METHODOLOGICAL DOCUMENT AFOLU SECTOR

Quantification of GHG emission reduction and removal

ACTIVITIES THAT AVOID LAND-USE CHANGE IN CONTINENTAL WETLANDS

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Table of content

Acronyms

ACTB	Amount of Carbon in Total Biomass
AGB	Above Ground Biomass
AFOLU	Agriculture, Forestry and Other Land Uses
BGB	Below Ground Biomass
CAB	Conformity assessment body
CBD	Convention of Biological Diversity
CNVC	Changes in Natural Vegetation Cover Surfaces
CH_4	Methane
CLC	CORINE Land Cover
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
f	Carbon Fraction in Dry Matter
FAO	Food and Agriculture Organization of the United Nations
GHG	Green House Gases
GIS	Geographic Information Systems
HCV	High Conservation Values
IPCC	Intergovernmental Panel on Climate Change
N_2O	Nitrous Oxide
SER	Society for Ecological Restoration International
SOC	Soil Organic Carbon
TB	Total Biomass
TC	Total Carbon
UN	United Nations
UNFCCC	United Nations Framework Convention of Climate Change
VCC	Verified Carbon Credits

1 Introduction

Natural tropical continental wetlands (hereinafter continental wetlands) are considered strategic ecosystems worldwide due to their importance on climate regulation. Likewise, they are recognized for presenting a high permanent and migratory species diversity[1], mainly due to the alternation of aquatic and terrestrial phases in the same space.

Furthermore, according to the Ramsar Scientific and Technical Review Panel, wetlands cover only 9% of the planet's land surface. However, it is estimated that they store 35% of terrestrial carbon.[2] These carbon stocks are decreasing rapidly due to the accelerated land-use change that has occurred in the last decades on Continental Wetlands[3]. Due to the above, it is important to generate alternatives that avoid land-use change, giving recognition, value, and visibility to GHG mitigation actions as a strategy for the conservation and restoration of Continental Wetlands.

The methodology covers aspects related to activities that prevent land-use change in Continental Wetlands, including GHG removals due to ecosystem restoration, identification of GHG sources and pools, spatial and temporal limits, causes and agents of land-use change, baseline scenarios, additionality, uncertainty and risk management, leakage management and monitoring activities.

Directing efforts towards the conservation and restoration of Continental Wetlands, this methodological document is presented for the complete and detailed guidance of GHG mitigation project holders, in the design of GHG reduction/removal and biodiversity conservation projects.

2 Objectives

The objectives of this methodological document are:

a) Provide the requirements for the quantification of GHG emission reductions resulting from activities that prevent land-use change in continental wetlands;

b) Provide the requirements for quantification of GHG removals resulting from restoration activities in continental wetlands;

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[1] Neue, H., Gaunt, J., Wang, Z., Becker-Heidmann, P. & Quijano, C. (1997). Carbon in tropical wetlands. Geoderma, 79(1-4), 163-185; Jennings, S., Nussbaum, R., Judd, N., Evans, T., Azevedo, T., Brown, N., Colchester, M., Iacobelli, T., Jarvie, J., Lindhe, A., Synnott, T., Vallejos, C., Yaroshenko, A. & Chunquan, Z. (2003). The high conservation value forest toolkit. Edition I, ProForest, Oxford OX, 12, 1-62.; Junk, W. J., & Wantzen, K. M. (2004). The flood pulse concept: new aspects, approaches and applications-an update. In Second international symposium on the management of large rivers for fisheries (pp. 117-149). Food and Agriculture Organization and Mekong River Commission, FAO Regional Office for Asia and the Pacific.

[2] Liu, Y. N., Ni, H. W., Zeng, Z. W., & Chai, C. R. (2013). Effect of disturbance on carbon cycling in wetland ecosystem. Advanced Materials Research, (610), pp. 3186-3186-3191. https://doi.org/10.4028/www.scientific.net/amr.610-613.3186.

[3] Mitsch, W.J., Nahlik, A., Wolski, P. et al. (2010). Tropical wetlands: seasonal hydrologic pulsing, carbon sequestration, and methane emissions. Wetlands Ecol Manage 18 (5), 573–586. https://doi.org/10.1007/s11273-009-9164-4

c) Provide the methodological requirements for the identification of the project baseline that avoids the land-use change in continental wetlands;

d) Provide the methodological requirements to demonstrate the additionality of projects that, through their activities, avoid the land-use change in continental wetlands;

e) Describe the requirements for project activities monitoring and follow-up that prevent land-use change in continental wetlands.

3 Version and validity

This methodological document corresponds to the Version 1.0, October 27, 2021.

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

4 Scope

This document corresponds to a methodology for the establishment of a baseline, quantification of GHG reductions/removals, monitoring, leakage management, and conservation of biodiversity associated with continental wetlands in the Orinoquia[4] region.

This methodology is applicable only for GHG mitigation projects that generate GHG emission reductions/removals, through activities that avoid land-use change, and those that opt for restoration activities that generate GHG removals, in the Orinoquia region, in ecosystems of continental wetlands.

This methodology must be used by projects in continental wetlands, to be certified and registered with the Certification and Registration Program for GHG Mitigation Initiatives and other Greenhouse Gas Projects and the Voluntary Carbon Market Standard.

5 Applicability Conditions

This methodology is applicable under the following conditions:

a) The limits of the project correspond to the continental wetland category;

b) Project activities avoid land-use change in natural continental wetlands, in the Orinoquia region;

c) Project activities include biodiversity conservation actions that integrate efforts for the preservation, restoration, and/or management and sustainable use of continental wetlands;

[4] The term Orinoquia includes the entire Orinoquia region (present in Colombia and Venezuela).

d) The causes of land-use change include: the expansion of the agricultural/livestock frontier[5], mining activity, extraction or loss of natural vegetation cover, infrastructure (roads and urban), and tourism exploitation (tourism activities that exceed the carrying capacity of the ecosystem);

e) Project activities do not lead to alteration of the water regime of the project area or hydrologically connected areas due to anthropic interventions (e.g. irrigation, and/or drainage systems);

f) Land alteration attributable to the project activities does not cover more than 10% of the surface area within the limits of the project[6];

g) The areas within the geographical limits of the project correspond to the category of continental wetlands;

h) It does not apply to coastal-maritime and high mountain wetlands, or artificial territories.

6 Normative reference

The following normative references are indispensable for the application of this methodology:

a) PROCLIMA program. Certification and Registration Program for GHG Mitigation Initiatives and other Greenhouse Gas Projects, in its most recent version, as applicable;

b) Voluntary Carbon Market Standard. From differentiated responsibility to common responsibility, when applicable;

c) The guidelines, orientations, and/or guides defined by PROCLIMA, in the scope of projects in the AFOLU sector;

d) The 2006 and 2019 IPCC guidelines for national greenhouse gas inventories. Vol. 04. Agriculture, forestry, and other land-uses, or that which modifies or updates it;

e) International Agreement RAMSAR Convention 1971, or the one that modifies or updates it;

f) Legal regulation on GHG mitigation actions, as applicable.

Similarly, compliance with the provisions of the following ISO Standards is essential:

a) ISO 14064-2: 2019 standard (es). Greenhouse gases - Specification with guidance, at the project level, for the quantification, monitoring, and reporting of the

[5] The expansion of the agricultural frontier may also include the draining of wetlands, as a practice associated with land use change in activities related to agricultural or livestock production.

[6] The condition is related to the preparation of the soil for activities proposed by the project owner. Depending on management practices, soil disturbances may or may not occur. In any case, the soil disturbance generated by GHG removal activities cannot be greater than 10%.

reduction of emissions or the increase in removals of greenhouse gases, or that which updates it;

b) ISO 14064-3: 2019 standard (es). Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas claims, or that which updates it;

c) ISO 14065: 2013 (es). Greenhouse gases - Requirements for bodies that perform greenhouse gas validation and verification, for use in accreditation or other forms of recognition.

d) ISO 19131 - Data product technical specifications; ISO 19115-1 Geographic Metadata and ISO 19157 - Data quality.

7 Terms and definitions

Additionality

Characteristic that allows demonstrating that GHG emission reductions or removals, derived from the implementation of a GHG mitigation initiative, generate a net benefit to the atmosphere in terms of reduced or removed GHG emissions.

GHG emission reductions or removals that the GHG mitigation project owner demonstrates that would not have occurred in the absence of the GHG mitigation project are considered additional.

In the AFOLU sector, for non-REDD + projects, additionality is the effect of the project activity to increase the actual net GHG removals by sinks, above the sum of the changes in carbon stocks in the reservoirs. of carbon within the project boundaries, which would have occurred in the absence of the project activity[7].

Agents causing land-use change in continental wetlands

People, social groups or institutions (public or private) that, influenced or motivated by a series of underlying factors or causes, decide to convert natural vegetation covers to other covers and land-uses, and whose actions are manifested in the territory as an alteration to the ecological integrity of the wetland.

Agriculture, forestry, and other land-use sector (AFOLU)

Sector comprising greenhouse gas emissions and/or removals attributable to project activities in the agriculture, forestry, and other land-use sectors.

Aquatic terrestrial transition zone (ATTZ)

Banks and coastline areas that are dynamic and present a lateral movement of contraction and expansion. In these areas, there is an alternation between the aquatic and terrestrial

[7] Adapted from the MDL Glossary.

phases, and they are considered highly productive.

Baseline scenario

Scenario for the GHG mitigation project that reasonably represents the sum of the changes in carbon stocks in carbon pools within the project boundary, which would occur in the absence of the GHG mitigation project[8].

The biodiversity baseline is understood as the status and trends of the biodiversity of the project area in the absence of the implementation and development of the GHG mitigation project activities.

Bioindicators

Organisms or communities of organisms whose study or observation generates information about the ecosystem in general.

Carbon credits

Greenhouse gas reductions and removals that can be traded, to mitigate GHG emissions generated by anthropogenic activity. A Verified Carbon Credit (VCC) is equivalent to one metric ton of CO_2e, which has been verified by a CAB, based on the rules and procedures defined for it and which has a unique serial code granted by ProClima.

Carbon pool

A compartment in which changes in carbon stocks occur in terrestrial ecosystems (above-ground biomass, below-ground biomass, litter, deadwood, and soil organic carbon), as defined in the Guidelines of the Intergovernmental Group of Experts on Climate Change (IPCC) for national greenhouse gas inventories.

Conservation of the ecosystem

It refers to efforts focused on the protection of biodiversity, under a broader vision that includes the protection of ecological processes and functions. According to the World Conservation Strategy (1980), it is defined as "*the management of the use of the biosphere by human beings, in such a way that it produces the greatest sustainable benefit for current generations, but that maintains its potential to satisfy the needs and aspirations of future generations*". Conservation has the following objectives or purposes:

- Maintain ecological processes and essential life systems
- Preserve genetic diversity
- Ensure the sustainable use of species and ecosystems

[8] Adapted from CDM Glossary

Direct causes of land-use change in wetlands

Direct causes are related to human activities that directly affect the natural vegetation cover of wetland ecosystems. These group the factors that operate at a local scale, different from the initial structural or systemic conditions, which originate in the use of the land and that affect the natural cover using the natural resource, or its elimination to give way to other uses.

