SAHBIO CARBONO

Natural Savanna and Forest Conservation

Terra Spectrum and Visso Consultores S.A.S

Name of the project	*SAHBIO CARBONO Natural Savanna and Forest Conservation*
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Other project participants	*Terra Spectrum SA*
Version	*1.1*
Date	*11/02/2025*
Project type	*AFOLU*
Grouped project	*The project corresponds to a group project.*
Applied Methodology (ies)	*BCR 0002 V 4.0 and BCR 0005 V 1.1*
Project location (City, Region, Country)	*Departments of Arauca y Casanare, Colombia* *Municipalities: Arauca, Cravo Norte, Tame* *Paz de Ariporo, Hato Corozal*
Starting date	(01/Jan/2021)
Quantification period of GHG emissions reduction	01/Jan/2021 to 31/Dec/2060

Estimated total and average annual GHG emission reduction/removal amount	***5,398,811.86*** *reductions of GHG emissions over 40 years.* ***134,970.30*** *annual reduction of GHG emissions.*
Sustainable Development Goals	*ODS: 5, 6, 7, 13 and 15*
Special category related to co-benefits	*Palma de Cera.*

General template instructions:

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1 Project type and eligibility

1.1 Scope in the BCR Standard

The SAHBIO CARBONO Project contributes to climate change mitigation through conservation activities in the floodplain natural savannas and forests of the Colombian Orinoquía, specifically within areas of the Arauca and Casanare departments. In line with the guidelines established by the BioCarbon Registry Standard V 3.4 (2024)[1], the scope of SAHBIO Carbono includes (Table 1-1):

Table 1-1. Project's eligibility under the BCR Standard V 3.4 (2024) through one or more of the following criteria

The scope of the BCR Standard is limited to:	
The following greenhouse gases are included in the Kyoto Protocol: Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O).	X
GHG projects using a methodology developed or approved by BioCarbon, applicable to GHG removal and REDD+ activities and AFOLU Sector.	X
Quantifiable GHG emission reductions and/or removals generated through the implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	X
GHG projects use a methodology developed or approved by BioCarbon **for** energy, transportation, and waste sector activities.	
Implementing energy, transportation, and waste activities generate quantifiable GHG emission reductions.	

Source: BioCarbon Standard V 3.4 and Sahbio Carbono, 2024

The SAHBIO Carbono project aligns with the scope of the BCR Standard by adhering to the following criteria:

[1] BIOCARBON CREDI® 2024. Estándar BCR. Versión. 3.4. 28 Junio 2024. 80 p. https://biocarbonstandard.com/es_es/estandar-bcr-biocarbon-standard/

1. Prevention of Land Use Change in Natural Savannas (BCR0005) and Support for REDD+ Activities (BCR0002): The project implements activities to prevent land use changes in natural savannas, a critical aspect of the BCR0005 methodology. The project effectively reduces GHG emissions from land degradation under the AFOLU sector by protecting these ecosystems.
   The project applies to the BCR0002 methodology, which provides a framework for REDD+ (Reducing Emissions from Deforestation and Forest Degradation). This methodology includes determining historical deforestation and degradation, establishing baselines, and quantifying emissions reductions attributable to project activities. Integrating this methodology ensures that the project addresses deforestation and forest degradation while promoting sustainable land management practices.

2. Prevention of Land Use Change in Natural Savannas: The project implements activities to prevent land use changes, a critical aspect of the BCR0005 methodology. By protecting these ecosystems, the project effectively contributes to reducing GHG emissions from land degradation and deforestation, aligning with the objectives of REDD+ activities under the AFOLU sector.

3. Inclusion of Kyoto Protocol Greenhouse Gases: The project quantifies and addresses emissions reductions for carbon dioxide (CO_2), explicitly included in the Kyoto Protocol. This gas is a key contributor to climate change, and the project's focus on mitigating their emissions reinforces its relevance under the BCR Standard.

4. Compatibility with BCR-Approved Activities: The project qualifies as a GHG removal and REDD+ initiative, meeting the requirements for activities in the AFOLU sector. Its focus on conserving natural savannas and preventing land-use change directly contributes to generating quantifiable GHG emission reductions and removals, as the BCR Standard mandates.

5. Demonstrable Impact on GHG Emissions: By implementing activities guided by the BCR0005 methodology, the project generates verifiable and quantifiable GHG emission reductions and removals. These results are measurable, reportable, and verifiable, aligning with the principles of transparency and accountability required by the BCR Standard.

1.2 Project type

In line with the scope of the SAHBIO Carbono Project, we focused efforts on developing conservation activities for natural savannas, including wetlands and natural forests within this landscape, in the Colombian Orinoquia. This initiative integrates comprehensive activities that align directly with AFOLU standards and REDD+ activities (Table 1-2).

Table 1-2. Project type and the activities associated

Activities in the AFOLU sector other than REDD+	X
REDD+ Activities	X
Activities in the energy sector	
Activities in the transportation sector	
Activities related to Handling and disposing of waste	

Source: BioCarbon Standard V 3.4 and Sahbio Carbono, 2024

1.3 Project scale

N/A

2 General description of the project

2.1 GHG project name

SAHBIO CARBONO- Sabanas y Bosques Biodiversos de la Orinoquía

2.2 Objectives

2.2.1 General Objective

To develop and implement a conservation project over 200,000 hectares of naturally flooded savannas and forests in the Arauca and Casanare Departments of the Colombian Orinoquia. The project seeks to preserve and enhance greenhouse gas retention in natural forests and savannas (Natural Herbaceous Coverage) through targeted actions that generate **Verifiable Carbon Credits (VCC)** over 40 years. To develop and implement a conservation project covering **143,973.56** hectares in the first phase, including **132,303.19** hectares of floodplain natural savannas and **11,670.37** hectares of forest in the Arauca and Casanare Departments of the Colombian. The second phase will expand the project over 200,000 hectares.

2.2.2 Specific Objectives

- Identify, design, and implement activities to conserve natural savannas and forests by applying landscape management tools alongside sustainable use and management practices. 124 stakeholders in protecting ecosystems and promoting sustainable and conservation-compatible productive practices will be incorporated as the project's principal participants.
- Conduct a detailed characterization of **129** properties involved in the project, identifying the ecosystems within natural forests and floodplain natural savannas to establish the baseline for stored carbon.
- Develop a monitoring plan to enable adjustments and improvements in management strategies based on accurate data on carbon retention.
- Promote the conservation of **143,340.76** hectares in the first phase, including **131,717.79** hectares of floodplain natural savannas and **11,622.96** hectares of forest within the project's eligible areas in the Arauca and Casanare departments.

2.3 Project activities

As part of the project and based on analyzing the causes and agents of land-use change in natural savannas, forest degradation, and deforestation, we have developed a series of activities to minimize these changes in the eligible areas of the SAHBIO Carbono Project. These activities fall into two main categories. First, we propose a comprehensive training program of eight sessions covering topics such as natural ecosystem conservation and compliance with safeguards. Second, we have designed nine conservation activities to protect forests, savannas, and natural wetlands. The project's activities are aimed at landowners and farm managers.

2.3.1 SAHBIO Carbono Training plan

We organized the Training Plan into four thematic categories addressing both technical and social aspects required for implementing conservation activities and ensuring the project's sustainability.

In this plan, three (3) training sessions are mandatory, while others are optional. Mandatory training ensures all participants acquire the essential knowledge to meet the project's objectives. Meanwhile, optional training allows landowners to develop the skills needed to implement conservation activities that best suit the characteristics of their properties, providing flexibility and customization in the learning process.

2.3.1.1 Risk Mitigation and Climate Change Adaptation

Provides participants with techniques and knowledge to address the effects of climate change and reduce risks associated with environmental degradation (See Table 2-1).

Table 2-1. Proposed training for risk mitigation and climate change adaptation (Training plan)

Training	Theme	Related SDGs	Training Type
How to prepare and adapt the farm to climate change.	Understanding the effects of climate change on the farm and the flooded savannas.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Mandatory
	Practices to protect and conserve the flooded savannas of the Orinoquía.		
Fire Prevention and Control	Fire Prevention.		Mandatory
	Training in Controlled Burning.		
	Fire Response and Contingency.		

Source: Sahbio Carbono, 2024

2.3.1.2 Carbon Monitoring and Quantification

Training in measurement, monitoring, and recording techniques for carbon and biodiversity to assess the impact on ecosystem conservation (See Table 2-2).

Table 2-2. Proposed training in carbon and biodiversity monitoring and quantification (Training plan)

Training	Theme	Related SDGs	Training Type
Measurement and Monitoring of Carbon in Soil and Biomass.	Introduction to carbon sequestration in soil and biomass and GHG emissions.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action	Mandatory
	Sampling, monitoring, and recording methods for measuring carbon in soil and biomass.		

Training	Theme	Related SDGs	Training Type
	Best practices to prevent carbon loss in soil and biomass.	SDG 15: Life on Land	
	Interpretation of results and their impact on carbon credits.		
Use of Georeferencing Tools and Geographic Information Systems (GIS).	Introduction to Georeferencing.		Optional
	Field GPS Use.		
	Creation of Basic Maps.		
	Interpretation of Geographic Data.		

Source: Sahbio Carbono, 2024

2.3.1.3 Ecosystem Management and Conservation

Training in restoration practices, territorial planning, waste management, and efficient water use to protect biodiversity and promote responsible use of natural resources in rural areas (See Table 2-3).

Table 2-3. Proposed training in sustainable land management (Training plan)

Training	Theme	Related SDGs	Training Type
Ecological Restoration Practices.	Reforestation with native species.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional
	Passive regeneration.		
	Biological corridors.		
	Control of exotic species.		
	Maintenance and monitoring of restored areas.		
	Land zoning.		Optional

Training	Theme	Related SDGs	Training Type
Planning and Zoning for the Conservation of Critical Areas to Protect Biodiversity.	Land-use planning.		
	Signage to delimit protected areas and prohibit unauthorized activities.		
	Monitoring protected areas through regular patrols.		

Source: Sahbio Carbono, 2024

2.3.1.4 *Regulatory Compliance and Safeguards*

Train landowners in environmental regulations and establish safeguards to ensure respect for human rights and compliance with regulations (See Table 2-4).

Table 2-4. Proposed training for regulatory compliance and safeguards (Training plan).

Training	Theme	Related SDGs	Training Type
Regulations Related to Conservation.	Introduction to environmental legislation.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional
	Regulations on soil, water, air, waste, and biodiversity.		
	Penalties and consequences for non-compliance.		
Safeguards Compliance Workshops	Community rights.		
	Safeguards.		
	Community participation.		

Source: Sahbio Carbono, 2024

2.3.2 Conservation Activities Framework

The following is the Conservation Activities Framework, which provides a guide for implementing specific conservation actions in natural Savanna and Forest ecosystems managed by the landowners participating in the project. We organized these activities into three levels with specific purposes:

- Essential Activities include implementing landscape management tools to establish a conservation and sustainable land management foundation.
- Community Well-Being Activities: We grouped these activities under increased Conuco productivity, which promotes access to food through sustainable practices focused on improving food security.
- Advanced Conservation Activities: These activities include implementing silvopastoral systems adapted to savannas in natural grasslands, constructing livestock water systems and reservoirs, optimizing resource use, and preserving the ecological balance of intervention areas. Aimed at sustainable production.

In this framework battery, some activities are mandatory, while others are optional. Mandatory activities ensure that all participants act to meet the project's objectives. Meanwhile, optional ones allow landowners to implement conservation activities that best suit the characteristics of their properties.

2.3.2.1 Implementation of landscape management tools (Natural Savannas and Forests)

These activities are aligned with implementing landscape management tools to support the conservation of forests, savannas, and natural wetlands. By integrating these tools, the focus is on maintaining ecological balance while promoting sustainable land-use practices. The approach emphasizes preserving biodiversity, enhancing ecosystem services, and mitigating land-use changes threatening these critical landscapes. Such activities may include spatial planning, ecological restoration strategies, and monitoring systems to ensure effective management and long-term conservation outcomes (See Table 2-5).

Table 2-5.. Proposed conservation activities in the implementation of landscape management tools

Conservation Activity	Goal	Indicator	Related SDG	Nature of the Activity
Regular patrolling according to Property Characteristics.	Ensure ecosystem protection through regular patrols on the property.	**Binary Indicator:** The property has implemented regular patrols (Y/N). **Yes:** The property conducts regular patrols. **No:** The property does not conduct regular patrols.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Mandatory REDD+
Installation of signage to delimit protected areas and prohibit unauthorized activities.	Ensure the protection of the ecosystem by installing signage that marks protected areas and indicates prohibited activities on the property.	**Binary Indicator**: The property has implemented signage (Y/N). **Yes**: The property has signage. **No**: The property does not have signage.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+
Regular patrolling according to property characteristics.	Ensure ecosystem protection through regular patrols on the property.	**Binary Indicator:** The property has implemented regular patrols (Y/N). **Yes:** The property conducts regular patrols. **No:** The property does not conduct regular patrols.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Mandatory **REDD+**
Implementation and maintenance of wire fences or natural barriers to delimit the property and protect key ecosystem	Protect ecosystems by implementing and maintaining fences or natural barriers on the property.	Binary Indicator: The property constructs and maintains fences (Yes/No). **Yes**: The property constructs and maintains fences. **No**: The property does not construct and maintain fences.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD +; Natural Savannas and Wetlands

Conservation Activity	Goal	Indicator	Related SDG	Nature of the Activity
Release or exclusion of areas for regeneration.	Facilitate the ecosystem's natural recovery by designating areas for passive restoration.	**Binary Indicator**: The property performs passive restoration (Yes/No). **Yes**: The property carries out passive restoration. **No**: The property does not carry out passive restoration.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands
Implementing biological corridors.	Promote ecosystem connectivity through the creation of biological corridors.	**Binary Indicator**: The property implements biological corridors (Yes/No). **Yes**: The property implements biological corridors. **No**: The property does not implement biological corridors.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands
Control and removal of non-native species.	Preserve ecosystem balance through the control and removal of non-native species.	**Binary Indicator**: The property controls and removes non-native species (Yes/No). **Yes**: The property carries out control and removal of non-native species. **No**: The property does not control and remove non-native species.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands
Execution of prescribed burns and/or construction of firebreak for fire prevention and management.	Prevent the occurrence of wildfires affecting the floodplain savanna ecosystems by implementing prescribed burns and/or firebreak construction.	**Binary Indicator:** The property has implemented prescribed burns and/or firebreaks (Yes/No). **Yes**: The property has implemented prescribed burns and/or firebreaks. **No**: The property has not implemented prescribed burns and/or firebreaks.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional Natural Savannas

Conservation Activity	Goal	Indicator	Related SDG	Nature of the Activity
Restoration with native species	Restore the ecosystem through the planting of native species from the region.	**Binary Indicator**: The property has implemented active restoration with native species (Yes/No). **Yes**: The property has implemented active restoration with native species. **No**: The property has not implemented active restoration with native species.	SDG 6: Clean Water and Sanitation. SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands
Establishment of conservation agreements or memorandums of understanding related to conservation.	Establish at least one conservation agreement in strategic areas, promoting the conservation of key ecosystems and sustainable practices.	**Binary Indicator**: The property has established conservation agreements (Yes/No). **Yes**: The property has established conservation agreements. **No**: The property has not established conservation agreements.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action. SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands

Source: Sahbio Carbono, 2024

2.4 Project location

2.4.1 Environmental aspects

The project is in the Arauca and Casanare departments, specifically in Arauca, Cravo Norte, Tame, Hato Corozal, and Paz de Ariporo municipalities. Those municipalities are part of the Orinoquia. The larger region of the Eastern Plains ("Los Llanos Orientales") spans approximately 34 million hectares, representing around 30% of Colombia's continental land area. The Eastern Plains features a diverse landscape of tropical savannas, wetlands, humid forests, and mountains, which provide essential ecosystem services like carbon storage, water regulation, sediment retention, and erosion control[2], [3], [4]. The region channels significant water volumes due to its eight-month rainy season and extensive wetlands, holding 48% of Colombia's continental wetlands and 32.5% of its underground water reserves.

Located across Arauca and Casanare, the Orinoquia includes ecosystems such as seasonally flooded savannas, the well-drained Altillanura savanna, and riparian forests, hosting remarkable biodiversity, with 35% of species endemic to the region. Its climate, characterized by 20–30°C temperatures and annual rainfall between 1000–2500 mm, drives distinct wet and dry seasons, supporting dynamic ecological processes.

Economically, the Orinoquia contributes 7% of Colombia's GDP through agriculture, including rice, palm oil, and livestock production[5][6]. However, unsustainable practices and rapid agricultural expansion threaten its ecosystems. Preserving the region's ecological health is crucial for biodiversity, carbon sequestration, and water regulation, ensuring long-term economic and environmental stability[7]. Balancing development with conservation will be vital for the region's future.

2.4.2 Socioeconomic Aspects

The analyzed data covers general aspects, competitiveness and development, poverty and social conditions, productive and agricultural structure, and foreign trade. This information was obtained from the economic and trade profiles of the Ministry of Commerce, Industry, and Tourism presented during the year 2024[8]. Finally, this section

[2] Lasso, Carlos & Rial, Anabel & Colonnello, Giuseppe & Machado-Allison, Antonio & Trujillo, Fernand. Humedales de la Orinoquia (Colombia-Venezuela). XI. Serie Editorial Recursos Hidrobiológicos y Pesqueros Continentales de Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. Bogotá, Colombia. 2014 301pp.
[3] Caro-Caro, C. I., y Torres-Mora, M. A. Servicios ecosistémicos como soporte para la gestión de sistemas socio ecológicos: aplicación en agroecosistemas. Orinoquia, 19(2), 2015 37–252.
[4] Bustamante, C. (ed). Gran Libro de la Orinoquia Colombiana. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. 2019 260 p.
[5] Portocarrero Aya, Marcela & Julián Lee. Toward a New Sustainable Development Model for the Orinoquía Region in Colombia. 2021 *World Bank Blogs. Latin America and Caribbean*. https://blogs.worldbank.org/en/latinamerica/toward-new-sustainable-development-model-orinoquia-region-colombia. (consulted 16/12/2024)
[6] Vargas LEP, Laurance WF, Clements GR, Edwards W. The Impacts of Oil Palm Agriculture on Colombia's Biodiversity: What We Know and Still Need to Know. Tropical Conservation Science. 2015;8(3):828-845.
[7] Pimentel Jonathan Nogales , Rogéliz Prada Carlos Andres , Walschburger Thomas. Hydrological Modeling for Multifunctional Landscape Planning in the Orinoquia Region of Colombia. Frontiers in Environmental Science, 9, 2021.
[8] MINCIT. (2024). Perfiles económicos y comerciales por departamento (Arauca y Casanare) Recuperado en: Perfiles económicos y comerciales por departamentos | MINCIT - Ministerio de Comercio, Industria y Turismo

concludes with an analysis of the productive activities that impact the properties where the project is implemented.

- Arauca: It has an area of 23,818 km² and an approximate population of 313,097 (2023), representing 0.6% of the national population. It has a GDP per capita of USD 6,335 in 2023, contributing 0.55% to the national GDP.

- Casanare: It covers an area of 44,640 km² and has an approximate population of 467,775 inhabitants (2023), equivalent to 0.9% of the national population. Its economy contributes 1.43% to the national GDP, with a GDP per capita of USD 11,130 in 2023.

2.4.2.1 Poverty and Social Conditions in Rural Areas

Poverty in the rural areas of the departments of Arauca and Casanare shows high levels of deprivation across various dimensions, with some specific differences reflecting the unique characteristics of each department:

- **Arauca[9]:** In Arauca's rural areas, multidimensional poverty indicators are high, with the following notable characteristics:
    - **Low educational attainment:** Affects approximately 70.5% of the rural population, reflecting limited access to formal education.
    - **Inadequate housing materials:** About 29.5% of rural homes have inadequate flooring, indicating poor living conditions.
    - **Informal employment:** Labor informality is remarkably high, reaching 98.4%, which limits opportunities for stable employment and access to labor benefits.

[9] Departamento Administrativo Nacional de Estadística (DANE). (2022). *Kit Territorial - Documento Regional UPRA Arauca*. Unidad de Planificación Rural Agropecuaria (UPRA). https://upra.gov.co/Kit_Territorial/2-%20Informaci%C3%B3n%20por%20Departamentos/ARAUCA/2-%20Documento%20Regional%20UPRA%20Arauca.pdf

- **Casanare[10]:** In Casanare, rural areas also exhibit significant deprivations, though with some differences compared to Arauca:
    - **Educational lag:** This is one of the leading educational deprivations, affecting 30.5% of the rural population.
    - **Lack of drinking water:** About 24.6% of rural households lack access to improved water sources, impacting health and quality of life.
    - **Informal employment:** Similar to Arauca, informality is high, although slightly lower, at 90.4% in rural areas.

2.4.2.2 Analysis of Productive Activities in the project area

Understanding the productive activities on the properties where the project is implemented is crucial to contextualizing its impact and relevance in the region. Based on information obtained from the survey interview conducted with property owners by SAHBIO Carbono in 2024, the specific productive sectors were identified and analyzed. This analysis influences sustainable development, and the intervention strategies proposed in the project.

According to the information, 63% of the properties implement livestock systems, highlighting the predominance of this productive system in the area. Of these properties, 54.8% raise crossbred Zebu cattle, and 19.2% incorporate Creole cattle, significantly contributing to savanna conservation.

Creole cattle, being genetically adapted to local conditions, exhibit greater disease resistance and a reduced impact on the ecosystem, minimizing the need for external inputs. Similarly, due to their adaptability to warm and tropical climates, Zebu cattle enable efficient production without compromising soil sustainability or regional resources.

Property activities are highly oriented toward cattle breeding (93%), followed by meat production (24%) and milk production (20.7%). This information indicates a strong

[10] Departamento Administrativo Nacional de Estadística (DANE). (2022). *Kit Territorial - Documento Regional UPRA Casanare*. Unidad de Planificación Rural Agropecuaria (UPRA). https://upra.gov.co/Kit_Territorial/2-%20Informaci%C3%B3n%20por%20Departamentos/CASANARE/2-%20Documento%20Regional%20UPRA%20Casanare.pdf

focus on livestock, particularly on breeding, which supports the maintenance of natural ecosystems by utilizing adapted breeds that contribute to preserving the ecological integrity of the savanna.

Additionally, the information shows that the agricultural system has significant representation alongside the livestock system, implemented in 50% of the properties. However, 22.5% of property owners report not engaging in productive activities. Although less prevalent, other systems, such as forestry, have a presence in 12.5% of the properties.

The high proportion of properties that also engage in agricultural activities (50%) suggests a potential land use shift, which could significantly impact the conservation of savanna ecosystems. Therefore, it is crucial to promote sustainable, productive systems that minimize environmental impact and prevent the degradation of natural areas. In this way, the synergy between livestock adapted to the savanna and conservation activities can become a driver that contributes to both productivity and the preservation of local ecosystems.

