METHODOLOGICAL DOCUMENT
AFOLU SECTOR

Quantification of GHG Emission Reductions
REDD+ Projects

BIOCARBON REGISTRY®

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Acronyms and abbreviations

AFOLU	Agriculture, Forestry and Other Land Uses
AB	Aboveground biomass
A/R (AR)	Afforestation and reforestation
AE	Annual emission
BB	Belowground biomass
BT	Total biomass
BCC	Biomass carbon content
CDM	Clean Development Mechanism
CF	Carbon fraction of the dry matter
CH_4	Methane
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
CT	Total carbon dioxide equivalent; tCO2e ha^{-1}
FAO	Food and Agriculture Organization of the United Nations
FSC	Change in the surface covered by forest
GHG	Greenhouse Gases
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
N_2O	Nitrous oxide
REDD+	Reducing Emissions from deforestation, forest degradation and forest conservation, sustainable management or enhancement of forest carbon stocks.
SOC	Soil organic carbon
QA/QC	Quality Control/Assurance Control
UNFCCC	United Nations Framework Convention on Climate Change
VCC	Verified Carbon Credits

1 Introduction

This Methodology provides to the REDD+ projects holders the best practices related to procedures, models, parameters, and data to quantify GHG emission reductions attributable to REDD+ project activities.

For the application of this Methodology, it is a necessary condition that the areas in the project boundaries present a forest cover that has remained stable for at least ten years counted backward from the project starting date.

The project holders applying this Methodology may choose to exclude or include the quantification of certain carbon pools.

The Methodology covers aspects related to the definition of REDD+ activities, spatial and temporal limits, causes and agents of deforestation and forest degradation, identification of the baseline scenario and additionality, management of uncertainty in the quantification of baseline and mitigation results, risk and leakage management and non-permanence management, as well as compliance with REDD+ safeguards.

This Methodology describes the procedures to determine the historical deforestation and forest degradation, following the requirements for the estimation of emission reductions attributable to activities of REDD+ Projects.

Project holders may submit methodological deviations to adjust the estimation of emission reductions to specific project characteristics as long as the approval process by BIOCARBON REGISTRY [1] is completed.

This Methodology shall be used by the REDD+ project holders to be certified and registered with the Voluntary Carbon Market Standard (BCR STANDARD).

1.1 Objectives

The objectives of this methodological document (from now on referred to as this Methodology) are:

(a) provide requirements for quantification of GHG Emission Reductions from REDD+ projects;

[1] Prior to validation of the REDD+ project, the project holder shall submit a detailed proposal for methodological deviation that includes an analysis in compliance with a) the principles set forth in ISO 14064-2:2006; numeral 3, or that which updates it and b) the requirements of applicable national legislation. BIOCARBON REGISTRY will review the proposal and if it contains sufficient information for the evaluation, will assign an expert for the review. The outcome of the review will indicate whether the methodological deviation is feasible and the additional aspects to be included in the final version of the project document.

(b) present the methodological requirements for the baseline identification for REDD+ projects;

(c) endow the methodological requests to demonstrate additionality of REDD+ projects;

(d) describe the requirements for the monitoring and follow-up of REDD+ projects;

(e) establish requirements related to permanence and leakages;

(f) facilitate the articulation of the Project accounting with national accounting, if applicable;

2 Version and validity

This document constitutes Version 3.0. February 16, 2022.

The present version may be adjusted periodically and intended users should ensure that they are using the document's updated version.

The project holders have a transition period of three months to use the updated version after publication.

3 Scope

This methodological document constitutes a baseline methodology, quantification of emission reductions, and monitoring of REDD+ projects.

This Methodology is limited to the following REDD+ activities:

(a) Emission reduction due to deforestation;

(b) Emission reduction due to forest degradation.

The project holders shall use this Methodology to be certified and registered with the Voluntary Carbon Market Standard. BCR STANDARD.

4 Conditions of applicability

This Methodology is applicable under the following conditions:

a) the areas in the project boundaries correspond to the forest category (as outlined by the national forest definition for the Clean Development Mechanism), at the start of the project activities and ten years before the project start date;

b) the identified causes of deforestation may include, among others, expansion of the agricultural frontier, mining, timber extraction, and infrastructural expansion;

c) the causes of forest degradation identified may include selective logging, fuelwood extraction, forest fires, forest grazing, and expansion of the agricultural frontier – illicit crops[2];

d) no reduction in deforestation or forest degradation is expected to occur in the absence of the Project;

e) the carbon stock in the organic matter of soil, the litter and deadwood in project boundary may decrease or remain stable;

f) the quantification of GHG other than CO_2 should be included in the quantification of emissions caused by forest fires (if applicable) during the monitoring period;

This Methodology allows the inclusion of areas in the Project that correspond to the wetlands category and the lands that contain organic soils. However, the project holder shall submit to BIOCARBON REGISTRY a methodological approach with activity data, emission factors, and quantification of emission reductions from avoided deforestation and forest degradation that would be applied[3].

5 Normative references

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

(a) Voluntary Carbon Market Standard. BCR STANDARD, in its most recent version;

(b) IPCC Guidelines for National Greenhouse Gas Inventories (2006 and 2019). Volume 4. Agriculture, Forestry and Other Land use;

(c) the guidelines, other orientations, and guides defined by BIOCARBON REGISTRY, in the framework of projects in the AFOLU sector.

[2] The project holder may include causes of degradation other than those described in this numeral through a qualitative and quantitative description of the relationship between the causes of degradation and the project activities. The inclusion of causes of degradation that persist in the project scenario shall not be allowed.

[3] Prior to validation of the REDD+ project, the project holder shall submit a detailed proposal that also includes an analysis of compliance with a) the principles set forth in ISO Standard 14064-2:2006; numeral 3 or that which updates it and b) the requirements contained in the national legislation applicable. BIOCARBON REGISTRY shall review the approach and indicate whether it is feasible and the additional aspects to be included in the final version of the project document.

6 Terms and definitions

Additionality

It is the characteristic that allows demonstrating that the reductions of GHG emissions or removals derived from implementing a GHG project activity generate a net benefit to the atmosphere in terms of reduced or removed GHG emissions.

Those GHG emission reductions project holder demonstrates that would not occur in the absence of the project are considered additional, as described in section 9 of this document.

Source: Adapted from the Glossary CDM terms. Version 10.0.

Agriculture, Forestry and Other Land Use (AFOLU)

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

Baseline scenario

The baseline scenario is the scenario that reasonably represents the sum of the variations in carbon stocks, included in the project boundaries, that would occur in the absence of the project's activities.

Source: Adapted from the Glossary CDM terms. Version 10.0

Carbon fraction

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

Carbon pools

A compartment in which carbon stock changes occur in terrestrial ecosystems (aboveground biomass, belowground biomass, deadwood, litter, soil organic matter), as defined in the Guidelines of the Intergovernmental Group of Experts on Climate Change (IPCC) for national greenhouse gas inventories.

Core area

Fragments of a forest with a minimum area of 202 hectares.

Deforestation

Deforestation is defined as the direct or induced conversion of forest cover to another type of land cover in a given period.

The UNFCCC Decision 11/CP.7 defines deforestation as the direct, human-induced conversion of forested land to non-forested land.

Deforestation agents

Individuals, social groups, or institutions (public or private) that, influenced or motivated by a series of factors or underlying causes, decide to convert natural forests to other land cover and land uses, and whose actions are manifested in the territory through one or more direct causes.

Direct causes of deforestation

Direct causes of deforestation[4] are related to human activities that directly affect forests. They include factors that operate at the local scale, different from the initial structural or systemic conditions, which originate in land use and affect forest cover by harvesting the arboreal resource or eliminating it to give way to other uses.

Eligible areas

Areas that meet the condition of forest presence on the reference dates established by the BCR STANDARD. The areas in the geographical limits of the Project that correspond to the category of forest (as outlined by the national forest definition for the Clean Development Mechanism), at the beginning of the project activities, and ten years before the starting date of the Project.

Forest (Natural Forest)

"Forest" is a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 meters at maturity in situ. A forest may consist either of closed forest formations where trees of various stores and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10-30 per cent or tree height of 2-5 meters are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes, but which are expected to revert to forest.[5]

Forest degradation

The IPCC special report on "Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegetation of Other Vegetation

[4] In the most national and international studies, the term "direct cause" is equated with the concept "driver" of deforestation.
[5] The Marrakech Accord. CP7/D11. https://unfccc.int/sites/default/files/resource/docs/cop7/13a01.pdf. The project holder shall use the definition that applies.

Types" (2003) suggested the following characterization for forest degradation: A direct, human-induced, long-term loss (persisting for X years or more) or at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation.

Leakages

Potential emissions that occur outside the project boundaries due to the activities of the GHG project. Leakage means the net change in anthropogenic emissions by sources of greenhouse gases (GHG) that occurs outside the project boundary and is measurable and attributable to the project activity.

