - 278)	212 (202- 406)	78 (45 - 90)	234 (48 - 348)	60

Temperate Forests			
Age Class	**Coniferous**	**Broadleaf**	**Mixed Broadleaf-Coniferous**
Eurasia & Oceania			
≤20 years	100 (17 - 183)	17	40
>20 years	134 (20 - 600)	122 (18 -320)	128 (20-330)
America			
≤20 years	52 (17-106)	58 (7-126)	49 (19-89)
>20 years	126 (41-275)	132 (53-205)	140 (68-218)

Boreal Forests			
Age Class	**Mixed Broadleaf-Coniferous**	**Coniferous**	**Forest-Tundra**
Eurasia			
≤20 years	12	10	4
>20 years	50	60 (12.3-131)	20 (21- 81)
America			
≤20 years	15	7	3
>20 years	40	46	15

Note: Data are given in mean value and as range of possible values (in parentheses).

[1] The definition of forest types and examples by region are illustrated in Box 2 and Tables 5-1, p 5.7-5.8 of the *IPCC Guidelines* (1996).

TABLE 3A.1.3
ABOVEGROUND BIOMASS STOCK IN PLANTATION FORESTS BY BROAD CATEGORY (tonnes dry matter/ha)

(To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in equation in Equation 3.3.8 in Cropland section and for $L_{conversion}$ in Equation 3.4.13. in Grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3)

Tropical and sub-tropical Forests							
	Age Class	Wet	Moist with Short Dry Season	Moist with Long Dry Season	Dry	Montane Moist	Montane Dry
		R > 2000	2000>R>1000		R<1000	R>1000	R<1000
Africa							
Broadleaf spp	≤20 years	100	80	30	20	100	40
	>20 years	300	150	70	20	150	60
Pinus sp	≤20 years	60	40	20	15	40	10
	>20 years	200	120	60	20	100	30
Asia:							
Broadleaf	All	220	180	90	40	150	40
other species	All	130	100	60	30	80	25
America							
Pinus	All	300	270	110	60	170	60
Eucalyptus	All	200	140	110	60	120	30
Tectona	All	170	120	90	50	130	30
other broadleaved	All	150	100	60	30	80	30

Temperate Forests				
	Age class	Pine	Other coniferous	Broadleaf
Eurasia				
Maritime	≤20 years	40	40	30
	>20 years	150	250	200
Continental	≤20 years	25	30	15
	>20 years	150	200	200
Mediterranean & steppe	≤20 years	17	20	10
	>20 years	100	120	80
S. America	All	100	120	90
N America	All	175 (50–275)	300	–

Boreal Forests				
	Age class	Pine	Other coniferous	Broadleaf
Eurasia	≤20 years	5	5	5
	>20 years	40	40	25
N. America	All	50	40	25

TABLE 3A.1.4
AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

a. AFRICA

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Algeria	44	75	NI
Angola	39	54	NI
Benin	140	195	PI
Botswana	45	63	NI
Burkina Faso	10	16	NI
Burundi	110	187	ES
Cameroon	135	131	PI
Cape Verde	83	127	ES
Central African Republic	85	113	PI/EX
Chad	11	16	ES
Comoros	60	65	ES
Congo	132	213	EX
Côte d'Ivoire	133	130	PI
Dem. Rep. of the Congo	133	225	NI
Djibouti	21	46	ES
Egypt	108	106	ES
Equatorial Guinea	93	158	PI
Eritrea	23	32	NI
Ethiopia	56	79	PI
Gabon	128	137	ES
Gambia	13	22	NI
Ghana	49	88	ES
Guinea	117	114	PI
Guinea-Bissau	19	20	NI
Kenya	35	48	ES
Lesotho	34	34	ES
Liberia	201	196	ES
Libyan Arab Jamahiriya	14	20	ES

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

a. AFRICA (Continued)