3 Quantification of GHG emissions reduction

3.1 Quantification methodology

We used the BCR Standard from differentiated responsibility to common responsibility (V. 3.4 June 28, 2024) and other GHG project certification and registration programs of the Biocarbon Standard program for the development of the Project. Which will provide the requirements applicable to it, as well as the following methodologies:

- We used BCR0002 Quantification of GHG Emission Reductions REDD+ Projects methodology of the AFOLU sector for the forest areas—version 4.0 (BCR, 2024)[11].
- We used the BCR0005 Quantification of GHG Emissions Reduction methodology for the agriculture, Silviculture, and other land uses (AFOLU) sector in the Savannas areas[12].

[11] Biocarbon Credi®. Quantification Of Ghg Emission Reductions Redd+ Projects (Bcr0002 V 4.0). Bogotá D.C. Biocarbon Credi, 2024, P 56.
[12] Biocarbon Credi®. Quantification Of Ghg Emissions Reduction Activities That Prevent Land Use Change in Natural Savannas (Bcr0005 V 1.1). Bogotá D.C. Biocarbon Credi, 2024, P 51

3.1.1 Applicability conditions of the methodology

3.1.1.1 Applicability conditions of the methodology Quantification of GHG Emission Reductions REDD +

This methodology applies to the Project under the following conditions (See Table 3-1)

Table 3-1. Conditions for applying Quantification of GHG Emission Reductions with the REDD+ methodology (BCR 0002, 2024)

Condition	Answer
The areas in the project boundaries correspond to the forest category (as outlined by the national forest definition for the Clean Development Mechanism) at the start of the project activities and a minimum of ten years before the project starts data.	We demonstrate that areas in the project boundaries correspond to the forest category based on the official CORINE Land Cover of Colombia cartographic inputs (2010, 2020) obtained from the Forest and Carbon Monitoring System of IDEAM.
The areas within project boundaries do not correspond to the wetlands category.	We demonstrate that the areas in the project boundaries, meaning the eligible forest areas, do not correspond to the wetlands category based on cartographic inputs of the official CORINE Land Cover legend for Colombia (Ideam, 2010, 2020).
There are no organic soils within the geographical limits of the Project.	In the soil sampling conducted to measure soil organic carbon (SOC), we did not find samples with values exceeding 12% within the top 15 cm of soil.
The identified causes of deforestation include expansion of the agricultural frontier, mining, timber extraction, and infrastructure expansion.	One of the leading causes of deforestation in the reference area is the expansion of the agricultural frontier, mainly by industrial crops (bananas, rice, oil palm, and cacao; UPRA, 2022) and the expansion of pastures planted with exotic grasses. Finally, the oil sector decreased from 2000 to 2007 in two Departments (Casanare and Arauca), which decreased from 67 to 47%.
No reduction in deforestation or forest degradation is expected to occur in the absence of the Project.	**Answer:** We expect deforestation and forest degradation to continue in the absence of the Project, which includes executing REDD+ activities and monitoring GHG reductions/removals for 2021-2023.

Condition	Answer
The carbon stock in the organic matter of soil, litter, and deadwood in the project boundary may decrease or remain stable.	We expect carbon reserves to remain stable or increase within the project boundaries. However, these reserves will decrease if agricultural activities continue to be carried out in the deforested areas previously identified in the project baseline.
GHG quantification other than CO_2 should be included in quantifying emissions caused by forest fires (if applicable) during the monitoring period.	The Project will incorporate methane (CH_4) and nitrous oxide (N_2O) emissions from forest fires in the eligible project areas.

Source: Sahbio Carbon, 2024

3.1.1.2 Applicability conditions of the methodology of activities that prevent land use change in Natural Savannas

This methodology applies to the Project under the following conditions (See Table 3-2)

Table 3-2. Applicability conditions of the methodology of activities that prevent land use change in Natural Savannas and Wetlands (BCR 0005, 2024)

Condition	Answer
The areas within the geographic boundaries of the Project correspond to natural savannas.	We used Colombia's official CORINE Land Cover methodology (IDEAM, 2010) to identify natural savannas in the project area. We establish the eligibility of the areas through an analysis made between 2008 and 2018.

Condition	Answer
Project activities prevent land use change in natural savannas.	We designed activities and monitored the Project to avoid changes in land use. These activities are a Training plan with thematic risk mitigation and adaptation to climate change, carbon and biodiversity monitoring and quantification, sustainable land management, sustainable agricultural practices, regulatory compliance and safeguards, and community empowerment and skills development with a gender focus. Also, we have Conservation activities such as implementing landscape management tools, increasing conucos productivity, implementing activities aligned with silvopastoral systems adapted to savanna in natural grasslands, and constructing livestock water systems and reservoirs.
Project activities include biodiversity conservation actions that integrate preservation, restoration, and/or management efforts and sustainable use of the savannas.	We include activities that conserve biodiversity by recognizing areas and figures of conservation and environmental planning for conservation in the project area, such as the installation of signage to delimit protected areas and prohibit unauthorized activities, regular patrolling, implementation, and maintenance of barbwire fences or natural barriers to delimit the property and protect key ecosystems; conduct prescribed burns; and implementing firebreaks; and signing conservation agreements.
The causes of the change in land use identified may include, among others, expansion of the agricultural frontier, mining, extraction, or loss of natural vegetation cover.	As identified in the baseline, the primary drivers of land use change in natural savannas include agricultural frontier caused by the planting of expansion, the replacement of native grasses with non-native species, rice cultivation, and oil palm plantations. These activities contribute to the loss and degradation of natural cover.
Carbon stocks in soil organic matter, litter, and dead wood may decrease or remain stable in the areas within the project boundaries.	We expect carbon reserves to remain stable or increase by developing conservation activities in natural savannas and forests w. However, these reserves decrease if agricultural activities continue to be carried out in the deforested areas previously identified in the project baseline.
Soil disturbance due to project activities, if any, is carried out following appropriate soil conservation practices and does not recur for less than 20 years.	The proposed activities do not involve altering the soil; see the project's activities.

Condition	Answer
The quantity of nitrogen-fixing species used in the project activities is insignificant, so GHG emissions from denitrification can be considered insignificant.	Our proposed activities do not include introducing, promoting, or using N-fixing species.

Source: Sahbio Carbono, 2024

3.2 Project boundaries, sources, and GHGs

Colombia's unique geographical position, along with its tectonic and ecological history, has made it one of the most biodiverse countries in the world, rich in species, ecosystems, and hydrobiological resources. Among Colombia's ecologically significant regions, the Orinoquia stands out. This area is a mosaic of terrestrial and aquatic ecosystems, shaped by its biogeographical history, a range of elevations (50 to 5,000 meters above sea level), varied precipitation patterns, diverse soil types, and a complex hydrological network[13], [14], [15].

The Orinoquia Region, also known as the Eastern Plains, covers approximately 34 million hectares—about 30% of Colombia's total land area. It hosts a heterogeneous landscape where savannas, wetlands, humid forests, and mountain ecosystems converge. These ecosystems provide crucial environmental services like regulating the water cycle, retaining sediments, controlling erosion, stabilizing the local climate, storing carbon, and supplying food and raw materials[16], [17], [18]. With eight months of rainfall annually and high cloud cover, the region channels large volumes of water from the oceans, flooding its soil and nourishing wetlands. As a result, the Orinoquia contains 48% of Colombia's continental wetlands and 32.5% of the nation's underground water reserves[19].

Stretching across departments such as Arauca, Casanare, Meta, and Vichada, the Orinoquia, Eastern Plains, encompasses diverse ecosystems, including hyper-seasonal flood savannas (which make up 12% of the area), the Altillanura savanna, and riparian forests. Its biodiversity is remarkable, with 35% of its species being endemic to the region.

[13] Lasso, Humedales de la Orinoquia, p 28.
[14] Usma, J.S., & F. Trujillo (Ed). Biodiversidad del Casanare: Ecosistemas Estratégicos del Departamento. Gobernación de Casanare - WWF Colombia. Bogotá D.C. 2011, 286p.
[15] Bustamante, Gran Libro de la Orinoquia Colombiana, p 28.
[16] Lasso, Humedales de la Orinoquia, p 28.
[17] Caro-Caro, Servicios ecosistémicos: aplicación en agroecosistemas, p 29
[18] Bustamante, Gran Libro de la Orinoquia Colombiana, p 28
[19] Ibid, p 36

The region's climate plays a defining role in shaping the savanna ecosystems. Temperatures range from 20 to 30 degrees Celsius, with annual rainfall between 1000 and 2500 millimeters[20]. These conditions create distinct wet and dry seasons, lasting 6–8 months and 4–6 months, respectively, driving dynamic ecological processes to which the flora and fauna have adapted.

Economically, this region is vital to Colombia, contributing 7% of the country's GDP. It is a crucial agricultural hub that produces rice, palm oil, and livestock[21] [22]. However, the region faces severe ecological threats. Unsustainable agricultural practices, coupled with aggressive expansion and intensification development plans, are rapidly degrading natural ecosystems. The health of the reference area ecosystems is essential for conserving biodiversity and the region's long-term economic prosperity, providing vital ecosystem services[23]. Balancing development with ecological preservation is critical for the future of the Orinoco River basin.

3.2.1 Spatial limits of the project

The project is located in the Arauca and Casanare departments. In Arauca, the municipalities of Arauca, Cravo Norte, and Tame, and in Casanare, the municipalities of Hato Corozal and Paz de Ariporo cover 157,956.08 ha. In Table 3-3, we present the geographical information of each of the properties belonging to the project.

Table 3-3. Spatial and geographical boundaries of the project SAHBIO Carbono for Natural Savannas, and Forests counting GHG emissions/ removals. Geographic coordinates are in Magna Sirgas – Origen Nacional and are the centroids of each property.

Property Name	Department	Municipality	X Cord	Y Cord
Santa Rosa	Arauca	Arauca	5313087.888	2303344.387
La Marranera	Arauca	Arauca	5318838.055	2297173.659
El Congrinal	Arauca	Arauca	5321717.389	2289716.777
La Bendicion	Arauca	Arauca	5302708.844	2293721.473
Capuriche	Arauca	Arauca	5316064.098	2290374.557
Fundo Nuevo	Arauca	Arauca	5308525.024	2291028.63
La Pradera	Arauca	Arauca	5319513.725	2302572.658
El Porvenir	Arauca	Arauca	5296967.227	2297917.036

[20] Lasso, Humedales de la Orinoquia, p 28.
[21] Portocarrero, New Sustainable Development Model for the Orinoquía Region in Colombia, p 29.
[22] Vargas, The Impacts of Oil Palm Agriculture on Colombia's Biodiversity, p 29.
[23] Pimentel, *Hydrological Modeling for Multifunctional Landscape Planning*, p 29.

Property Name	Department	Municipality	X Cord	Y Cord
Buron	Arauca	Arauca	5306267.263	2302082.746
Chaparral	Arauca	Arauca	5270026.046	2333627.097
San Pablo	Arauca	Arauca	5308845.568	2297073.403
Santa Maria	Arauca	Arauca	5313067.706	2296804.406
El Molino	Arauca	Cravo Norte	5368238.298	2257294.507
El Moriche	Arauca	Cravo Norte	5365255.965	2258058.392
La Union	Arauca	Cravo Norte	5372008.488	2258486.467
El Taparo	Arauca	Cravo Norte	5369330.883	2262344.849
El Retiro	Arauca	Cravo Norte	5370361.124	2257333.323
La Esperanza	Arauca	Cravo Norte	5365833.928	2262448.784
La Popular	Arauca	Cravo Norte	5367553.675	2262007.602
La Primavera	Arauca	Cravo Norte	5371058.448	2262950.736
Santa Maria	Arauca	Cravo Norte	5361613.714	2270226.13
La Trinitaria	Arauca	Cravo Norte	5358001.04	2263181.444
La Fortuna	Arauca	Cravo Norte	5354256	2258826.204
Villa Zorro	Arauca	Cravo Norte	5360727.148	2263763.53
Las Delicias	Arauca	Cravo Norte	5355254.074	2260211.306
La Esperanza	Arauca	Cravo Norte	5360132.206	2269271.173
Provincia	Arauca	Cravo Norte	5357272.697	2268173.924
Los Naranjos	Arauca	Cravo Norte	5356341.641	2261523.33
El Roble	Arauca	Cravo Norte	5362783.967	2263861.388
Los Alcaravanes	Arauca	Cravo Norte	5358734.994	2268603.299
El Paraiso	Arauca	Cravo Norte	5362985.388	2270307.468
La Tormenta	Arauca	Cravo Norte	5355846.208	2267358.245
Los Pionios	Arauca	Cravo Norte	5352985.666	2265339.043
El Divino Niño	Arauca	Cravo Norte	5303114.386	2283798.809
El Bogante	Arauca	Cravo Norte	5376826.587	2251235.43
La Ilusion	Arauca	Arauca	5223731.368	2308072.321
La Union	Arauca	Cravo Norte	5372207.809	2248910.822
Las Azules	Arauca	Arauca	5265498.839	2311716.738
San Jose	Arauca	Cravo Norte	5297114.87	2284669.249
San Luis	Arauca	Cravo Norte	5376778.118	2240398.93
Valledupar	Arauca	Cravo Norte	5370647.047	2246066.994
Villa Gabi 2	Arauca	Arauca	5261879.139	2324604.999
Villa Gabi	Arauca	Arauca	5261408.767	2327472.869
Vietnam Ii	Arauca	Tame	5173231.33	2252612.092
Vietnam	Arauca	Tame	5171148.841	2251887.578
Banderitas Ii	Arauca	Tame	5165705.661	2247942.008
Canta Rana	Arauca	Tame	5170597.038	2256713.443
Las Palmas	Arauca	Tame	5174193.596	2255281.152
El Tesoro	Arauca	Tame	5169425.771	2246396.388
Banderitas	Arauca	Tame	5167531.097	2247637.647
Chaparral	Casanare	Hato Corozal	5261185.12	2245808.135
El Guasimo	Arauca	Arauca	5269931.144	2290236.682

Property Name	Department	Municipality	X Cord	Y Cord
Guayavital	Arauca	Arauca	5267649.243	2289773.525
La Oportunidad	Arauca	Cravo Norte	5362548.427	2234796.282
La Virgen	Arauca	Cravo Norte	5361246.201	2234080.016
Maticas	Arauca	Cravo Norte	5264526.819	2274976.081
Los Gavilanes	Arauca	Cravo Norte	5266507.805	2274335.124
Villa San Juan	Arauca	Cravo Norte	5355724.98	2235276.343
Villa Luciana	Arauca	Cravo Norte	5355524.056	2232147.047
La Pereza	Arauca	Cravo Norte	5372824.331	2246935.482
La Esperanza Jg	Arauca	Arauca	5329709.518	2303300.218
Villa Vivi	Arauca	Cravo Norte	5332413.559	2260246.402
Villa Del Sol	Arauca	Cravo Norte	5332904.52	2260886.418
Kalama	Arauca	Cravo Norte	5333293.686	2261716.298
Los Clavelillos	Arauca	Cravo Norte	5333699.048	2262595.996
La Patrona	Arauca	Cravo Norte	5334359.96	2263539.799
La Laguna	Casanare	Paz De Ariporo	5298105.416	2227947.108
El Salero	Casanare	Paz De Ariporo	5300919.261	2232144.278
Mata Redonda	Casanare	Paz De Ariporo	5303180.801	2231664.846
El Orejal	Casanare	Paz De Ariporo	5300390.856	2227151.883
El Conuco	Casanare	Paz De Ariporo	5305035.365	2231025.246
El Milagro	Arauca	Cravo Norte	5306719.574	2254521.517
Las Delicias	Arauca	Puerto Rondon	5242249.754	2281059.908
Guatapury	Arauca	Puerto Rondon	5243558.644	2281253.372
Los Araguatos	Arauca	Arauca	5260490.943	2283591.021
La Yaguita	Arauca	Cravo Norte	5337725.951	2243811.092
Morabia	Arauca	Arauca	5259862.148	2278623.739
Matalarga	Arauca	Arauca	5251472.827	2316752.325
El Laurel	Arauca	Arauca	5249937.57	2317414.403
Villa Eliza	Arauca	Arauca	5250430.668	2315251.878
La Fortaleza	Arauca	Arauca	5251816.755	2315129.566
Cancun	Arauca	Cravo Norte	5368454.05	2240691.07
San Pedro	Arauca	Arauca	5325793.696	2300716.533
Matazul	Arauca	Arauca	5343634.227	2292315.192
Tijuana	Arauca	Cravo Norte	5368099.31	2237803.619
Los Alelies	Casanare	Paz De Ariporo	5126443.823	2206963.74
El Rubi	Casanare	Paz De Ariporo	5298733.812	2219630.46
Las Tres Palmas	Arauca	Cravo Norte	5292533.511	2276336.286
El Refugio	Arauca	Arauca	5281347.328	2332129.121
Las Violetas	Arauca	Cravo Norte	5285883.329	2269108.831
La Sonrisa	Arauca	Cravo Norte	5276079.094	2285123.831
La Carolita	Arauca	Arauca	5335114.883	2305817.49
Santa Rosa	Arauca	Arauca	5286054.573	2321674.475
Acaricuara	Arauca	Arauca	5280603.369	2331861.454
Buenos Aires	Arauca	Cravo Norte	5286737.448	2280660.16
Playa Blanca	Arauca	Cravo Norte	5283672.898	2268509.309

Property Name	Department	Municipality	X Cord	Y Cord
La Estaca	Arauca	Cravo Norte	5316161.779	2272844.483
Las Queseras	Arauca	Arauca	5257301.568	2282912.604
Cruz De Amor	Arauca	Arauca	5256940.874	2283405.562
Brazuca	Arauca	Arauca	5256508.426	2283802.664
La Estación	Casanare	Hato Corozal	5157172.44	2206299.537
Los Aceites	Arauca	Cravo Norte	5329487.435	2248552.43
La Regalia	Arauca	Cravo Norte	5332003.212	2257680.945
Guadalupe	Arauca	Arauca	5281420.783	2331226.169
Indostan	Arauca	Cravo Norte	5280295.022	2271780.391
El Eden	Arauca	Cravo Norte	5276741.572	2274224.572
La Guafilla	Casanare	Hato Corozal	5257693.745	2242949.177
La Esperanza	Arauca	Cravo Norte	5326645.528	2257566.746
Portugal	Arauca	Cravo Norte	5326402.485	2248687.988
Los Aceites	Arauca	Cravo Norte	5317189.303	2277376.495
Las Pinedas	Casanare	Paz De Ariporo	5298686.177	2224998.594
Las Morochas	Casanare	Paz De Ariporo	5299906.421	2230034.855
El Rincon	Casanare	Paz De Ariporo	5299415.167	2223369.377
Hato Viejo	Casanare	Paz De Ariporo	5306321.422	2223104.36
Los Claveles	Arauca	Arauca	5259436.999	2296725.389
Santa Catalina	Casanare	Paz De Ariporo	5305492.01	2222045.77
La Aurora	Arauca	Cravo Norte	5330036.765	2258538.147
Marbella	Arauca	Cravo Norte	5278441.53	2271808.375
Los Matapalos	Casanare	Hato Corozal	5262172.281	2243610.344
Barquereña	Arauca	Arauca	5221751.386	2313290.159
Hasta Que Dios Quiera	Arauca	Cravo Norte	5288842.954	2276786.641
El Yagual	Casanare	Paz De Ariporo	5302912.067	2225306.426
Capanaparo	Arauca	Arauca	5330264.012	2306163.552
El Edem	Arauca	Cravo Norte	5283450.445	2270741.462
Hato Nuevo	Casanare	Paz De Ariporo	5308599.533	2224824.238
Las Piñas	Arauca	Arauca	5274135.779	2285749.237
La Guanipera	Arauca	Arauca	5283482.289	2331474.402
El Miedo	Arauca	Cravo Norte	5331074.095	2268382.645
Genesaret	Arauca	Arauca	5256165.827	2317397.965
Casa Blanca	Arauca	Arauca	5279861.517	2293764.27

Source: Sahbio Carbono, 2024

Figure 3-1 shows the property boundaries within the map of the reference area. These properties participated in carbon credit initiatives for natural savannas, wetlands, and the REDD+ program. The eligibility section identifies the areas that qualify for natural savannas and forests.

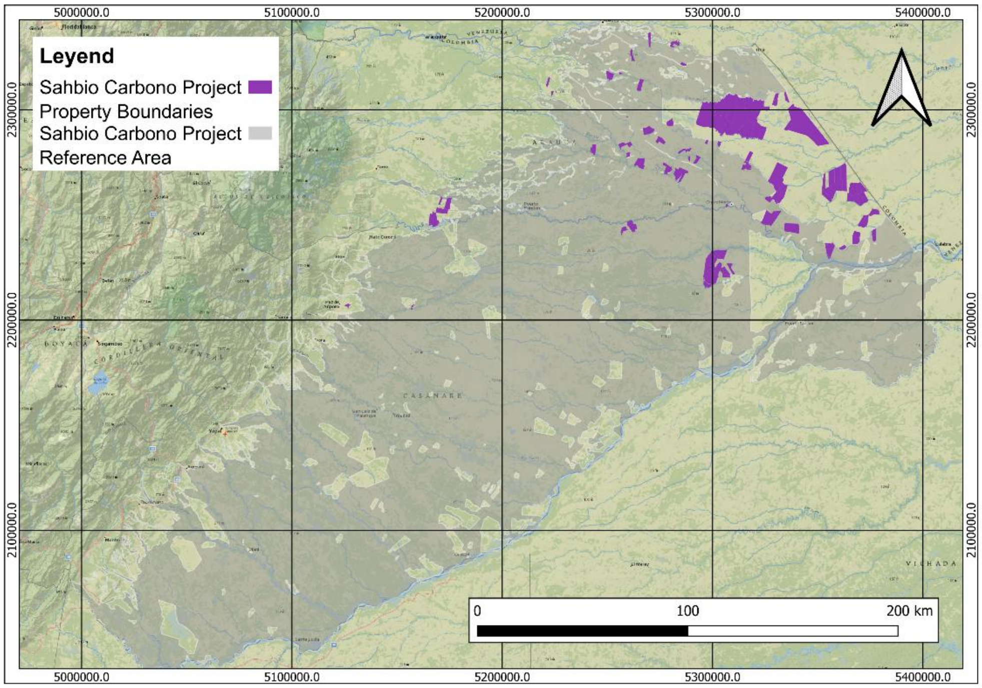

Figure 3-1. Spatial boundaries of the project SAHBIO Carbono. Location of properties and reference area for GHE emissions/Removals accounting. Coordinates are in Magna Sirgas – Origen Nacional.

Source: Sahbio Carbono, 2024

3.2.2 Carbon reservoirs and GHG sources

We identified the GHG sources and reservoirs relevant to the project by considering the carbon pools and emission sources outlined in the applied methodologies within the project scope (See Table 3-4).

Table 3-4. GHG sources and reservoirs relevant to the Project SAHBIO Carbono

Source or reservoir	GHG	Included (Yes/No/Optional)	Justification
Above ground Biomass	CO_2	Yes	Carbon is stored in living aboveground biomass, and CO2 emissions are accounted for when biomass is lost due to deforestation or degradation, as well as changes in the vegetation cover of Natural Savannas.
	CH_4	No	CH4 is typically not significantly emitted from aboveground biomass under most conditions in forest and natural savannas carbon projects.
	N_2O	No	N2O is not typically released from aboveground biomass.