Non-forest

Land that has never had a forest cover and cannot support trees or was previously an arboreal cover but changed to a different cover. It includes commercial forest plantations, palm crops, and trees planted for agricultural production.

Organic soils

According to FAO (definition adopted by IPCC)[6], they are soils with organic carbon content equal to or greater than 12%. Organic soils (e.g., peat and manure) have at least 12 to 20 percent organic matter by mass and thrive under poorly drained wetlands conditions.

Organic soils are identified based on criteria 1 and 2, or 1 and 3 listed below:

1. Organic horizon thickness is greater than or equal to 10 cm. A horizon of less than 20 cm has 12 percent or more organic carbon when mixed to a depth of 20 cm.

2. Soils that are never saturated with water for more than a few days shall contain more than 20 percent organic carbon by weight (i.e., about 35 percent organic matter).

3. Soils are subject to water saturation episodes and have either:

    a) At least 12 percent organic carbon by weight (i.e., about 20 percent organic matter) if the soils have no clay;

    b) At least 18 percent organic carbon by weight (i.e., about 30 percent organic matter) if the soils have 60% or more clay; or

    c) An intermediate proportional amount of organic carbon for intermediate amounts of clay.

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[6] Hiraishi, Takahiko, et al. "2013 supplement to the 2006 IPCC guidelines for national greenhouse gas inventories: Wetlands." *IPCC, Switzerland* (2014).

Patch

Forest fragments with a minimum area of 101 hectares.

Perforated

Limit of non-forest areas, surrounded by forest fragments between 101 and 202 hectares, at a distance from the border of the forest of 100 m.

Permanence

The condition resulting from the project activities whereby the system implemented within its limits extends continuously and over time, removing GHG from the atmosphere.

Project Start date

The start date is when the activities that result in effective GHG emission reductions begin. For REDD+ projects, the start date is when the activities proposed by the Project to demonstrate reduced emissions from deforestation and forest degradation begin. It may be, for example, the start of forest management strategies as also when applicable to forest resource conservation plans, including agreement and contracts. In other words, concrete actions to reduce deforestation/degradation.

REDD+

It is an international mitigation mechanism framed in the decisions of the CMNUCC, whose objective is to reduce emissions and remove GHGs through the implementation of activities to reduce emissions from deforestation, forest degradation, and other forestry activities.

REDD+ Project

These are GHG projects that implement activities aimed at reducing emissions due to deforestation and forest degradation, as well as promoting conservation, sustainable forest management and increasing forest carbon stocks.

REDD+ safeguards

Measures aimed at preventing the affectation of fundamental social, economic, or environmental rights and negative impacts due to the design and implementation of REDD+ activities. Likewise, it includes measures to improve the obtainment and distribution of benefits generated by REDD+ activities.

Reference region

These are the geographic boundaries within which historical patterns of deforestation and forest degradation are analyzed and projected in the project area to obtain forest cover change values in the project area in the baseline scenario.

Source, sink, or carbon pool-related

Source sink or reservoir of GHG with flows of energy or materials to the interior, the exterior, or within the Project.

Underlying causes of deforestation

Underlying causes are factors that reinforce the direct causes of deforestation. They include social, political, economic, technological, and cultural variables, which constitute the initial conditions in the existing structural relationships between human and natural systems. These factors influence the decisions made by agents and help explain why deforestation occurs.

Wetlands

According the Ramsar Convention on Wetlands (Article 1)"wetlands are *areas of marsh, fen, peat, and or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters*." (Ramsar, 1971)[7].

IPCC defines wetlands as: "Wetlands include any land that is covered or saturated by water for all or part of the year, and that does not fall into the Forest Land, Cropland, or Grassland categories. Managed wetlands are restricted to wetlands where the water table is artificially changed (e.g., drained or raised) or those created through human activity"[8].

7 Carbon pools and sources of emissions

7.1 Carbon pools

The Intergovernmental Panel on Climate Change (IPCC) foresees the estimation of carbon stock changes in the following pools: aboveground biomass, belowground biomass, deadwood, litter, and soil organic carbon (SOC). However, the project holders may choose not to consider one or more carbon pools as long as they provide transparent and verifiable

[7] https://ramsar.org/documents?field_quick_search=2550
[8] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_07_Ch7_Wetlands.pdf

information and demonstrate that such a choice does not increase emission reductions or removals GHG, quantified by the Project.

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

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

Carbon pool	Whether selected (Yes/No)	Justification/Explanation
Aboveground biomass Arboreal vegetation	Yes	The change in carbon content in this pool is significant according to the IPCC.
Aboveground biomass Non-arboreal vegetation	Optional	Mandatory if the final land use (after the change) consists of the establishment of permanent crops.
Belowground biomass	Yes	The change in carbon content in this pool is significant according to the IPCC.
Deadwood and litter	Optional	Being conservative with the baseline scenario, if the carbon content in this pool is expected to decrease, it can be omitted.
	Optional	If, in the post-deforestation scenario, the carbon content can be increased, it should be included.
Soil organic carbon	Optional	The change in carbon stocks in this reservoir may increase due to project activities.

7.2 Source of emissions

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

Table 2. Emission sources and GHGs selected for accounting

Source	GHG	Whether selected (Yes/No)	Justification/Explanation
Burning of woody biomass [9]	CO_2	No	CO_2 emissions due to woody biomass combustion are not quantified as changes in carbon stocks.
	CH_4	Yes	CH_4 emission should be included if the presence of fires was identified in the monitoring period.

[9] The quantification of CH_4 and N_2O emissions caused by burning woody biomass is estimated based on the guidelines presented in the 2006 IPCC guidelines for national greenhouse gas inventories. Volume 4. Agriculture, forestry and other land uses. Non-CO_2 greenhouse gas emissions from biomass burning.

Source	GHG	Whether selected (Yes/No)	Justification/Explanation
	N_2O	Yes	N_2O emission should be included if the presence of fires was identified in the monitoring period.

8 Spatial and temporal limits

8.1 Eligible areas for REDD+ projects

The REDD+ project holder shall demonstrate that the areas within the geographical boundaries of the Project correspond to the forest category (as outlined by the national forest definition for the Clean Development Mechanism), at the start of project activities, and ten years before the project start date (defined as a stable forest) [10]

8.1.1 Adding areas after validation

REDD+ project holders may add areas to the Project under the following conditions:

a) the project holder shall identify the project expansion area during the validation process and define the criteria for adding new areas;

b) the default criteria that a new area shall meet to be added to the REDD+ Project are:

   i) comply with the guidelines of the BCR Standard, in their most recent version;

   ii) comply with all the provisions in the Methodological document Quantification of GHG Emission Reductions from REDD+ Projects, in their most recent version;

   iii) include emission reduction only for validated REDD+ project activities[11].

   iv) implement the activities to avoid deforestation and forest degradation, described in the validated project document;

   v) the causes and agents of deforestation/degradation, the baseline scenario and the additionality conditions of new areas should be consistent with the characteristics of the initial areas validated;

[10] The cartographic inputs for obtaining the stable and the detailed description of the methodological process for the generation of information on changes in forest area shall be based on credible information.

[11] An activity excluded in the validation cannot be contemplated in a new area. This does not refer to REDD+ activities (described in section 3 of this document) but to activities proposed by the project to avoid deforestation/degradation.

vi) have a start date later than the start date of the areas included in the validation.

a) Given that the leakage belt may overlap with the validated expansion area in some cases, the project holder should update the leakage belt to include potential deforestation displacements due to the implementation of REDD+ project activities.

8.2 Reference region for baseline estimation

The REDD+ project holder shall outline a reference region to estimate deforestation and forest degradation that could occur in the project area in the baseline scenario. The reference region should be similar to the project area regarding access, drivers and determinants of deforestation/degradation and possible land use changes.

To determine the geographic boundaries of the reference region is mandatory to consider the following criteria:

(a) the reference region may include all or part of the project area;

(b) the agents and drivers of deforestation/degradation, identified in the reference region, can access the project area;

(c) the project area is of interest to the agents identified in b, above;

(d) Land tenure and land use rights should be characterized in the reference region;

(e) Exclude areas of restricted access to agents and drivers of deforestation and forest degradation.

8.3 Leakage area

Area of a forest[12] where deforestation or forest degradation activity may be displaced, outside the REDD+ project holder's control. That is, areas to which deforestation or forest degradation agents may be displaced due to project activities.

The leakage area is delimited based on the following criteria:

(a) all areas in the forest that are a range of mobility of the agents identified in section **¡Error! No se encuentra el origen de la referencia.** (below).[13]

(b) exclude areas of restricted access to deforestation and forest degradation agents.