Degraded wetland

A wetland that has been disturbed and shows evidence of deterioration of physical, chemical, and biological properties, and consequently results in a reduction of species diversity, land carbon, or the complexity of other ecosystem functions. The most frequent causes are human activities or disturbances that are too frequent or severe to allow natural recovery.

Drainage

Elimination of excess water either from the surface of the soil or under it, caused by rains, too much irrigation, seepage of channels, floods, among other causes, to control the water table of agricultural soils[9].

Ecological integrity

Combination of ecosystem processes (functions) and biodiversity that characterize an area in a specific period. Maintaining the ecological integrity of an area implies the continuous provision of ecosystem goods and services[10].

Eligible Areas

Areas within the geographical limits of the project that correspond to the category of continental wetland, which comply with their condition as a wetland maintaining their natural functions, hydrological conditions, sedimentation, and native vegetation, on the reference dates, meaning at the beginning of the project activities, and at least five years before the project start date[11].

Flagship species

Species selected or recognized as symbols of a given habitat, campaign, or environmental initiative. The conservation of these species can contribute to improving

[9] Brouwer, C., Goffeau, A., & Heibloem, M. (1985). Irrigation water management: training manual no. 1-introduction to irrigation. Food and Agriculture Organization of the United Nations, Rome, Italy, 102-103.
[10] Bridgewater, P., Kim, R. & Bosselmann, K. (2015). Ecological Integrity: A Relevant Concept for International Environmental Law in the Anthropocene? Yearbook of International Environmental Law. 25. 61-78. 10.1093/yiel/yvv059.
[11] Currently, wetlands present an accelerated rate of loss, with an average value of 50% globally (Van der Valk AG (2006) The biology of freshwater wetlands. Oxford University Press, Oxford, UK). In response to the accelerated loss, the reference date of at least five (5) years is evaluated, in order to also be able to choose wetlands whose degradation is recent.

the status of other species that are in the same habitat, or that are vulnerable to the same threats. They can also be key species and indicator species of biological processes[12].

Flood pulse

A concept that explains how periodic flooding and drought control the lateral exchange of water, nutrients, and organisms between the main river channel and the connected floodplain[13].

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 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest.

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

GHG mitigation project

GHG mitigation projects include sectoral GHG mitigation projects and other greenhouse gas projects, as provided for in the ProClima Program.

High conservation value - HCV

Exceptionally significant or critical Biological, ecological, social, or cultural value.

Leakage

Possible emissions that would occur outside the project boundaries, caused by the activities of the GHG mitigation initiative. Leakage refers to the net change in anthropogenic emissions from greenhouse gas (GHG) sources that occur outside the project scope, and that is measurable and attributable to the project activity.

Leakage Area

Natural vegetation cover areas, to which activities that generate land-use change can be displaced and that are beyond the control of the project holder. That is the areas to which the agents that generate land-use change can move, because of the project activities.

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[12] https://wwf.panda.org/discover/our_focus/wildlife_practice/flagship_keystone_indicator_definition/

[13] Junk, W., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110-127 in D.P. Dodge, ed. Proceedings of the International Large River Symposium (LARS). Canadian Special Publication of Fisheries and Aquatic Sciences 106

Maximum flood level

The maximum level of the ground where the water reaches due to the annual flood pulse and not due to extreme climatic events.

Natural tropical continental wetland

According to the United States Environmental Protection Agency, they are all wetlands that are not coastal, nor have they been created by man. They commonly occur in floodplains along rivers and streams, in isolated depressions surrounded by dry land, along the margins of lakes and ponds, and in other low-lying areas where groundwater intercepts the surface of the soil or where rainfall sufficiently saturates the soil[14]. Geographically located in the tropical zone of the planet (20 ° N - 20 ° S).

Natural vegetation cover, different from forests

It comprises a group of plant covers of a natural type and product of natural succession, whose growth habit is shrubby and herbaceous, developed on different substrates and altitudinal floors, with little or no anthropic intervention. For the CORINE Land Cover legend adapted for Colombia, this class includes other types of cover such as areas covered by shrub vegetation with an irregular canopy and the presence of shrubs, palms, vines, and small growth vegetation.

Organic Soils

According to the FAO definition (adopted by IPCC)[15], organic soils (histosols) are soils with organic carbon content equal to or greater than 12%. Organic soils (e.g. peat and manure) have at least 12-20 percent organic matter by mass and thrive under poorly drained wetland conditions. Organic soils are identified based on criteria 1 and 2 or 1 and 3 shown below:

1. Thickness of the organic horizon greater than or equal to 10 cm. A horizon less than 20 cm should have 12% 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 should contain more than 20% organic carbon by weight (i.e., about 35% organic matter).
3. Soils are subject to water saturation episodes and meet criteria a, b or c:

    a) At least 12% organic carbon by weight (i.e. around 20% organic matter) if the soil is clay-free.
    b) At least 18% organic carbon by weight (i.e. about 30% organic matter) if the

[14]www.epa.gov/wetlands/what-wetland, mayo 27 de 2021
[15]Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M., & Troxler, T. G. (2014). 2013 supplement to the 2006 IPCC guidelines for national greenhouse gas inventories: Wetlands. IPCC, Switzerland.

soil is more than 60% clay.

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

Permanence

Longevity of a carbon deposit and its stability, considering the handling and alteration of the environment where it occurs.

Project Area

The area on which project activities that demonstrate net climate benefits are implemented. If a programmatic approach is used, the project area also includes all potential areas, that is, all new areas where project activities can be implemented after initial validation.

Reference region

Geographic limits defined by GHG project owners, where they establish a baseline or reference scenario in which historical patterns of land-use change are analyzed, which will be projected in the project area to obtain change rates in land-use in the project area for the baseline scenario.

Restoration

According to the Society for Ecological Restoration International (SER), "*ecological restoration is the process of assisting the reestablishment of an ecosystem that has been degraded, damaged or destroyed*"[16].

Restoration involves intentional activities that initiate or accelerate the recovery of ecological functionality or reestablishment of an ecosystem that has been degraded, damaged or destroyed.[17]

According to the National Ecological Restoration Plan (MADS, 2015)[18], restoration is an interdisciplinary strategy, in which scientific knowledge is articulated to respond to management processes and ecosystem management, in the face of the need to restore

[16] https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser-primer-spanish.pdf
[17] Adapted from SER primer, 2004, UNEP, 2019, IPBES, 2018:
- Society for Ecological Restoration International Science & Policy Working Group. 2004. The SER International Primer on ecological Restoration. www.ser.org & Tucson: Society for Ecological Restoration International.
- UNEP, 2019. New UN Decade for Ecosystem Restoration, a great opportunity for food security and climate action. https://www.unep.org/es/noticias-y-reportajes/comunicado-de-prensa/nueva-decada-de-la-onu-para-la-restauracion-de-los
- IPBES, 2018: The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 744 pages. https://doi.org/10.5281/zenodo.3237392
[18] Ministry of Environment and Sustainable Development. 2015. National Restoration Plan: ecological restoration, rehabilitation and recovery of disturbed areas. Bogotá, .: Colombia. 92 p.

degraded ecosystems and prevent future damage.

Restoration includes interventions such as: (a) ecological restoration, (b) ecological rehabilitation, and (c) ecological recovery.

Ecological restoration consists of restoring the degraded ecosystem to a condition similar to the pre-disturbance ecosystem concerning its composition, structure, and functioning. Furthermore, the resulting ecosystem must be a self-sustaining system and must guarantee the conservation of species, the ecosystem in general, as well as most of its goods and services.

Ecological rehabilitation seeks to bring the degraded system to a system similar or not to the pre-disturbance system, it must be self-sustaining, preserve some species, and provide some ecosystem services.

Ecological recovery aims to recover some ecosystem services of social interest. The resulting ecosystems are generally not self-sustaining and do not resemble the pre-disturbance system.

Start date

The date on which the activities that will translate into effective GHG emission reductions or removals begin. For GHG mitigation initiatives, in Continental Wetlands, the start date corresponds to the date on which the implementation of the project activities begins to generate the reduction of emissions by avoiding land-use change in the eligible areas, within the limits of the project. These can be, for example, agreements with the actors who hold the right to use the land and/or the initiation of management actions in the areas within the project boundaries.

Tropical zone

Tropical or Equatorial Climate Zone according to the Köppen climate classification and distribution. It is characterized by being humid and rainy.

Umbrella species

Species whose conservation is expected to confer protection to a large number of naturally coexisting species. They are usually species that need large areas of land that are home to other species to maintain viable populations. Umbrella species commonly correspond to species of birds, mammals, and lesser extent invertebrates[19].

Underlying causes of land-use change in wetlands

The underlying causes are factors that reinforce the direct causes. The social group,

[19] Roberge, J. M., & Angelstam, P. E. R. (2004). Usefulness of the umbrella species concept as a conservation tool. *Conservation biology*, 18(1), 76-85. DOI: 10.1111/j.1523-1739.2004.00450.x.

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 changes in land-use occur.

Land-use change in wetlands

Land-use change in wetlands constitute losses of natural vegetative cover and are generated by anthropic activities, which result in the conversion of natural vegetation cover to other land-uses.

Wetlands

According to the Ramsar Convention for the protection of wetlands, in its article number 1 of the protocol *"it defines a humid zone or wetland as any extension of marsh, swamp or peat bog, or surface covered with water, whether they are natural or artificial, permanent or temporary, stagnant or currents, fresh, brackish or salty, including the extensions of marine waters whose depth at low tide do not exceed six meters "*(Ramsar, 1971) [20].

The IPCC defines wetlands as follows: *"this category includes peat extraction areas and land that is covered or saturated with water throughout the year or during part of the year (for example, peatlands) and that is not within the categories of forest land, cropland, grassland, or settlements. It includes the reservoirs as a managed subdivision and the natural rivers and lakes as unmanaged subdivisions"* [21].

8 Carbon ownership and rights

Carbon rights are defined by ownership of verified carbon credits (VCC) and / or ownership over benefits from the sale of carbon rights, or other payments or benefits received for emission reductions or GHG removals.

In this sense, the GHG mitigation projects holders, in Continental Wetlands, must demonstrate full legal ownership over the VCC, as requested in the numeral concerning "Property and rights over carbon" of the ProClima Certification and Registration Program.

9 Carbon pools and GHG sources

9.1 Carbon pools

The Intergovernmental Panel of Experts on Climate Change (IPCC) foresees the estimation of changes in carbon stocks in the following pools: aboveground biomass, underground

[20] En:http://www.minambiente.gov.co/index.php/component/content/article?id=411:plantilla-bosques-biodiversidad-y-servicios-ecosistematicos-13#imágenes.
[21] https://www.ipcc-nggip.iges.or.jp/public/2006gl/spanish/pdf/4_Volume4/V4_03_Ch3_Representation.pdf

biomass, deadwood, leaf litter, and soil organic carbon. Project owners can choose one or more carbon pools, as long as they provide transparent and verifiable information and demonstrate that such a choice will not lead to an increase in GHG emission reductions, quantified by the project.