Source or reservoir	GHG	Included (Yes/No/Optional)	Justification
Belowground Biomass	CO_2	No	Carbon is stored in roots and other belowground biomass, with CO2 emissions released when forests and Natural Savannas are cleared or degraded.
	CH_4	No	CH4 emissions from belowground biomass are generally not relevant unless there is a specific condition that enhances methane production
	N_2O	No	N2O emissions are unlikely from belowground biomass under typical conditions in the forest and Natural Savannas carbon projects.
Litter	CO_2	Yes	Carbon stored in litter is released as CO2 when it decomposes.
	CH_4	No	CH4 emissions are not typically significant from litter decomposition unless in waterlogged, anaerobic conditions.
	N_2O	No	N2O emissions from litter are generally minimal unless specific conditions lead to enhanced denitrification processes.
Soil Organic Carbon	CO_2	Yes	Soil stores organic carbon, which can be emitted when soil is disturbed or degraded.
Burning of woody biomass	CO_2	No	Based on standard methodologies, CO2 emissions from burning biomass are typically excluded because they result from deforestation, which is accounted for elsewhere.
	*CH_4	Yes	Burning biomass of woody species, incomplete combustion, releases methane, which must be accounted for.
	*N_2O	Yes	N2O emissions can occur from burning woody biomass, particularly during high-temperature fires.

**These GHG emission sources will be part of the Reed+ program*

Source: Sahbio Carbono, 2024

3.2.3 Time limits and analysis periods

The project began on January 01, 2021, with a 40-year timeline that will conclude on December 31, 2060.

3.2.3.1 Project start date

The project's start date is January 01, 2021, marking the beginning of GHG project activities. For GHG removal projects, this date corresponds to when actions related to the project's implementation began, following Section 10.4 of the BCR Standard. In the case of REDD+ activities, this is the date when the project holder began implementing activities to reduce emissions from deforestation and forest degradation. Moreover, In the case of Natural Savanna's activities, this is the date on which the project holder began implementing activities to reduce emissions from land use change.

3.2.3.1.1 Methodology for Identifying and Validating Conservation Activities

We carried out the identification of conservation activities implemented in the last years on the properties through the following steps:

- Characterization Survey

The property owners completed a socioeconomic, environmental, and cultural characterization survey (Appendix: Interviews). This survey facilitated the documentation of conservation activities to determine the project's start date.

- Individual Validation with Owners

Following the initial data collection, individual validation sessions were held with each owner. We reviewed and confirmed the reported conservation activities during this process, ensuring their accuracy and consistency.

- Evidence Collection

We asked the owners to provide documentation to support the identified conservation activities, such as invoices for materials and machinery purchases, maintenance records, certificates of conservation agreements, contracts, payment receipts for personnel hired for these activities, and photographic records.

- Verification of Evidence

The submitted evidence was meticulously verified to ensure its authenticity and relevance to the reported conservation activities.

- Determination of Start Dates

Based on the validated evidence, we established start dates for each conservation activity undertaken by each owner. This procedure allowed for determining the timing and retroactivity of these actions within the project's framework.

These elements help establish a start date that reflects when the project began, generating positive impacts in terms of GHG emission reductions that align with the criteria of the BioCarbon Registry standard[24].

3.2.3.1.2 <u>Information to Establish the Project Start Date</u>

In recent years, various organizations have promoted conservation initiatives in Colombia's Orinoquía region, focusing on protecting wetlands, savannas, and forests. Some of these initiatives were connected to agricultural and livestock production without altering ecosystems. Several properties involved in the SAHBIO Carbono Project have directly participated in or are aligned with these principles.

For instance, Fundación Horizonte Verde has implemented regional conservation strategies, including identifying priority areas and promoting voluntary civil society natural reserves[25]. Similarly, WWF Colombia has contributed to projects like GEF Orinoquía, launched in September 2021, to promote sustainable regional development and ecosystem management[26]. Additionally, USAID, through its Natural Wealth Program, focused on preserving grasslands and freshwater ecosystems to protect biodiversity[27]. These efforts have involved government entities such as Corporinoquía and National Parks and private entities like chambers of commerce and livestock associations.

Despite these initiatives, landowners have expressed concerns about insufficient long-term resources to implement and sustain such programs. They also lack the capital to conduct in-depth studies and systematically measure carbon emission reductions or ecosystem conservation gains. This limitation has hindered their access to additional income sources, such as payments for ecosystem services (PES). As a result, landowners' participation has been limited, often constrained by economic challenges.

Given this context, farmers in the region have expressed interest in developing a unified conservation program involving significant protected areas. The goal is to

[24] Biocarbon credi, *Estándar V3.4*, p 18.
[25] Fundación Horizonte Verde. Planeación climáticamente inteligente en sabanas, a través de la Incidencia Política, Ordenamiento y Buenas Prácticas- Sulu 2. Convenio WWF y Fundación Horizonte Verde. 2019. https://horizonteverde.org.co/convenio-wwf-y-fundacion-horizonte-verde/ (consulted 10/01/2025).
[26] WWF. Una apuesta por conservar la Orinoquia. 2021. https://www.wwf.org.co/?369450/Una-apuesta-por-conservar-la-Orinoquia (consulted 10/01/2025).
[27] The United States Agency for International Development (USAID). Natural Wealth Program, Final Report, 2017-2022. Washington D.C. 2022 pp 83.

collaborate with experts with technical knowledge and financial resources to establish a carbon credit project based on forest, wetland, and savanna conservation.

In response, during the second half of 2020, several landowners approached the manager of the FORE Capital Fund to secure resources for launching a carbon credit project[28]. FORE is Colombia's first private equity fund, regulated by the Financial Superintendence and dedicated to supporting carbon credit initiatives. Its mission is to combat climate change by investing in projects that reduce GHG emissions and fostering a transparent, independent, and professional emissions reduction market.

As part of this effort, SAHBIO Carbono initiated its activities in January 2021, including project outreach, technical studies, conservation strategy development, and monitoring program design. These efforts aimed to measure and certify carbon emission reductions in an organized manner, adhering to international standards. The Project also facilitated collaboration among landowners with shared conservation goals who lacked the cohesion and knowledge to advance in developing such a large-scale project.

Since FORE's investment period has concluded, SAHBIO Carbono has secured additional funding to finalize the project's structuring. As a carbon expert, the Project has organized and documented sustainable practices according to international standards, leveraging the methodology outlined by the BioCarbon Registry (BCR). This approach quantified and validated the benefits of these practices regarding carbon sequestration, enhancing their integration into emerging carbon credit markets.

3.2.3.2 Quantification period of GHG emission reductions/removals

The project began on January 01, 2021, with a 40-year timeline that will conclude on December 31, 2060. 3.

3.2.3.3 Monitoring periods

The project will conduct periodic monitoring processes to align with relevant methodologies and the BCR Standard, ensuring consistent and timely assessments of outcomes such as GHG emission reductions and other environmental impacts. Each monitoring period will follow a structured protocol to facilitate reliable data collection and reporting that meets all standard requirements throughout the project's duration. The accreditation period spans from January 01, 2021, to December 31, 2060.

[28] Visso. FORE | Fondo Mercado Reducción de Emisiones. Visso. 2021 https://vissogp.com/es/fore (consulted 10/01/2025).

3.3 Identification and description of the baseline or reference scenario

We applied the BCR guidelines for baseline and additionality V1.3 (2024) [29]. We considered the following criteria to determine the geographical boundaries of the reference area (See Table 3-5). We chose 4,574,109.54 ha in the reference area, in which the project areas are included in the reference area.

Table 3-5. Criteria to determine the geographical boundaries of the reference region of the Sahbio Carbono Project

[29] BIOCARBON CERT©. Biocarbon guidelines. Baseline and additionality. BCR projects generate verified carbon credits (VCC) that represent emissions reductions, avoidance, or removals that are additional.2024 p 11.

Condition	Answer
Ecoregional Consistency	The reference region and project area belong to the same ecoregion based on Map of Continental, Coastal, and Marine Ecosystems of Colombia, version 2.1, scale 1:100,000[30]. This selection ensures similar ecological characteristics, facilitating effective management and conservation strategies. The project focuses on the Orinoco region of Colombia, particularly within the Arauca and Casanare departments, encompassing the hyper-seasonal flooded savannas of the ecoregion. This area includes biomes such as the Helobiome, Peinobiome, and Hydrobiome, all located within the Arauca, Bita, and Casanare River basins[31]. Most project sites fall within the Helobiome, a region known for frequent flooding. This area consists of poorly drained regions that often-become swamps and wetlands, with vegetation dominated by tall palms like Moriches (*Mauritia flexuosa*). The ecological gradient in the area ranges from aquatic plants near water bodies to forests along floodplains. The Peinobiome represents the hyper-seasonal savannas of the Orinoquia, which exhibit unique environmental conditions and vegetation adapted to periodic flooding. These savannas are critical to Colombia's biodiversity, featuring rolling topography that creates diverse microclimates, supporting a wide range of flora and fauna. The region's soil generally possesses bad physical properties and is low in nutrients due to poor organic matter and nutrient content. Soils here are highly acidic, deficient in calcium, and often contain toxic levels of aluminum. The Orinoquia, the Eastern Plains, accounts for 31.7% of Colombia's floodplains, covering approximately 1.5 million hectares of wetlands and 33.4% of the country's water reserves. Significant rivers include the Meta, Arauca, Casanare, and Bita.

[30] **WWF (World Wide Fund for Nature)**, *Ecorregiones Terrestres del Mundo*, Washington D.C.: WWF, 2001.
[31] IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales), Mapa de Ecosistemas Continentales, Costeros y Marinos de Colombia, versión 2.1, escala 1:100.000, Bogotá: IDEAM, 2017.

Condition	Answer
Land Use Change Drivers	The reference region has experienced significant land-use changes and deforestation, primarily driven by livestock farming and agricultural expansion. Extensive cattle ranching, deeply rooted in Llanero culture, has led to widespread deforestation as grazing areas expand. In recent years, industrial crops such as oil palm and rice have further accelerated land conversion, supported by government policies promoting agribusiness. Economic shifts, particularly the 2014 oil price collapse, redirected regional development toward agriculture and livestock, though conservation initiatives like ecotourism have gained traction. Between 2008 and 2018, the region lost 181,211 hectares of natural forest, with pasture expansion, forest degradation, and agricultural conversion being the main contributors.
Stakeholder Interest	The stakeholders in the reference area are the owners of the farms participating in the project, the mayors' offices of the municipalities involved in the project, Corporinoquía, the Ministry of Environment and Sustainable Development, National Natural Parks, and NGOs present in the reference area, such as the World Wildlife Fund (WWF), The Nature Conservancy, the Orinoquia Biodiverse Foundation (FOB), among other.
Land Tenure and Usage Rights	Land tenure systems and usage rights in the reference region closely resemble the project area, as legal similarities can influence conservation practices and resource management strategies.
Exclusion of Special Management Areas	The reference region does not include areas designated for special management or those already encompassed within the geographical boundaries of other greenhouse gas (GHG) projects. This exclusion prevents overlaps that could complicate management efforts. We generated the shape presented using the intersection and clip as geoprocessing tools in the software QGis V 3.41[32]. The reference area or baseline of the SAHBIO Carbono project does not include areas from other carbon credit projects (CO2Bio, CO2Bio2, CultivO2, OrinoCO2; RENARE, 2024)[33], nor Indigenous reservations (Agencia Nacional de Tierras, 2024)[34] or areas from the national

[32] QGIS Development Team, QGIS: Open-Source Geographic Information System, disponible en: https://qgis.org/ (consulted 20/09/2023).
[33] Ministerio de Ambiente y Desarrollo Sostenible, RENARE: Registro Nacional de Reducción de Emisiones, Bogotá: MADS, 2024
[34] Agencia Nacional de Tierras, "Constitución de Resguardo Indígena", In: https://apps.ant.gov.co/BARRIDO_PREDIAL/3-4-5-constitucion-de-resguardo-indigena/ (consulted 11/11/2024).

Condition	Answer
	single registry of protected areas (Parques Nacionales Naturales, 2024[35]; See Figure 3 2).

Source: Sahbio Carbono, 2024

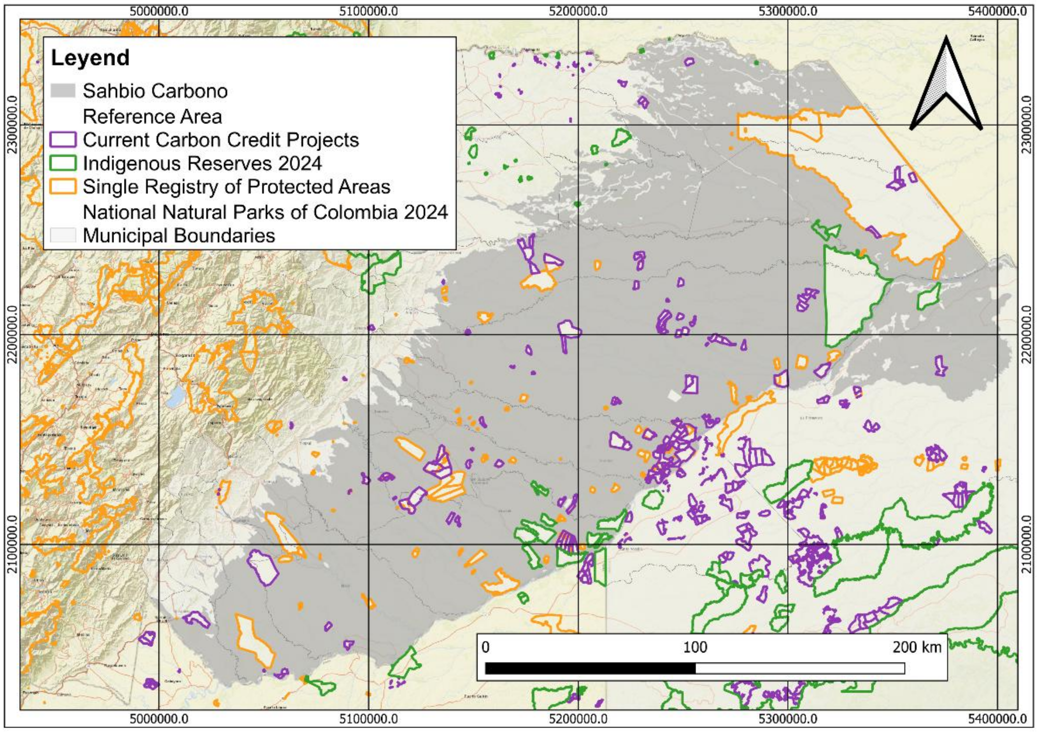

Figure 3-2. Reference areas do not include areas designated for special management or those already encompassed within the geographical boundaries of other greenhouse gas (GHG) projects.

Source: Sahbio Carbono, 2024

These criteria (Table 3-5) collectively ensure that our chosen boundaries reflect ecological, social, and legal realities, providing a robust regional planning and environmental management framework. Integrating these aspects can enhance our understanding of ecological interactions and improve project implementation and sustainability. This reference area is part of the Redd+ and the Savannas project.

[35] Parques Nacionales Naturales de Colombia, Registro Único Nacional de Áreas Protegidas (RUNAP), disponible en: https://runap.parquesnacionales.gov.co (consultado el 11/11/2024).

3.3.1 Quantification baseline scenario

3.3.1.1 Methodology

To quantify land use change in the reference area in the Orinoquia region of Colombia between 2008 and 2018, we analyzed the country's official CORINE Land Cover (CLC) maps for those years[36] [37]. These maps, developed by the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM; published in 2010 and 2020), provide detailed classifications of land cover types and their changes over time on a scale of 1:100,000.

We began by defining the boundaries of the reference region in the Orinoquia region. We obtained the CLC datasets for 2008 and 2018 from IDEAM and reprojected them to a consistent coordinate system (MAGNA SIRGAS - Origen Nacional: 9377). This step ensured uniform spatial resolution, which is crucial for accurate comparisons. We classified land cover into relevant categories: forests, savannas, wetlands, agriculture, and infrastructure areas. This classification enabled us to track transitions between natural and modified landscapes effectively.

Using Geographic Information Systems (GIS) software (ArcGIS and QGis, 2024), we compared the 2008 and 2018 maps pixel-by-pixel to detect changes in land cover types. Over this decade, we identified areas where land use had changed by overlaying these datasets. We calculated the total area (in hectares) gained or lost for each land cover type to quantify these changes. This analysis allowed us to assess deforestation patterns, agricultural expansion, wetland reduction, and other significant transitions.

We categorized the transitions into distinct types—forest-to-agriculture or savanna-to-urban—and calculated the percentage change for each category. Our results were summarized in tables and visualized through land cover change maps, highlighting regional transformation hotspots.

Finally, we analyzed these changes in the context of regional development trends, agricultural expansion, and conservation efforts.

[36] IDEAM–Instituto de Hidrología Meteorología y Estudios Ambientales. Leyenda Nacional de Coberturas de la Tierra. Metodología CORINE Land Cover Adaptada para Colombia. Escala 1:100.000., Bogotá, D.C. 2010.

[37] Castellanos, H., Gómez, W. F. y Mayorga, N. Mapa nacional de coberturas de la tierra, escala 1:100.000, periodo 2018. Metodología Corine Land Cover adaptada para Colombia. Memoria técnica y resultados. Instituto de Hidrología, Meteorología y Estudios Ambientales (Ideam). Bogotá, D. C., Colombia 2021.

3.3.1.2 *Results*

3.3.1.2.1 Natural Savannas

3.3.1.2.1.1 Land-Use Change in the Flooded Natural Savannas of Arauca and Casanare

The reference area, including the flooded natural savannas of Arauca and Casanare, is undergoing significant land-use changes driven by livestock farming, agricultural expansion, and economic policies[38]. These changes have implications for the region's ecosystems and biodiversity[39]

Livestock Farming as a Driver of Land-Use Change

Livestock farming has been a central force in shaping land use in the Reference area. This activity has led to land concentration, soil overexploitation, and low rural population density[40]. Historically, cattle ranching is embedded in Llanero culture, tracing its origins to Jesuit missions in the Eastern Plains[41].

Despite its cultural significance, extensive cattle ranching contributes to deforestation and threatens the region's valuable forest resources[42]. The main cause of land-use change in the reference area is the expansion of cattle grazing areas[43]. About 15.9% of all land in the Orinoquía region is suitable for livestock production[44].

Expansion of the Agricultural Frontier

While livestock farming has long dominated the region, agricultural expansion is a recent land-use change driver[45]. In recent years, large-scale industrial crops, including

[38] BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL). Orinoquía Sustainable Integrated Landscape Program. in: https://www.biocarbonfund-isfl.org/programs/orinoquia-sustainable-integrated-landscape-program. consulted 12/09/2024.

[39] Science for Nature and People Partnership (SNAPP), Land Use Change in the Orinoquía, in: https://snappartnership.net/teams/land-use-change-in-the-orinoquia/ (consulted 12/09*/2024).

[40] BioCarbon. Orinoquía Sustainable Integrated Landscape Program., p 48.

[41] Ibid, p 48

[42] Marin, A.; Montoya, A.; Molina, I.C.; Germer, L.A.; Ramirez Diaz, M.; Gomez, M.; Galindo, W.; Arango, J. Prioritizing climate-smart cattle farming practices and technologies for sustainable livestock production in Colombia's Orinoquia region. Poster prepared for Tropentag 2023 - Competing pathways for equitable food systems transformation: trade-offs and synergies 2023. Berlin, Germany, 20-22 September 2023. Cali (Colombia): International Center for Tropical Agriculture. 1 p.

[43] BioCarbon. Orinoquía Sustainable Integrated Landscape Program., p 48.

[44] González-Orozco CE, Diaz-Giraldo RA and Rodriguez-Castañeda C. An early warning for better planning of agricultural expansion and biodiversity conservation in the Orinoco high plains of Colombia. Front. Sustain. Food Syst. 2023. 7:1192054. doi: 10.3389/fsufs.2023.1192054.

[45] BioCarbon. Orinoquía Sustainable Integrated Landscape Program., p 48.

oil palm, soy, and rice, have expanded across the Orinoquía[46]. The plantation area of palm oil has increased the most compared with other plantations and agricultural commodities.[47]

Agricultural Production and Economic Policies

By 2016, the Orinoquía region contributed 28% of Colombia's total agricultural production[48]. Government policies have actively promoted agricultural expansion in the region.

Economic Shifts and the Role of Conservation

The 2014 drop in oil prices triggered an economic crisis in Arauca, Casanare, and Meta, departments historically reliant on hydrocarbons[49]. This crisis influenced departmental development plans, emphasizing agriculture and livestock as the primary economic sectors[50]. Recently, nature-based conservation initiatives have gained traction as an alternative economic strategy. Ecotourism and conservation-driven land use are now considered viable economic activities, reflecting a growing recognition of sustainable development opportunities in the flooded savannas of Arauca and Casanare. Mitigation and adaptation to climate change in Orinoquia are key to developing a low-carbon agricultural production and land use economy.

3.3.1.2.1.2 Spatial Patterns and Impact of Transformation in the Flooded Natural Savannas of Arauca and Casanare (Multitemporal Analysis: 2008–2018)

Between 2008 and 2018, the flooded and non-flooded natural savannas of Arauca and Casanare in the reference area underwent significant transformations, primarily driven by agricultural expansion, cattle ranching, and infrastructure development. The expansion of industrial crops such as oil palm, soy, and rice led to the conversion of vast areas of natural savannas into croplands. Additionally, the intensification of cattle grazing contributed to deforestation, changed land use, and soil degradation, while the construction of roads and

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[46] BioCarbon. Orinoquía Sustainable Integrated Landscape Program., p 48.

[47] Ibid, p 48

[48] Gonzalez-Orozco, An early warning for better planning of agricultural expansion and biodiversity conservation in the Orinoco high plains of Colombia, p 48

[49] BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL), Driving Change: Private Sector Boosts Sustainable Agriculture in Colombia's Orinoquía, in: https://www.biocarbonfund-isfl.org/result-stories/driving-change-private-sector-boosts-sustainable-agriculture-colombias-orinoquia (consulted el 12/09/2025).

[50] Ibid, p 49

transportation networks facilitated access to previously remote areas, accelerating land conversion.

To quantify these changes, we conducted a multitemporal analysis, comparing the extent of natural savannas in 2008 and 2018. In 2008, the region contained **3,397,060.66** hectares of natural savannas, but by 2018, this area had decreased to **2,563,000.87** hectares, resulting in a gross loss of **834,059.79** hectares over ten years. This decline represents an annual loss rate of 2.45%, underscoring the rapid transformation of these ecosystems.

3.3.1.2.1.3 *Drivers of land-use change*

Of the **834,059.79** hectares lost, **220,691.43** hectares were converted to other natural land covers, while the remaining **613,368.36** hectares were transformed into non-natural land covers. The most significant portion was converted into introduced pasture grasses for cattle ranching, followed by herbaceous and tree crops. The remaining hectares were converted into secondary vegetation and infrastructure developments. These changes highlight a significant shift from natural savannas to agricultural and infrastructural uses (Table 3-6).