[12] The forest area shall meet the same eligibility criteria as the project area.
[13] The mobility distance of the agents can be determined from secondary studies or from the collection of primary information (participatory rural appraisal).

8.4 **Temporal limits and analysis period**

The Project's temporal limits correspond to the periods during which project activities avoid land-use changes, and GHG emission reductions are quantified.

The temporal limits of the Project should be defined considering the following:

(a) the start date of the Project,

(b) the quantification period of the reductions,

(c) monitoring periods.

8.4.1 **Historical period of deforestation**

The analysis of the historical rate of deforestation for the reference region and leakage area should be conducted at least two times (project start date and ten years before the project start date).

The analysis of the historical rate of forest degradation for the reference region and the leakage area should be performed for at least two periods: start date - intermediate year - ten years before the start date.

The projection of deforestation and forest degradation in the reference region and leakage area contemplates at least five years from the start date[14].

8.4.2 **REDD+ project emissions reduction**

The project emissions reduction corresponds to the Project's quantification period, that is, the period during which the project holder quantifies the GHG emissions reductions or removals, measured against the baseline, to apply to the certification program issuance of Verified Carbon Credits (VCC).

The analysis period for each verification corresponds to the monitoring period.

9 Identification of the baseline scenario and additionality

The Project holders shall identify the baseline scenario to demonstrate that the Project is additional. Under the UNFCCC, when selecting the Methodology to determine the baseline

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[14] At each verification, the Project holder must demonstrate that the baseline corresponds to the baseline identified during project validation, as long as there is no update to the baseline scenario.

scenario of a project in the AFOLU[15] sector, the project holder shall select the most appropriate among the criteria listed below, justifying the convenience of their choice.

(a) existing or historical changes, as appropriate, in carbon stocks at project boundaries;

(b) changes in carbon stocks, within the project boundary, due to land use that represents an attractive course of action considering barriers to investment;

(c) changes in carbon stocks within the project boundaries, identifying the most likely land use, at the beginning of the Project.

For this Methodology's application, it is recommended to use what is stated in literal (c) above. However, the REDD+ Project holder may use either of the other two approaches, as long as appropriate explanation and justification for the selected option are presented.

The project holder shall demonstrate with reliability that all the assumptions, justifications, and documentation considered are adequate to identify the baseline scenario.

The project holder shall identify the baseline scenario through the following steps[16]:

PASO 0. Project start date

The date on which the activities effective GHG emission reductions begin.

Determine the project start date, describe this selection, and present evidence that proves the project starting date. Show that the start date is defined within the five (5) years prior to the project validation.

STEP 1. Identification of alternative land-use scenarios

This step consists of identifying the most probable land-use scenarios, which could be the baseline scenario, through the following sub-steps:

Sub-step 1a. Identification of probable land use alternatives in the project areas

Identify realistic and credible land use alternatives in the project areas in the absence of the proposed project activity. The alternatives shall be feasible considering the relevant national and sectoral circumstances and policies, considering historical land uses in the Project's area

[15] In the Executive Board Decisions, it is noted: Afforestation and Reforestation, however, the scope of this methodology also applies to REDD+ Projects.
[16] Adapted of "Combined tool to identify the baseline scenario and demonstrate additionality" (Report EB35, Annex 19).

of influence, economic practices, and economic tendencies in the region. These alternatives shall include at least the following activities:

(a) continuation of previous land use (before Project);

(b) REDD+ projects without the emission reduction certification;

(c) other plausible and credible land-use alternatives concerning location, size, funding, experience requirements, among others. These may include alternatives that represent common practices land use in the region where the Project is located.

Result of sub-step 1a. List of probable land use alternatives in the project area in the absence of the REDD+ Project.

Sub-step 1b. Consistency of land use alternatives with applicable laws and regulations

The applicable laws and regulations are given by national and sectoral policies related to natural resources, the REDD+ activities, and the land use change activities. Show that all land use alternatives identified in sub-step 1a comply with all applicable statutory and mandatory regulatory requirements.

If a land-use alternative does not comply with all mandatory applicable laws and regulations, demonstrate that, based on a careful analysis of current practice (in the region where the Law is mandatory or regulation applies), the systematically applicable mandatory legal or regulatory requirements are not met.

Remove from the land-use scenarios identified in sub-step 1a any land use alternatives that do not comply with applicable mandatory laws and regulations unless you can demonstrate that such alternatives result from systematic failure to comply with the mandatory laws and regulations.

Result of sub-step 1b. List of possible land-use alternatives that comply with the legislation and mandatory norms and regulations, considering their compliance in the region or country, for national and sectoral policies.

If the list resulting from sub-step 1b is empty or contains only one land-use scenario, the Project is not additional.

STEP 2. Barrier analysis

Determine if the REDD+ Project faces barriers that:

(a) prevents or limits the implementation of this kind of GHG project; and,

(b) they do not prevent the implementation of at least one of the probable land use alternatives.

Apply the following sub-steps:

Sub-step 2a. Identify the barriers that would prevent the project implementation

Identify realistic and credible barriers that prevent the Project's realization if it did not contemplate participation in the carbon market. The barriers should not be specific for the project participants but should apply to the project activity. Such barriers may include, among others:

Investment barriers, *inter alia*:

- Debt funding is not available for this type of Project;
- No private capital is available due to real or perceived risks associated with national or foreign direct investment in the country where the Project is to be implemented;
- Lack of access to credit;

Institutional barriers, *inter alia*:

- Risk related to changes in government policies or laws;
- Lack of enforcement of land-use-related legislation.

Barriers due to social conditions, *inter alia*:

- Demographic pressure on the land (e.g., increased demand on land due to population growth);
- Social conflict among interest groups in the region where the Project takes place;
- Widespread illegal practices (e.g., illegal grazing, illicit crops, non-timber product extraction, and tree felling);
- Lack of skilled and properly trained labor force;
- Lack of organization of local communities.

Barriers relating to land tenure, ownership, inheritance, and property rights, *inter alia*:

- Communal land ownership with a hierarchy of rights for different stakeholders limits the incentives to undertake the project activities;
- Lack of suitable land tenure legislation and regulation to support the security of tenure;
- Absence of clearly defined and regulated property rights about natural resource products and services;

- Formal and informal tenure systems that increase the risks of fragmentation of landholdings.

The barriers identified constitute sufficient evidence to demonstrate the project additionality, only if they prevent the potential project if it does not participate in the carbon market.

The GHG project holder shall provide transparent and documented evidence and offer conservative interpretations of how it demonstrates the existence and significance of the identified barriers. The type of evidence to be provided may include:

(a) relevant legislation, regulatory information or environmental and natural resource management norms, acts or rules;

(b) relevant studies or surveys, for example, studies by institutions such as universities, research institutions, associations, companies, bilateral or multilateral agencies;

(c) relevant statistical data from national or international statistics;

(d) written documentation from the company or institution developing or implementing the Project;

(e) activities of the project holder or developer project, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information;

(f) documents prepared by the project developer, contractors, or project partners in the context of the proposed project activity or similar previous project implementations;

(g) written documentation of independent expert judgments from agriculture, forestry, and other land-use related Government and Non-Government bodies or individual experts, educational institutions (e.g., universities, technical schools, training centers), professional associations, and others.

Sub-step 2 b. Demonstrate that the identified barriers would not prevent the implementation of at least one of the identified land use alternatives (except the project activity):

If the identified barriers also affect other identified alternatives, the project holder shall demonstrate how they are less affected than they affect the Project. To be precise, it shall explain how the identified barriers do not prevent the implementation of at least one land use alternatives. Any alternative, which prevents the barriers identified in Sub-step 2a, is not a viable alternative and should be removed from the analysis. At least one viable alternative (other than the Project) should be identified.

The baseline scenario shall be the one that is not affected by the barriers identified in sub-step 2a.

If one of Sub-steps 2a or 2b is not fulfilled, the Project cannot be considered additional through the barrier analysis.

If both Sub-steps (2a and 2b) are satisfied, proceed to Step 3 (Impact of project registration).

STEP 3. Impact of the project registration

Explain how certification and registration of the Project, and the associated benefits and incentives derived from this, would lessen the impact of the identified barriers (Step 2) and enable the Project to proceed. The benefits and incentives can be of various types, such as:

- GHG emission reduction by project activities;
- The financial benefit from the VCC sale, including the certainty and predefined timing of the proceeds;
- Build capacity in the entities in charge of land use planning in the project area to ensure the implementation of REDD+ activities;
- Attract new stakeholders to implement new technologies and practices.

If Step 3 is met, the Project does not correspond to the baseline scenario and is therefore additional.

If Step 3 is not met, the Project is not additional.

10 Causes and drivers of deforestation and forest degradation

The project holder shall identify, describe and analyze the causes and agents of deforestation and forest degradation in the project area as input for:

(a) design measures and actions to avoid deforestation and forest degradation (REDD+ activities); and,

(b) delimit the reference region.