The wetlands referred to in this methodology may present different types of vegetation (natural vegetation covers, other than forest[22]) that are categorized into vegetation: woody, shrub, herbaceous, at ground level, aquatic and dispersed (Section 16.1)[23]. The choice of carbon pools and their rationale for quantifying changes in carbon stocks within project boundaries are shown in Table 1.

Table 1. Carbon pools

Carbon Sink	Type of Sink	Inclusion	Justification
Soil	Soil Organic Carbon - SOC or Total Soil Carbon – TSC	Yes	Wetland soil has a large carbon storage capacity and the change in this pool is significant.
Total Biomass- TB	Above Ground Biomass - AGB	Yes	Living biomass, both aboveground and underground, are significant carbon pools. Therefore, the variation in the content of these reserves must be quantified.
	Below Ground Biomass - BGS	Yes	
	Leaf litter	Optional	This pool is subject to the type of wetland vegetation cover and water flows.
	Deadwood	Optional	This deposit is subject to the type of wetland vegetation cover.

9.2 Emission sources and GHG selected for accounting

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

Table 2. Emission and GHG sources

Source	GHG	Inclusion	Consideration
Combustion of woody and bushy biomass.[24]	CO_2	NO	CO_2 emissions due to the combustion of woody biomass are quantified as changes in carbon stocks.
	CH_4	YES	Emissions should be included if the presence of fires was identified in the monitoring period.
	N_2O		

[22] The covers included in this methodology are natural plant covers other than forest; given that for projects that include forests there is the AFOLU sector methodological document. Quantification of GHG Emission Reductions from REDD + Projects of the ProClima Program.
[23] The types of vegetation are associated with the Land Cover Classification System (latest version: LCML - LCCS v.3; Global Land Cover (GLC) ESA, which aims to provide a classification scheme applicable worldwide).

[24]The quantification of CH_4 and N_2O emissions caused by the combustion of woody biomass is estimated from the guidelines presented in the 2006 IPCC guidelines for national GHG inventories.

Source	GHG	Inclusion	Consideration
Alteration into the water regime	CH_4	YES	CH_4 and CO_2 emissions should be included if it is identified that, in the project area, it is common practice to drain wetlands to change areas to other land uses (e.g., for agricultural or infrastructure uses).
	CO_2		

10 Project boundaries

10.1 Project area

The project area is the surface in which the project activities are expected to be implemented and that may correspond to contiguous or separate lands, of a single or of several owners (small or large), each one of them with property or possession of the demonstrated land and/or demonstrated ownership and carbon rights (Section 8).

The project owner must ensure that the surface on which he proposes to implement the project activities is included in the ecosystems of continental wetlands, in the Orinoquia region, which must be identified and delimited, following the classification of Ricaurte et. al (2019)[25], as described below.

10.1.1 Delimitation of continental wetlands

The project holder must:

Identify, delimit and classify the Continental Wetlands present in the project area, through a cartographic analysis of land cover combined with the analysis of geomorphology, hydrology, vegetation, and soils. It is recommended to consider at least two (2) of these criteria for delimitation[26]. In particular, the maximum elevation of the flood pulse is the main criterion for generating the polygons that describe the wetland area. Then follow the concave geo-forms, the presence of hydric soils, and hydrophyte-type vegetation.

The maximum flood level is the maximum level that the water can reach and that is due to the annual flood pulse and not to extreme weather events. To define the maximum flood level, you must:

a) Consult the climatic information of the area for the last 10 years (or whatever is available in case there are less than 10 years of information on record for the area);

[25] Ricaurte, L. F., Patiño, J. E., Restrepo, D. F., Arias, J. C., Acevedo, O., Aponte, C., Medina, R., González, M., Rojas, S., Flórez, C., Estupiñan, L., Jaramillo, U., Santos, A. C., Lasso, C. A., Duque, S. R., Nuñez, M., Correa, I. D., Rodriguez, J. A., Vilardy, S., Prieto, A., Rudas, A., Cleef, A., Finlayson, M. C. & Junk, W. J. (2019). A Classification System for Colombian Wetlands: An Essential Step Forward in Open Environmental Policy-Making. Springer. https://doi.org/10.1007/s13157-019-01149-8.

[26] Cortés-Duque, J. and L. M. Estupiñán-Suárez. (Eds.). 2016. The tracks of the water. Methodological proposal to identify and understand the limit of the wetlands of Colombia. Alexander von Humboldt Biological Resources Research Institute. Adaptation Fund. Bogotá D. C., Colombia. 340 pp.

b) Evaluate the rainfall regime of the area and its distribution throughout the year (e.g. mono-modal or bimodal regime);

c) Identify the rainy and dry seasons in terms of periods of occurrence, duration, and intensity;

d) Identify the rainy season with the highest rainfall (if there is more than one rainy season per year), and when this is reflected in river flows and flood levels of wetlands in the project area. Take into account the time lag that may occur between the occurrence of the rainy season and the maximum flood level;

e) From literals (a to d), delimit the wetland area taking into account the maximum flood level or height.

10.1.2 Eligible areas within project boundaries

The project owner must demonstrate that the areas in the geographical limits of the project are part of continental wetland ecosystems and that they correspond to the category of natural vegetation cover, other than forest, at the beginning of the project activities and five (5) years before the project start date.

The project must have geographic data and adequate cartographic information to evaluate the land cover and use during the historical reference period, based on the digital processing of remote sensing images[27],. using the CORINE Land Cover classification, if applicable.

10.1.3 Adding areas to the project after validation

Areas may be added to the project, after validation, under the following conditions:

(a) The project holder must 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 must meet to be added to the project are:

i. Comply with the guidelines of the ProClima standards, in the most recent versions;

ii. Comply with all the provisions of the AFOLU SECTOR METHODOLOGICAL DOCUMENT. Quantification of the Reduction of GHG Emissions and Removals. Activities that prevent land-use change in Continental Wetlands, in their most recent version;

[27] Geographic data must be handled following international standards promoted by organizations such as ISO, OGC, or the American Society for Photogrammetry and Remote Sensing.

iii. Include GHG emission reduction and removal, only for validated project activities; [28]

iv. Implement the activities to avoid land-use change in Continental Wetlands, described in the validated project document;

v. Additionality, causes and agents of changes in land-use, land tenure, and the baseline scenario of the new areas must be consistent with the characteristics validated for the initial areas;

vi. Have a start date after the start date of the areas included in the validation;

vii. If the leakage area overlaps with the validated expansion area, the project owner must update the leakage area to include the possible displacements of land-use change actions due to the implementation of the project activities.

10.2 Reference region for baseline estimation

A reference region that allows an evaluation in natural vegetation cover, other than forest, in wetland areas, must be defined. This region should be similar to the project area in terms of access, agents, and determinants of land-use change, land-use categories and/or land-use change, landscape configurations and environmental and socioeconomic conditions. The geographic boundaries of the reference region must meet the following criteria:

a) The reference region and the project area are part of the same ecoregion[29];

b) The causes and agents that generate changes in land-use, identified in the reference region, can access the project area;

c) The land tenure and land-use rights figures in the reference region must be similar to the project areas, after excluding them;

d) The reference region may include all or part of the project area.

10.3 Leakage areas

Areas with natural vegetation cover[30], to which activities that generate land-use change can be displaced and that are beyond the control of the project owner. That is, the areas to which the agents that generate land-use change can move, as a consequence of the project activities.

[28] An activity excluded in the validation Cannot be contemplated as a new area.

[29] Geographic region with certain characteristics in terms of climate, geology, hydrology, flora, and fauna. https://www.worldwildlife.org/biomes

[30] That meets the eligibility criteria of the area within the project boundaries.

The leakage area must include all areas with natural vegetation cover that are within the range of mobility of the agents identified in section 12 of this methodological document.

10.4 Time limits and analysis periods

The project's time limits correspond to the periods during which the project activities prevent land-use change in Continental Wetlands and for which GHG emission reductions and GHG removals are quantified.

Time limits of the project should be defined considering the following:

a) the project start date,

b) the period of quantification of the reductions, and

c) monitoring periods.

10.4.1 Historical period of land-use change in continental wetlands

Analysis of changes in natural vegetation cover, other than forest, for the reference region, must be carried out for at least two reference dates: project start date and ten (10) years before the start date.

It is recommended to use official sources of land cover, according to classification methodologies such as CORINE Land Cover or others to reduce inconsistencies with official data, uncertainty and minimize costs. As far as possible, use the base cartography that the country uses and adapt it to the temporal needs of the historical period.

10.4.2 Estimation of project GHG emission reduction and removals

The estimation of the reduction of GHG emissions and removals, when applicable, corresponds to the quantification period during which the project owner will quantify the reductions of GHG emissions or removals, measured according to the baseline, to request the certification program, the issuance of Verified Carbon Credits (VCC).

11 Identification of the baseline scenario and additionality

11.1 Baseline scenario

The project holder must build the baseline scenario keeping consistency with the emission factors, activity data, projection variables of GHG emissions, and the other parameters used for the construction of said scenario, in accordance with the applied methodology and ensuring that the identification of the project baseline does not lead to an overestimation of project mitigation results. Likewise, he must identify the baseline scenario to demonstrate that the project is additional. In accordance with the UNFCCC, when selecting the methodology to determine the baseline scenario of a project in the

LULUCF[31] sector, its owners must 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 within the project boundaries;
b) Changes in carbon stocks, within the project limits, due to land-use, which 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 the application of this methodology, the use of what is stated in literal (c), above, is recommended. However, if the project owner intends to use either of the other two approaches, it is allowed, as long as he presents an adequate explanation and justification for the selected option.

The project owner must reliably demonstrate that all the assumptions, justifications, and documentation considered are adequate to identify the baseline scenario.

The project owner must identify the baseline scenario, through the following steps[32]:

STEP 0. Project start date

Date on which activities that will translate into effective GHG emission reductions and removals begin (when applicable).

Determine the project start date, describing the start date selection and presenting the evidence. Show that the start date is defined within the five (5) years prior to the start of the project validation.

STEP 1. Identification of land-use alternatives

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

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

Identify realistic and credible land-use alternatives that would occur in the project area in the absence of the proposed project activity. The alternatives must be feasible taking into account the relevant national and / or sectoral circumstances and policies, considering

[31] In the Decisions of the Executive Board, it is stated: Afforestation and Reforestation, however, the scope of this methodology also applies to forestry activities to reduce GHG emissions.

[32] Adapted from "Combined tool to determine the baseline scenario and demonstrate additionality in afforestation/reforestation activities - Clean Development Mechanism" (Report EB35, Annex 19).

historical uses of the project's area of influence, or economic practices and trends in the region. These alternatives must include at least the following activities:

a) Continuation of previous land-use (prior to the project);
b) Projects without certification of emission reduction;
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, which would occur in the absence of the 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, project activities and activities generated as a result of land-use change. 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 statutory or regulatory requirements are not met.