Table 3-6. Hectares of Natural Savannas Lost between 2008 and 2018 Converted Areas in Hectares and Percentages

Land cover category	Area (ha)	Percentage (%)
Converted to Other Natural Land Covers	220,691.43	26.46
Converted to Non-Natural Land Covers	613,368.36	73.54
Non-Natural Land Covers:		
Continuous urban fabric	136.20	0.02
Discontinuous urban fabric	159.62	0.02
Industrial or commercial areas	158.27	0.02
Airports	16.20	0.00
Mining extraction areas	106.47	0.01
Urban green areas	0.07	0.00
Other temporary crops	13,408.47	1.61
Cereals	65,676.78	7.87
Permanent herbaceous crops	666.54	0.08
Permanent tree crops	32,592.07	3.91
Clean pastures	316,881.81	37.99
Tree-covered pastures	2,127.39	0.26
Overgrown pastures	26,516.72	3.18
Crop mosaic	4,024.17	0.48
Pasture and crop mosaic	39,673.18	4.76

Land cover category	Area (ha)	Percentage (%)
Mosaic of crops, pastures, and natural spaces	7,770.38	0.93
Pasture mosaic with natural spaces	78,379.07	9.40
Crop mosaic with natural spaces	116.53	0.01
Forest plantation	2,382.22	0.29
Secondary or transitional vegetation	22,534.91	2.70
Artificial water bodies	41.30	0.00
Total Land Lost	**834,059.79**	**100.00**

Source: Sahbio Carbono, 2024

The socioeconomic landscape of the region complicates effective land-use planning. Factors such as weak land tenure security, inadequate governance, and insufficient infrastructure hinder the development of robust policies. Farmers and agribusinesses often prioritize short-term economic gains from agriculture over sustainable and conservation practices, exacerbating environmental degradation[51]. While some government policies promote sustainability and conservation, inconsistent enforcement and limited resources undermine these efforts[52]. Environmental NGOs strive to advocate for a balanced approach that harmonizes development with conservation, seeking sustainable conservation practices that benefit both ecosystems and local communities[53] [54].

The primary economic activities in the reference area —livestock (Figure 3-3), farming, and agriculture (Figure 3-4)—come at a considerable ecological cost. Converting natural flooded and non-flooded savannas into monoculture systems results in significant biodiversity loss and disrupts essential ecosystem services such as pollination and habitat provision[55]. The recent expansion of overgrazing and intensive farming practices has

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[51] ISFL (Iniciativa de Fondos para Bosques y Paisajes Sostenibles), Colombia partners with World Bank Group and agribusinesses to scale up climate-smart agriculture, disponible en: https://www.biocarbonfund-isfl.org/result-stories/colombia-partners-world-bank-group-and-agribusinesses-scale-climate-smart (consulted 09/09/2024).

[52] Parques Nacionales Naturales de Colombia, La Orinoquía colombiana busca el establecimiento de áreas de conservación ambiental: https://old.parquesnacionales.gov.co/portal/en/la-orinoquia-colombiana-busca-el-establecimiento-de-areas-de-conservacion-ambiental/ (consulted 09/09/2024).

[53] **Alliance Bioversity-CIAT**, *Development and Conservation Go Hand in Hand in Colombia's Orinoquía Region*, disponible en: https://alliancebioversityciat.org/stories/development-conservation-go-hand-hand-colombias-orinoquia-region (consulted 09/09/2024)

[54] González-Orozco. An early warning for better planning of agricultural expansion and biodiversity conservation in the Orinoco high plains of Colombia. P 49.

[55] Foley, Jonathan A., Ruth DeFries, Gregory P. Asner, Carol Barford, Gordon Bonan, Stephen R. Carpenter, F. Stuart Chapin, Michael T. Coe, Gretchen C. Daily, Holly K. Gibbs, Joseph H. Helkowski, Tracey Holloway, Erica A. Howard, Christopher J. Kucharik, Chad Monfreda, Jonathan A. Patz, I. Colin Prentice, Navin Ramankutty, and Peter K. Snyder Global Consequences of Land Use. Science 309,570-574 (2005).

severely degraded soil in the flooded savannas, particularly in Arauca and Casanare. These practices lead to soil compaction, diminishing the soil's capacity to retain water and nutrients while accelerating erosion and reducing fertility. The loss of organic matter further diminishes the soil's ability to support diverse plant and animal life, fostering conditions that favor invasive species. Moreover, intensive farming disrupts natural hydrological cycles by altering seasonal flooding patterns through drainage and irrigation systems. This disruption harms wetlands and impairs groundwater recharge, a critical process for sustaining these ecosystems[56]. The ecological consequences extend beyond soil health—overgrazing and monoculture farming fragment habitats, leading to declining biodiversity and threatening wildlife reliant on native vegetation. Poor irrigation practices have also resulted in soil salinization in certain areas, further diminishing agricultural productivity while increasing the risk of desertification. As soils degrade, they release stored carbon into the atmosphere, exacerbating climate change[57].

3.3.1.2.1.4 Agents

The key agents driving land-use change in the reference area fall into three main categories: industrial and traditional agricultural producers (for both consumption and sale), agents formally associated with oil pipelines, and, to a lesser extent, expanding rural and urban populations, particularly in the eastern foothills of the Eastern Cordillera[58].

Underlying socio-economic and cultural factors influence these agents, including regional traditions, migration patterns, and economic opportunities. Many migrants come from regions historically dedicated to rice cultivation, while others arrive as laborers for the oil industry or palm oil plantations, primarily from the Pacific coast. Their activities are largely driven by the need to improve living conditions and the political and economic influence of cattle ranching and agriculture. Additionally, a generalized perception of the reference area as a single, uniform ecosystem, particularly the Floodplain of Orinoquia Region, reinforces its appeal for large-scale agricultural production due to

[56] Rupngam, T., & Messiga, A. J. Unraveling the Interactions between Flooding Dynamics and Agricultural Productivity in a Changing Climate. Sustainability, 16(14), 6141. 2024

[57] Edwards FA, Edwards DP, Sloan S, Hamer KC. Sustainable Management in Crop Monocultures: The Impact of Retaining Forest on Oil Palm Yield. PLoS ONE 9(3): e91695. 2014.

[58] BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL), Orinoquía Sustainable Integrated Landscape Program, disponible in: https://www.biocarbonfund-isfl.org/programs/orinoquia-sustainable-integrated-landscape-program (consulted 09/09/2024).

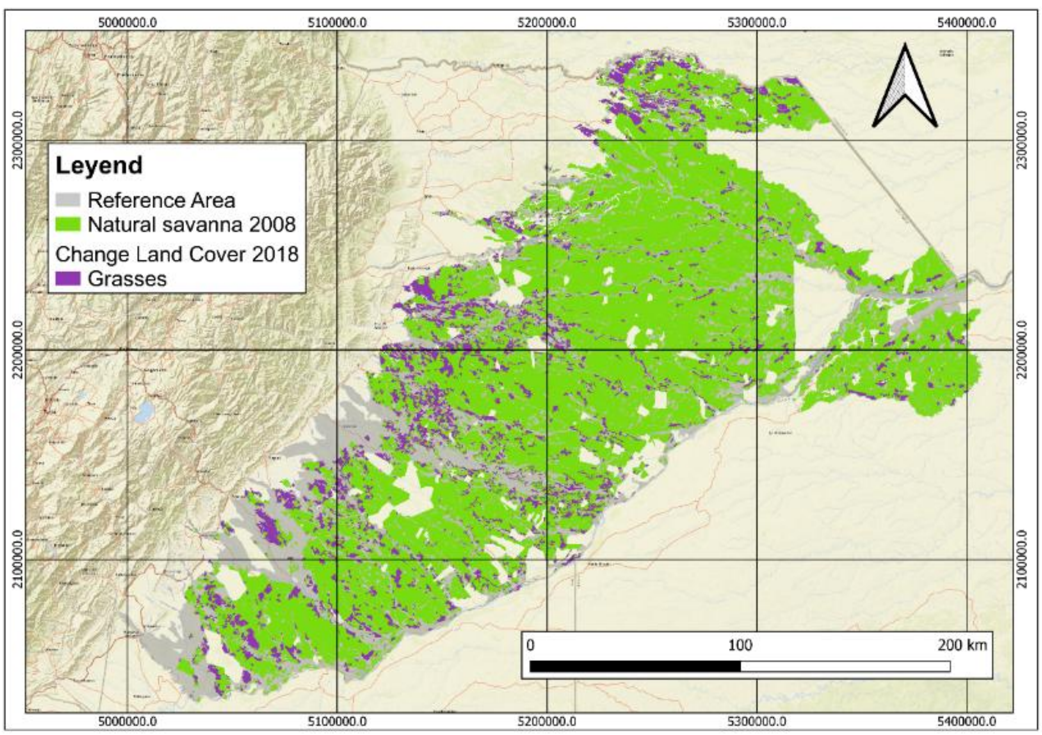

Figure 3-3. The percentage of Natural Savanna transformed in 2018 by human activities that correspond to clean pastures used for intensive livestock farming

Source Sahbio Carbono, 2024

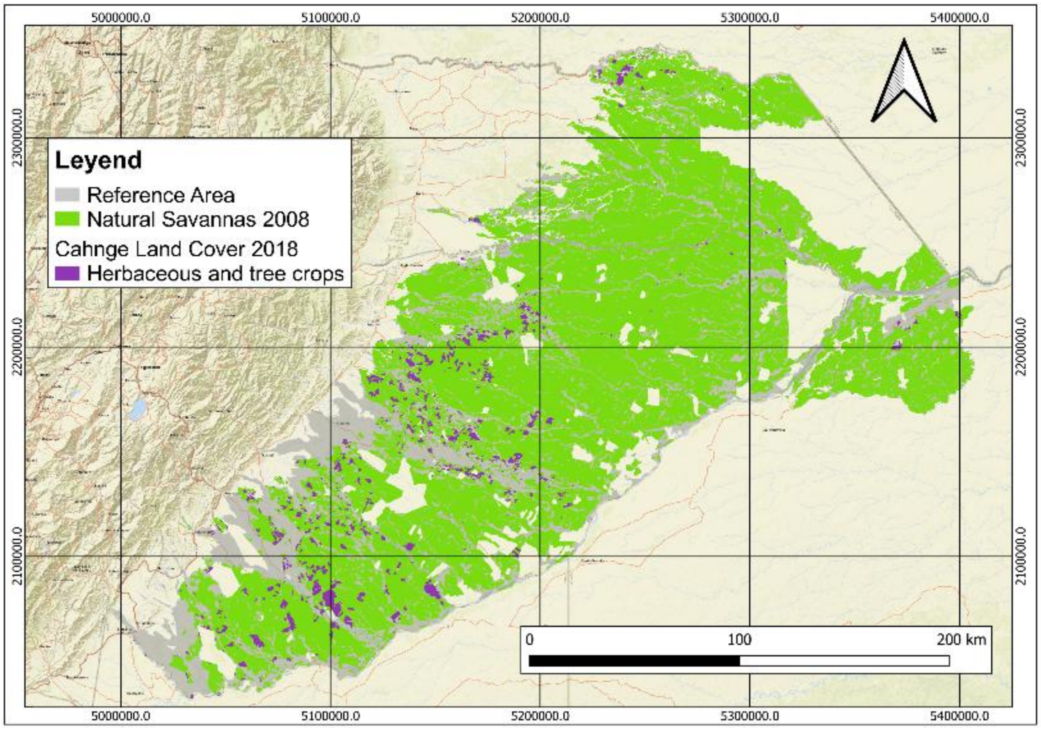

Figure 3-4. The percentage of Natural Savannas transformed in 2018 by human activities that correspond to herbaceous and tree crops, including rice crops

Source Sahbio Carbono, 2024

Its perceived advantages for farming[59].

3.3.1.2.1.5 Causal chain

The causal chain of events serves as a tool to illustrate the processes leading to land-use change, highlighting the drivers, responsible agents, and underlying factors that contribute to the transformation of the territory. In the flooded natural savannas of the project's reference region, these changes occur within two major strata: natural herbaceous areas and wetlands, each containing different land covers that undergo modifications affecting the ecosystem's development.

We identified various anthropogenic activities as direct causes of land-use change in these ecosystems. These activities, along with the agents responsible and the underlying

[59] Vitar-Mendoza, J., Sandoval-Parra, K. y Ortiz-Moreno, M. Land-cover change in the department of Vichada, Colombia, from 1985 to 2017. Revista de Investigación Agraria y Ambiental, 2022. 13(1), 149 - 174. https://doi.org/10.22490/21456453.4630

motivations, are summarized in Table 3-7, which outlines the causal chain of events. This table establishes connections between direct causes, such as agriculture, cattle grazing, and infrastructure expansion, and their impacts on flooded savanna ecosystems. It also highlights the social, economic, and political drivers that contribute to these transformations, shedding light on the extent of the impact on the region's natural landscapes.

Table 3-7. The chain of events in land use change for the flooded natural savannas of the reference area

	Direct Activities	**Direct Causes or Anthropogenic Activities**		**Agents**	**Underlying Factors**	**Direct Impact**
Land use change in flooded natural savannas	**Expansion of the Agricultural Frontier**	1	Livestock Production	An industrial or traditional agricultural producer for consumption and/or sale	Socio-economic, cultural, political, and institutional factors	76.85% of the flooded natural savanna areas in the reference region were converted into clean pasture, wooded, or shrubby areas where livestock activities developed.
		2	Agricultural Production			Agricultural and agro-industrial activities account for 13.68% and 5.70% of the activities carried out in the region, leading to the transformation of the flooded natural savannas in the reference area.
	Expansion of Infrastructure	3	Infrastructure	Formal or informal construction of local, regional, and national roads	Socio-economic, cultural, demographic, political, and institutional factors	3.77% of the flooded natural savanna areas in the reference region were transformed into civil works. Although this impact is smaller than other anthropogenic activities, it still affects flooded savannas.

Source: Sahbio Carbono, 2024

3.3.1.2.2 <u>Redd+</u>

3.3.1.2.2.1 <u>Causes and agents of deforestation and degradation</u>

It is crucial to understand the anthropogenic dynamics in a given territory and their environmental impact. This study identifies the causes and agents responsible for historical deforestation and degradation in the project's reference area. The primary objective is to describe the factors contributing to forest cover loss and reducing carbon reserves in these areas. This analysis is essential for developing effective policies to mitigate ecosystem damage.

3.3.1.2.2.2 Spatial and temporal dimensions

The study defines spatial and temporal scope, covering 10 years before the project's start date (2008 - 2018). Secondary data sources were used to identify activities contributing to deforestation and forest degradation in the specified area.

3.3.1.2.2.3 Context

It is essential to consider the reference region's territorial, sociocultural, economic, and historical context to understand the causes and agents of deforestation in the Orinoquía region of Colombia, Arauca, and Casanare.

Territorial Context

The study area encompasses the departments of Casanare and Arauca, part of the Orinoquía region. These departments have a combined population of approximately 680,000 with a nearly even gender distribution (48% male and 52% female). A significant portion of the population (33%) resides in dispersed rural areas and small towns[60], [61]

Sociocultural Context

Before the Spanish conquest, various Indigenous groups inhabited the region, including the Mitua, Bare, Guayape, Guahibos, and Maipure peoples. Early European explorers, arriving from Venezuela, primarily traversed the Eastern Plains[62].

Today, the Reference region has a diverse population, including Indigenous communities, Afro-Colombians, and Llanero farmers[63]. Since the late 1960s, significant

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[60] Departamento Administrativo Nacional de Estadística (DANE). Infografía del Censo Nacional de Población y Vivienda 2018: Perfil departamental de Arauca. 2018. in: https://sitios.dane.gov.co/cnpv/app/views/informacion/perfiles/81_infografia.pdf (Consulted 12/11/2024).
[61] Departamento Administrativo Nacional de Estadística (DANE). Infografía del Censo Nacional de Población y Vivienda 2018: Perfil departamental de Casanare. 2018. in: https://sitios.dane.gov.co/cnpv/app/views/informacion/perfiles/81_infografia.pdf (Consulted 12/11/2024).
[62] Rozo López, Damaris. Deforestación en Colombia: "una verdadera guerra contra los mundos relacionales". [en línea]. Programa de Investigación de Política Exterior Colombiana (PIPEC), 2020 [consulted: 12/11/2024].
[63] Ibid, p 56

social transformations have occurred due to agricultural land redistribution by the Institute for Agrarian Reform (Incora). This policy altered traditional communal landownership, changing livestock management practices and the region's social organization[64].

The intensification of oil exploration and extraction in the 1980s promoted an economic model that favored productive technologies over traditional agricultural labor[65]. This shift spurred demographic changes, including population growth around oil fields, the influx of new economic actors, and rural-to-urban migration.

The presence of armed groups has further impacted land use and natural resource management, contributing to forced displacement towards urban centers[66]. Vegueros, a distinct rural group inhabiting riverbanks, practice slash-and-burn agriculture to cultivate crops such as maize, rice, beans, and plantainsduring the dry season. Extractive industries have reshaped Andean farming communities' economic and social dynamics in recent decades[67].

Economic Context

Between 2010 and 2016, the Orinoquía region experienced Colombia's highest GDP growth rate, averaging 5.4% annually, primarily driven by hydrocarbon extraction in Meta and Casanare[68]. This economic expansion contributed to a decline in monetary poverty, which reached 24.5% in 2016, the second lowest in the country after the Central region[69].

The mining and quarrying sector dominated the region's economic activity, accounting for 56.2% of the GDP in 2016, followed by agriculture, livestock, forestry, and fishing at 11.2%[70]. The region produces approximately 30% of Colombia's agricultural

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[64] Rozo López, Deforestación en Colombia p 56.
[65] BiCarbon, Orinoquía Sustainable Integrated Landscape Program, p xxx
[66] Earth.Org. Deforestation in Colombia: An Intricate Story of Conflict and Power. In: https://earth.org/deforestation-in-colombia/ (consulted el 12/11/2024).
[67] Movimiento Mundial por los Bosques Tropicales (WRM), La región de la Orinoquía en Colombia: Entre el olvido, el extractivismo y una reserva agrícola, in: https://www.wrm.org.uy/bulletin-articles/the-orinoquia-region-of-colombia-between-oblivion-extractivism-and-an-agricultural-reserve (consulted 12/11/2024)
[68] BiCarbon, Orinoquía Sustainable Integrated Landscape Program, p xxx
[69] Ibid, p 57
[70] Ibid, p 57

goods. However, challenges such as land tenure informality, inadequate infrastructure, and limited access to financing hinder its full agricultural potential[71].

Historical Context

The region's historical background, which has shaped its current socio-economic landscape, can be summarized in five key stages[72]:

- Indigenous Settlement: Hunter-gatherer communities originally inhabited the Orinoquía region, practicing subsistence agriculture by growing maize, cassava, and other crops while supplementing their diet through hunting, fishing, and foraging.
- Cattle Ranching Colonization: Following the pre-Hispanic occupation, Spanish colonization, and urban expansion led to the development of large cattle ranches, shaping the region's social organization and economy. During the wars of independence, land was seized from Indigenous and mestizo communities and redistributed to settlers, reinforcing the dominance of large estates.
- Intensive Agricultural Expansion (Rice and Oil Palm): Rice cultivation dramatically altered ecosystems, particularly in specific geographic areas where intensive irrigation and land-use changes led to irreversible resource depletion1.
- Impact of Oil Exploration and Extraction Projects: Beginning in the 1980s, the "oil boom" significantly altered the landscape and socio-cultural identity of the region, particularly in the four departments within the study area1. This transformation is evident in the influx of people from other parts of the country, driven solely by interest in hydrocarbon resources, often disregarding the region's traditional Llanero culture.

3.3.1.2.2.4 Key Stakeholders, Interests, and Motivations in Deforestation and Forest Degradation in the Orinoquía Region

Deforestation and forest degradation in the reference area involve diverse stakeholders, including government entities, non-governmental organizations (NGOs), and civil society groups. These stakeholders can be categorized into those contributing to deforestation and degradation and those promoting forest conservation and sustainable practices. Several regional initiatives, such as the Colombia Tropical Forest Alliance TFA 2020, aim

[71] Alexander von Humboldt Institute (IAvH) and WWF. The Challenge of Deforestation in Colombia: Policy Brief. In: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://wwfeu.awsassets.panda.org/downloads/wwf_the_challenge_of_deforestation_in_colombia_preview_v02.pdf. (consulted 12/11/2024).

[72] Rozo López, Deforestación en Colombia p 56.

to promote agricultural, livestock, and forestry production with zero deforestation[73]. The BioCarbon Fund's Initiative for Sustainable Forest Landscapes (ISFL) also supports the Colombian government in engaging the private sector to achieve sustainable land use and reduce emissions[74].

The following describes the key stakeholders, their interests, and their motivations that influence decision-making:

- *Land Speculators and Large-Scale Landowners*: These actors acquire large land areas anticipating appreciation over time. They aim to rent or sell land for infrastructure projects, attract investments, or exploit natural resources.
- *Absent Investors as Indirect Agents*: These stakeholders convert forested areas into pasture for cattle ranching. After the production cycle, they often sell deforested land for agricultural expansion and new farming ventures.
- *Industrial and Traditional Agricultural Producers*: These producers cultivate commercial and subsistence crops, including oil palm, rice, soybeans, timber, cassava, and plantains, for personal consumption or sale[75].
- *Formal and Informal Road Builders*: Road construction at local, regional, and national levels improves mobility, reduces travel times, and increases access to remote areas, indirectly contributing to land-use change.
- *Pipeline Operators*: These operators install pipeline networks for transporting oil and its derivatives. Pipeline construction can cause erosion and degrade water quality.
- *Electric Grid Developers*: Whether formally or informally, these actors build and expand electrical transmission networks to connect energy providers with consumers. Landowners often grant passage for power lines.
- *Expanding Rural and Urban Populations*: Growing settlements require space and resources, leading to deforestation. The geographic location and infrastructure

[73] Banco Mundial. Colombia - Orinoquia Integrated Sustainable Landscapes Project. In: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/602251565575276312/Colombia-Orinoquia-Integrated-Sustainable-Landscapes-Project (consulted 12/11/2024).

[74] BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL). Driving Change: Private Sector Boosts Sustainable Agriculture in Colombia's Orinoquía. 20 de diciembre de 2024. In: https://www.biocarbonfund-isfl.org/result-stories/driving-change-private-sector-boosts-sustainable-agriculture-colombias-orinoquia (consulted 12/11/2024).

[75] The Nature Conservancy (TNC). Un pacto por el desarrollo sostenible de la Orinoquia colombiana y sus llanos orientales. 28 de julio de 2021. In: https://www.nature.org/es-us/sobre-tnc/donde-trabajamos/tnc-en-latinoamerica/colombia/pacto-desarrollo-sostenible-orinoquia-colombia-llanos-orientales/ (consulted 12/11/2024).

connectivity influence access to essential services and social protection, potentially straining public services.