The following is a description of the key elements to develop a characterization of deforestation's causes and agents, as suggested by UN-REDD Program[17].

10.1 Spatial and temporal dimensions

Deforestation and forest degradation have spatial and temporary dimensions that shall be characterized. The spatial dimension helps to know and analyze the process's location and extent (project area and proposed reference region). The temporal dimension allows understanding deforestation and forest degradation in terms of its historical antecedents, current dynamics, and probable future behavior (historical period of deforestation and forest degradation).

10.2 Context

An adequate characterization of the causes and agents of deforestation and forest degradation in a particular area implies recognizing and understanding the socio-environmental surrounding of the process and analyzing its influence on the dynamics of deforestation and forest degradation.

a) The *territorial context* refers to the biophysical environment and how societies relate and construct their living space. It includes elements such as occupation, land use, social interaction, and legal and regulatory aspects that govern these dynamics.

b) The *sociocultural context* is based on the relationships between societies and how different human groups interact and organize themselves to live and establish production in the community.

c) The *economic context* refers to using the means of production to generate and trade goods and services, which in aggregate contribute to the (economic) growth of a region.

d) The *historical context* conditions the other types of contexts described above, as it is based on the construction of human societies as a process that occurs and changes in time and space. Of particular relevance are the processes of occupation and production in the territory by different human groups.

10.3 Key actors, interests, and motivations

The deforestation and forest degradation processes involve multiple actors, non-governmental organizations and civil society. Within this group are the agents of

[17] The present methodology accepts the use of the Minimum Characterization Scenario (MCS).

deforestation and forest degradation and those actors that indirectly promote forest transformation processes.

It is essential to characterize the interests or motivations that determine their decisions and their relationships with other key actors. In this sense, it is necessary to include in the analysis the underlying causes of deforestation and forest degradation identified for the project area, pointing out their importance within the group of factors that motivate agents to deforest and/or degrade.

Each key actor involved in the dynamics of deforestation and forest degradation has a degree of responsibility and influence and a geographic expression that shall be characterized and related to the phenomenon of deforestation and/or forest degradation.

10.4 Economic activities and their importance

Activities that directly cause deforestation and/or degradation should be characterized in terms of the spatial patterns associated with their presence, but also in terms of their economic and socio-cultural importance for the agents of deforestation or degradation and other key stakeholders involved. It is clear that activities with a high level of socio-cultural practices require different measures and actions than those where economic benefit prevails over other interests.

10.5 Direct and indirect impact

Each cause and agent have a differential impact on forests. The impact can be assessed qualitatively or quantitatively. Quantitative estimation of impacts can be made using a spatial analysis that determines the relationship between the identified cause and the calculated deforestation forest degradation. Qualitative estimations can be made through the use of stakeholder participation in the territory.

10.6 Relations and synergies

The project holder shall identify and analyze the interactions and synergies between all elements and actors to define REDD+ activities.

10.7 Deforestation and forest degradation chain of events

The analysis of chain and events seeks to identify the relationships between major groups of agents and causes to try to explain the sequence of events that usually leads to the loss of forest and forest degradation in a particular area.

For each activity that causes forest loss or forest degradation, a causal chain of at least 3 links shall be identified, which is composed of a different sequence of events or conditions that result in the occupation of the territory, as follows:

a) identify each of the activities that generate forest loss or forest degradation. If possible, these should be grouped according to the most common direct causes of;

b) identify the agents associated with the actions and direct causes of deforestation or forest degradation established;

c) identify the underlying causes that promote or facilitate agents' decisions to carry out actions resulting in forest loss or forest degradation.

11 REDD+ activities

REDD+ activities should be designed based on the results of causes and agents of deforestation and forest degradation analysis. Likewise, they shall consider what has been established by the communities, e.g., in the community life plans (in indigenous territories) and ethno-development plans (in afro communities). In the case of other rural communities, based on participatory construction. The design of each REDD+ activity shall include, at a minimum, the following:

a) activity ID;

b) relationship between activity and direct or underlying cause;

c) compliance with life plans or ethno-development plans or the interests of rural communities;

d) consultation mechanism for objectives identification and the definition of REDD+ activities;

e) responsibility and role of the actors involved in the implementation of the activity;

f) implementation schedule;

g) indicators to report the activity's progress, including name, type[18], goal[19], measurement unit, and responsible for measurement.

12 Safeguards REDD+

As described in section 18 of the BCR Standard, the project holder shall demonstrate compliance with REDD+ safeguards, considering the national context and including the definition of indicators for monitoring, reporting and verification.

[18] Result, product, or impact
[19] Expected value and time for compliance

To demonstrate compliance, the project holder shall use the Safeguards interpretation tool of BioCarbon Registry[20].

13 GHG emission reduction from REDD+ activities

13.1 Uncertainty management

According to GOFC-GOLD (2016)[21], uncertainty is *a property of a parameter estimate and reflects the degree of lack of knowledge of the true parameter value because of factors such as bias, random error, quality and quantity of data, state of knowledge of the analyst, and knowledge of underlying processes. Uncertainty can be expressed as a percentage confidence interval relative to the mean value. For example, if the area of forest land converted to cropland (mean value) is 100 ha, with a 95% confidence interval ranging from 90 to 110 ha, we can say that the area estimate's uncertainty is ±10%.*[22]

Under the BCR STANDARD, uncertainty management is determined by the accuracy of the maps used to estimate activity data values and the application of discounts1 in emission factors. For activity data, the accuracy should be greater than 90%. The accuracy assessment should be made from the use of field observations or analysis of high-resolution imagery. For emission factors, an uncertainty of 10% is acceptable for the use of average carbon values (assessment should be done per repository). If the uncertainty is greater than 10%, the 95% confidence interval's lower value should be applied[23].

13.2 Activity data

13.2.1 Deforestation

The data of change in forest (CCF) area constitutes the activity data for deforestation estimation. This Methodology proposes two approaches for estimating activity data: from historical average and modeling. The project holder may choose one of the two approaches to quantify the activity data.

[20] Available in www.biocarbonregistry.com
[21] GOFC-GOLD, 2016, A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals associated with deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation. GOFC-GOLD Report version COP22-1, (GOFC-GOLD Land Cover Project Office, Wageningen University, The Netherlands). Disponible en: http://www.gofcgold.wur.nl/redd/sourcebook/GOFC-GOLD_Sourcebook.pdf.
[22] The project holder should describe how it addressed the GOFC-GOLD (2016) guidelines in estimating uncertainty.
[23] The project holder may use data from scientific studies that have a data uncertainty of less than 20%.

Estimating historical rate of deforestation

The project holder shall perform the forest analysis to non-forest change between at least two dates (start date and ten years prior to the start date) [24].

Only the areas for which forest is detected on the first date and no forest on the second date are considered to calculate the area deforested between two dates so that there is a certainty that the event occurred in the period analyzed (gross deforestation).

Forest losses detected after one or several dates without information[25] should not be included in the calculation to avoid overestimated rates in which the areas without information increase due to different factors, like periods of high cloud cover or failures in the satellite programs' sensors that take the images.

Historical annual deforestation in the reference region

The following equation estimates annual historical deforestation in the reference region:

$$FSC_{yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_1 - A_2\right)$$

Where:

$FSC_{yr} =$	Annual change in the surface covered by forest in the reference region; ha
$t_2 =$	Final year of the reference period; yr
$t_1 =$	Initial year of the reference period; yr
$A_1 =$	Forest surface in the reference region in the initial moment; ha
$A_2 =$	Forest surface in the reference region in the final moment; ha

The Forest surface change (FSC) corresponds to the historical rate of the reference region deforestation and is the value used to represent the expected forest loss in the baseline scenario.

Projected annual deforestation in the REDD+ project scenario

The projected annual deforestation in the REDD+ Project is estimated with the equation:

[24] Always using the cartographic inputs adequate and credible.

[25] Complementary information may be used to reduce the area without information. Detailed information about the methodology, the relevance of the use of the selected information source and the evaluation of the accuracy of the image classification should be presented.

$$FSC_{REDD+project,yr} = FSC_{bl,yr}\ x\ (1 - \%DD)$$

Where:

$FSC_{REDD+project,yr}$[26] =	Annual change in the surface covered by forest in the project scenario; ha
$FSC_{bl,yr}$ =	Annual change in the surface covered by forest in the baseline scenario; ha
%DD =	Projected decrease in deforestation due to the implementation of REDD+ activities

Annual historical deforestation in the leakage area

The annual historical deforestation in the leakage area is estimated whit the equation:

$$FSC_{lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x\ (A_{1lk} - A_{2lk})$$

Where:

$FSC_{lk,yr}$ =	Annual change in the surface covered by forest in the leakage area; ha
t_2 =	Final year of the reference period; yr
t_1 =	Initial year of the reference period; yr
$A_{1,lk}$ =	Forest surface in the leakage area in the initial moment; ha
A_{2lk} =	Forest surface in the leakage area in the final moment; ha

Projected annual deforestation in the leakage area in the project scenario

The projected annual deforestation in the leakage area in the project REDD+ scenario is estimated with the equation:

$$FSC_{REDD+project,f,yr} = FSC_{lk,bl}\ x\ (1 + \%E_{lk})$$

Where:

[26] If applicable the project holder may adjust the value of $FSC_{REDD+project,yr}$ following the guidelines for estimating the national circumstances adjustment.