Remove from the land-use scenarios identified in sub-step 1a from the project area any alternative that does not comply with applicable mandatory laws and regulations, unless you can demonstrate that such alternatives are the result of systematic lack of compliance with the laws and mandatory regulations.

Result of sub-step 1b. List of probable land-use alternatives that comply with the legislation and mandatory norms, taking into account their compliance in the region or country, with respect to national and / or sectoral policies.

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

11.2 Additionality

11.2.1 Conditions that demonstrate additionality through a positive list.

This positive list represents automatic additionality for projects that show special conditions. A project is additional if it meets at least one of the following conditions:

a) Projects developed by ethnic or farmer communities that are constituted as community associations or organizations.

b) Projects that include areas destined for active ecological restoration, in 40% or more, of the total project area.

c) Projects that bring together landowners; each of them with proven ownership or tenure of the land, over areas not exceeding 100 hectares.

d) Projects that estimate an emission reduction, less than 10,000 tons of CO_2e, on average per year.

e) Projects that demonstrate a positive impact on profitability indicators (for example, IRR, NPV, VET) considering the sale of carbon credits in the financial evaluation.

The project compliance with the conditions of the positive list must be evaluated at least every 2 years (to guarantee its continuous compliance) with updated data that shows that the project is still additional.

If the project does not meet at least one of the conditions described, the project owner must apply the steps detailed below to demonstrate the additionality of the project.

STEP 2. Barrier analysis.

Determine if the GHG mitigation initiative faces barriers that:

a) Prevents or limit the implementation of this type of GHG mitigation initiative; and,

b) Does not prevent the implementation of at least one of the probable land-use alternatives (the result of sub-step 1b).

Use the following sub-steps:

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

Establish that there are barriers that would prevent project implementation if it does not include participation in the carbon market. The barriers preventing a project should not be analyzed in relation to the project participants, but only in relation to the project activities. Such barriers can include:

Investment barriers, among others:

a) Debt financing is not available for this type of project;

b) There is no access to capital markets due to the risks, real or perceived, associated with national or foreign direct investment in the country where the project is to be implemented;

c) Lack of access to credit;

Institutional barriers, among others:

a) Risk related to changes in government policies or laws;

b) Lack of application of the legislation on Continental Wetlands or that related to the use of the land.

Barriers due to social conditions, among others:

a) Demographic pressure on the land (e.g. increased demand for land due to population growth);
b) Social conflict between interest groups in the region where the project is being developed;
c) Widespread illegal practices (e.g. illegal grazing, extraction of non-timber products, felling of trees);
d) Lack of qualified and/or properly trained manpower;
e) Lack of organization of local communities.

Barriers related to land tenure, property, inheritance, and property rights, among others:

a) Land ownership, with a hierarchy of rights for different stakeholders, limits the incentives to undertake the project;
b) Lack of legislation and regulation of land tenure, adequate to support the security of tenure;
c) Absence of clearly defined and regulated property rights in relation to natural resource products and services;
d) Formal and informal tenure systems that increase the risks of land fragmentation.

Identified barriers constitute sufficient evidence to demonstrate the additionality of the project, only if they prevent the potential holders from carrying out the project if their participation in the carbon market is not expected.

The GHG mitigation project holder must provide transparent and documented evidence, and offer conservative interpretations as to 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 norms, acts or rules of environmental/natural resource management;
b) Relevant studies or surveys, for example, studies carried out by universities, research institutions, associations, companies, bilateral/multilateral institutions, etc.
c) Relevant statistical data at the national or international level;
d) Written documentation of the company or institution that develops or implements the project;

e) Activities of the project owner or project developer, such as board meeting minutes, correspondence, feasibility studies, financial or budget information, etc.

f) Documents prepared by the project developer, contractors, or project partners in the context of the project or similar prior project implementations;

g) Written documentation of judgments of independent experts and other governmental/non-governmental organizations, related to land-use or individual experts, educational institutions (e.g., universities, technical schools, training centers), professional associations, and others.

Sub-step 2b. Show 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 alternatives, the project owner must demonstrate how they are less affected than they affect the project. That is, he must explain how the identified barriers do not prevent the implementation of at least one of the land-use alternatives. Any alternative, which prevents the barriers identified in sub-step 2a, is not a viable alternative and should be eliminated from the analysis. At least one viable alternative (other than the project) should be identified. The baseline scenario will 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 using the barrier analysis.

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

STEP 3. Project registration impact

Explain how the 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 thus allow the project to be carried out. The benefits and incentives can be of various types, such as:

a) Reduction of greenhouse gas emissions by avoiding changes in land-use;

b) The financial benefit of the income obtained from the sale of VCC, including the certainty and the predefined moment of income;

c) Create capacity in the entities in charge of land-use planning in the project area to guarantee the implementation of the project activities;

d) Attract new stakeholders who provide the ability to implement a new technology/practice.

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

12 Causes and agents that generate land-use change

The project owner must identify, describe and analyze the causes and agents of land-use change in the project area, as input to:

a) Design measures and actions to reduce the land-use change in Continental Wetlands.

b) Delimit the reference region (Section 10.2).

The key elements to develop an analysis and characterization of the causes and agents that generate land-use change are described below:

a) Identify the direct causes or anthropic activities that generate land-use change, characterizing its importance in economic and socio-cultural terms. Delimit the spatial patterns associated with the presence of these activities, in addition to measuring their impact on the transformation of the wetland, through a multi-temporal spatial analysis determining the relationship between the wetland area, the change in natural vegetation cover, and the direct causes identified.

b) Identify and characterize the agents that generate land-use change in the project area, associated with the direct causes identified. Delimit and describe the underlying causes that motivate the decisions of the agents to carry out the activities that lead to the land-use change.

c) For each activity that causes land-use change, a causal chain must be identified that is made up of at least three parts, according to the elements identified, that is: the agents, the direct causes, and the underlying causes.

13 Project activities

The activities for reducing emissions, removing GHGs, when applicable, and conserving biodiversity must be designed based on the results of the analysis of causes and agents that generate land-use change in Continental Wetlands and the identification of the pressures on biodiversity (Section 17.2). The project owner can design conservation activities and restoration activities complemented with management and sustainable use activities, as well as landscape conservation or management tools.

The design of each activity should include, at a minimum, the following:

a) Activity ID;

b) The relationship of the activity with a direct or underlying cause;

c) A consultation mechanism for the definition of project activities and aspects of participatory construction, when applicable;

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

e) An implementation schedule;

f) Indicators to report the progress of the activity, which should be recorded in the monitoring plan for the activity executions.

14 Socio-environmental assessment

The project holder must carry out an analysis of the main socio-environmental effects of the project activities, within the limits of the project, clearly explaining the assumptions used and justifying the results of the analysis. Causal chains of events must be identified, in which each project activity is related to the possible direct and indirect effects, that is, to the short and medium-term changes on the conditions of both the inhabitants and users of ecosystem services as well as the ecosystems themselves.

If the analysis allows to conclude that relevant negative effects would be generated, the project owner must define actions and corrective measures to prevent and/or reduce the effects derived from the development of GHG emission reduction and removal activities.

15 Managing uncertainty

In the framework of the ProClima Standard, the management of uncertainty is determined by the precision of maps used to estimate data values activity and discount applications in emission factors [33]. For activity data, the precision must be greater than 90%. Accuracy assessment should be made from the use of field observations or high-resolution image analysis. For emission factors, an uncertainty of 10% is accepted for the use of average carbon values (assessment must be done by stock). If the uncertainty is greater than 10%, the lower value of the 95% confidence interval should be applied[34].

However, if the data and parameters used to calculate the reduction and/or removal of GHG emissions are consistent with the emission factors, activity data, projection variables of GHG emissions, and the rest parameters used for the construction of national GHG inventories and national reference scenarios, as applicable, it will not be necessary to apply discounts for uncertainty.

[33] The discounts are different and additional to the 15% reservation provided in the PROCLIMA Program.
[34] The project owner may use data from scientific studies that have a data uncertainty of less than 20%.

16 Quantification of GHG emission reduction and removal

The emission reduction of the project corresponds to the quantification of the emission reduction and removal during the period of quantification, that is, the period during which the project holder will quantify the reductions of emissions and removals of GHG (when applicable) measured according to the baseline.

The analysis period for the project area during verification corresponds to the monitoring period.

16.1 Stratification and sampling plan

If the distribution of biomass in the project areas is not homogeneous, a stratification process should be carried out, to improve the precision concerning the biomass estimates in the project.

The project holder must determine different strata for the baseline scenario and the project scenario. In this way, precision in estimating GHG emission reductions and removals (when applicable) is optimized.

This methodology establishes the steps for the stratification of Continental Wetlands according to the type of associated vegetation as described in the classification system for wetlands proposed by Ricaurte (2019)[35], whose categories are described below:

- Woody: vegetation units dominated by plants with a height> 5 m, characterized by having a stem or main axis, including trees and palms;
- Shrubs: vegetation units dominated by plants with a height between 1.5 to 5 m, includes bushes and grasses;
- Herbaceous: vegetation units dominated by plants with a height between 0.3 to 1.5 m;
- At ground level: vegetation units dominated by herbaceous plants with a height <30 cm;
- Aquatic: all types of macrophytes associated with freshwater wetlands;
- Scattered: there is no continuous vegetation cover, the plants are separated and widely dispersed. They include trees, palms, shrubs, grasses, and grass species that do not form a continuous cover or layer.

To calculate the carbon stock in the defined strata, the total carbon of the stratum is multiplied by its corresponding area (ha):

[35] Ricaurte, L. F., Patiño, J. E., Restrepo, D. F., Arias – G, J. C., Acevedo, O., Aponte, C., Medina, R., González, M., Rojas, S., Flórez, C., Estupinan – Suarez, L. M., Jaramillo, U., Santos, A. C., Lasso, C. A., Duque, A. A., Restrepo, S., Velez, J. I., Caballero, J, H., Duque, S. R., Avellaneda – Nuñez, M., Correa, I. D., Rodríguez – Rodríguez, J. A., Vilardy, S. P., Prieto, A., Rudas – Ll, A., Cleef, A. M., Finlayson, C. M. & Junk, W. J. (2019). A Classification System for Colombian Wetlands: An Essential Step Forward in Open Environmental Policy – Making. *Wetlands* **39**, 971–990 (2019). https://doi.org/10.1007/s13157-019-01149-8

$$\text{Carbon/strata: } \Sigma\,(CT * Area)_{strata}$$

16.2 Direct estimation of carbon in continental wetlands

Based on the identification of land covers and the analysis of geographic and ecological information for the delimitation and classification of wetlands, field sampling is defined. Direct carbon estimation from field measurements allows emission factors to be calculated (Section 16.4). This estimate consists of three stages:

16.2.1 Measuring plan

For the quantification of carbon stocks, a measuring plan must be developed based on the following steps:[36]

a) Define project boundaries (Section 10).

b) Stratify project area (Section 16.1).

c) Select the carbon pools to measure (Section 9.1)

16.2.2 Sampling plots

The delimitation and stratification of the project area give rise to the strata polygons. On these, the type of sampling to be carried out is defined: systematic (Figure 1.a), random (Figure 1.b) or in transect (Figure 1.c), it is defined considering the different types of land cover, in general, systematic sampling is recommended. In the event of steep slopes, transect sampling is recommended. The spacing of the points is given by the spatial scale.