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Madagascar	114	194	NI
Malawi	103	143	NI
Mali	22	31	PI
Mauritania	4	6	ES
Mauritius	88	95	ES
Morocco	27	41	NI
Mozambique	25	55	NI
Namibia	7	12	PI
Niger	3	4	PI
Nigeria	82	184	ES
Réunion	115	160	ES
Rwanda	110	187	ES
Saint Helena			
Sao Tome and Principe	108	116	NI
Senegal	31	30	NI
Seychelles	29	49	ES
Sierra Leone	143	139	ES
Somalia	18	26	ES
South Africa	49	81	EX
Sudan	9	12	ES
Swaziland	39	115	NI
Togo	92	155	PI
Tunisia	18	27	NI
Uganda	133	163	NI
United Republic of Tanzania	43	60	NI
Western Sahara	18	59	NI
Zambia	43	104	ES
Zimbabwe	40	56	NI

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

TABLE 3A.1.4

AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

b. ASIA

Country	Volume (aboveground)	Biomass (aboveground)	Infor-mation
	m³ / ha	t / ha	Source
Afghanistan	22	27	FAO
Armenia	128	66	FAO
Azerbaijan	136	105	FAO
Bahrain	14	14	FAO
Bangladesh	23	39	FAO
Bhutan	163	178	FAO
Brunei Darussalam	119	205	FAO
Cambodia	40	69	FAO
China	52	61	NI
Cyprus	43	21	FAO
Dem People's Rep. of Korea	41	25	ES
East Timor	79	136	FAO
Gaza Strip			
Georgia	145	97	FAO
India	43	73	NI
Indonesia	79	136	FAO
Iran, Islamic Rep.	86	149	FAO
Iraq	29	28	FAO
Israel	49	-	FAO
Japan	145	88	FAO
Jordan	38	37	FAO
Kazakhstan	35	18	FAO
Kuwait	21	21	FAO
Kyrgyzstan	32	-	FAO
Lao People's Dem. Rep	29	31	NI
Lebanon	23	22	FAO
Malaysia	119	205	ES
Maldives	-	-	-
Mongolia	128	80	NI
Myanmar	33	57	NI
Nepal	100	109	PI
Oman	17	17	FAO
Pakistan	22	27	FAO
Philippines	66	114	NI

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

b. ASIA (Continued)

Country	Volume (aboveground)	Biomass (aboveground)	Infor-mation
	m³ / ha	t / ha	Source
Qatar	13	12	FAO
Republic of Korea	58	36	NI
Saudi Arabia	12	12	FAO
Singapore	119	205	FAO
Sri Lanka	34	59	FAO
Syrian Arab Rep.	29	28	FAO
Tajikistan	14	10	FAO
Thailand	17	29	NI
Turkey	136	74	FAO
Turkmenistan	4	3	FAO
United Arab Emirates	-	-	-
Uzbekistan	6		FAO
Viet Nam	38	66	ES
West Bank	-	-	-
Yemen	14	19	FAO

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

c. OCEANIA

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Infor-mation Source
American Samoa			
Australia	55	57	FAO
Cook Islands	-	-	-
Fiji	-	-	-
French Polynesia	-	-	-
Guam	-	-	-

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

Table 3A.1.4 (Continued) Average growing stock volume (1) and aboveground biomass content (2) (dry matter) in forest in 2000. (source FRA 2000)

(1) To be used for V in Equation 3.2.3.
(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

c.OCEANIA (Continued)

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Kiribati	-	-	-
Marshall Islands	-	-	-
Micronesia	-	-	-
Nauru	-	-	-
New Caledonia	-	-	-
New Zealand	321	217	FAO
Niue	-	-	-
Northern Mariana Isl.	-	-	-
Palau	-	-	-
Papua New Guinea	34	58	NI
Samoa	-	-	-
Solomon Islands	-	-	-
Tonga	-	-	-
Vanuatu	-	-	-

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

Table 3A.1.4 (Continued) Average growing stock volume (1) and aboveground biomass content (2) (dry matter) in forest in 2000. (source FRA 2000)

(1) To be used for V in Equation 3.2.3.
(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

d. EUROPE

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Albania	81	58	FAO
Andorra	0	0	FAO
Austria	286	250	FAO
Belarus	153	80	FAO
Belgium & Luxembourg	218	101	FAO
Bosnia & Herzegovina	110	-	FAO
Bulgaria	130	76	FAO