$FSC_{REDD+project,yr}$ = Annual change in the surface covered by forest in leakage area in the project scenario; ha

$FSC_{lk,bl}$ = Annual change in the surface covered by forest in leakage area in the baseline scenario; ha

$\%E_{lk}$ = Percentage of emissions increase in the leakage area due to the implementation of REDD+ activities. The use of a default value of 10% is allowed in this Methodology.

Estimating deforestation from modeling

The estimation of deforestation may be carried out through spatial modeling, which allows the generation of future scenarios based on multi-temporal historical analysis. To obtain the surface that is deforested in the baseline scenario and its location. The use of the DinamicaEGO[27] software is suggested.

To appraisal the project deforestation dynamics, the following steps shall be completed[28]:

(a) *Calculate transition matrices*[29]*:* forest/non-forest information is used to describe forest changes from discrete periods. The forest/non-forest layers are required at the start date, ten years before the start date, and one year in between;

(b) *Calculate ranges to categorize continuous variables and their weights of evidence*: Transition probabilities and weights are obtained for the variables with the greatest influence on forest change, and significant variables are determined. The project holder should select biophysical and socioeconomic variables that may be determinants of the agents and drivers of deforestation and consistent with the results of section 10.

(c) *Identify the correlation between maps*: the spatial correlation between the study variables is identified. The final variables shall be independent. Therefore, with correlation (Cramer's index greater than 0.5[30]), one of the variables shall be eliminated.

(d) *Build and run the simulation model*: a simulated forest/non-forest layer is generated for the intermediate year. Selection of values for expansion (common in frontier

[27] Free access program used successfully in several projects for the projection of land use changes. The program and its instructions for use can be downloaded at: https://csr.ufmg.br/dinamica/.
[28] The project holder shall present the methodological description and the results of each of the steps.
[29] To calculate the area deforested between two dates, only the areas for which forest is detected on the first date and non-forest on the second date are taken into account, so that there is certainty that the event occurred in the time period analyzed (gross deforestation).
[30] Espinoza-Mendoza, Victoria. "DINAMICA EGO: UNA HERRAMIENTA GRATUITA PARA MODELAR Y BRINDAR SOPORTE EN EL ANÁLISIS DE CCUS.". http://cgp.org.pe/web/b3-08/

deforestation) and new patches (common in mosaic deforestation) from historical deforestation behavior is required.

(e) *Model validation*: the simulated layer is compared with the real one considering the spatial coincidence under different tolerance levels.

(f) *Deforestation trajectory projection*: the calibrated and validated model is used to create the future annual deforestation in the reference region (FSC_r) and in the project area (FSC_p) in the without-project scenario.

Projected annual deforestation in the REDD+ project scenario

The projected annual deforestation in the project scenario is estimated with the following equation:

$$FSC_{REDD+project,yr} = FSC_{yr} \ x \ (1 - \%DD)$$

Where:

$FSC_{REDD+project,yr}$ = Annual change in the surface covered by forest in the project scenario; ha

FSC_{yr} = Annual change in the surface covered by forest in the without-project scenario; ha

%DD = Projected decrease in deforestation due to the implementation of REDD+ activities

Projected annual deforestation in the leakage area in the project scenario

The projected annual deforestation in the leakage area in the project REDD+ scenario is estimated with the following equation:

$$FSC_{lk,p,yr} = FSC_{bl,yr} \ x \ (1 + \%E_{lk})$$

Where:

$FSC_{lk,p,yr}$ = Annual change in the surface covered by forest in leakage area in the project scenario; ha

$FSC_{lk,bl}$ = Annual change in the surface covered by forest in leakage area in the baseline scenario; ha

$\%E_{lk}$ = Percentage of emissions increase in the leakage area due to the implementation of REDD+ activities. The use of a default value of 10% is allowed in this Methodology.

13.2.2 Forest degradation

Forest degradation implies a negative impact on carbon stocks. The estimation of this impact shall be calculated through variables that can be measurable in areas where the extension, canopy cover, and minimum height remain above the forest definition thresholds.

Given the lack of historical biomass data to establish appropriate reference points and the limited capacity for estimating and monitoring forest degradation using remote sensing, it has been proposed to estimate and monitor this process using a local reference point representing low or no degradation has comparable biophysical characteristics.

To define the forest degradation activity data, the project holder shall apply the Methodology adequate and credible for estimating forest degradation, by means of which the changes in aboveground biomass present in different forest cover categories are determined, assigned through a fragmentation analysis[31]. The Methodology and results associated with the following steps should be described:

a) Layers of natural forest cover used:

   (i) year closest to the biomass map utilized

   (ii) initial year of the reference period

   (iii) final year of the reference period

   (iv) intermediate year between the start and end of the reference period. If benchmark (*i*) is different from (*ii*) and (*iii*), then layer (*i*) can be used as the intermediate year.

b) Forest fragmentation for each layer used: processing with the *Landscape Fragmentation Tool* is suggested[32].

c) Fragmentation classes: the result of the areas per fragmentation class each year evaluated should be presented according to Table 3.

Table 3. Fragmentation classes

Class	Area (ha)			
	Year biomass	Year 1	Year 2	Year 3
Core				
Perforated				
Patch				

[31] The project holder may propose a methodological deviation (section 1) to quantify the avoided degradation emission reductions in the scenario with project.
[32] The minimum distance to the forest to be used is 100m.

d) Precision analysis reduces the uncertainty of the estimation of forest degradation. This analysis should include corroboration of fragmentation classes, with information from additional remote sensing and field monitoring points[33].

e) Transitions between the fragmentation classes:

   (i) primary degradation: core to patch

   (ii) secondary degradation: perforated to patch

Table 4. Fragmentation class transition (ha)

Class Year 1/Class Year 2	Perforated	Patch
Core		X
Perforated	X	

<u>*Historical annual forest degradation in the project area in the baseline scenario*</u>

The following equations estimate the annual historical forest degradation in the baseline scenario[34]:

$$PFD_{bl,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{core,bl} - A_{c-p,bl}\right)$$

Where:

$PFD_{bl,yr}$	=	Annual historical primary forest degradation in baseline scenario; ha
t_1	=	Initial year of the reference period; yr
t_2	=	Final year of the reference period; yr
$A_{core,bl}$	=	Area in core class of the reference region, in the year of the start of the reference period; ha
$A_{c-p,bl}$	=	Reference region area that changes from the core to patch in the final year of the reference period; ha

And,

[33] The project holder can use the following study as a guide for accuracy analysis of activity data: Finegold, Y., Ortmann, A., Lindquist, E., d'Annunzio, R., & Sandker, M. (2016). Map accuracy assessment and area estimation: a practical guide. Rome: Food and Agriculture Organization of the United Nations.

[34] The area reported as degraded is that with a degradation trend in the two periods of analysis. That is, areas that move from a primary to a secondary class in one period and then return to a primary class will not be considered degraded.

$$SFD_{bl,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{perforated,bl} - A_{perforated-patch,bl}\right)$$

Where:

$SFD_{bl,yr} =$	Annual secondary forest degradation in baseline scenario; ha
$t_1 =$	Initial year of the reference period; yr
$t_2 =$	Final year of the reference period; yr
$A_{perforated,bl} =$	Area in a perforated class of the reference region, in the initial year of the reference period; ha
$A_{per-par,bl} =$	Area in the reference region that change from perforated to patch in the final year of the reference period; ha

<u>Historical annual forest degradation in leakage area in the baseline scenario</u>

The following equations estimate annual historical forest degradation in baseline scenario:

$$PFD_{bl,lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{core,bl,lk} - A_{c-p,bl,lk}\right)$$

Where:

$PFD_{bl,lk,yr} =$	Annual primary forest degradation in leakage area; ha
$t_1 =$	Initial year of the reference period; yr
$t_2 =$	Final year of the reference period; yr
$A_{core,bl,lk} =$	Area in core class in the leakage area, in the initial year of the reference period; ha
$A_{c-p,bl,lk} =$	Leakage area that changes from the core to patch in the final year of the reference period; ha

And,

$$SFD_{bl,lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{perforated,bl,lk} - A_{perforated-patch,bl,lk}\right)$$

Where:

$SFD_{lk,yr} =$	Annual secondary forest degradation in leakage area; ha
$t_1 =$	Initial year of the reference period; yr

$t_2 =$ Final year of the reference period; yr

$A_{perforated,bl,lk} =$ Area in perforated class in the leakage area, in the initial year of the reference period; ha

$A_{perforated-patc,bl,lk} =$ Area in the leakage area that changes from perforated to patch in the final year of the reference period; ha

Annual projected forest degradation in the project area in the REDD+ project scenario

The projected forest degradation in the project area in the project scenario is estimated with the following equations:

$$PFD_{REDD+projec,yr} = PFD_{lb}\ x\ (1 - \%PFD)$$

Where:

$PFD_{REDD+project,yr} =$ Annual primary forest degradation in the project area, in project scenario; ha

$PFD_{bl} =$ Historical primary forest degradation in the without project scenario; ha

%PFD = Projected decrease in primary forest degradation due to the implementation of REDD+ activities

And,

$$SFD_{REDD+project,yr} = SFD_{bl}\ x\ (1 - \%SFD)$$

Where:

$SFD_{REDD+project,yr} =$ Annual secondary forest degradation in project scenario; ha

$SFD_{bl} =$ Historical secondary forest degradation in the without project scenario; ha

%SFD = Projected decrease in secondary forest degradation due to the implementation of REDD+ activities

Annual projected forest degradation in leakage area in the project scenario

The annual projected forest degradation in leakage area is estimated with the following equations:

$$PFD_{lk,yr} = PFD_{lk}\ x\ (1 + \%E_{lk})$$

Where:

$PFD_{lk,yr} =$	Annual primary forest degradation in leakage area, in the project scenario; ha
$PFD_{lk} =$	Historical primary forest degradation in leakage area in the without project scenario; ha
$\%E_{lk}=$	Percentage of emissions increase in the leakage area due to the implementation of REDD+ activities. The use of a default value of 10% is allowed in this Methodology.

And,

$$SFD_{lk,yr} = SFD_{lk}\ x\ (1 + \%E_{lk})$$

Where:

$SFD_{lk,yr} =$	Annual secondary forest degradation in leakage area, in the project scenario; ha
$SFD_{lk} =$	Historical secondary forest degradation in leakage area in the project scenario; ha
$\%E_{lk} =$	Percentage of emissions increase in the leakage area due to the implementation of REDD+ activities. The use of a default value of 10% is allowed in this Methodology.

13.3 Emission factors

13.3.1 Deforestation

Emission factors vary, depending on the carbon pool being quantified. The Methodology presents the values for aboveground biomass, belowground, and soil carbon pools. If the REDD+ project holder intends to use additional pools, they shall provide a detailed description of their estimation by IPCC guidelines and demonstrate that their use does not lead to an overestimation of emissions in the baseline or the mitigation results.

Factor emission of biomass total carbon

Total biomass (TB) is estimated from the sum of aboveground biomass (AB) and belowground biomass (BB). The carbon content of total biomass (CCB) is the TB product and the carbon fraction of dry matter (CF[35]). The carbon dioxide equivalent content in the total biomass (CO_{2eq}) is the product of CCB and the molecular ratio constant between carbon (C) and carbon dioxide (CO_2). Then, the estimation of CO_{2eq} is done according to the equation:

$$CO_{2eq} = CCB \ x \ \frac{44}{12}$$

Where:

$CO_{2eq} =$	Carbon dioxide equivalent content in the total biomass; $tCO_2e \ ha^{-1}$
$TB =$	Total biomass; $t \ ha^{-1}$
$44/12 =$	The molecular ratio constant between carbon (C) and carbon dioxide (CO_2)

According to the IPCC, it is assumed that all carbon contained in the aboveground and belowground biomass is emitted in the same year that the deforestation event occurs.

Soil organic carbon emission factor

To estimating emissions from deforestation of the soil, a gross emission is assumed where the soil organic carbon (SOC) is emitted in equal proportions for 20 years once the deforestation event occurs. According to the following equation, the annual rate of carbon emissions in 20 years (SOC20years) was calculated by dividing the SOC of each natural region by 20.

$$SOCeq = \frac{SOC}{20} \ x \ \frac{44}{12}$$

Where:

$SOCeq =$	Carbon dioxide equivalent in organic soils; $tCO_2e \ ha^{-1}$
$SOC =$	Soil organic carbon content; $tC \ ha^{-1}$

Total carbon emission factor

The total carbon emission factor includes the carbon dioxide equivalent emission per hectare deforested, including the biomass and organic soil carbon, according to the following equation:

$$TCeq = CBeq + \ SOCeq$$

Where:

[35] Carbon fraction of the dry matter is 0,47, according to IPCC (2006)

$TCeq$ = Total carbon dioxide equivalent; tCO2e ha^{-1}

$CBeq$ = Carbon dioxide equivalent contained in total biomass; tCO2e ha-1

$SOCeq$ = Carbon dioxide equivalent contained in organic soils; tCO2e ha-1

13.3.2 **Forest degradation**

Emission factors are estimated from the mean aboveground biomass[36] for each fragmentation class (Table 5) and the average aboveground biomass differences concerning transitions between fragmentation classes (Table 6).

Table 5. Aboveground biomass per fragmentation class

Fragmentation class	Average biomass per class (tC ha^{-1})
Core	
Perforated	
Patch	

Table 6. Difference in aboveground biomass by fragmentation type

Transition ID	Fragmentation classes transition	Average difference in aboveground biomass (tC ha-1)
1	Core - patch	
2	Perforated - patch	

Total forest biomass is the sum of aboveground forest biomass and belowground forest biomass. The forest shall be stratified by ecological zone to obtain the total biomass by fragmentation class transition.

$$DTBi = DAB\ x\ (1 + R)$$

Where:

$DTBi$ = Difference total biomass transition i; t ha^{-1}

DAB = Average difference in aboveground biomass transition i; tC ha^{-1}

R = Belowground/aboveground biomass ratio; ton d.m.$^{-1}$

i = Degradation type; 1-primary degradation, 2-secondary degradation

[36] According the available local or national values.

The carbon in total biomass is the product of total biomass and the carbon fraction, according to the following equation:

$$DTCBi = DTBi\ x\ CF$$

Where:

$DTCBi =$	Difference total carbon biomass; tC ha^{-1}
$DTBi =$	Difference total biomass; t ha^{-1}
$CF =$	Carbon fraction; 0,47
$i =$	Degradation type; 1-primary degradation, 2-secondary degradation

The equivalent carbon dioxide contained in the DTB is the product between the DBCF and the molecular ratio constant between carbon (C) and carbon dioxide (CO_2), according to the following equation:

$$DTBCO_{2eq} = DCTBi\ x\ \frac{44}{12}$$

Where:

$DTBCO_{2eq} =$	Carbon dioxide equivalent in the difference of total biomass per hectare; tCO_2e ha^{-1}
$DCTBi =$	Carbon content in the difference of total biomass; tC ha^{-1}
$i =$	Degradation type; 1-primary degradation, 2-secondary degradation

13.4 GHG emissions in the analysis period

13.4.1 Deforestation

The annual emission due to deforestation in the baseline scenario is estimated with the following equation:

$$AE_{bl,yr} = AD_{bl,yr}\ x\ TCO_{2eq}$$

Where:

$AE_{bl,yr} =$ Annual emission in the baseline scenario; tCO2 ha^{-1}

$AD_{bl,yr} =$ Historical annual deforestation in the baseline scenario; ha

$TCO_{2eq} =$ Total carbon dioxide equivalent; tCO2e ha^{-1}

The annual emission due to deforestation in the project scenario is estimated with the following equation:

$$AE_{REDD+project,yr} = AD_{REDD+project}\ x\ TCO_{2eq}$$

Where:

$AE_{REDD+project,yr} =$ Annual emission in the project scenario; tCO2 ha^{-1}

$AD_{REDD+project} =$ Projected deforestation with project activities; ha

$TCO_{2eq} =$ Total carbon dioxide equivalent; tCO2e ha^{-1}

The annual emission due to deforestation in the leakage area is estimated as follow:

$$AE_{lk,yr} = AD_{lk,yr}\ x\ CO_{2eq}$$

Where:

$AE_{lk,yr} =$ Annual emission in the leakage area; tCO2 ha^{-1}

$AD_{lk,yr} =$ Annual projected deforestation in leakage area; ha

$TCO_{2eq} =$ Total carbon dioxide equivalent; tCO2e ha^{-1}

13.4.2 Forest degradation

The annual emission due to forest degradation in the baseline scenario is estimated with the following equation:

$$AE_{fd,bl,yr} = \left(PFD_{bl,yr}\ x\ DTBCO_{2eq,1}\right) + \left(SFD_{bl,year}\ x\ DTBCO_{2eq,2}\right)$$