Sampling precision is required to be within (10%) of the true value of the mean, with a 95% confidence level [37]. Field data and samples must be representative of the different systems and taken independently.

The new number of plots is calculated as follows[38]:

$$(n) = ((t * s)/E)^2$$

n= number of plots
t= statistic of the t distribution for the 95% confidence interval, t is generally 2, because the sample size is unknown.

[36] Pearson, T., Walker, S. & Brown, S. (2005). Sourcebook for Land use, Land-use change and forestry projects. Winrock International. 11-33 pp. Additionally, the project must take into account the IPCC Good Practices Guide for land use, land use change and forestry.
[37] Cisneros-de la Cruz D.J., J. A Herrera-Silveira, C. Teutli-Hernández, S.A Ramírez-García, A. Moreno-Martínez, J. Mendoza-Martínez, J. Montero-Muñoz, F. Paz-Pellat, R. M. Roman-Cuesta. 2021. Manual for the Measurement, Monitoring and Reporting of Carbon and Greenhouse Gases in Mangroves under Restoration. Project, Mainstreaming Wetlands into the Climate Agenda: A multi-level approach (SWAMP). CIFOR/CINVESTAVIPN/UNAM-Sisal/PMC, 90pp.
[38] A useful tool for calculating the number of plots is available at http://www.winrock.org/Ecosystems/tools.asp (Winrock International 2011). To use the tool, enter the desired precision and the number, area, mean carbon density, and coefficient of variation for each stratum.

s= expected or known standard deviation of previous or initial data.
E= admissible error in the first half of the confidence interval, obtained by multiplying the average of the carbon stock by the desired precision, i.e. * 0.1 (10% accuracy).

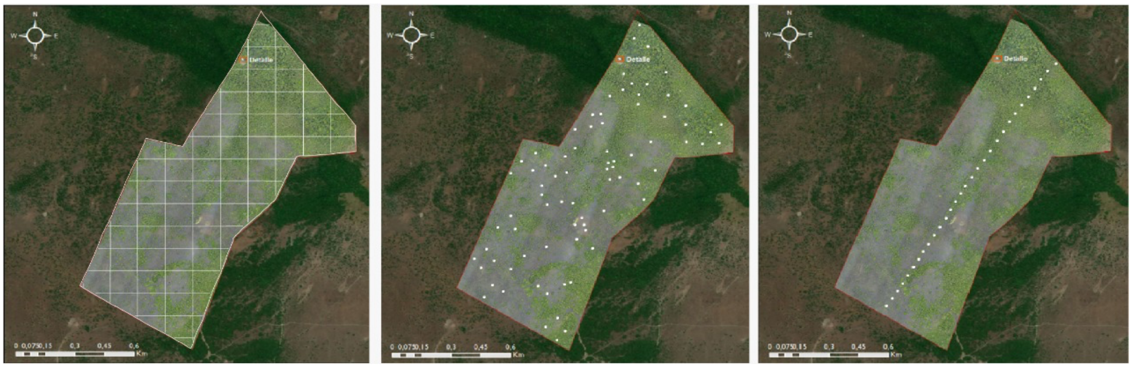

Figure 1. Sampling a) systemic, b) random, c) in transect

Plan the fieldwork season according to the climatic conditions in the project area, it is suggested to collect data and samples at least once a year, at the end of the dry season. If there are two or more dry seasons a year, it should be done at the end of the driest period of the year. At that time, the net carbon value remains, especially in the soil, after the potential increase in the rainy season and loss in the dry season.

Data collection more than once a year can be done at the peak of the flood or drought season and/or during the transition of the seasons, to assess the cumulative effect of each season. This makes it possible to monitor variations in carbon stocks within the same year. Additionally, this frequency depends on factors such as the rates of change in carbon stocks, finding for example that the soil accumulates carbon very slowly and variations can be measured in periods of 10 or even 20 years[39].

16.2.3 Field measurements

Locate in the field the pre-established sampling points, according to the delimitation and the stratification of the wetland, considering the following guidelines:

a) Soil

Take the soil profile samples using a sediment sampler. Because wetland soil has a deep organic layer, it is advisable to collect the samples at 1m deep or more, segmented as follows: 0-30, 30-50, 50-100 cm, to ensure that the entire organic layer is measured. However, at least the 0-30 cm deep segment must be sampled.

[39] Pearson, T., Walker, S. & Brown, S. (2005). Sourcebook for Land use, Land-use change and forestry projects. Winrock International. 11-33 pp.

b) Herbaceous and leaf litter biomass

Delimit the sample of herbaceous biomass, leaf litter, or aquatic plants using a quadrant with a defined area (0.25 m^2, 0.50 m^2 o 1.00 m^2).

Collect manually or with the help of a cutting tool, all the biomasses found inside the quadrat. In the case of using the smallest quadrat, a composite sample, meaning one sample integrated by at least three different samples, should be taken.

In flooded areas with rooted aquatic plants, it is recommended to use quadrats with high edges to delimit the biomass within the water column. In deeply vegetated areas, a quadrat of floating material is recommended.

Samples should be individually packaged, duly labeled with a pre-established code system to identify the sampling point. They should be stored and transported in a cool or refrigerated place.

c) Woody, shrub and dead wood biomass

Regarding the deposits of woody, shrub, and dead wood biomass, we suggest the use of the methodology proposed by Kauffman et al. (2016) [40], for both field measurements and laboratory analysis and calculations. Estimated carbon contents for these pools should be added to the sum of the Total Biomass (TB).

i. *Dead wood*

Wood fragment samples should be preferably dried at 100°C until they are free of moisture and weighed.

Calculate the density of the fragments as follows:

$$DAf = \frac{Dry\ weight\ (g)}{Fresh\ sample\ volume\ (cm^3)}$$

Where:

DAf = Dead wood fragment density (gr/cm^3)

Calculate the root mean quadratic diameter of dead wood fragments.

$$MQD\ (cm) = \frac{\sqrt{(\sum Di^2)}}{n}$$

Where:

[40] Kauffman JB, Arifanti VB, Basuki I, Kurnianto S, Novita N, Murdiyarso D, Donato DC and Warren MW. 2016. *Protocols for the measurement, monitoring, and reporting of structure, biomass, carbon stocks and greenhouse gas emissions in tropical peat swamp forests.* Working Paper 221. Bogor, Indonesia: CIFOR.

MQD= Mean quadratic diameter (cm)
Di^2 = diameter of each wood fragment
n = Number of sampled fragments.

Calculate the volume of dead wood per unit area from line intersection data using scaling equations.

Wood volume for the class 2.5-7.5 cm:

$$Volume\ (m^3/ha) = \pi^2 * \left[\frac{Ni *\ QMDi^2}{8 * L}\right]$$

Where:

Volume (m^3/ha) = Wood volume per unit area

Ni = Sample number

QMDi2 = Root mean square diameter of size class (cm2)

L = Transect length (m)

Wood volume for the class >7.5 cm:

$$Volume\ (m^3/ha) = \pi^2 * \left[\frac{{d_1}^2 + {d_2}^2 + {d_3}^2 + \cdots {d_n}^2}{8 * L}\right]$$

Where:

Volume (m^3/ha) = Wood volume per unit area
Ni = Sample number
di = diameter of the i wood fragment (cm2). Each fragment is measured separately.
L = Transect length (m)

Dead wood biomass

$$Dead\ wood\ biomass(kg/ha) =\ Volume\ (m^3/ha) *\ DA(kg/m^3)$$

Where:

Volume (m^3/ha) = Wood volume per unit area

Ni = Sample number

DA = Average fragment density

16.2.4 Laboratory analysis

a) Soil

Soil samples are dried at 60ºC until they are free of moisture to ensure their preservation. They are then sieved with a 2 mm sieve in order to remove the remains of subway biomass

(>2 mm). The samples are then sent to the laboratory for final preparation and subsequent CNH[41] elemental analysis by combustion. The amount of sample to be sent and other details of sample preparation for analysis (grinding and sieving) should be coordinated with the laboratory performing the analysis. A portion of the sample should be reserved as a counter sample to be used in case of loss of the samples or in case the repetition of the analysis is required.

The density in the different soil profile segments sampled must be calculated. This data is important to be able to quantify the carbon content. The density is measured by taking a soil sample of defined volume, paying special attention not to alter the soil volume by compacting the sample, for example. Once the sample is completely dry, it is weighed and the density is calculated as follows:

DAs = Dry weight (g) / Fresh sample volume (cm^3)

$$DAs = \frac{dry\ weight\ (g)}{Fresh\ sample\ volume\ (cm^3)}$$

Where:

DAs= Soil bulk density (gr/cm^3) (*Bulk density)*

16.3 Activity data

The change in area covered by natural vegetation (CNVC) data are the activity data for estimating land-use change. The estimation of changes will depend on the results obtained based on the analysis for the reference region, identified under section 10.2.

16.3.1 Estimation of land-use change in continental wetlands

The project holder must analyze natural vegetation cover change to another cover between at least two dates: start date and five (5) years before the project start date.

To calculate the area with loss of natural cover between the two dates, only the areas for which natural vegetation cover was detected on the first date that changed to another type of cover on the second date should be considered, so that there is certainty that the event occurred in the analyzed period (change of cover).

Natural cover losses detected after one or several dates without information[42] should not be included in the calculation, in order to avoid overestimated rates in periods in which the areas without information increase due to different factors. For example, climatic

[41] Carbon, Nitrogen and Hydrogen

[42] Complementary information may be used to reduce the area without information. It should present 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.

periods of high cloudiness or failures in the sensors of the satellite programs that take the images.

This process should be supported by cartographic inputs for the reference period, based on the following recommendations:

(a) Collect data that will be used to analyze land-use change on the natural vegetation cover of the wetland during the historical reference period within the project boundaries. It is good practice to do this for at least three-time points, (3) to (5) years apart.

(b) Select medium resolution spatial data (from 10 meters to a maximum of 100 meters of spatial resolution) from optical and radar sensor systems, such as (but not limited to) Landsat, SPOT, ALOS, AVNIR2, ASTER, Sentinel 1, and 2, among others, covering the last 5 -10 years.

(c) Collect high-resolution remotely sensed data (< 5 x 5 meters per pixel) and/or direct field observations for validation of field maps. Describe the type of data, coordinates and, sampling design used to collect them.

(d) In tabular format (Table 4), provide the following information about the data collected.

Table 4. Characterization of cartographic inputs.

Vector (Satellite or aircraft)	Sensor	Resolution		Land cover	Date of acquisition	Scene or Identification Point	
		Spatial	Spectral	(Km²)	(DD/MM/AAAA)	Path/Latitude	Row/Longitude

(e) If interpreted data of adequate spatial and temporal resolution is available, they may also be considered for further analysis[43]. To complete the land cover analysis, it is recommended to classify the natural land cover with the strata defined in section 16.1 "Stratification", looking for the lowest number of land cover units.