- *Self-Consumption Timber Extractors*: These landowners harvest wood for on-farm use, such as fence construction, firewood, building materials, and ornamentation, sometimes without forestry permits.
- *Commercial Timber Extractors*: Engaged in timber extraction on varying scales, these actors may or may not operate with legal permits. Sustainable logging requires a forestry permit to ensure planned harvesting that minimizes harm to the ecosystem.
- *Agricultural Producers Practicing Controlled Burning*: These actors intentionally use fire as a land management tool. Properly planned and managed controlled burns with firebreaks can serve specific agricultural purposes. Poorly managed burns, however, can escalate into large-scale wildfires.

3.3.1.2.2.5 Economic Overview of Casanare and Arauca

Casanare

The department of Casanare contributes 1.4% to Colombia's national GDP despite its vast geographical area of 44,640 km², larger than countries like Switzerland. Various economic activities occur in this region, making it strategically vital for the nation. Casanare accounts for 20% of Colombia's hydrocarbon extraction, ranking as the country's second-largest oil producer with a daily output of 128,139 barrels[76].

In the livestock sector, Casanare ranks fourth nationally in cattle population, with 2,304,387 head of cattle, according to the latest bovine census by the Colombian Agricultural Institute (ICA)[77]. It is surpassed only by Antioquia, Córdoba, and Meta departments. Additionally, Casanare ranks fourth in palm oil cultivation, with 387,317 hectares planted. The department has also led Colombia in rice cultivation for several years, with 939,741.64 hectares planted in the first half of 2023, yielding 5,280,003.01 tons during the same period[78].

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[76] Agencia Nacional de Hidrocarburos (ANH), Agencia Nacional de Hidrocarburos, disponible en: https://www.anh.gov.co/en/

[77] Instituto Colombiano Agropecuario (ICA), Censo Bovino en Colombia, disponible en: https://www.ica.gov.co/areas/pecuaria/servicios/epidemiologia-veterinaria/censos-2016/censo-2018 (consulted 05/10/2024).

[78] UPRA (Unidad de Planificación Rural Agropecuaria), Microanálisis Evaluaciones Agropecuarias 2023 - Casanare, disponible en: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://upra.gov.co/Kit_Territorial/2-%20Informaci%C3%B3n%20por%20Departamentos/CASANARE/3-%20Microan%C3%A1lisis%20Evaluaciones%20agropecuarias%202023-Casanare.pdf (consulted 05/10/2024).

According to the Casanare Chamber of Commerce, the department encompasses over 4.4 million hectares, with approximately 10% suitable for agriculture. However, only around 17,000 hectares are used for agriculture, primarily for subsistence crops such as plantains, corn, cassava, tubers, vegetables, legumes, and fruits. Between 2019 and 2023, the total area planted with rice, palm oil, and small-scale farming reached 1,426,141.36 hectares[79].

Arauca

The Department of Arauca has a diversified economy, with key sectors contributing significantly to its GDP, including mining and quarrying, agriculture, livestock, hunting, forestry, and fishing.

- Mining and Quarrying: The most significant sector, accounting for 47.4% of Arauca's GDP, is dominated by the oil industry.
- Agriculture and Livestock: The second most significant sector, contributing 20.8% of the department's GDP.

According to the 2023 livestock census by ICA, Arauca has approximately 1,223,967 cattle, 174,339 pigs, 365,030 poultry, and 72,246 animals classified as buffaloes, goats, sheep, and horses[80]. The department has seen fluctuations in its cattle inventory over the past five years. In the Sabana subregion, cattle inventory decreased by 0.88% between 2019 and 2020 and by an additional 0.16% in 2021. However, from 2021 to 2022, it increased by 6.37%, followed by a slight decline of 0.69% in 2023, reflecting an overall upward trend. Between 2021 and 2023, the inventory grew by 8.70% and 4.22%, respectively, indicating recovery and strengthening of the livestock sector. The analysis of agricultural production was based on data from 2019 to 2023 for each of Arauca's subregions, using information from the Municipal Agricultural Evaluations[81].

The agricultural sector in Arauca includes 22 different crops, including fruits, vegetables, cereals, and tubers. The most significant are plantain, cacao, rice, corn, cassava, and sugarcane. From 2019 to 2023, rice had the highest harvested area participation index (IP) at 62%, averaging 12,877 hectares harvested annually. Corn followed with an IP of 12% (4,053 hectares) and plantain with an IP of 10% (1,047 hectares).

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[79] Ibid., p 61.
[80] Instituto Colombiano Agropecuario (ICA*), Censo Bovino en Colombia*, p 61.
[81] Unidad de Planificación Rural Agropecuaria (upra), Evaluaciones Agropecuarias Municipales (EVA), disponible en: https://upra.gov.co/en/Pages/eva.aspx (consulted 05/10/2024)

According to SIPRA, Arauca's agricultural frontier covers 1,643,161 hectares, representing 68.9% of the department's total area. Of this, 482,631 hectares are designated for agricultural activities, equivalent to 29.4% of the agricultural frontier.

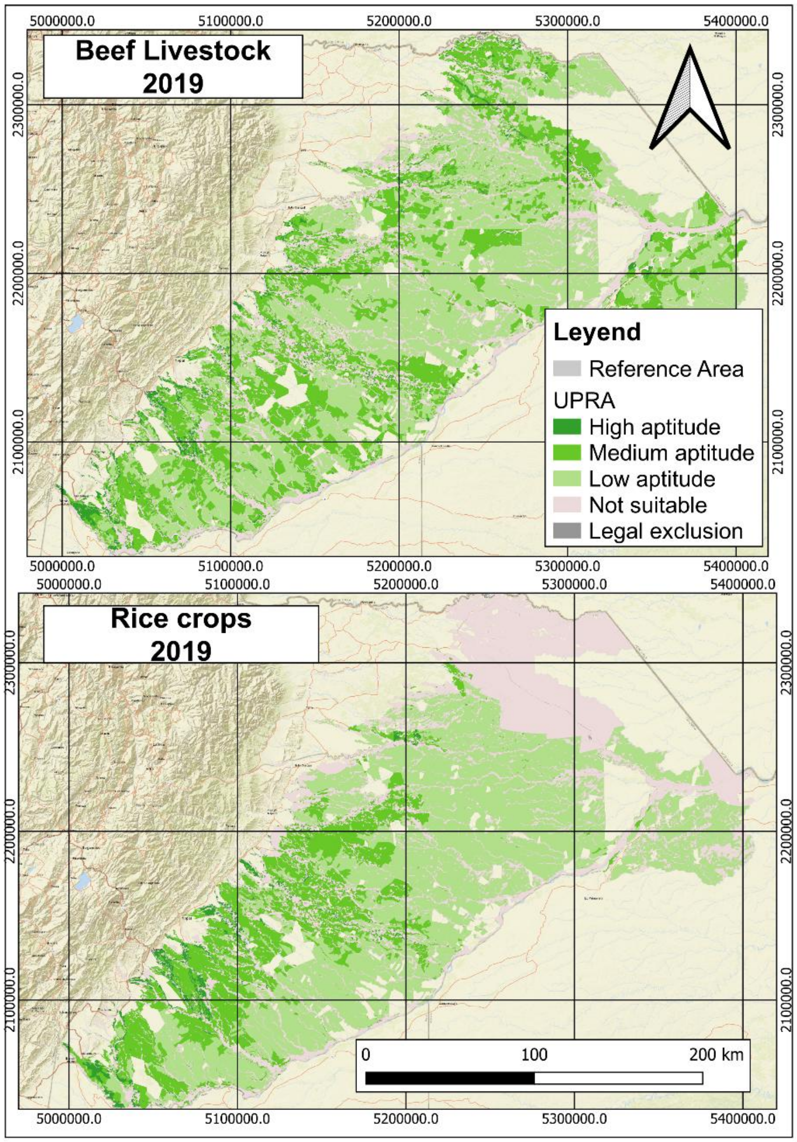

Figure 3-5. Aptitude for beef and rice farming in the reference area in the departments of Arauca and Casanare

Source: Sahbio Carbono & SIPRA, 2024

Land Suitability and Conflicts

Figure 3-5 presents land suitability for beef and rice farming in Casanare and Arauca[82]. Suitability zoning indicates that rice, cacao, sugarcane, bulb onion, and corn have areas classified as high, medium, or low suitability. However, a significant portion of the territory is unsuitable for these activities due to technical or legal constraints.

Figure 3-6 illustrates milk and buffalo farming suitability in Casanare and Arauca[83]. In Casanare, rice has the highest potential with 3,037,742 hectares, whereas palm oil cultivation has very low suitability across 2,348,264 hectares. In contrast, plantain cultivation has high and low suitability areas, covering 59,988 hectares.

Livestock suitability is highest for beef cattle and poultry, with 248,318 and 162,371 hectares, respectively. However, land-use conflicts persist, with 1,727,456.68 hectares overlapping the main ecological structure and agricultural frontier and 727,448.64 hectares facing challenges due to land cover classifications.

The department's productive aptitude zoning reveals that crops such as rice, cacao, sugarcane, bulb onion, and corn, and livestock such as buffalo, beef cattle, and goats have specific areas classified as high, medium, or low suitability (Figure 3-6). However, a significant portion of the territory is not suitable for these activities, either technically or legally.

[82] UPRA (Unidad de Planificación Rural Agropecuaria), Sistema de Información de la Planificación Rural Agropecuaria (SIPRA), disponible en: https://sipra.upra.gov.co/nacional (consulted 01/10/2024).
[83] Ibid, p 63

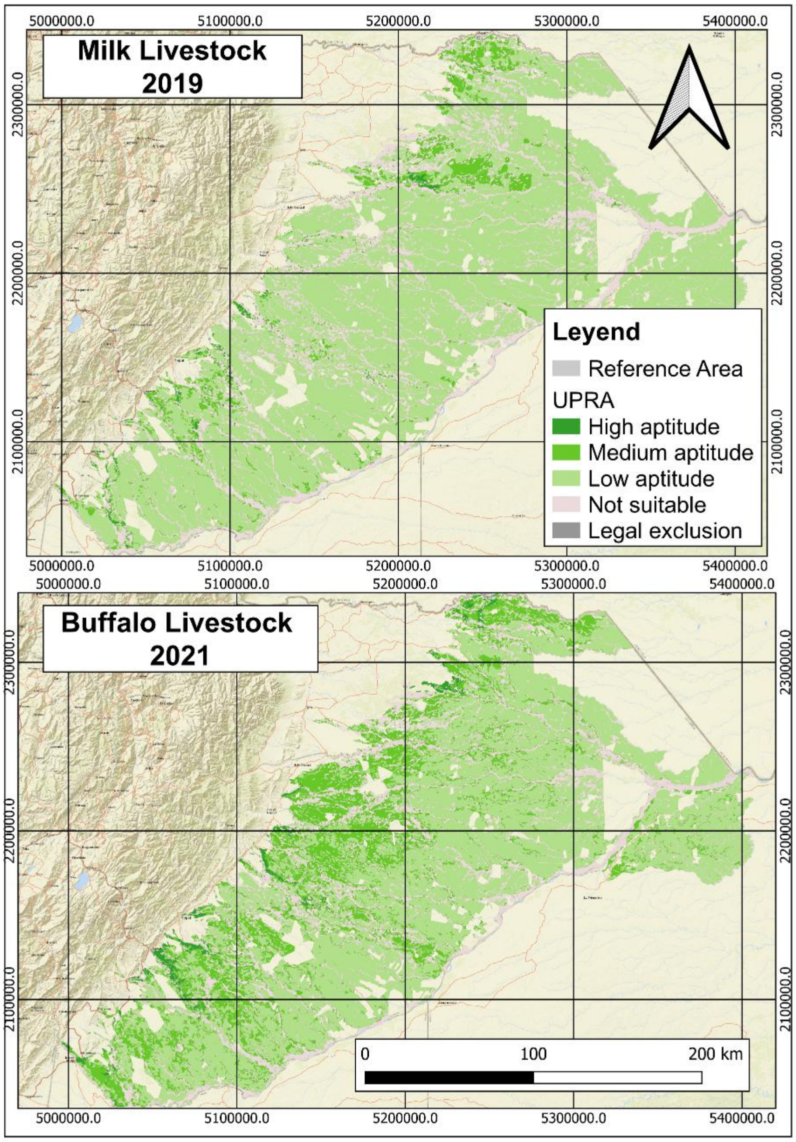

Figure 3-6. Aptitude for milk and Buffalo farming in the reference area in the departments of Arauca and Casanare

Source: Sahbio Carbono & SIPRA, 2024

3.3.1.2.2.6 *Direct and Indirect Impact*

Between 2008 and 2018, the reference area experienced rapid deforestation and forest degradation, primarily driven by agricultural expansion, extensive livestock farming, and agro-industrial projects. These activities dramatically altered the landscape, replacing forests with croplands, non-native pastures, and grass mosaics. This transformation threatens the region's rich biodiversity and disrupts essential ecosystem services such as carbon sequestration, soil fertility, and water regulation.

We measured gross deforestation by comparing the total forest area from 2008 to 2018 to quantify these changes. 2008, the reference area contained **519,864.68** hectares of natural forests (CORINE Land Cover categories: gallery, dense, fragmented, and open forests). By 2018, this area had declined to **338,653.37** hectares, resulting in a gross forest loss of **181,211.31** hectares over ten years. This decline represents an annual deforestation rate of 3.4%. Of this loss (**181,211.31 Ha**), **81,328.89** hectares resulted from natural land cover transformations, different from forests, while the remaining **99,882.44** hectares were lost due to land use changes.

Our analysis reveals significant shifts in land cover use changes. Clean pastures were replaced, indicating a strong trend toward intensive livestock farming and monoculture plantations that prioritize short-term agricultural gain (**Error! Reference source not found.**). In addition, forest degradation accounted as converted into secondary vegetation (Figure 3-7). Finally, herbaceous and tree crops changed land cover (Table 3-8).

Table 3-8. Hectares of Forest Lost between 2008 and 2018 Converted Areas in Hectares and Percentages

Land cover category	Area (ha)	Percentage (%)
Converted to Other Natural Land Covers	81,328.89	44.88
Converted to Non-Natural Land Covers	99,882.44	55.12
Non-Natural Land Covers		
Continuous Urban Fabric	4.44	0.00
Discontinuous Urban Fabric	9.33	0.01
Industrial or Commercial Areas	16.84	0.01
Airports	4.00	0.00
Mining Extraction Areas	26.23	0.01
Other Temporary Crops	1,130.04	0.62
Cereals	7,735.66	4.27
Permanent Herbaceous Crops	504.62	0.28
Permanent Tree Crops	1,589.62	0.88
Clean Pastures	23,823.70	13.15
Tree-Covered Pastures	1,378.60	0.76
Shrubby Pastures	5,835.66	3.22
Crop Mosaic	369.91	0.20
Pasture and Crop Mosaic	5,639.24	3.11
Crop, Pasture, and Natural Space Mosaic	4,222.31	2.33
Pasture and Natural Space Mosaic	14,663.81	8.09
Crop and Natural Space Mosaic	723.48	0.40
Forest Plantation	4,292.00	2.37
Secondary or Transitional Vegetation	27,902.18	15.40

Land cover category	Area (ha)	Percentage (%)
Artificial Water Bodies	10.79	0.01
Total forest loss	**181,211.33**	**100.00**

Source: Sahbio Carbono, 2024

Grass mosaics have also expanded due to changes in grazing practices that degrade soil quality and diminish the region's capacity for carbon sequestration. This trend not only disrupts ecological balance but also jeopardizes the long-term sustainability of agricultural productivity[84] [85].

Local farmers, agribusinesses, and government agencies are crucial in these transformations. Farmers often prioritize immediate economic gains from agricultural production, while agribusinesses exploit the existing lands. Unfortunately, government policies frequently lack effective enforcement of sustainable practices. Conservation organizations strive to promote sustainable land-use practices but face significant challenges reconciling economic interests with environmental conservation[86].

The economic activities driving these changes yield both immediate benefits and long-term costs. Clean pastures, tree crops, and grain production significantly change the land cover. While these activities enhance local economies, they also fragment habitats and reduce biodiversity, threatening the region's ecological integrity.

[84] Teague R and Kreuter U. Managing Grazing to Restore Soil Health, Ecosystem Function, and Ecosystem Services. Front. Sustain. Food Syst. 4:534187. 2020

[85] Janowiak, M. and Connelly, W.J. and Dante-Wood, K. and Domke, G.M. and Giardina, C. and Kayler, Z. and Marcinkowski, K. and Ontl, T. and Rodriguez-Franco, C. and Swanston, C. and Woodall, C.W. and Buford, M 2017, Considering Forest and Grassland Carbon in Land Management. U.S. Department of Agriculture, Forest Service.

[86] Brooke Williams, Hedley S Grantham, James EMWatson , Silvia J Alvarez, Jeremy S Simmonds, Carlos ARogéliz, Mayesse Da Silva , Germán Forero-Medina, Andrés Etter, Jonathan Nogales, Tomas Walschburger, Glenn Hyman and Hawthorne L Beyer. Minimising the loss of biodiversity and ecosystem services in an intact landscape under risk of rapid agricultural development. Environmental research Letters. 15: 014001. 2020.

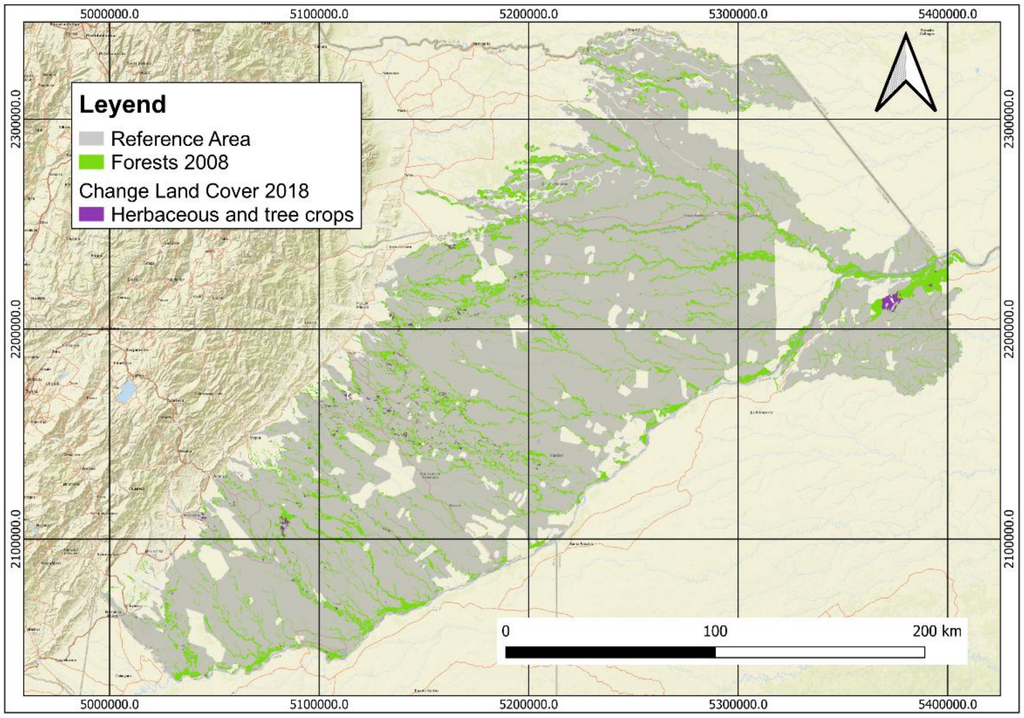

Figure 3-7. The percentage of forest lost up to 2018 by human activities that correspond to secondary or transitional vegetation

Source: Sahbio Carbono, 2024

In summary, transforming the reference region between 2008 and 2018 exemplifies how socioeconomic drivers can accelerate ecological change. Increased by local demands and global market forces, agricultural expansion has led to substantial biodiversity loss and environmental degradation. The relationships among farmers, government agencies, and conservationists will be critical in shaping the future of land use in this vital region.

3.3.1.2.2.7 *Relationships and Synergies*

We analyzed the interactions and synergies among all project elements and stakeholders to define the established REDD+ activities. It determines the direct and indirect causes, the responsible agents, and the underlying factors driving land occupation (see Table 3-9).

Table 3-9. Matrix of Interactions and Synergies in Deforestation and Forest Degradation in the Reference area

Factor / Agent	Pasture Expansion	Livestock Production	Agricultural Production	Transportation	Hydrocarbons	Settlements	Logging	Forest Fires	Wetland Drainage
Pasture Expansion	-	6 (moderate)	5 (moderate)	4 (moderate)	8 (strong)	8 (strong)	5 (moderate)	8 (strong)	4 (moderate)
Livestock Production	6 (moderate)	-	8 (strong)	7 (strong)	5 (moderate)	4 (moderate)	8 (strong)	5 (moderate)	4 (moderate)
Agricultural Production	5 (moderate)	8 (strong)	-	7 (strong)	5 (moderate)	4 (moderate)	8 (strong)	4 (weak)	4 (moderate)
Transportation	4 (moderate)	7 (strong)	7 (strong)	-	8 (strong)	5 (moderate)	6 (moderate)	4 (moderate)	5 (moderate)
Hydrocarbons	8 (strong)	5 (moderate)	5 (moderate)	8 (strong)	-	4 (weak)	6 (moderate)	5 (moderate)	6 (moderate)
Settlements	8 (strong)	4 (moderate)	4 (moderate)	5 (moderate)	4 (weak)	-	3 (weak)	4 (moderate)	6 (moderate)
Logging	5 (moderate)	8 (strong)	8 (strong)	6 (moderate)	6 (moderate)	3 (weak)	-	5 (moderate)	4 (moderate)
Forest Fires	8 (strong)	5 (moderate)	4 (weak)	4 (moderate)	5 (moderate)	4 (moderate)	5 (moderate)	-	6 (moderate)
Wetland Drainage	4 (moderate)	4 (moderate)	4 (moderate)	5 (moderate)	6 (moderate)	6 (moderate)	4 (moderate)	6 (moderate)	-

Source: Sahbio Carbono, 2024

Interaction Analysis

Strong interactions (7-9):

- Pasture expansion and settlements (1,6) → Deforestation for land use change, infrastructure expansion, or rural/urban settlement growth.
- Pasture expansion and hydrocarbons (1,5) → Oil pipeline easements lead to pasture expansion.
- Pasture expansion and forest fires (1,8) → Controlled burns are used for land clearing but can become uncontrolled fires.
- Livestock, agriculture, and logging (2,3,7) → Deforestation for crops and cattle ranching, driven by income or subsistence needs.
- Transportation and hydrocarbons (4,5) → Road construction to access oil extraction areas causes deforestation.

Moderate interactions (4-6):

- Livestock and pasture expansion (1,2) → Expanding pastureland to support cattle ranching.
- Agriculture and pasture expansion (1,3) → Some agricultural areas are converted into pastures.
- Logging and hydrocarbons (5,7) → Deforestation for wood extraction often coincides with oil activities.
- Settlements and wetland drainage (6,9) → Land conversion for settlements near water sources leads to deforestation.
- Transportation and agriculture/livestock (4,2,3) → Need for roads to transport agricultural and livestock products.