Where:

$AE_{fd,bl,yr} =$ Annual emission due to degradation in the baseline scenario; tCO2 ha^{-1}

$PFD_{bl,year} =$ Annual primary forest degradation in the baseline scenario; ha

$SFD_{bl,year}$ Annual secondary degradation in the baseline scenario; ha

$DTBCO_{2eq,1}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of primary degradation; $tCO_2e\ ha^{-1}$

$DTBCO_{2eq,2}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of secondary degradation; $tCO_2e\ ha^{-1}$

1,2 = Degradation type; 1-primary degradation, 2-secondary degradation

The annual emission due to degradation in the project scenario is estimated as follow:

$$AE_{fd,REDD+project,yr} = \left(PFD_{fd,REDD+project,yr}\ x\ DTBCO_{2eq,1}\right) + \left(SFD_{REDD+project,year}\ x\ DTBCO_{2eq,2}\right)$$

Where:

$AE_{fd,REDD+project,yr}$ = Annual emission due to degradation in the project scenario; $tCO_2\ ha^{-1}$

$PFD_{REDD+project,year}$ = Annual primary forest degradation in the project scenario; ha

$SFD_{REDD+project,year}$ Annual secondary degradation in the project scenario; ha

$DTBCO_{2eq,1}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of primary degradation; $tCO_2e\ ha^{-1}$

$DTBCO_{2eq,2}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of secondary degradation; $tCO_2e\ ha^{-1}$

1,2 = Degradation type; 1-primary degradation, 2-secondary degradation

The annual emission by degradation in the leakage area is calculated, following the equation:

$$AE_{fd,lk,yr} = \left(PFD_{lk,yr}\ x\ DTBCO_{2eq,1}\right) + \left(SFD_{lk,year}\ x\ DTBCO_{2eq,2}\right)$$

Where:

$AE_{fd,lk,yr}$ = Annual emission due to degradation in the leakage area; $tCO_2\ ha^{-1}$

$PFD_{lk,year}$ = Annual primary forest degradation in the leakage area; ha

$SFD_{lk,year}$ Annual secondary degradation in the leakage area; ha

$DTBCO_{2eq,1}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of primary degradation; $tCO_2e\ ha^{-1}$

$DTBCO_{2eq,2}$ = Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of secondary degradation; $tCO_2e\ ha^{-1}$

1,2 = Degradation type; 1-primary degradation, 2-secondary degradation

13.5 Expected GHG emissions reduction in the project scenario

13.5.1 Project reduction emission due to avoided deforestation

The emission reduction due to avoided deforestation is estimated with the following equation:

$$ER_{DEF,REDD+project} = (t_2 - t_1)\ x\ \left(AE_{DEF,bl,yr} - AE_{DEF,REDD+project,yr} - AE_{DEF,lk,yr}\right)$$

Where:

$ER_{DEF,REDD+project}$ = Emission reduction due to avoided deforestation; tCO_2e

t_2 = Final year of the reference period; yr

t_1 = Initial year of the reference period; yr

$AE_{bl,yr}$ = Annual emission by deforestation in the baseline scenario; tCO_2e

$AE_{REDD+project}$ = Annual emission by deforestation in the project scenario; $tCO_2\ ha^{-1}$

$AE_{lk,yr}$ = Annual emission by deforestation in the leakage area; $tCO_2\ ha^{-1}$

13.5.2 Project reduction emission due to avoided forest degradation

The emission reduction due to avoided forest degradation is estimated with the following equation:

$$ER_{FD,REDD+project} = (t_2 - t_1)\ x\ \left(AE_{FD,bl,yr} - AE_{FD,REDD+project,yr} - AE_{FD,lk,yr}\right)$$

Where:

$ER_{FD,REDD+project}$ = Emission reduction due to avoided forest degradation; tCO_2e

t_2 = Final year of the reference period; yr

t_1 = Initial year of the reference period; yr

$AE_{FD,bl,yr}$ = Annual emission by forest degradation in the baseline scenario; tCO_2e

$AE_{FD,REDD+project,yr}$ = Annual emission by forest degradation in the project scenario; $tCO_2\ ha^{-1}$

$AE_{FD,lk,yr}$ = Annual emission by forest degradation in the leakage area; $tCO_2\ ha^{-1}$

14 Monitoring plan

The project holders shall describe the procedures established to follow-up the project activities, the safeguards compliance, and the GHG emission reduction or removals in the Project.

The monitoring plan should provide the collection of all relevant data necessary to:

(a) Verify that the applicability conditions listed in numeral 4 of this document have been met;

(b) Verify changes in carbon stocks in selected pools;

(c) Verify project emissions and leakage;

The data collected shall be archived for at least two years after the end of the last project period, including the data and parameters monitored, the methods used to generate data and their proper collection and archiving, and the processes related to sampling models and data quality control.

14.1 Monitoring of the project boundary

The Project's geographic limits, constituted by the eligible areas[37] over which REDD+ activities are developed, shall be included in a Geographic Information System (GIS), georeferencing the total project areas, including the reference region and the leakage belt.

Thus, the monitoring of the emission reduction from deforestation and forest degradation shall be carried out for geographic areas within the project boundary. Periodic verification of deforestation and degradation in the Project shall be carried out using the Methodology described in sections **¡Error! No se encuentra el origen de la referencia.** and 13.5.

14.2 Monitoring of the REDD+ activities implementation

The REDD+ project holder shall design a monitoring plan for each proposed activity, according to the following table's information.

[37] Eligible area refers to areas that meet the condition of forest presence on the reference dates established by the BCR STANDARD.

Table 7. Monitoring of the REDD+ activities implementation

Activity ID	
Indicator ID	
Indicator name	
Type[38]	
Goal[39]	
Measurement unit	
Monitoring methodology	
Monitoring frequency	
Responsible for measurement	
Result indicator in the reporting period	
Documents to support the information	
Observations	

14.3 Monitoring of the REDD+ Safeguards

The REDD+ project holder shall design a monitoring plan for each safeguard with the following table's information.

Table 8. Monitoring of the REDD+ Safeguards

Safeguard ID	
Indicator ID	
Indicator name	
Type	
Goal	
Measurement unit	
Monitoring methodology	
Monitoring frequency	
Responsible for measurement	
Result indicator in the reporting period	
Documents to support the information	
Observations	

[38] Result, product or impact.
[39] Expected value and time for compliance.

14.4 Monitoring of the project permanence

The project holder shall identify the risks of project permanence and design a monitoring plan that includes mitigation measures, monitoring indicators, and reporting procedures[40]. Biophysical and socioeconomic risks should be assessed, including fires, floods, land tenure disputes, conflicts between project stakeholders, non-ownership of project activities, and governance failures.

14.5 Monitoring of the project emissions

In the project scenario, at a minimum, activity data should be monitored. Validated emission factors can be applied in the estimation of monitored emissions[41]. The parameters for the estimation of activity data shall be determined following the guidelines in Section 13.2.

14.5.1 Activity data

Annual deforestation in the project area

The deforestation in the project area during the monitoring period shall use the following equation:

$$FSC_{REDD+project,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{REDD+projec1} - A_{REDD+project2}\right)$$

Where:

$FSC_{REDD+project,yr}$	=	Annual change in the surface covered by forest in the project area; ha
t_2	=	Final year of the reference period; yr
t_1	=	Initial year of the reference period; yr
$A_{REDD+projec,1}$	=	Forest surface in the project area at the beginning of the monitoring period; ha
$A_{REDD+project,2}$	=	Forest surface in the project area at the end of the monitoring period; ha

Annual deforestation in the leakage area

The estimation of the annual deforestation in the leakage area, in the monitoring period, is estimated by equation:

[40] In the event of fires, the affected area shall be identified, CO_2 and CH_4 emissions shall be estimated and included in the quantification of the project's emissions during the monitoring period.
[41] The REDD+ Project holder shall review and adjust the activity data and emission factors according to the national official information and data.

$$FSC_{lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x\ (A_{lk,1} - A_{lk,2})$$

Where:

$FSC_{lk,yr} =$	Annual change in the surface covered by forest in the leakage area; ha
$t_2 =$	Final year of the reference period; yr
$t_1 =$	Initial year of the reference period; yr
$A_{lk,1} =$	Forest surface in the leakage area at the beginning of the monitoring period; ha
$A_{lk,2} =$	Forest surface in the leakage area at the end of the monitoring period; ha

Annual degradation in the project area

The following equations estimate the annual forest degradation in the project area[42]:

$$PFD_{REDD+project,yr} = \left(\frac{1}{t_2 - t_1}\right) x\ (A_{core} - A_{c-p})$$

Where:

$PFD_{REDD+project,yr} =$	Annual primary forest degradation in the project area; ha
$t_1 =$	Initial year of the monitoring period; yr
$t_2 =$	Final year of the monitoring period; yr
$A_{core} =$	Area in core class in the project area, in the year of the start of the monitoring period; ha
$A_{c-p} =$	Project area that changes from the core to patch in the final year of the monitoring; ha

And,

$$SFD_{REDD+project,yr} = \left(\frac{1}{t_2 - t_1}\right) x\ (A_{perforated} - A_{perforated-patch})$$

Where:

$SFD_{REDD+project,yr} =$	Annual secondary forest degradation project area; ha
$t_1 =$	Initial year of the monitoring period; yr

[42] The area reported as degraded is that with a degradation trend in the two periods of analysis. That is, areas that move from a primary to a secondary class in one period and then return to a primary class will not be considered degraded.