(f) Validation processes for the treatment of satellite images and geographic data should be supported by international standards promoted by organizations

[43]Existing maps should be used by doing a full quality validation of these as they often do not report documentation, error estimates, whether they were obtained by change detection techniques rather than by comparison of static maps, etc. If historical land cover and land-use change data are already available, information on the minimum mapping unit, the methods used to produce these data, and descriptions of cover and use classes, change categories should be compiled, including how these classes can be matched to cover classes and categories.

such as ISO, OGC, or the American Society for Photogrammetry and Remote Sensing.

(g) The detailed methodological procedures used in the pre-treatment, classification, post-classification processing, and accuracy assessment of the remote sensing data should be carefully documented in a technical annex. In particular, the following information should be documented:

i. Data sources and pre-processing[44].

ii. Data classification and further processing[45].

(h) The assessment of classification accuracy that ensures the quality of land cover and land-use maps should be above 90%:

As a result of this analysis, a land cover change matrix is obtained, which combines all the defined land cover classes in which land cover changes are evidenced. The following table should list the resulting categories of change. In addition, the same table should be made with the area data for each of the periods and their totals.

Table 5. Land cover change and land-use matrix[46].

IDcl		**Initial Classes Land cover/Use**			
		I1	**I2**	**I3**	**I4**
Final Classes Land cover	F1				
	F2				
	F3				
	F4				

16.3.2 Historical annual changes in the reference region

The historical annual changes in the reference region for the baseline scenario is estimated as follows[47]:

[44] Specify type, resolution, source, and date of acquisition of remote sensing data (and other data) used; geometric, radiometric, and other corrections made; spectral bands and indices used (such as NDVI); projection and parameters used to georeference images; error estimate of geometric correction; software version and software used to perform pre-processing tasks; etc.
[45] Definition of land cover and land use classes and categories of change; classification approach and classification algorithms; coordinates and description of ground truthing data collected for training purposes; ancillary data used in classification, if any; software and software version used to perform the classification; additional spatial data and analysis used for post-classification analysis, including class subdivisions using spectral criteria, if any; etc.
[46] Each class will have a unique identifier (IDcl). The methodology sometimes uses the notation icl (= 1, 2, 3, ... Icl) to indicate the initial land cover classes; and fcl (= 1, 2, 3, Fcl) to indicate the final classes. All initial and final classes are listed in this table.
[47] Puyravaud, J. (2003). Standardizing the calculation of the annual rate of deforestation. Forest Ecology and Management 177:593–596.

$$CNVC_{BL} = \left(\frac{1}{t_2 - t_1} ln \frac{A_2}{A_1}\right) x\text{Ap}$$

Where:

$CNVC_{BL}$: change in the area with natural vegetation cover in the baseline scenario, in the reference region (ha/year).
t_2: ending year of the reference period in which the changes are analyzed.
t_1: beginning year of the reference period in which the changes are analyzed.
A_1: area in natural vegetation cover in the reference region in t1 (ha).
A_2: area in natural vegetation cover in the reference region in t2 (ha).
A_P: eligible area for the project (ha).

The result of the analysis of changes in natural vegetation cover will be the value used to represent the expected loss, in the baseline scenario, of the representative natural cover of the Inland Wetland ecosystems.

16.3.3 Projection of the annual changes in the scenario with project

The annual changes in the scenario with project are estimated as follows:

$$CNVC_P = CNVC_{BL} x (1 - \%P)$$

Where:

$CNVC_P$: change in the area with natural vegetation cover in the scenario with project (ha/year).

$CNVC_{BL}$: change in the area with natural vegetation cover in the baseline scenario (ha/year).

%P: percentage of projected decrease in land cover changes due to the implementation of project activities.

Within the project area, different rates of change in the area with natural vegetation cover are estimated for each stratum[48]. The land cover should be presented using the following table:

Table 6. Land cover units in the project area.

Land cover		**Description**	**Area per year**			
			1	***2***	***...***	***T***
ID_i	**Name**		***ha***	***ha***	***ha***	***Ha***
1						
2						

[48] Land cover or strata can be static (with fixed boundaries) or dynamic (with boundaries that change over time).

Land cover		**Description**	**Area per year**			
			1	***2***	***...***	***T***
...						
N						

16.3.4 Historical annual changes in leakage area

Historical changes in leakage area are estimated using the following equation:

$$CNVC_{BL,L} = \left(\frac{1}{t_2 - t_1} ln \frac{A_2}{A_1}\right) x A_L$$

Where:

$CNVC_{BL,L}$: change in the area with natural vegetation cover in the leakage area, in the baseline scenario (ha/year).
t_2: ending year of the reference period in which the changes are analyzed.
t_1: beginning year of the reference period in which the changes are analyzed.
A_1: area in natural vegetation cover in the reference region in t1 (ha).
A_2: area in natural vegetation cover in the reference region in t2 (ha).
A_L: leakage areas (ha).

In this section, a change of land-use matrix is obtained that combines all the defined classes. The following table should list the resulting categories of change:

Table 7. Matrix of land cover changes in the leakage area.

IDcl		**Initial land cover classes**			
		I1	***I2***	***I3***	***I4***
Final land cover classes	*F1*				
	F2				
	F3				
	F4				

16.3.5 Projected annual changes in leakage area in the scenario with project

The annual changes in leakage area, for the scenario with the project, are estimated using the following equation:

$$CNVC_{P,L} = CNVC_{BL,L}(1 + \%PL)$$

Where:

$CNVC_{P,L}$: change in the area with natural vegetation cover in the leakage area, in the scenario with project (ha/year).

$CNVC_{BL,L}$: change in the area with natural vegetation cover in the leakage area, in the baseline scenario (ha/year).

%PL: percentage of the projected increase in emissions in the leakage area due to the implementation of project activities.

In the leakage area, different rates of change in the area with natural vegetation cover can be estimated if a stratification process has been carried out[49]. The land cover should be briefly summarized using the following table:

Table 8. Land cover units in the leakage area.

Land cover		**Description**	**Area per year**			
			1	***2***	***...***	***T***
ID_i	**Name**		***ha***	***ha***	***ha***	***ha***
1						
2						
..						
N						

16.4 Emission factors

To calculate the emission factors, the carbon in the different biomass and soil carbon pools must be estimated (Table 1).

16.4.1 Carbon emission factor in total biomass

Total biomass (TB) is estimated from the sum of the biomass of the different compartments: aboveground biomass (AB), belowground biomass (BB), dead wood, and leaf litter are optional pools.

$$\text{TB} = AB + BB + B_{dead\ wood} + B_{Leaf\ litter}$$

TB = Total biomass (t dry matter)
AB= Aboveground Biomass
BB = Belowground biomass
$B_{\text{Dead wood}}$ = Dead wood biomass
$B_{\text{Leaf litter}}$ =Leaf litter biomass

[49] Land cover or strata can be static (with fixed boundaries) or dynamic (with boundaries that change over time).

AB and BB are the sums of carbon contents in different types of vegetation such as trees, shrubs, and herbaceous plants.

The carbon in total biomass (CTB), in a land-use change scenario in continental wetlands, is the product of the TB and the carbon fraction of dry matter (f)

Carbon dioxide equivalent contained in total biomass (TC_{eq}) is the product of CTB and the molecular ratio constant between carbon and carbon dioxide.

CBF_{eq} is estimated using the following equation:

$$CBF_{eq} = (TB)(f)\left(\frac{44}{12}\right)$$

Where:

CBF_{eq}: equivalent carbon dioxide contained in the total biomass (tCO2e/ha/year). It is assumed that CO_2 emissions from biomass occur in the same year.

TB: Total biomass (t/ha).

CF: carbon fraction in dry matter (0,47).

44/12= 3,67: constant of the molecular ratio between carbon (C) and carbon dioxide.

16.4.2 Calculation of soil organic carbon

Equation for estimating soil organic carbon content:

$$SOC = \%C \times DA\ (gr/cm^3) \times P(cm)$$

SOC = Soil carbon (gr/m^2), which allows conversion to tons/hectare (tSOC/ha), according to the total area sampled.

%C = Carbon content

DA = Soil bulk density (gr/cm^3)

P = Sample profile depth (cm)

Calculation of the equivalent organic carbon potentially emitted by the soil in a land-use change scenario. It is assumed that SOC is emitted in equal proportions over 20 years once the land-use change event occurs. Using this assumption for wetland-use change, the annual rate of soil carbon emitted over 20 years is calculated (IPCC, 2006) according to the following equation:

$$SOC_{eq} = \left(\frac{SOC}{20}\right)\left(\frac{44}{12}\right)$$

Where:

SOC_{eq}: carbon dioxide equivalent contained in soils (tCO2e/ha).

SOC: Soil carbon content (tC/ha).

44/12: 3,67: constant of the molecular ratio between carbon (C) and carbon dioxide (CO_2).

The estimation of emissions related to changes in soil organic carbon (SOC) should be carried out separately for each soil mapping unit identified in the project boundaries and can be measured as total carbon (CTS) or soil organic carbon (SOC).

16.4.3 Other GHG emissions

If the project holder identifies the presence of fires in the arboreal component, in the monitoring period (Section 9.2) the CH_4 and N_2O emissions caused by woody biomass combustion should be quantified taking into account, the guidelines presented in the 2006 IPCC guidelines for national GHG inventories. Biomass burning is the largest natural (or semi-natural) source of non-CO2 gas production, the amount released can be estimated using emission factors based on the amount of carbon released.[50].

$$CH_4 Emissions \ = released\ Carbon * 0{,}016 * CO_2EFM$$

Where:

CO2EFM= carbon dioxide equivalent factor of 21.

$$N_2O\ Emissions = released\ Carbon * 0{,}00011 * CO_2EFN$$

Where:

CO2EFN= carbon dioxide equivalent factor of 310.

The quantification of CH4 and N2O emissions caused by woody biomass combustion (Section 9.2) should consider the guidelines presented in the 2006 IPCC guidelines for national GHG inventories.

16.5 GHG emissions in the period of analysis

The annual emission from land-use change in the baseline scenario is calculated following the equation:

$$AE_{BL} = LUC_{BL}\left(BCF_{eq} + COS_{eq}\right)$$

Where:

AE_{BL}: annual emission in the baseline scenario (tCO_2e/ha/year).

LUC_{BL}: historical changes in the baseline scenario (ha/year).

[50] Pearson, T., Walker, S. & Brown, S. (2005). Sourcebook for Land use, Land-use change and forestry projects. Winrock International. 11-33 pp.

BCF_{eq}: carbon dioxide equivalent contained in total biomass (tCO_2e/ha).

SOC_{eq}: carbon dioxide equivalent contained in soils (tCO_2e/ha).

The annual emission from land-use change in the scenario with project is calculated following the equation:

$$AE_P = LUC_P\left(BCF_{eq} + COS_{eq}\right)$$

Where:

AE_P: emission in the scenario with the project ($tCO_2/ha/year$).

LUC_P: change in land-use in the scenario with the project (ha/year).