Weak interactions (1-3):

- Agriculture and forest fires (3,8) → Controlled burns for soil preparation occasionally led to wildfires.
- Settlements and hydrocarbons (5,6) → The presence of settlements near extraction sites may require deforestation of infrastructure (e.g., power lines).
- Settlements and logging (6,7) → Wood extraction occurs near expanding settlements but is not always a direct driver.

3.3.1.2.2.8 Cause chain in forest degradation and deforestation

The direct causes of deforestation and degradation in the reference area include four activities: agricultural expansion, infrastructure development, timber extraction, and biophysical factors.

Agricultural Expansion

Agricultural expansion occurs for three main reasons: crop production (for subsistence or sale), livestock production (for sale or subsistence), and pasture expansion (for rental or land tenure purposes). However, traditional small-scale crops for subsistence or informal trade also contribute to deforestation[87]. Local communities clear forested land

[87] CORPORINOQUIA. Normas de aprovechamiento forestal. [Online]. In: https://corporinoquia.gov.co/es-co/la-corporacion/normatividad/normatividad-vigente/normas-aprovechamiento-forest.html. [Consulted: 12/11/2024].

to create croplands, often using timber extraction to expand agricultural areas, driven by economic necessity and subsistence needs.

Livestock farming is traditionally practiced in the region, primarily through breeding systems and, to a lesser extent, fattening operations. This activity ensures daily sustenance, conserves ecosystems, promotes wildlife conservation, and maintains cultural traditions. However, it is also closely linked to pasture expansion. Large landowners often rent vast tracts for extensive cattle ranching, pasture cultivation, or land tenure purposes. Agricultural inputs, including grains (cereals, soybeans) and fertilizers, are common. Small producers require improved access to technology and innovative production systems to ensure market access and enhance food security[88].

Infrastructure Development

Infrastructure expansion is another direct cause of deforestation in the region, driven by activities related to transportation, hydrocarbons, and population settlements. Road construction, whether regional or for rural access, contributes significantly to deforestation. The hydrocarbons industry has expanded in this area, altering socio-economic conditions and negatively impacting biodiversity. Additionally, population growth has led to increased settlements, requiring new housing and infrastructure, further driving land-use change in rural areas.

Timber Extraction

Timber extraction is a major cause of deforestation, occurring for commercial purposes (often illegally) and subsistence. In the designated area, logging activities target species such as Mosco, Cedro Espino, Algarrobo, and Yopo. Farmers frequently clear additional forest areas to afford input, allowing them to cultivate more intensively on reduced land areas.

Biophysical Factors

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[88] FAO. How to feed the world in 2050. [Online]. Organización de las Naciones Unidas para la Alimentación y la Agricultura, 2009. In: https://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf. [Consulted: 12/11/2024].

Biophysical factors, the fourth direct cause of deforestation, refer to the natural predisposition of the land to change use due to variables such as climate, soil characteristics, lithology, topography, hydrology, and vegetation. Landslides and forest fires occasionally occur in the region, though they are not primary drivers of deforestation[89]. Additionally, underlying causes such as economic (increased production), demographic (population growth), and cultural (indigenous beliefs) factors influence social dynamics and land-use practices in the reference area.

Deforestation and Degradation Dynamics

All the activities mentioned above contribute to deforestation. However, they are also key factors in forest ecosystem degradation. Specifically, agricultural expansion, selective logging, timber extraction, and forest fires significantly reduce biomass and hinder natural regeneration. Sustainable land-use strategies are essential to mitigate increasing pressure on this region's natural resources and environment.

3.3.2 Sustainability and conservation projects in the project reference area

The Orinoquia region in Colombia, particularly the departments of Arauca and Casanare, has long been a hub for agricultural activities, focusing on crops like rice, maize, and oil palm, alongside cattle ranching. This region's economy depends heavily on these practices. However, in recent years, a significant shift towards sustainability has emerged. Local policymakers, backed by institutions such as AGROSAVIA, are pushing for agricultural practices that respect biodiversity and ecosystem services while supporting local livelihoods.

A standout initiative in this transformation is the *Biocarbon Model*, which promotes low-carbon rice production and aims to reduce greenhouse gas emissions[90]. Farmers in Arauca and Paz de Ariporo have reduced their daily methane emissions by efficiently incorporating crop residues (such as rice straw, maize stover, and other plant waste) into the soil. As for maintaining productivity while reducing nitrogen fertilizer use, sustainable practices often include using alternative nitrogen sources, such as organic fertilizers, nitrogen-fixing cover crops (e.g., legumes), and integrated nutrient management techniques that optimize nitrogen availability in the soil. These strategies

[89] ROZO LÓPEZ, Damaris. Alerta temprana por deforestación en la Orinoquia: un desafío medioambiental que Colombia debe enfrentar. [Online]. 2018 [Consulted: 12/11/2024].
[90] Proyecto Biocarbono Orinoquia & Agrosavia. Guía de implementación de mejores prácticas para un modelo de arroz bajo en carbono. Colombia. P 48. 2022.

allow for the maintenance or improvement of agricultural productivity while reducing greenhouse gas emissions and production costs[91].

AGROSAVIA and the Rural Planning Unit (UPRA) are at the forefront of these changes. While AGROSAVIA focuses on sustainable agricultural systems, UPRA is crucial in rural planning and land management. They use satellite monitoring for crops like rice and cacao and aim to conserve floodplains through territorial planning. Moreover, the *Territorial Strategy for Rural Property Regularization* (ETGRPR) seeks to address land tenure issues through community engagement and education, promoting legal and sustainable land use.

Climate-smart agriculture is gaining momentum in this region as well. This approach encourages practices that adapt to climate change and improve productivity without depleting natural resources. These efforts align with Colombia's national goal to reduce greenhouse gas emissions by 51% by 2030.

The Biocarbono Model in the Orinoquía[92] region has demonstrated significant economic benefits for farmers by increasing productivity and reducing costs. This initiative promotes eco-efficiency, allowing producers to lower fertilizer expenses by 20%, which enhances their financial returns. The collaboration between the public and private sectors has been pivotal in providing access to technical resources and fostering knowledge-sharing networks. The project's inclusive nature is highlighted by the participation of 472 stakeholders, including 182 women, which contributes to community resilience and local empowerment[93].

Despite these achievements, several challenges hinder progress. Resistance from farmers accustomed to traditional practices, climatic variability, and infrastructure limitations pose significant obstacles. Competition for land from industries such as mining further strains regional resources. A critical challenge is the lack of reliable data for monitoring emissions and assessing long-term impacts, complicating efforts to evaluate the model's effectiveness.

To participate in the Biocarbono Model, landowners must meet specific criteria, including owning land within the Orinoquía region and committing to sustainable agricultural practices that reduce greenhouse gas emissions. Eligible properties are

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[91] AGROSAVIA, Biocarbo/AGROSAVIA cierra su primera fase, disponible en: https://www.agrosavia.co/noticias/biocarbo-agrosavia-cierra-su-primera-fase?utm_source=chatgpt.com (consulted 05/10/2024).
[92] Biocarbono Orinoquia, Paisajes sostenibles bajos en carbono, disponible en: https://biocarbono.org/ (Consulted 20/08/2023).
[93] Ibid, p 66.

typically medium to large-sized, though smaller properties may qualify if they can significantly impact the ecosystem. However, many landowners hesitate to participate due to a lack of information about the model, economic uncertainties regarding short-term income, initial implementation costs, resistance to change from traditional practices, and legal restrictions on land use. Addressing these barriers through education, awareness campaigns, and financial support is essential for the model's success[94].

Justifying further conservation projects for carbon removal involves understanding the successes and lessons learned from the Biocarbon Model. New initiatives like the one in the present Project focus on reducing greenhouse gases and emphasize biodiversity conservation. Addressing the region's specific challenges is essential while building on the inclusive, sustainable practices established by the Biocarbon Model. Through continued collaboration and innovative approaches, these conservation efforts can help transform the agricultural landscape of the Orinoquia region, fostering both environmental sustainability and economic growth.

3.4 Additionality

3.4.1 Step 0 Preliminary screening based on the starting date of the A/R project activity

The start date for the SAHBIO Carbono project is January 2021, supported by evidence of conservation activities carried out by property owners. Annex XX summarizes the evidence of the early dates of the activities performed at the eligible lands. These activities include farm monitoring, installation and maintenance of wire fences, passive restoration, prescribed burns and/or firebreaks, active restoration with native species, establishment of conservation agreements, training, and workshops. These actions have been documented through field reports, photographic records, and property owner testimonies, gathered using a survey-interview process for structuring the farm plan. It is important to highlight that each property has a specific start date based on the evidence collected.

It should also be noted that in 2018, the ecosystems targeted by the SAHBIO Carbono project in Arauca and Casanare were severely degraded. According to CORINE Land Cover maps analyses, natural savannas lost 834,059 hectares between 2008 and 2018, primarily converted into clean pastures for livestock and herbaceous crops. Forests

[94] Biocarbono Orinoquia, Paisajes sostenibles bajos en carbono, p 66.

experienced alarming deforestation, decreasing from 519,864 to 338,653 hectares, with areas transformed for livestock use with exotic pastures and degraded.

These actions have been documented through field reports, photographic records, and testimonies from property owners, gathered using a survey-interview process to structure farm management plans for the SAHBIO Carbono Project.

3.4.2 Step 1. Identification of alternative scenarios

3.4.2.1 Substep 1.a. Realistic and Credible Scenarios for Project Areas

Based on Section 3.3.2.3, "Lands suitable for change of land use in the reference area between Arauca and Casanare" of this document, realistic and credible alternative scenarios for the project areas include:

- Continuation of pre-project land uses, encompassing natural forests and grasslands, characterized by:
    - Unmanaged pastures,
    - Degraded forested pastures within cattle-grazing regimens,
    - Forest areas with free access for cattle seeking shade or edible plants,
- Conservation or restoration of natural grasslands, wetlands, and forests without securing long-term financial resources.
- Conservation or restoration of natural grasslands, wetlands, and forests supported by long-term carbon credit revenues.
- Commercial reforestation initiatives.
- Industrial-scale production of oil palm.
- Extensive cultivation of rice and other crops.
- Conversion of grasslands into exotic grass pastures for cattle farming.
- Establishment of illegal crops.

Land leasing by property owners often facilitates the expansion of the agricultural frontier in these regions. Similarly, economic returns incentivize landowners to transition from traditional land uses to intensive livestock farming, which involves replacing native pastures and wetlands with commercial alternatives. Assessments conducted by UPRA

(Unidad de Planificación Rural Agropecuaria Arauca[95] / Casanare[96]) have highlighted these trends as key factors driving land-use changes in the Orinoquia region, as noted in section 3.3.2.3 of this document.

Interviews conducted by the Corocoras Foundation in 2023 and 2024 reveal that many landowners have received proposals and anticipate transitioning current land uses to more profitable activities[97].

Therefore, the land use alternatives are realistic and credible:

- Continuation of pre-project land uses, i.e., forest and natural grasslands composed of:
  - Unmanaged pastures,
  - Pastures in degraded forests are part of the grasslands management regimen for cattle raising.
  - Forest areas with free access for cattle seeking shade or edible plants
- Conservation or restoration of natural grasslands, wetlands, and forests without securing long-term financial resources.
- Conservation or restoration of natural grasslands, wetlands, and forests supported by long-term carbon credit revenues.
- Commercial reforestation initiatives.
- Industrial-scale production of oil palm.
- Extensive cultivation of rice and other crops.
- Conversion of grasslands into exotic grass pastures for cattle farming.
- Establishment of illegal crops.

3.4.2.1.1 Substep 1.b. Consistency and Regulation of Scenarios

All the scenarios outlined, **except the illegal crop production**, are authorized and regulated under national and regional legislation, including agriculture, livestock, and sustainable and non-sustainable land management regulations. These activities are also

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[95] Unidad de Planificación Rural Agropecuaria (UPRA). (2023). Presentación Regional UPRA Arauca: Planificación del Ordenamiento Productivo y Social de la Propiedad en Arauca. Ministerio de Agricultura y Desarrollo Rural, Colombia.
[96] Unidad de Planificación Rural Agropecuaria (UPRA). (2023). Presentación Regional UPRA Casanare: Planificación del Ordenamiento Productivo y Social de la Propiedad en Casanare. Ministerio de Agricultura y Desarrollo Rural, Colombia.
[97] Informe Técnico de Encuestas para Plan de Finca

outlined in the planning documents for the productive and social land-use planning of Arauca and Casanare, developed by UPRA (Unidad de Planificación Rural Agropecuaria).

Consequently, the SAHBIO Carbono Project fulfills the additionality criteria because more than one of the realistic and credible legal land-use alternatives listed is included in the project's scope of land-use alternatives.

3.4.3 Step 2: Barrier analysis.

3.4.3.1 Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenario

Land use changes have historically been directed towards its conversion to agricultural and livestock systems in the project's reference region.

Credible and realistic scenarios include oil palm production, reforestation, and conservation actions without a secure long-term financial source. However, implementing these has economic, technical, institutional, or social barriers.

3.4.3.1.1 Economic Barriers:

Landowners face significant financial constraints in implementing conservation and restoration projects. These initiatives do not generate direct income and require substantial upfront investments for fencing, restoration, and fire management activities. Additionally, the limited availability of funding from financial institutions, which categorize conservation projects as high-risk due to their perceived lack of straightforward financial returns, further restricts access to capital.

The findings from the WRI study on Nature-based Solutions (NbS) in Latin America reinforce this challenge, revealing that none of the 156 analyzed projects received private capital contributions[98]. These results underscore the broader issue of insufficient private investment in regional conservation efforts. Given these economic barriers, conservation and restoration projects rely heavily on alternative financial mechanisms, such as carbon credit or public funding, to become viable and sustainable in the long term.

[98] World Resources Institute. (2023). *Nature-based solutions in Latin America and the Caribbean: Financing mechanisms for replication*. World Resources Institute. https://www.wri.org/research/nature-based-solutions-latin-america-and-caribbean-financing-mechanisms-replication

3.4.3.1.2 Technical Barriers:

Limited technical knowledge among landowners about sustainable management practices for savannas, wetlands, and gallery forests. According to surveys conducted by the SAHBIO Carbon Project in 2024, only 26% of landowners have received any training related to conservation, further highlighting the need for capacity-building initiatives in the region.

Furthermore, the lands within the project's area of influence are characterized by poorly drained soils, low fertility, and prolonged susceptibility to flooding. These conditions are unsuitable for many commercially valuable forest species, which require more stable environments and well-drained soil for optimal growth.

3.4.3.1.3 Institutional Barriers:

The region's weak enforcement of environmental regulations has caused continuous ecosystem degradation. Furthermore, governmental promotion of these areas as Colombia's "last agricultural frontier," as highlighted in the Pacto Región Llanos-Orinoquia of the National Development Plan 2018-2022[99], which emphasizes the region's extensive availability of land for agroindustrial and agricultural production and its role as a sustainable food source for Colombia and the world, incentivizes intensive activities such as monocultures and livestock farming, complicating the implementation of sustainable conservation measures.

There are also inadequate government programs promoting long-term conservation, particularly in remote rural areas.

3.4.3.1.4 Social Barriers:

The properties in the region face significant barriers to the development of oil palm cultivation, primarily due to their considerable distance from processing centers. The remoteness of population centers with more than 30,000 inhabitants, with travel times ranging from 8 to 10 hours, presents critical logistical challenges for efficiently transporting agricultural products such as oil palm nuts. This issue is particularly acute in the departments of Arauca, especially in areas of the National Integrated Management

[99] National Planning Department (DNP). (2018). *National Development Plan 2018-2022: Pact for Colombia, Pact for Equity*. Bogotá, Colombia. Retrieved from: https://colaboracion.dnp.gov.co/CDT/Prensa/Resumen-PND2018-2022-final.pdf

District of Cinaruco, and in the northeastern part of the department of Casanare (See Figure 3-8.

Horas	Área (ha)	Porcentaje (%)**
Menor a 1	279.888	6%
Entre 1 y 2	743.030	17%
Entre 2 y 3	611.831	14%
Entre 3 y 4	552.743	12%
Entre 4 y 5	420.622	9%
Entre 5 y 6	329.697	7%
Entre 6 y 7	230.126	5%
Entre 7 y 8	162.944	4%
Entre 8 y 10	345.056	8%
Mayor a 10	758.202	17%

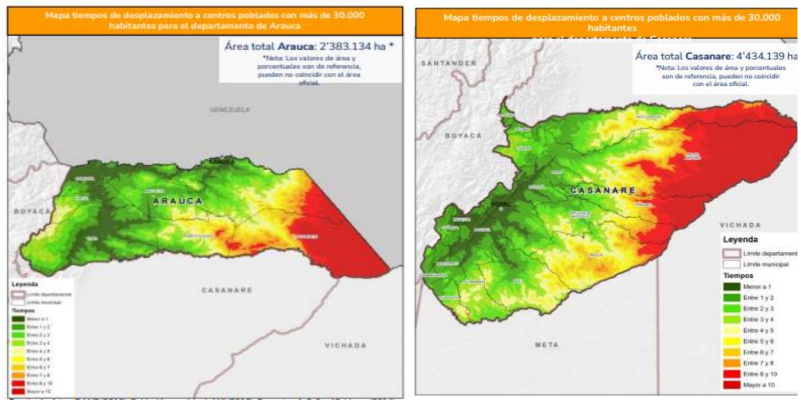

Figure 3-8. Data Source: DANE (2010). Municipal population. ANI (2016), Projects 1, 2, 3, and 4G. IDEAM (2014). Land cover map. CORINE Land Cover methodology adapted for Colombia. Period 2010-2012. IGAC (2012). Basic cartography, scale 1:100,000. — (2014). Digital Elevation Model. Mintransporte (2014). Navigable river sections.

3.4.3.2 *Sub-step 2b. Elimination of Land Use Scenarios Impeded by Identified Barriers*

According to Sub-step 2a. Identified barriers eliminate the following land use scenarios for the SAHBIO Carbono Project:

- Conservation Without Long-Term Financing
  Implementing **conservation without long-term financing** is not a feasible land-use option due to the **lack of sustained financial support** necessary to maintain conservation efforts over time. Conservation activities require continuous investment, including ecosystem monitoring, habitat restoration, fire prevention, and sustainable land management. However, without a stable long-term funding source, landowners face **significant financial barriers** that make it difficult to sustain these initiatives independently.

- Commercial Reforestation by Landowners

  The option of Commercial reforestation by Landowners is not feasible due to the soil conditions within the project's area of influence. The floodplain savannas of the Colombian Orinoquía are characterized by poorly drained soils and prolonged susceptibility to flooding, significantly limiting the successful establishment of commercial forestry plantations.

Many commercially valuable forest species require well-drained and stable soils to ensure optimal growth and long-term productivity. However, the hydrological dynamics of these flood-prone areas create unfavorable conditions for large-scale afforestation. Furthermore, the combination of high water saturation, periodic flooding, and low soil fertility makes it difficult for trees to develop deep root systems, further reducing the viability of reforestation efforts.

- Land-Use Change for Industrial Production of Oil Palm

  Adopting oil palm cultivation is eliminated as a viable option in the project areas due to the significant remoteness of the properties from production centers, population hubs, and primary road networks. The long distances and poor connectivity make it extremely challenging to transport agricultural inputs, such as seedlings and fertilizers, and deliver harvested products to processing facilities. Properties in regions like the National Integrated Management District of Cinaruco in Arauca[100] and the northeastern part of Casanare[101] face 8 to 10 hours to reach population centers with more than 30,000 inhabitants, highlighting the severe logistical constraints.

  This geographic isolation and the absence of nearby processing facilities and access to essential transportation infrastructure render oil palm cultivation impractical. Logistical challenges increase costs and create inefficiencies, making it unfeasible for small-scale farmers to establish and sustain this crop type.

  Therefore, the properties' significant remoteness eliminates oil palm cultivation as a realistic or sustainable alternative in these areas, as the distances and lack of connectivity pose insurmountable barriers to its development.

[100] Unidad de Planificación Rural Agropecuaria (UPRA). (2023). *Regional Presentation UPRA Arauca*. Ministry of Agriculture and Rural Development of Colombia. Available at: https://sipra.upra.gov.co/documents/Resolucion_000261_2018.pdf
[101] Unidad de Planificación Rural Agropecuaria (UPRA). (2023). *Regional Presentation UPRA Casanare*. Ministry of Agriculture and Rural Development of Colombia. Available at: https://sipra.upra.gov.co/documents/Resolucion_000261_2018.pdf

Outcome of Sub-step 2b: The following land use alternatives have been identified as viable options that are not hindered by any significant barriers:

- Continuation of pre-project land uses, i.e., forest and natural grasslands composed of:
  - Unmanaged pastures,
  - Pastures under degraded forest are part of the grasslands management regimen for cattle raising.
  - Forest areas with free access for cattle seeking shade or edible plants
- Conservation/Restoration of natural grasslands/wetlands and forests with long-term carbon credits revenues.
- Extensive production of rice and other crops.
- Grasslands conversion to introduce grass for cattle raising.

3.4.3.3 Sub-step 2c. Determination of the Baseline Scenario

- As a result of the barrier analysis, the following land uses constitute the baseline scenario:
  - Continuation of pre-project land uses,
  - Conservation/Restoration of natural grasslands/wetlands and forests with long-term carbon credits revenues.
  - Extensive production of rice and other crops
  - Grasslands conversion to introduced grass for cattle raising

According to the barrier analysis, at least four land-use scenarios are feasible, so the proposed project maintains the additionality criterion.

3.4.4 Step 3: Investment Analysis

The investment analysis within the additionality assessment of the SAHBIO Carbono project considers the following:

3.4.4.1 Sub-step 3a. The selected method of analysis

The Simple Investment Analysis method was chosen because the internal rates of return (IRR) are low.

3.4.4.2 Sub-step 3b – Option I. Simple Investment Analysis

The Investment Comparison Analysis evaluated four land-use scenarios, considering the costs and revenues for a 1,000-hectare property (Table 3-10). Following the financial analysis presented in Annex 1, an assessment of the different land uses in the area was conducted. Each activity, except for land leasing for rice cultivation, was evaluated over 40 years. Table 3-10. Property Activities Analysis evaluating various land-use practices on a typical 1,000-hectare property

Table 3-10. Property Activities Analysis evaluating various land-use practices on a typical 1,000-hectare property

Land uses	Description	Financial Analysis
Continuation of pre-project land uses, i.e., forest and natural grasslands.	Landowners with properties that have neither productive nor conservation activities incur operational expenses, primarily the payment of property taxes.	IRR cannot be calculated without income due to a lack of revenue.
Conservation/Restoration of natural grasslands/wetlands and forests with long-term carbon credits revenues.	Landowners with properties that have neither productive nor conservation activities incur operational expenses, primarily the payment of property taxes. However, conservation activities such as surveillance, fencing, and others also represent additional costs. (The BCR methodologies allow the development of sustainable activities).	Required Investment: 121.004.042 COP per 1,000 hectares. Conservation without carbon credit (including property value): Without income, IRR cannot be calculated due to a lack of revenue. Conservation with carbon credits (including property value): IRR of 9.16%. REDD+ Project with carbon credits (excluding property value): IRR of 10.7%.
Grasslands conversion to introduced grass for cattle raising	This practice involves planting large areas of introduced pastures, improving livestock production, considering a stocking rate of 0.50 bovines per hectare, and a birth rate of 70% to 80%. Bank loans are available for these projects with interest rates of 15.51%[102]	Required Investment: 1,387,138,164 COP per 100 hectares. With property value included: IRR of 14%. Without property value: IRR of 17%.