$t_2 =$ Final year of the monitoring period; yr

$A_{perforated} =$ Area in perforated class in the project area, in the initial year of the monitoring period; ha

$A_{perforated-patch} =$ Area in the project area that changes from perforated to patch in the final year of the monitoring period; ha

<u>Annual degradation in the leakage area</u>

The following equations estimate annual forest degradation in the leakage area:

$$PFD_{lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{core} - A_{c-p}\right)$$

Where:

$PFD_{REDD+project,yr} =$ Annual primary forest degradation in leakage area; ha

$t_1 =$ Initial year of the monitoring period; yr

$t_2 =$ Final year of the monitoring period; yr

$A_{core} =$ Area in core class in the leakage area, in the year of the start of the monitoring period; ha

$A_{c-p} =$ Leakage area that changes from the core to patch in the final year of the monitoring; ha

And,

$$SFD_{lk,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{perforated,lk} - A_{perforated-patch,lk}\right)$$

Where:

$SFD_{lk,yr} =$ Annual secondary forest degradation in the leakage area; ha

$t_1 =$ Initial year of the monitoring period; yr

$t_2 =$ Final year of the monitoring period; yr

$A_{perforated,lk} =$ Area in perforated class in the leakage area, in the initial year of the monitoring period; ha

$A_{perforated-patch,lk} =$ Area in the leakage area that changes from perforated to patch in the final year of the monitoring period; ha

14.5.2 GHG emissions in the monitoring period

Deforestation

The annual emission due to deforestation in the project area is estimated with the following equation:

$$AE_{REDD+project,yr} = AD_{REDD+project,yr}\ x\ TCO_{2eq}$$

Where:

$AE_{REDD+project,yr}$	=	Annual emission in the project area; tCO2 ha^{-1}
$AD_{REDD+project,yr}$	=	Annual deforestation in the project area; ha
TCO_{2eq}	=	Total carbon dioxide equivalent; tCO2e ha^{-1}

The annual emission due to deforestation in the leakage area is estimated as follow:

$$AE_{lk,yr} = (AD_{lk,yr}\ x\ TCO_{2eq}) - AE_{bl,lk,yr}$$

Where:

$AE_{lk,yr}$	=	Annual emission in the leakage area; tCO2 ha^{-1}
$AD_{lk,yr}$	=	Annual deforestation in leakage area; ha
TCO_{2eq}	=	Total carbon dioxide equivalent; tCO2e ha^{-1}
$AE_{bl,lk,yr}$	=	Annual emission in the leakage area, in the baseline scenario; tCO2 ha^{-1}

Forest degradation

The annual emission due to degradation in the project area is estimated as follow:

$$AE_{fd,REDD+project,yr} = \left(PFD_{fd,REDD+project,yr}\ x\ DTBCO_{2eq,1}\right) + \left(SFD_{REDD+project,year}\ x\ DTBCO_{2eq,2}\right)$$

Where:

$AE_{fd,REDD+project,yr}$	=	Annual emission due to degradation in the project area; tCO2 ha^{-1}
$PFD_{REDD+project,year}$	=	Annual primary forest degradation in the project area; ha

$SFD_{REDD+project,year}$	Annual secondary degradation in the project area; ha
$DTBCO_{2eq,1} =$	Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of primary degradation; tCO2e ha^{-1}
$DTBCO_{2eq,2} =$	Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of secondary degradation; tCO2e ha^{-1}
1,2 =	Degradation type; 1-primary degradation, 2-secondary degradation

The annual emission by degradation in the leakage area is calculated, following the equation:

$$AE_{fd,lk,yr} = \left(PFD_{lk,yr}\ x\ DTBCO_{2eq,1}\right) + \left(SFD_{lk,year}\ x\ DTBCO_{2eq,2}\right)$$

Where:

$AE_{fd,lk,yr} =$	Annual emission due to degradation in the leakage area; tCO2 ha^{-1}
$PFD_{lk,year} =$	Annual primary forest degradation in the leakage area; ha
$SFD_{lk,year}$	Annual secondary degradation in the leakage area; ha
$DTBCO_{2eq,1} =$	Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of primary degradation; tCO2e ha^{-1}
$DTBCO_{2eq,2} =$	Carbon dioxide equivalent in the difference of total biomass per hectare, in the class of secondary degradation; tCO2e ha^{-1}
1,2 =	Degradation type; 1-primary degradation, 2-secondary degradation

14.5.3 **Total project emissions reduction**

Deforestation

Emission reductions from avoided deforestation in the monitoring period are estimated according to the following equation:

The emission reduction due to avoided deforestation is estimated with the following equation:

$$ER_{DEF,REDD+project} = (t_2 - t_1)\ x\ \left(AE_{DEF,bl,yr} - AE_{DEF,REDD+project,yr} - AE_{DEF,lk,yr}\right)$$

Where:

$ER_{DEF,REDD+project} =$	Emission reduction due to avoided deforestation, monitoring period; tCO_2e

$t_2 =$ Final year of the monitoring period; yr

$t_1 =$ Initial year of the monitoring period; yr

$AE_{bl,yr} =$ Annual emission by deforestation in the baseline scenario; tCO_2e

$AE_{REDD+project} =$ Annual emission by deforestation in the project area; $tCO2\ ha^{-1}$

$AE_{lk,yr} =$ Annual emission by deforestation in the leakage area; $tCO2\ ha^{-1}$

Forest degradation

The emission reduction due to avoided forest degradation is estimated with the following equation:

$$ER_{FD,REDD+project} = (t_2 - t_1)\ x\ \left(AE_{FD,bl,yr} - AE_{FD,REDD+project,yr} - AE_{FD,lk,yr}\right)$$

Where:

$ER_{FD,REDD+project} =$ Emission reduction due to avoided forest degradation, monitoring period; tCO_2e

$t_2 =$ Final year of the monitoring period; yr

$t_1 =$ Initial year of the monitoring period; yr

$AE_{FD,bl,yr} =$ Annual emission by forest degradation in the baseline scenario; tCO_2e

$AE_{FD,REDD+project,yr} =$ Annual emission by forest degradation in the project scenario; $tCO2\ ha^{-1}$

$AE_{FD,lk,yr} =$ Annual emission by forest degradation in the leakage area; $tCO2\ ha^{-1}$

14.6 **Quality control and quality assurance procedures**

The REDD+ project holder shall design a quality management and assurance system to ensure the proper management, quality, and reliability of the information. The Quality Control/Assurance Control (QA/QC) system should conform to IPCC recommendations[43]. To provide consistency in the processes, protocols, and manuals should be developed for all project activities. The QA/QC process should include, in a complementary manner, what is described in the following sections.

[43] IPCC GPG LULUCF (2005). http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf/spanish/full.pdf

14.6.1 Review of the information processing

The processing of the data collected in the field and the digital systems recording should be reviewed. The recorded data should be reviewed using a sample of 10% of the records (selected at random) to identify possible inconsistencies. If there are errors, a percentage estimate of the errors should be made. The typing error should not exceed 10%, in which case the entire data should be reviewed, and the necessary corrections made.

14.6.2 Data recording and archiving system

The information should be stored in an organized and secure manner in digital and physical formats with sufficient copies (depending on the personnel in charge). In general, each file should contain field forms, estimates of carbon content changes (equations and calculations), geographic information (GIS) [44], and measurement and monitoring reports.

According to the Methodology, the data collected shall be archived for at least two years after the project activity's last accreditation period.

[44] Geographic information shall be handled following the quality standards.

Document history

Type of document. Methodological Document for REDD+ projects

Version	Date	Nature of the review
1.0	February 3, 2020	Initial version – Document submitted for public consultation
2.0	April 13, 2020	Updated version – After consultation
2.1	June 5, 2020	Adjusted version Reference region Leakage area Activity data Some terms and definitions
2.2	February 5, 2021	Adjusted version Editorial changes Notation in some equations
3.0	February 16, 2022	Actualized version Normative references Definitions REDD+ safeguards Minor Editorial Changes Copyright BioCarbon Registry
3.1	September 15, 2022	Actualized version GHG Sources. Soil Organic Carbon, optional Minor Editorial Changes