BCF_{eq}: carbon dioxide equivalent contained in total biomass (tCO2e/ha).

SOC_{eq}: carbon dioxide equivalent contained in soils (tCO_2e/ha).

The annual emission from land-use change in the leakage area is calculated following the equation:

$$ER_L = LUC_L\left(CBF_{eq} + cos_{eq}\right)$$

Where:

ER_L: annual emission in the leakage area ($tCO_2/ha/year$).

LUC_L: land-use change in the leakage area (ha/year).

CBF_{eq}: carbon dioxide equivalent contained in total biomass (tCO_2e/ha).

SOC_{eq}: carbon dioxide equivalent contained in soils (tCO_2e/ha).

16.6 GHG emission reductions expected from the implementation of project activities

Emission reductions from avoided land-use change in wetland ecosystems, in the scenario with the project, are calculated following the equation:

$$ER = (t_2 - t_1)(ER_{BL} - ER_P - ER_L)$$

Where:

ER: emission reductions from avoided land-use change in the project scenario (tCO_2e/ha).

t_2: year-end of the period in which the changes are analyzed.

t_1: year of the beginning of the period in which the changes are analyzed.

ER_{BL}: emission in the baseline scenario (tCO_2e/ha/year).

ER_P: emission in a scenario with the project (tCO_2e/ha/year).

ER_L: emission in the leakage area (tCO_2e/ha/year).

16.7 Quantification of GHG removal

GHG removals attributable to ecological restoration activities should be estimated for each carbon pool in the baseline and project scenario.

$$CT_{P,t} = C_{Trees_{P,t}} C_{Shrubs_{P,t}} + C_{Herbaceous\ plants\ P,t} + C_{Deadwoodwood_{P,t}} + C_{Leaf\ litter_{P,t}} + \Delta COS_{P,t}$$

Where:

$CT_{P,t}$: Total carbon dioxide equivalent; tCO_2e

$C_{Tree_{P,t}}$: Carbon dioxide, from tree biomass within the project boundary, (tCO_2e)

$C_{Shrubs_{P,t}}$: Carbon dioxide, from shrub biomass within the project boundary, (tCO_2e)

$C_{Herbaceous\ plants\ p,t}$: Carbon dioxide, by biomass of herbaceous vegetation within the project boundaries., (tCO_2e).

$C_{dead\ wood_{P,t}}$: Carbon dioxide in deadwood within the project boundary, (tCO_2e).

$C_{leaf\ litter_{P,t},}$: Carbon dioxide in leaf litter within the project boundaries, (tCO_2e).

16.7.1 Removals by sinks in the baseline scenario

The removals in the baseline scenario can be calculated as follows:

$$\Delta C_{BL,t} = \Delta C_{Soil_{BL},t} + \Delta C_{Herbaceous\ plants_{BL},t} + \Delta C_{Shrubs\_BL,t} + \Delta C_{Trees\_BL,t} + \Delta C_{Dead\ wood\_BL,t} + \Delta C_{Leaf\ litter\_BL,t}$$

Where:

$\Delta C_{BL,t}$: GHG removals by sinks, in the baseline scenario, in year t (tCO_2e).

$\Delta C_{Trees_{BL},t}$: changes in carbon stocks, in the baseline scenario, by tree biomass within the project boundary, in year t (tCO_2e)

$\Delta C_{Shrubs_{BL},t}$: changes in carbon stocks, in the baseline scenario, by shrub biomass within the project boundary, in year t (tCO_2e)

$C_{Herbaceous\ plants\ BL,t}$: cambios en las reservas de carbono, en el escenario de línea base, por la biomasa de vegetación herbácea dentro de los límites del proyecto, en el año t (tCO_2e).

$\Delta C_{Dead\ Wood_{BL},t}$: carbon stock changes in deadwood within the project boundary, in year t (tCO_2e).

$\Delta C_{Leaf\ litter_{BL},t}$: carbon stock changes in litter within the project boundary, in year t (tCO_2e).

Section 16.4 explains how to calculate the carbon in each carbon pool. The carbon delta is given by the difference of the carbon content at the assessment time with respect to the baseline

$$\Delta C_{i\_Bl,t} = C_{i\_,t} - C_{i\_Bl}$$

Where:

$\Delta C_{i\_Bl,t}$ = Change in carbon stocks in carbon pool i within the project boundary, in year t

16.7.2 Actual net GHG removals by sinks

Emissions resulting from the elimination of herbaceous vegetation, combustion of fossil fuels, application of fertilizers, use of woody biomass, decomposition of litter and fine roots of nitrogen-fixing species, construction of access roads within the project boundaries, as well as emissions due to transportation, as a project activity, can be considered insignificant and, therefore, quantified as zero.

GHG removals by sinks can be calculated in the following way [51]:

$$\Delta C_{Actual,t} = \Delta C_{P,t} - GEI_{E,t}$$

Where:

$\Delta C_{Actual,t}$: current net GHG removals by sinks, in year t (tCO_2e).

$\Delta C_{P,t}$: carbon stock changes in the project, occurring in the selected reservoirs, in year t (tCO_2e).

$GHG_{E,t}$: increase in GHG emissions, other than CO_2, within project boundaries, as a result of project activities, in year t (tCO_2e).

[51]See section 5.5. Actual net GHG removals by sinks of the AR-AMS0003 methodology: Afforestation and reforestation project activities implemented on wetlands - Version 3.0 and consult the conditions of the methodological tools.

It is estimated with the tool: "*Estimation of non-CO_2 GHG emissions resulting from biomass burning attributable to an F/R CDM project activity*".

Changes in carbon stocks occurring in selected carbon pools in year *t* can be calculated as follows:

$$\Delta C_{P,t} = \Delta C_{Shrubs_{P,t}} + \Delta C_{Herbaceous\ plants\ P,t} + \Delta C_{Dead\ wood_{P,t}} + \Delta C_{Leaf\ litter_{P,t}} + \Delta cos_{P,t}$$

Where:

$\Delta C_{P,t}$: Carbon stock changes in the Project in the selected pools, in year t (tCO_2e).

$\Delta C_{Shrubs_{P,t}}$: carbon stock changes, in shrub biomass, in the year(tCO_2e).

$\Delta C_{Herbaceous\ plants\_P,t}$: carbon stock changes in herbaceous vegetation biomass in the year t (tCO_2e).

$\Delta C_{Dead\ wood_{P,t}}$: carbon stock changes in deadwood in the year t (tCO_2e).

$\Delta C_{leaf\ litter_{P,t}}$: carbon stock changes in life leader in the year t (tCO_2e).

$\Delta cos_{P,t}$: *organic* carbon stock changes in soil, within the project boundaries, in the year t (tCO2e).

The change in carbon stock in the soil organic carbon (SOC), within the project boundary, in year t, is estimated as:

$$\Delta SOC_{P,t} = \left(\frac{44}{12}\right)\left(\sum_{t=1}^{t} A_{REST,t}\right)(dSOC_t)(1year)$$

Where:

$\Delta SOC_{P,t}$: *organic* carbon stock changes in soil, within the project boundaries, in the year t (tCO_2e).

$A_{REST,t}$: Area restored in the year t (ha).

$dSOC_{t:}$ rate of changes in SOC stock, within the project boundaries, in the year t (t C/ha/year).

When the soil is free of carbonates, a common situation in acid tropical soils, the soil organic carbon– SOC is equivalent to the total soil carbon– CTS.

In cases where transparent in verifiable information cannot be provided and restoration activities are focused on planting, the following default value of dSOC is used, unless transparent and verifiable information can be provided to justify a different value:

i. $dSOC_t$: 0,50 t C/ha/year for $t=t_{REST}$ to $t=t_{REST}+20$ years, where $t=t_{REST}$ is the year in which sowing takes place.
ii. $dSOC_t$: 0 t C/ha/year para t> $t_{REST}+20$.-

16.7.3 Net removals of GHG by sinks

Net GHG removals by sinks should be calculated as follows[52]:

$$\Delta C_{project,t} = \Delta C_{actual,t} - \Delta C_{BL,t}$$

Where:

$\Delta C_{ProJec,t}$: net GHG removals by sinks, in the year t (tCO_2e).

$\Delta C_{actual,t}$: net removals of GHG by sinks, in the year t (tCO_2e).

$\Delta C_{BL,t}$: GHG removals by sinks in the baseline scenario in the year t (tCO_2e).

17 Assessment of the biological component in continental wetlands

17.1 Biodiversity baseline

The state of biodiversity is directly related to ecological processes, which correspond to complex interactions between biotic and abiotic elements of the ecosystem. In wetlands, these processes occur at small spatial and temporal scales, as a consequence of water and geomorphological dynamics, among others.

To design appropriate activities for the conservation of continental wetlands, the status of biodiversity in the project area should be known by establishing a baseline based on secondary information and, as far as possible, field data. For this, the project proponent should:

a) To carry out a characterization of the vegetation and fauna groups associated with continental wetland types which should consist of:

   i. Complementary to the process of defining project boundaries, the project area should be described according to regional and national scale cartographic information, such as official maps of ecoregions, watersheds, hydrogeological zoning, natural ecosystems, key areas for the conservation of species, etc.

[52] See numeral 5.7. Net anthropogenic GHG removals by sinks of the methodology AR-AMS0003: Afforestation and reforestation project activities implemented on wetlands - Version 3.0.

ii. Describe the current vegetation status of the Project area associated with the different types of continental wetlands, with quantitative and qualitative information on specific vegetation attributes such as diversity and richness.

iii. Identify whether native, endemic, invasive, endangered, threatened, and local species are present in the project area and determine their relative abundances.

iv. Estimate the species richness of the different groups of fauna present in the project area through primary and secondary information. From this information, select at least one group or species considered as a bioindicator, flagship, umbrella[53], endemic, or threatened species and describe their status by estimating their relative abundance, population density, or distribution patterns.

v. Conduct interviews with the local community about historical changes (natural or anthropogenic) in the vegetation associated with continental wetlands. If this is not possible, official secondary information on historical natural cover change for the project reference area should be collected.

vi. The results of this characterization should be validated with reliable and recent secondary sources such as records and inventories published by GBIF, IUCN, CITES, MOL, among others.

b) Identify whether High Conservation Values (HCVs) related to biodiversity and the provision of ecosystem services exist in the project area under the following categories[54]:

i. HCV 1. Species diversity: Concentration of biological diversity containing endemic, rare, threatened, or endangered species that are of significant global, regional, or national importance.

ii. HCV 2. Landscape-scale ecosystems and mosaics: large landscape-scale ecosystems, ecosystems of global, regional, or national importance, ecosystems that support viable populations of most species present in the project area under natural patterns of distribution and abundance.

iii. HCV 3. Ecosystems and habitats: Rare, threatened, or endangered ecosystems, habitats, or refuges.

[53]See terms and conditions

[54]Retrieved from: https://hcvnetwork.org/

iv. HCV 4. Ecosystem services: Basic ecosystem services in critical situations, such as protection of water catchment areas and erosion control of vulnerable soils and slopes.

c) Describe the attributes that classify the identified HCV (s) into one of the above categories.