[102] Banco Agrario de Colombia. (s.f.). **Banco Agrario reduce nuevamente sus tasas para 5 líneas de crédito: 15,65% EA, en promedio**. Recuperado de https://www.bancoagrario.gov.co/noticias/banco-agrario-reduce-nuevamente-sus-tasas-para-5-lineas-de-credito-1565-ea-en-promedio

Land uses	Description	Financial Analysis
Extensive production of rice	The investment made by landowners includes the property's market value, with annual property tax payments considered a recurring expense. Additionally, in the Investment Comparison Analysis, a rental price of 350,000 COP[103] per hectare was factored in based on the valuation.	Required Investment: 22.120.000 COP per 55.3 hectares, representing the area suitable for rice cultivation on a 1,000-hectare property. IRR: 25%.

Source: SAHBIO Carbono, 2024

The Simple Investment Analysis evaluates the economic viability of different land-use scenarios by comparing their Internal Rates of Return (IRR). Below is the analysis of the options provided:

Continuation of Pre-Project Land Uses: Forest and Natural Grasslands

This scenario represents landowners maintaining the current land use without implementing productive or conservation activities. As this scenario generates no competitive income, the IRR cannot be calculated, highlighting its lack of financial viability.

Conservation and Restoration with Long-Term Carbon Credits

Conservation and restoration activities under REDD+ projects show limited financial returns:

- With Carbon Credits and Including Property Value: The IRR is 8.27%, reflecting minimal financial attractiveness.
- With Carbon Credits but Excluding Property Value, The IRR improves to *13.04% but* remains unappealing compared to other land-use practices.

These findings indicate that conservation and restoration activities are **not financially** attractive (sustainable) **without external financial incentives**, as they yield significantly lower returns than alternative land uses.

[103] Navas Hernández, E. L. (2024). *Caracterización preliminar del mercado de tierras en el Distrito Nacional de Manejo Integrado Cinaruco, departamento de Arauca.* Visso Consultores S.A.S.

Grasslands Conversion to Introduced Grass for Cattle Raising

This scenario involves converting natural grasslands into introduced pastures for livestock production. Although it requires a substantial investment of 13,871,381 COP per hectare, it offers attractive returns:

- Including Property Value: An IRR of 27.41% makes this option economically viable.
- Excluding Property Value: The IRR increases to 37.37%, further reinforcing its profitability.

The availability of bank loans with interest rates of 15.51% supports the feasibility of this option, as the returns are significantly higher than the borrowing costs.

Extensive Rice Production

For this scenario, landowners lease their land to third parties for rice production. Only 5.53%[104] of the property suitable for rice cultivation is utilized for this activity. This means the effective cost per hectare for the land-use scenario is 400,000 COP per hectare. Over 10 years, this land-use scenario generated an IRR of 25%. This analysis assumes that rice production followed good agricultural practices, ensuring optimal productivity and sustainability.

The results of this scenario make it clear that **revenue from carbon credit does not provide sufficient financial incentives** for the landowner. The low profitability relative to the WACC (24%) indicates that these activities **are not undertaken with direct economic interest** but rather are driven by **environmental conservation goals**. This reinforces the project's additionality, as the conservation activities would not occur without the support of the carbon credit generation program.

3.4.5 Step 4. Common practice analysis

The Colombian Orinoquia, known for its biological and ecosystem diversity, is home to a vast expanse of forests, natural pasture savannas, and wetlands. The departments of

[104] Instituto Geográfico Agustín Codazzi (IGAC). (n.d.). *Estudio general de suelos y zonificación de tierras del IGAC ratifica vocación ganadera de Casanare*. Retrieved from: https://prensalibrecasanare.com/casanare/17767-estudio-general-de-suelos-y-zonificaciun-de-tierras-del-igac-ratifica-vocaciun-ganadera-de-casanare.html

Casanare and Arauca represent key areas within this region that are facing significant challenges in terms of conservation and sustainability.

The forests in Casanare and Arauca comprise areas of gallery forests and rainforests that face serious threats such as deforestation due to agricultural and livestock expansion, exploitation of natural resources, and climate change.

Forest cover in these areas has declined significantly in recent decades. According to data from IDEAM (Institute of Hydrology, Meteorology, and Environmental Studies), the rate of deforestation in the Orinoquia has increased; between 2008 and 2018, the loss of more than 42,000 hectares of forests of the floodable natural savannas of the departments of Casanare and Arauca is recorded. Added to this is the transformation of more than 12,000 hectares of forests and about 98,000 hectares of natural savannas for oil palm production.

On the other hand, natural pasture savannas are crucial in regulating the hydrological cycle and preserving biodiversity. However, the intensive use of livestock and the implementation of inadequate agricultural management practices have degraded these ecosystems. In fact, according to the document *Arroz Indicadores y Acciones*, the Eastern Plains (Llanos Orientales) region, which includes Arauca and Casanare, represents 45.3%[105] of Colombia's total rice cultivation area. This expansion has converted extensive areas once occupied by flooded forests and natural savannas into rice production zones. Recurrent droughts, exacerbated by climate change, have further contributed to the degradation of vegetation cover.

However, despite these challenges, there are practically no management and conservation strategies that effectively conserve or restore native vegetation and improve the resilience of these systems.

On the other hand, wetlands in Casanare and Arauca are vital for water regulation, flood mitigation, and providing habitats for numerous aquatic species and migratory birds. However, these ecosystems also face threats such as agrochemical contamination, destruction due to agricultural and livestock activities, and, in some cases, the pressure of

[105] Ministerio de Agricultura y Desarrollo Rural. (2017). *Arroz: Indicadores y Acciones*. Retrieved from: https://sioc.minagricultura.gov.co/Arroz/Documentos/2017-12-30%20Cifras%20Sectoriales.pdf

urban development. Recent studies indicate a reduction in the extension and quality of these ecosystems, affecting their ability to sustain biodiversity and its ecosystem services.

The continued presence of these land-use change drivers could disrupt the region's hydrological dynamics, affecting water regulation and increasing the risk of erosion and desertification[106] in certain areas. Wetlands, essential for ecological balance and water provision, could experience a reduced capacity for filtration and storage, negatively impacting local communities that rely on these ecosystems for their livelihoods. Without implementing conservation and sustainable management strategies, pressure on natural resources would intensify, compromising the territory's resilience to extreme climate events and diminishing the long-term viability of economic activities dependent on the area's environmental health.

Considering the eligible project areas by land cover type, there are 11,670.37 hectares of forests, 127,517.90 hectares of natural savannas, and 4,785.29 Ha of flooded savannas. We used Equation 3-1 to calculate the loss of each of these ecosystems over the next 40 years.

Equation 3-1. Calculating the loss of each of these ecosystems over the next 40 years

$$Af = Ai\ x\ (1 - r)t$$

Where:

- Af= Remaining area after 40 years
- Ai = Initial area of the ecosystem
- r = Annual deforestation rate (expressed as a fraction)
- t = Number of years (in this case, 40 years)

Applying this formula, the estimated losses over the next **40 years** are:

[106] Ministry of Environment and Sustainable Development of Colombia. (n.d.). *Colombia confronts desertification and drought*. Retrieved from https://www.minambiente.gov.co/colombia-le-hace-frente-a-la-desertificacion-y-la-sequia-minambiente/

- **Forests**: With an annual deforestation rate of **3.4% (0.034)**, an estimated reduction of **9,311.05 hectares** is projected, leaving only **3,114.62 hectares remaining**.

$$Af = 11{,}670.37 \times (1 - 0.034)40$$

- **Wetland areas**: With a transformation rate of **5.98% (0.0598)**, an estimated **4,484.24 hectares** will be lost, leaving only **415.93 hectares** after the analysis period.

$$Af = 4{,}785.29 \times (1 - 0.0598)40$$

- **Natural grasslands**: With a transformation rate of **2.46% (0.0246)**, a reduction of **82,429.40 hectares** is expected, leaving only **48,253.50 hectares after 40 years**.

$$Af = 127{,}517.90 \times (1 - 0.0246)40$$

These calculations highlight the severe threat these ecosystems face from deforestation and land-use changes, emphasizing the urgent need for effective conservation measures to mitigate their degradation and ensure long-term environmental sustainability. In total, 99,339.31 hectares of various ecosystems within the project's area of influence would be lost.

3.4.6 Impacts of Project Registration

3.4.6.1 Financial Benefits from Carbon Credit Revenues

The **registration of the SAHBIO Carbono project** represents a milestone in consolidating the environmental, economic, and social benefits derived from its implementation. This process validates greenhouse gas (GHG) emissions reduct**ions** and ensures **transparency, traceability, and alignment** with international best practices in carbon projects.

- **Environmental Impact**

The project registration validates and formalizes the environmental benefits of SAHBIO Carbono, ensuring its effective contribution to climate change mitigation and the conservation of key ecosystems:

- Validated GHG emission reductions: With an estimated reduction of 5,494,228.62 tCO_2e over 40 years, the registration certifies the project’s effectiveness in carbon capture and storage.
- Protection of 143,973.56 hectares, including:
    - 132,303.19 hectares of natural floodplain savannas, essential for water regulation and carbon storage in soils.
    - 11,670.37 hectares of forest, crucial for biodiversity and ecological connectivity.
- Supported conservation activities:
    - Zoning and planning of critical areas for biodiversity conservation.
    - Strategic fencing as a deterrent measure against illegal logging and hunting.
    - Monitoring, active and passive ecological restoration with native species.

- **Economic Impact**

The registration of the project under **BCR** provides **stability and confidence** in the carbon market, ensuring the commercialization of the credit generated:

- Validation of revenue distribution: Memorandums of Understanding certify that 65% of the revenue from carbon credit will go to the landowners, ensuring direct benefits for those leading conservation efforts on their lands.
- Financial security: The registration provides certainty to landowners regarding the generation and commercialization of credits, ensuring the project's long-term economic sustainability.

- **Social and Governance Impact**

The project registration strengthens the role of landowners, ensuring that their participation in conservation is formally recognized through a structured and transparent framework:

- Farm plans tailored to each property, developed in collaboration with landowners to ensure customized conservation and sustainable production strategies.

- Training and safeguards compliance: The project certification process supports the development of workshops on:

  - Ecological restoration and conservation zoning planning.

  - Conservation regulations and safeguards compliance.

  - Gender equity and social inclusion (GEDSI) are linked to the conservation of Wax Palm.

- **Legal and Regulatory Impact**

The registration of the project ensures regulatory compliance and alignment with national and international environmental policies:

- Accreditation under international carbon standards, reinforcing transparency and traceability of credits.

- Contribution to national climate strategies, aligning policies for climate change mitigation and ecosystem conservation.

3.5 Uncertainty management

According to GOFC-GOLD (2016), *uncertainty is an inherent parameter estimation aspect. It reflects the extent of unknowns regarding the parameter's actual value, stemming from factors like bias, random error, data quality and quantity, the analyst's level of knowledge, and understanding of underlying processes*. Uncertainty can be expressed as a confidence interval percentage relative to the mean value.

Under the BCR STANDARD (V 4.0, 2024), uncertainty management depends on the accuracy of maps to estimate the values and determine appropriate discounts for emission factors. The data collected requires a precision level above 90%, assessed through field observations or high-resolution image analysis (e.g., 10 m, Sentinel). An uncertainty level of up to 10% is acceptable for emission factors for average carbon values (evaluated by reservoir). If uncertainty exceeds 10%, the lower bound of the 95% confidence interval must be applied.

In this project, we estimate or calculate independent uncertainty values for each of its components: natural forests, savannas, and wetlands. This approach is a strategy for managing uncertainty, as it avoids using a single value for all components. By recognizing each ecosystem's unique characteristics and dynamics, we can better address their specific uncertainties, leading to more accurate assessments and informed decision-making.

3.5.1 Savannas and wetlands

The project used CORINE Land Cover maps from 2005-2009 (IDEAM, 2010) and 2018 (IDEAM, 2020), which are official data on land cover in the national territory[107]. If the range of the first map is four years (2005-2009), the year 2008 falls within this period. The map covers the changes in land cover that occurred between 2005 and 2009, making 2008 a valid year within that range.

The Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) adopted, adapted, and standardized Colombia's CORINE Land Cover methodology[108]. This approach enables the association and comparison of land cover data at an international level and supports multi-temporal analyses, establishing it as the national standard[109]. The maps are generated using satellite imagery, primarily from Landsat 7 and 5, with field verification for land cover changes exceeding 5 hectares[110]. The technical guidelines follow the CORINE Land Cover methodology and legend[111], adapted for Colombia. Uncertainty was calculated at a rate of 6.25% using the BCR Savannas and Wetlands methodology.

On the other hand, we used Equation 3-2 to calculate the confidence intervals for the emission factors in the land use change analysis.

Equation 3-2. Confidence intervals

$$IC = \bar{x} \pm \frac{t\alpha}{2(ns)}$$

[107] INSTITUTO DE HIDROLOGÍA, METEOROLOGÍA Y ESTUDIOS AMBIENTALES (IDEAM). Coberturas Nacionales. [En línea]. In: https://www.ideam.gov.co/web/ecosistemas/coberturas-nacionales. [Consulted: 12/07/2024].
[108] INSTITUTO DE HIDROLOGÍA, METEOROLOGÍA Y ESTUDIOS AMBIENTALES (IDEAM). Coberturas Nacionales. [En línea]. In http://www.ideam.gov.co/web/ecosistemas/coberturas-nacionales. [Consulted: 12/07/2024].
[109] IDEAM. Leyenda Nacional de Coberturas de la Tierra. Metodología CORINE Land Cover adaptada para Colombia Escala 1:100.000. Instituto de Hidrología, Meteorología y Estudios Ambientales. 2010. Bogotá, D. C., 72p.
[110] IDEAM, Coberturas Nacionales, p 90
[111] IDEAM, Leyenda Nacional de Coberturas de la Tierra, p 90

Where:

- x̄ is the average of the emission factor.
- tα/2t is the critical t-value for a confidence level (95%).
- s is the standard deviation of the measurements.
- n is the number of measurements.

Then, we used relative uncertainty propagation, calculated as a weighted mean of the emission factor, to calculate the total combined uncertainty of emission factors for various components (such as aboveground biomass, litter, and roots; Equation 3-3, Equation 3-4).

Equation 3-3. Reference Emission Factor Uncertainty

$$RU = \left(\frac{Maximum\ Value - Minimum\ Value}{(2 \times Average\ Value)}\right) \times 100$$

Equation 3-4. Total Relative Uncertainty

$$TRU = \sqrt{\left(\left(\frac{C_1}{C_{Total}}\right) RU1\right)^2 + \left(\left(\frac{C_2}{C_{Total}}\right) RU2\right)^2 + \left(\left(\frac{C_3}{C_{Total}}\right) RU3\right)^2} + \cdots$$

The uncertainty analysis resulted in a total relative uncertainty value of 11.06%, making the average carbon source values acceptable under the Savannas methodology's uncertainty management guidelines, as it is above the 10% threshold using the lower value of the CI of 95% (See Table 3-11).

Table 3-11. Uncertainty of carbon source to the herbs and shrubs strata with the lower bound of the 95% confidence interval applied

Variable	Stratum	Mean	CI	UR
AGB	Natural Savannas	1.641	0.31154753	18.98522
AGB LL	Natural Savannas	0.914	0.09989649	10.92959
TRU	**Natural Savannas**			**11.06625**

Source: Sahbio Carbono, 2024

3.5.2 Redd +

This project used the Corine Land Cover maps from 2005-2009[112] and 2018[113], developed by IDEAM, which are official data on land cover in the national territory. Therefore, calculating uncertainty for activity data, that is, for quantifying forest cover area and change, is unnecessary for the 10-year analysis period.

The Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) adopted, adapted, and standardized Colombia's CORINE Land Cover methodology[114]. This approach enables the association and comparison of land cover data at an international level and supports multi-temporal analyses, establishing it as the national standard[115]. The maps are generated using satellite imagery, primarily from Landsat 7 and Landsat 5, with field verification for land cover changes exceeding 5 hectares[116]. The technical guidelines follow the CORINE Land Cover methodology and legend[117], adapted for Colombia. Uncertainty was calculated at a rate of 6.25% using the BCR Savannas and Wetlands methodology.

We used Equations 3, 3, and 4 to calculate the uncertainty for the emission factors in the deforestation analysis. To estimate the total aboveground biomass and carbon percentage for Tropical Moist Forests, we relied on the study by Phillips et al. (2011)[118], which assessed current carbon stocks in Colombia's natural forests.

We focused exclusively on the AGB leaf litter data we sampled for the uncertainty analysis. The total relative uncertainty was calculated at 10.88%, which meets the uncertainty management guidelines established by the REDD+ methodology. This is

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[112] Ideam, Leyenda Nacional de Coberturas de la Tierra, p 50.

[113] Castellanos, Mapa Nacional de Coberturas de la Tierra, periodo 2018, p 50.

[114] INSTITUTO DE HIDROLOGÍA, METEOROLOGÍA Y ESTUDIOS AMBIENTALES (IDEAM). Coberturas Nacionales. [En línea]. In http://www.ideam.gov.co/web/ecosistemas/coberturas-nacionales. [Consulted: 12/07/2024].

[115] IDEAM. Leyenda Nacional de Coberturas de la Tierra. Metodología CORINE Land Cover adaptada para Colombia Escala 1:100.000. Instituto de Hidrología, Meteorología y Estudios Ambientales. 2010. Bogotá, D. C., 72p.

[116] IDEAM, Coberturas Nacionales, p 90

[117] IDEAM, Leyenda Nacional de Coberturas de la Tierra, p 90

[118] Phillips J.F., Duque A.J., Yepes A.P., Cabrera K.R., García M.C., Navarrete D.A., Álvarez E., Cárdenas D. Estimación de las reservas actuales (2010) de carbono almacenadas en la biomasa aérea en bosques naturales de Colombia. Estratificación, alometría y métodos análiticos. Instituto de Hidrología, Meteorología, y Estudios Ambientales -IDEAM-. 2011 Bogotá D.C., Colombia. 68 pp.

because the value is at the limit of the 10% threshold based on the lower limit of the 95% confidence interval (see Table 3.12).

Table 3-12. Uncertainty of carbon sources to forest with the lower bound of the 95% confidence interval applied

Stratum	**Carbon Source**	Mean	**CI**	**Relative Uncertainty %**
Forest+	AGB LL	2.92	0.32	10.88

**Source: Sahbio Carbono, 2024*

3.6 Leakage and non-permanence

Following the methodologies outlined in BCR0002 and BCR0005, a systematic approach was employed to quantify and manage the risk of leakage within the project. This approach involves identifying potential sources of leakage and estimating their impact on project outcomes. Key parameters include the project area and a designated leakage area, set at 9.99% of the eligible area for the sum of savanna and REDD+ projects. The relevant equations for this assessment typically calculate expected emissions reductions against potential increases in emissions due to displacement effects. For example, if a project reduces emissions by a specific amount, the leakage calculation will account for any corresponding increase in emissions in surrounding areas, ensuring that the project's net benefits remain positive. We can track these dynamics over time by implementing rigorous monitoring and verification protocols and maintaining transparency and accountability.

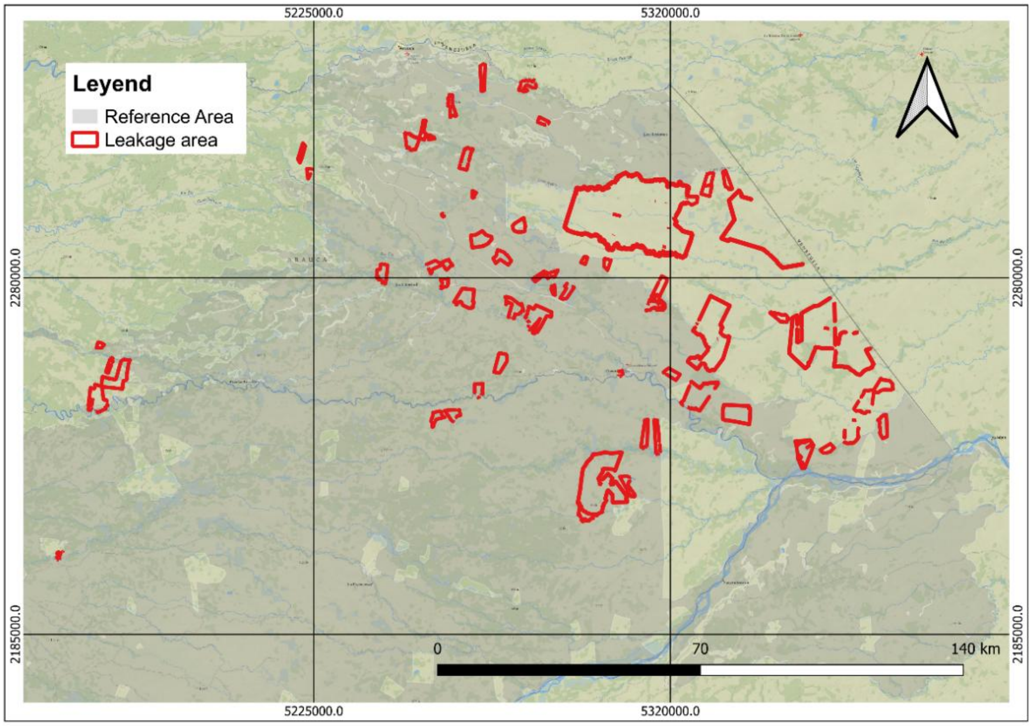

Figure 3-9. The leakage area (location) for the Sahbio Carbono Project. This area accounts for the potential displacement of activities that could lead to carbon emissions outside the project boundaries.

Source: Sahbio Carbono, 2024

Understanding land use change dynamics in savannas and wetlands and the potential displacement of deforestation activities in REDD+ projects is crucial for justifying the 10% leakage area designated for our project (see Figure 3-9). Research indicates that conservation initiatives may unintentionally prompt local communities or industries to shift their activities to adjacent areas, resulting in increased deforestation or land use changes outside the project's boundaries. This phenomenon, known as leakage, can arise from various factors, including market effects and the mobility of displaced activities. For instance, if a project successfully reduces logging in one area, it may inadvertently increase pressure on nearby forests if demand for timber remains unchanged, ultimately leading to a net loss of carbon benefits.

Causes of leakage can be categorized into two main types: Activity displacement and market effects. Activity displacement occurs when individuals or businesses relocate their operations outside the project area to continue practices such as logging or agriculture. Market effects arise when reduced resource availability within the project area leads to increased exploitation elsewhere. The design of conservation projects plays a significant role in influencing these outcomes. Well-designed projects incorporating community engagement and alternative livelihood strategies can mitigate these risks effectively. Ensuring the permanence of project activities is essential for sustaining carbon benefits over time. Continuous monitoring and verification will evaluate whether project activities adhere to established standards.