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

Table 3A.1.4 (Continued) Average growing stock volume (1) and aboveground biomass content (2) (dry matter) in forest in 2000. (source FRA 2000)

(1) To be used for V in Equation 3.2.3.
(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

d. EUROPE (Continued)

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Croatia	201	107	FAO
Czech Republic	260	125	FAO
Denmark	124	58	FAO
Estonia	156	85	FAO
Finland	89	50	NI
France	191	92	FAO
Germany	268	134	FAO
Greece	45	25	FAO
Hungary	174	112	FAO
Iceland	27	17	FAO
Ireland	74	25	FAO
Italy	145	74	FAO
Latvia	174	93	FAO
Liechtenstein	254	119	FAO
Lithuania	183	99	FAO
Malta	232		FAO
Netherlands	160	107	FAO
Norway	89	49	FAO
Poland	213	94	FAO
Portugal	82	33	FAO
Republic of Moldova	128	64	FAO
Romania	213	124	FAO
Russian Federation	105	56	FAO
San Marino	0	0	FAO
Slovakia	253	142	FAO
Slovenia	283	178	FAO
Spain	44	24	FAO
Sweden	107	63	NI
Switzerland	337	165	FAO
The FYR of Macedonia	70	-	FAO
Ukraine	179	-	FAO
United Kingdom	128	76	FAO
Yugoslavia	111	23	FAO

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

e. NORTH AND CENTRAL AMERICA

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Antigua and Barbuda	116	210	ES
Bahamas	-	-	-
Barbados	-	-	-
Belize	202	211	ES
Bermuda	-	-	-
British Virgin Islands	-	-	-
Canada	120	83	FAO
Cayman Islands	-	-	-
Costa Rica	211	220	ES
Cuba	71	114	NI
Dominica	91	166	ES
Dominican Republic	29	53	ES
El Salvador	223	202	FAO
Greenland	-	-	-
Grenada	83	150	PI
Guadeloupe	-	-	-
Guatemala	355	371	ES
Haiti	28	101	ES
Honduras	58	105	ES
Jamaica	82	171	ES
Martinique	5	5	ES
Mexico	52	54	NI
Montserrat	-	-	-
Netherlands Antilles	-	-	-
Nicaragua	154	161	ES
Panama	308	322	ES
Puerto Rico	-	-	-
Saint Kitts and Nevis	-	-	-
Saint Lucia	190	198	ES
Saint Pierre & Miquelon	-	-	-

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

e. NORTH AND CENTRAL AMERICA (Continued)

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Saint Vincent and Grenadines	166	173	NI
Trinidad and Tobago	71	129	ES
United States	136	108	FAO
US Virgin Islands	-	-	-

TABLE 3A.1.4 (CONTINUED) AVERAGE GROWING STOCK VOLUME (1) AND ABOVEGROUND BIOMASS CONTENT (2) (DRY MATTER) IN FOREST IN 2000. (SOURCE FRA 2000)

(1) To be used for V in Equation 3.2.3.

(2) To be used for B_w in Equation 3.2.9, for $L_{conversion}$ in Equation 3.3.8 in cropland section and for $L_{conversion}$ in Equation 3.4.13. in grassland section, etc. Not to be applied for C_{t_2} or C_{t_1} in Forest section Equation 3.2.3.

f. SOUTH AMERICA

Country	Volume (aboveground) m³ / ha	Biomass (aboveground) t / ha	Information Source
Argentina	25	68	ES
Bolivia	114	183	PI
Brazil	131	209	ES
Chile	160	268	ES
Colombia	108	196	NI
Ecuador	121	151	ES
Falkland Islands	-	-	-
French Guiana	145	253	ES
Guyana	145	253	ES
Paraguay	34	59	ES
Peru	158	245	NI
Suriname	145	253	ES
Uruguay	-	-	-
Venezuela	134	233	ES

Information source: NI = National inventory; PI = Partial inventory; ES = Estimate; EX = External data (from other regions)