17.2 Identification of pressures on biodiversity

It must be identified whether there are pressures on biodiversity in the project area that correspond to or are associated with the five pressures identified globally by the CBD[55]. Because these pressures directly or indirectly generate alterations in ecological integrity[56] and species loss, activities should be designed to avoid or reduce these effects, for which the project proponent should:

a) Describe the effects of pressures on biodiversity at the level of taxonomic groups, through species distributing analysis, population densities, presence-absence studies of key or ecologically important species, distribution range modeling, among others, which demonstrate changes in population dynamics and possible species losses.

b) Identify and describe pressures that threaten the permanence of the HCVs in the project area.

c) Design measures that avoid or reduce the identified pressures, thereby conserving HCVs and the overall biodiversity of the project area.

Project holders may use the "Biodiversity Conservation Toolkit for Projects Avoiding Land Use Change in Inland Wetlands". This tool serves as a guide for compliance with biodiversity-related requirements.

18 Monitoring plan

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

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

a) Verify that the applicability conditions listed in section 5 of this document have met;
b) Verify carbon stock changes in selected reservoirs;

[55] According to the CBD the main pressures on biological diversity are: habitat loss and degradation, ii. climate change, iii. excessive nutrient loading and other forms of pollution, iv. overexploitation and unsustainable use and v. invasive alien species. https://www.cbd.int/gbo3/?pub=6667&section=6711

[56]See Terms and Definitions

c) Verify project emissions and leakage.

The data collected shall be archived for a period of 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, as well as the processes related to sampling patterns and quality control of these.

18.1 Project boundary monitoring

The geographic boundaries of the project, constituted by the eligible areas over which the project activities are developed, must be included in a Geographic Information System organized and compiled in a geographic database, geo-referencing the total project areas and including the reference region and the leakage area.

Thus, monitoring of emission reductions from land-use change in wetlands will be conducted for the geographic areas included in the project. Periodic verification of land-use change in the project area shall be conducted using the procedures described in Section **¡Error! No se encuentra el origen de la referencia.**.

Remote sensing processes should use satellite imagery to map wetlands to assess land-use change. Because wetlands have lateral movements throughout the year, expanding during the rainy season and contracting during the dry season, images of the same season should be acquired[57].

18.2 Project activities execution monitoring

The project holder must design a monitoring plan for each activity proposed for the reduction of emissions, GHG removals (where applicable), and the conservation of continental wetlands biodiversity, according to the information presented in the following table.

Table 9. Monitoring of the implementation of project activities

Activity ID	
Indicator ID	
Indicator name	
Type	
Goal	
Unit of measure	
Monitoring methodology	
Frequency of monitoring	
Responsible for measurement	
Indicator result in the reporting period	

[57]The images should be from the rainy season, preferably during the peak flood season so that the reported changes in the wetland reflect a real change in its extent rather than a seasonal change.

Documents to support the information	
Remarks	

18.3 Monitoring of socio-environmental effects

The project proponent should design a plan for monitoring the socio-environmental effects of project activities identified in the assessment in section **¡Error! No se encuentra el origen de la referencia.**, including:

a. Project activities that will generate socio-environmental effects.
b. Positive or negative effects per activity.
c. Corrective actions for negative effects.
d. Frequency of follow-ups for positive effects of corrective actions for negative effects.
e. Indicators and methodologies for monitoring positive impact and corrective actions for negative impact.
f. Information on the results of the implemented actions.
g. If necessary, adapt the monitoring plan according to the results information.

18.4 Project permanence monitoring

The project owner should identify the risks of non-permanence of the project and design a monitoring plan including mitigation measures, monitoring indicators, and reporting procedure. Biophysical and socio-economic risks should be assessed including at least: fires, floods, conflicts related to land tenure, conflicts between project stakeholders, and lack of ownership of project activities.

For this monitoring, detailed information about the methodology used, the data sources (alphanumeric and geographic) of information selected and the reports generated should be presented.

18.5 Project emissions monitoring

In the with-project scenario, at a minimum, activity data should be monitored. Validated emission factors can be applied in the estimation of monitored emissions.

18.5.1 Activity data

18.5.1.1 Annual land-use change in the project area

The estimation of changes in the natural cover of the wetland, in the project area, during the monitoring period is carried out with the equation:

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

Where:

LUC_P: change in area with natural vegetation cover in the project area (ha/year).

t2: final year of the monitoring period.

t1: year of the beginning of the monitoring period.

Ai: area in natural vegetation cover in the project area at the beginning of the monitoring period (ha).

Am: area in natural vegetation cover in the project area at the end of the monitoring period (ha).

18.5.1.2 Annual land-use change in the leakage area

The estimation of changes in the natural cover of the wetland, in the leakage area, during the monitoring period is carried out with the equation:

$$LUC_L = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{L,1} - A_{L,2}\right)$$

Where:

LUC_L: change in area with natural vegetation cover in the leakage area (ha/year).

t2: final year of the monitoring period.

t1: year of the beginning of the monitoring period.

$A_{L,1}$: area in natural vegetation cover in the leakage area at the beginning of the monitoring period (ha).

$A_{L,2}$: area in natural vegetation cover in the leakage area at the end of the monitoring period (ha).

18.5.2 GHG emissions in the period of analysis

The annual emission from changes in natural vegetation cover in the project area is calculated using the equation:

$$AE_P = CNCV_P x \left(CBF_{eq} + soc_{eq}\right)$$

Where:

AE_P: annual emission in the project area (tCO_2e/ha/year).
$CNCV_P$: change in area with natural vegetation cover in the project area (ha/year).
CBFeq: carbon dioxide equivalent contained in total biomass (tCO_2e/ha).
SOCeq: equivalent soil carbon content (tCO_2e/ha).

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

$$AE_L = [CNCV_L x(CBF_{eq} + soc_{eq})] - AE_{L,BL}$$

Where:

AE_L: annual emission in the leakage area (tCO_2e/ha/year).
$CNCV_L$: change in area with natural vegetation cover in the leakage area (ha/year).
CBFeq: carbon dioxide equivalent contained in total biomass (tCO_2e/ha).
SOCeq: equivalent soil carbon content (tCO_2e/ha).
$AE_{L,BL}$: annual emission in the leakage area in the baseline scenario (tCO_2e).

18.5.3 Project emission reductions

Emission reductions from avoiding changes in natural vegetation cover during the monitoring period are estimated according to the equation:

$$ER_{P,mp} = (t_2 - t_1)x(bl - AE_p - AE_L)$$

Where:

$ER_{P,mp}$: reduction of emissions by avoiding changes in the natural vegetation cover of the wetland, in the monitoring period (tCO_2e/ha/year).

t2: final year of the monitoring period.
t1: year of the beginning of the monitoring period.

AE_{bl}: emission from changes in the natural vegetation cover of the wetland in the baseline scenario (tCO_2e/ha/year).

AE_P: Emission from changes in the natural vegetation cover of the wetland in the project area for the monitored period (tCO_2e/ha/year).

AE_L: Emission from changes in the natural vegetation cover of the wetland in the leakage area for the monitored period (tCO_2e/ha/year).

18.6 Monitoring of GHG removals

The estimate of actual removals considers the changes in carbon stocks in the project area, minus the estimate of non-CO_2 GHG emissions at the project boundary as a result of the implementation of project activities.

$$\Delta C_{Actual,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{Actual,t}$: net removals of GHGs by sinks, in year t (tCO_2e).

$\Delta CP,t$: carbon stock changes in the project, occurring in the selected pools, in year t (tCO_2e).

$GHG_{E,t}$: increase in non-CO_2 GHG emissions within the project boundary as a result of project activities in year t (tCO_2e). It is estimated with the tool: "Estimation of non-CO_2 GHG emissions resulting from biomass burning attributable to an F/R CDM project activity".

18.7 Monitoring changes in biodiversity associated with continental wetlands

The project proponent must establish a monitoring plan that identifies and describes procedures for tracking the status and trends of biodiversity change within the project boundaries[58]. This to evidence positive changes or improvements to biodiversity due to the implementation of project activities with respect to the baseline scenario.

The monitoring plan should include at least the following aspects:

a) Clear and specific objectives for the conservation of Inland Wetland types, associated vegetation, and fauna (either at taxonomic group or species level), and HCVs present in the project area.

b) Indicators whose periodic evaluation will make it possible to monitor compliance with the established objectives. These indicators should be qualitative and quantitative and should provide information on the general state of biodiversity, through the measurement of specific attributes such as richness, abundance, diversity, coverage, etc.

c) The sampling design for data collection should be based on a GIS analysis using maps, satellite images, or aerial photographs of the project area, in order to identify potential areas and points to be sampled. Sampling can be random or systematic, but in either case, it should be shown to be representative and cover the different wetland types (depending on the objectives set).

[58] The following documents can serve as a guide for the design of the monitoring plan of the state of biodiversity at the national and international levels respectively: Vallejo, M. I. & Gómez, D. I. (2017). Conceptual framework for biodiversity monitoring in Colombia. Biodiversity in practice, Humboldt institute working papers, Vol 2, Number 1. 47pp; Werner, F. & Gallo-Orsi, U. (2018). Biodiversity monitoring for natural resource management. GIZ (German Society for International Cooperation). 36pp.

d) The specific sampling procedures, tools, equipment, or inputs for each type of wetland, adequate and standardized for the measurement of the indicator, avoiding an error greater than 10%, which can generate underestimation, or overestimation of the indicators. For this, the project holder should define the size and number of samples, as well as replicates and repetitions if necessary.

e) Databases where all the information collected related to the evaluation of biodiversity indicators is recorded. These should include at least the code or ID of the project area, type of wetland, code or ID of the sampling point, code or ID of the sample, date, geographic coordinates, and type of sampling carried out. In case the sampling is at the level of taxonomic groups, specific information of the organism, such as family, scientific name, common name, growth type, height, DBH, etc., must be integrated.

f) Frequency of monitoring of biodiversity indicators, considering seasonality and water dynamics of the wetland, species distribution patterns, migration events, as well as accessibility to the study area. If indicator conditions or attributes vary with seasonality (e.g., wetlands that have a flood pulse or marked drought periods), the project proponent should provide indicator information for each season.

g) The monitoring results should be analyzed quantitatively and qualitatively by means of biostatistical analysis and GIS tools, which allow the status and trends of change of biodiversity indicators at spatial and temporal scales, to demonstrate the improvement of biodiversity conditions and its conservation due to the implementation of project activities.

19 Quality control and quality assurance procedures

The project owner must design a quality management and quality assurance system that ensures the good management, quality, and reliability of the information. The Quality Control/Assurance Control (QA/QC) system should conform to IPCC recommendations[59]. 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.

19.1 Review of data processing

The processing of data collected in the field and recorded in digital systems 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.

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

The data collected must be archived for a period of at least two years after the end of the accreditation period of the project activity.

19.2 Data recording and archiving system

Data 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), and measurement and monitoring reports.

The data collected should be archived for a period of at least two years after the end of the crediting period of the project activity.

Document History

Type of document

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