We will report the ex-ante emissions value associated with leakage to provide a baseline for understanding potential emissions from the project's implementation. This information is vital for assessing the overall effectiveness of our efforts in reducing greenhouse gas emissions. A summary table will consolidate estimated leakages for each property, facilitating clear comparisons across different properties and enhancing planning and management of the project's environmental impacts (See Annex xxx Calculations).

Leakage areas correspond to 10% of the eligible area within each farm. For example, if the eligible area is 100 hectares, the leakage area accounts for 10 hectares. This designated portion is strategically located along the property's periphery to account for the potential displacement of activities that could lead to unintended emissions outside the project boundaries.

3.6.1 Savannas and Wetlands

These areas play a significant role in carbon sequestration. Natural Flooded savannas offer unique opportunities for carbon storage through their rich organic soil and water retention capabilities. The leakage area selected for natural savannas and wetlands was 10% of the eligible areas of the project (See Table 3-13).

3.6.2 REDD+

The initiative addresses the movement of deforestation agents outside the control of the project by recognizing that such displacement can lead to increased emissions elsewhere. The methodology ensures that overall emissions reductions are accurately represented by accounting for this leakage effect—estimated at 10% of the eligible project area. This proactive approach helps mitigate potential negative impacts on surrounding ecosystems while reinforcing the project's commitment to sustainable land management practices. The leakage area selected for the forest was 10% of the eligible areas of the project (See Table 3-13).

Table 3-13. The leakage area (in hectares) for the Sahbio Carbono Project represents the land where emissions may shift due to land use change and deforestation prevention *efforts. This area accounts for the potential displacement of activities that could lead to carbon emissions outside the project boundaries.*

Coverage	Leakage area 2021 Ha
Natural Savannas	9,921.29
Wetland zones	318.31
REDD+ Forest	3,174.65

Source: Sahbio Carbono, 2024

3.7 Mitigation results

3.7.1 Eligible areas within GHG project boundaries (AFOLU sector projects)

The areas within the geographical boundaries of the SAHBIO Carbono Project align with the required land cover and land use categories as defined by the project's methodology[119] [120]. These areas have been classified according to national land use definitions[121], ensuring compliance with the country's regulatory framework. These classifications incorporate the region's ecological and socio-economic characteristics, accurately reflecting land use categories according to national and international standards. Table 3-14 presents the eligible areas within the project boundaries, and Figure 3-10 shows their spatial distribution.

Table 3-14. Eligible area of the Sahbio Carbono Project

Eligible Area (Ha)	
Natural Savannas and Wetlands	131,717.79
REDD + Forest	11,622.96
Total	143,340.76

Source: Sahbio Carbono, 2024

We selected a cartographic scale of 1:100,000 for the multi-temporal land cover and land use analysis for its balance of detail and regional applicability over the 2008 to 2018 period. This scale captures land cover changes accurately over time and aligns with

[119] Biocarbon Credi®. Quantification Of Ghg Emission Reductions Redd+ Projects, p 32.
[120] Biocarbon Credi®. Quantification Of Ghg Emissions Reduction Activities That Prevent Land Use Change in Natural Savannas. P 32.
[121] Ideam, Leyenda Nacional de Coberturas de la Tierra, p 50.

national land cover classifications[122], [123], [124]. It also enables comparisons with other datasets, enhancing the reliability of the analysis. Land cover and land use types were identified using national classifications and region-specific data, considering methodological requirements and practical aspects of mapping in the Orinoquia.

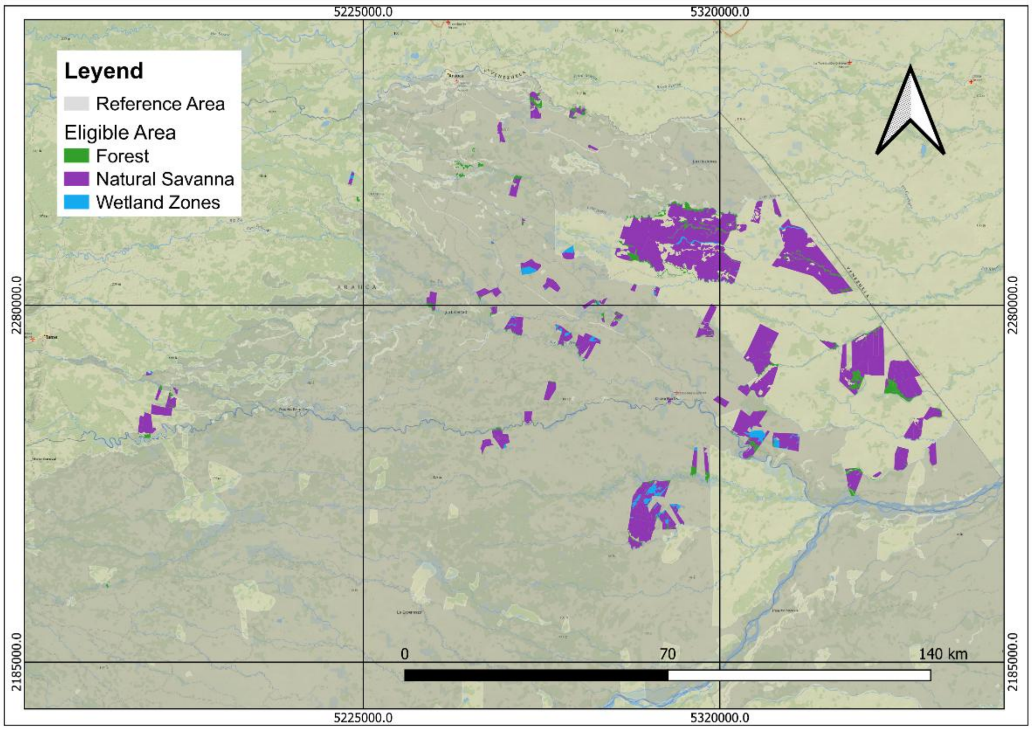

Figure 3-10. Map of the Eligible Areas for the Sahbio Project

Source: Sahbio Carbono, 2024

We processed all datasets and analyzed them in alignment with international standards set by ISO, OGC, and the American Society for Photogrammetry and Remote Sensing (ASPRS) to ensure the accuracy and reliability of the geographic data. These standards govern geographic data handling to meet technical and quality benchmarks.

[122] Ideam, Leyenda Nacional de Coberturas de la Tierra, p 50
[123] Castellanos, Mapa Nacional de Coberturas de la Tierra, periodo 2018, p 50
[124] IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales). Cobertura de la Tierra Metodología CORINE Land Cover Adaptada para Colombia Periodo 2020 límite administrativo. República de Colombia. Escala 1:100.000. 2024. https://visualizador.ideam.gov.co/geonetwork/srv/spa/catalog.search#/metadata/3800e520-6f89-475a-96e9-d1a24036cecb (consulted 09/09/2024).

Data acquisition, processing, and analysis methods follow best practices, ensuring that the project upholds high standards for geographic data management. Eligible areas include natural flooded savanna ecosystems designated for the Activities that Prevent Land Use Change in Natural Savannas program and Forest Ecosystems for the REDD+ program, which aims to prevent land and forest use change. These areas lie within the project boundaries (project properties) and have remained unaltered since the project's start date and at least five years prior.

3.7.2 Direct Carbon Estimation in Natural Savannas, Swampy Areas, and Forests

We conducted the Carbon estimation in the selected deposits to determine the emission factors. The sampling plan was first established based on the project vegetation strata. We did fieldwork, laboratory work, and final data analysis.

3.7.2.1 Measure plan and sample points

We developed a measurement plan based on regional representativeness project boundaries vegetation soil type (See Figure 3-11; We collected sampling points for three vegetation types: Natural Savannas (flooded and non-flooded), wetlands, and forests. We gather data on biomass for various ecosystem compartments to calculate emission factors. The sampling included 151 points of aboveground biomass, leaf litter, and soil organic carbon across seasonally flooded and non-flooded grasslands (highlands, lowlands, and wetland areas); fine root (less than 2 mm diameter) biomass was also measured but discarded from this analysis because it was highly variable.

For natural forests, we used data from the 2010 official estimate of carbon stocks stored in aboveground biomass in Colombia's natural forests to estimate emission factors. This study assigns an aboveground biomass for different forest types using a stratification legend based on Holdridge's life zones, adapted for Colombia. The official maps classify forests in the project area as "tropical humid forests." These forests are defined as those at altitudes below 800 meters, with temperatures above 24°C and annual rainfall between 2000 and 4000 mm. This category includes dense, open, and gallery forests. The SAHBIO Carbono team also collected 55 leaf litter and soil samples in forests across the project areas and in representative locations.

Table 3-15).

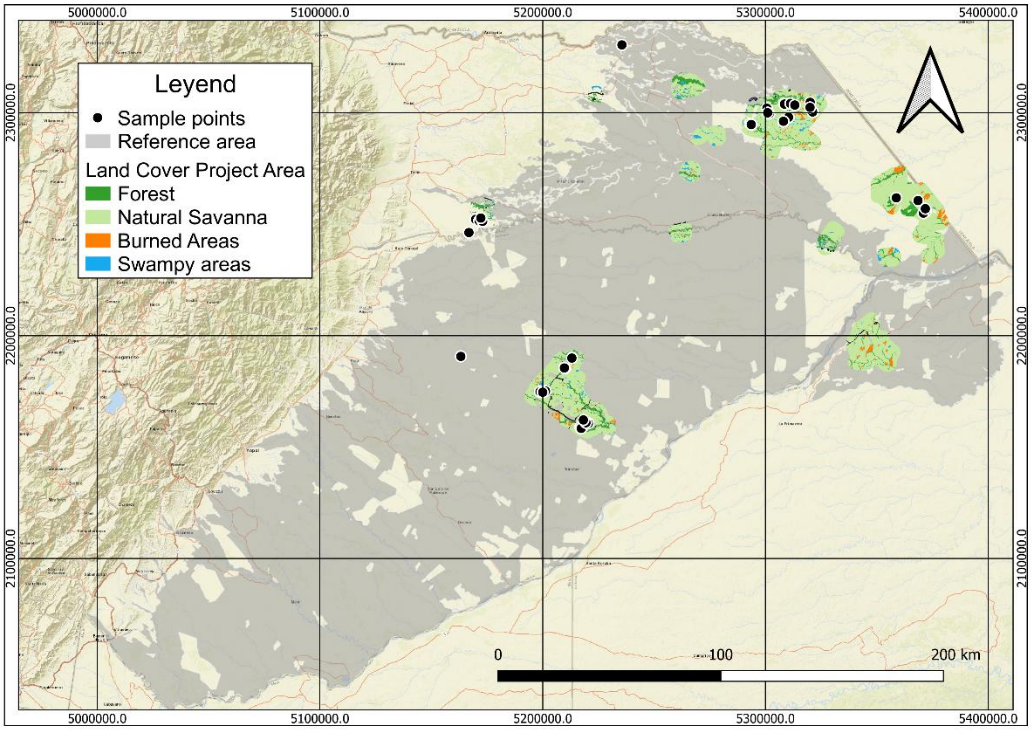

Figure 3-11. Sample points within the project area

Source: Sahbio Carbono, 2023

We collected sampling points for three vegetation types: Natural Savannas (flooded and non-flooded), wetlands, and forests. We gather data on biomass for various ecosystem compartments to calculate emission factors. The sampling included 151 points of aboveground biomass, leaf litter, and soil organic carbon across seasonally flooded and non-flooded grasslands (highlands, lowlands, and wetland areas); fine root (less than 2 mm diameter) biomass was also measured but discarded from this analysis because it was highly variable.

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Table 3-15. Sampling points in Natural Savannas, Wetlands, and Forests in the SAHBIO Carbono project area. Coordinates are in Magna Sirgas Origen Nacional for Colombia

Number	Coordinate X	Coordinate Y	Elevation	Strata
1	5201032.64	2175203.575	94.650536	Natural Grassland
2	5201070.05	2175177.93	94.95845	Natural Grassland
3	5201141.104	2175122.542	96.66597	Natural Grassland
4	5201186.605	2175131.744	96.66597	Natural Grassland
5	5201260.48	2175094.833	99.474503	Natural Grassland
1	5198781.959	2174769.609	107.181656	Natural Grassland
2	5198839.547	2174772.768	110.941925	Natural Grassland
3	5198886.502	2174810.06	111.389801	Natural Grassland
4	5198902.88	2174852.559	112.518814	Natural Grassland
5	5198969.741	2174828.884	113.330582	Natural Grassland
1	5171391.324	2251413.116	155.337357	Natural Grassland
2	5171391.324	2251413.116	155.337357	Natural Grassland
3	5171414.618	2251467.906	157.091522	Natural Grassland
4	5171384.729	2251473.784	157.502075	Natural Grassland
5	5171352.565	2251502.652	158.537781	Natural Grassland
1	5172949.606	2251300.017	172.160599	Natural Grassland
2	5172982.84	2251320.019	173.756149	Natural Grassland
3	5173014.013	2251325.189	175.211731	Natural Grassland
4	5173011.226	2251370.507	176.350067	Natural Grassland
5	5172991.417	2251409.798	176.835266	Natural Grassland
6	5173026.528	2251431.241	177.572388	Natural Grassland
1	5198982.632	2174851.477	152.528824	Natural Grassland
2	5198912.308	2174847.723	155.934525	Natural Grassland
3	5198861.899	2174816.397	159.676132	Natural Grassland
4	5198839.282	2174786.593	161.169037	Natural Grassland
5	5198775.142	2174751.899	160.86113	Natural Grassland
1	5210076.52	2185282.982	193.481232	Natural Grassland
2	5210058.081	2185300.945	191.941666	Natural Grassland
3	5210076.967	2185316.483	192.734772	Natural Grassland
4	5210069.774	2185347.197	193.005356	Natural Grassland
5	5210056.823	2185378.773	191.829697	Natural Grassland
1	5209818.298	2185506.347	189.739624	Natural Grassland
2	5209788.6	2185509.79	189.851593	Natural Grassland
3	5209760.745	2185494.446	189.65564	Natural Grassland
4	5209735.292	2185488.496	189.03981	Natural Grassland
5	5209735.292	2185488.496	189.03981	Natural Grassland
5	5217437.957	2158381.905	160.226639	Natural Grassland
4	5217411.952	2158373.425	160.823807	Natural Grassland
3	5217384.411	2158357.85	161.532928	Natural Grassland
2	5217351.849	2158352.444	161.262344	Natural Grassland
1	5217330.909	2158354.368	162.45668	Natural Grassland
5	5220515.791	2160700.959	174.810516	Natural Grassland

Number	Coordinate X	Coordinate Y	Elevation	Strata
4	5220506.589	2160669.531	175.528976	Natural Grassland
2	5220499.569	2160613.116	177.460434	Natural Grassland
3	5220503.468	2160641.552	177.152512	Natural Grassland
1	5220496.014	2160584.367	178.141571	Natural Grassland
5	5219400.273	2160804.311	180.40892	Natural Grassland
4	5219407.595	2160834.185	182.732269	Natural Grassland
3	5219415.589	2160863.181	183.730652	Natural Grassland
2	5219421.16	2160888.962	184.654388	Natural Grassland
1	5219420.385	2160921.135	185.39151	Natural Grassland
5	5218289.085	2162025.029	186.240601	Natural Grassland
4	5218287.552	2162053.66	186.85643	Natural Grassland
3	5218286.792	2162081.515	186.949738	Natural Grassland
2	5218289.69	2162109.724	187.378952	Natural Grassland
1	5218286.048	2162138.672	187.481583	Natural Grassland
1	5169813.034	2252057.003	212.021317	Natural Grassland
2	5169827.533	2252092.087	215.221741	Natural Grassland
3	5169842.754	2252108.605	214.708542	Natural Grassland
4	5169868.997	2252134.986	216.490707	Natural Grassland
5	5169889.949	2252157.155	217.535751	Natural Grassland
1	5171514.793	2251405.299	228.238052	Natural Grassland
2	5171507.066	2251434.907	229.199112	Natural Grassland
3	5171498.151	2251458.748	229.730957	Natural Grassland
4	5171479.499	2251483.126	229.674973	Natural Grassland
5	5171479.499	2251483.126	229.674973	Natural Grassland
1	5172936.893	2251297.663	227.939468	Natural Grassland
2	5172962.113	2251296.96	227.444946	Natural Grassland
3	5172991.526	2251301.801	228.191391	Natural Grassland
4	5173019.538	2251291.053	228.33136	Natural Grassland
5	5173044.556	2251283.614	228.340683	Natural Grassland
1	5172298.307	2252722.055	188.041428	Natural Grassland
2	5172281.015	2252697.905	189.795609	Natural Grassland
3	5172257.621	2252677.164	190.50473	Natural Grassland
4	5172241.519	2252698.343	191.773712	Natural Grassland
5	5172227.269	2252729.478	192.370865	Natural Grassland
1	5300755.793	2301966.62	130.387085	Natural Grassland
2	5300746.456	2301995.22	130.499054	Natural Grassland
3	5300722.011	2302016.986	130.900269	Natural Grassland
4	5300693.428	2302024.245	130.722992	Natural Grassland
5	5300657.542	2302014.532	132.337204	Natural Grassland
1	5301633.728	2299602.43	134.324646	Natural Grassland
2	5301663.69	2299604.145	133.055664	Natural Grassland
3	5301689.577	2299583.379	134.427277	Natural Grassland
4	5301714.867	2299570.14	133.792786	Natural Grassland
5	5301742.875	2299584.677	134.110031	Natural Grassland

Number	Coordinate X	Coordinate Y	Elevation	Strata
1	5308597.369	2303748.005	175.659607	Natural Grassland
2	5308590.454	2303777.065	176.536682	Natural Grassland
3	5308585.955	2303809.894	176.853928	Natural Grassland
4	5308580.47	2303840.065	177.105865	Natural Grassland
5	5308577.192	2303871.798	177.105865	Natural Grassland
1	5313136.9	2303360.849	177.973618	Natural Grassland
2	5313146.785	2303392.325	176.779282	Natural Grassland
3	5313167.778	2303415.575	175.91153	Natural Grassland
4	5313192.229	2303432.419	176.751297	Natural Grassland
5	5313216.894	2303452.259	176.685974	Natural Grassland
1	5321194.366	2300465.985	136.713303	Natural Grassland
2	5321187.889	2300438.616	138.812698	Natural Grassland
3	5321196.898	2300411.014	139.568481	Natural Grassland
4	5321197.717	2300385.57	140.520218	Natural Grassland
5	5321193.576	2300356.778	142.433014	Natural Grassland
1	5321193.576	2300356.778	142.433014	Natural Grassland
2	5320052.506	2302310.469	143.5870163	Natural Grassland
3	5320047.366	2302337.915	144.9742901	Natural Grassland
4	5320043.13	2302368.317	146.361564	Natural Grassland
5	5320048.676	2302396.748	147.7488378	Natural Grassland
1	5293279.893	2295081.332	156.0724807	Natural Grassland
2	5293253.695	2295085.432	157.4597545	Natural Grassland
3	5293253.695	2295085.432	157.4597545	Natural Grassland
4	5293183.724	2295105.336	158.8470284	Natural Grassland
5	5293152.93	2295107.014	160.2343022	Natural Grassland
1	5293742.751	2294673.974	161.621576	Natural Grassland
2	5293715.302	2294670.692	163.0088498	Natural Grassland
3	5293681.199	2294670.693	164.3961236	Natural Grassland
4	5293654.291	2294685.439	167.1706713	Natural Grassland
5	5293628.164	2294694.56	168.5579451	Natural Grassland
1	5308196.129	2296130.522	183.8179571	Natural Grassland
2	5308175.021	2296146.629	185.205231	Natural Grassland
3	5308150.423	2296160.503	186.5925048	Natural Grassland
5	5308127.09	2296178.994	187.9797786	Natural Grassland
4	5308111.003	2296154.748	189.3670524	Natural Grassland
1	5358798.756	2261790.462	162.261	Natural Grassland
2	5368585.954	2260577.951	156.942	Natural Grassland
3	5368531.858	2260551.81	157.689	Natural Grassland
4	5368610.772	2260592.714	156.018	Natural Grassland
5	5368559.794	2260563.94	156.308	Natural Grassland
1	5358691.665	2261829.634	161.216	Natural Grassland
2	5358725.882	2261828.633	161.71	Natural Grassland
3	5358747.065	2261823.673	161.71	Natural Grassland
4	5358774.933	2261810.786	161.71	Natural Grassland

Number	Coordinate X	Coordinate Y	Elevation	Strata
5	5358796.762	2261791.664	162.419	Natural Grassland
1	5370960.459	2254902.702	129.949	Natural Grassland
2	5370936.154	2254962.101	133.877	Natural Grassland
3	5370916.479	2255059.495	137.59	Natural Grassland
4	5370937.731	2254991.225	137.768	Natural Grassland
5	5370948.758	2254930.748	132.132	Natural Grassland
1	5371884.671	2256832.239	146.613	Natural Grassland
2	5371888.352	2256861.6	147.22	Natural Grassland
3	5371870.019	2256887.265	148.517	Natural Grassland
4	5371848.711	2256912.261	150.271	Natural Grassland
5	5371830.384	2256936.934	151.316	Natural Grassland
1	5219419.135	2160727.863	82.156738	Forest
2	5219375.839	2160753.484	80.486549	Forest
3	5219344.864	2160774.168	79.861389	Forest
4	5219305.292	2160811.181	78.956314	Forest
5	5219238.169	2160940.211	79.506828	Forest
1	5171355.367	2252874.348	188.741226	Forest
2	5171312.463	2252870.348	190.933945	Forest
3	5171287.162	2252861.211	191.363159	Forest
4	5171267.873	2252875.636	191.540436	Forest
5	5171239.305	2252886.494	192.230911	Forest
5	5199926.616	2174612.253	157.632706	Forest
4	5199946.815	2174597.952	157.632706	Forest
3	5199970.664	2174586.526	157.632706	Forest
2	5199997.939	2174577.982	157.632706	Forest
1	5200028.213	2174566.029	157.632706	Forest
5	5216890.368	2159004.585	150.252136	Forest
4	5217170.949	2158342.349	153.303268	Forest
3	5217187.88	2158348.039	153.303268	Forest
2	5217227.108	2158348.166	153.303268	Forest
1	5217239.902	2158366.676	153.303268	Forest
5	5172403.934	2252795.993	183.040176	Forest
4	5172394.715	2252809.78	183.040176	Forest
3	5172381.262	2252831.736	183.040176	Forest
2	5172360.392	2252819.517	183.040176	Forest
1	5172333.704	2252831.047	183.040176	Forest
1	5301032.004	2300049.002	136.03215	Forest
2	5301010.694	2300043.468	136.713303	Forest
3	5300998.718	2300028.129	136.713303	Forest
4	5301011.471	2300003.758	136.713303	Forest
5	5301028.282	2299982.941	138.784714	Forest
1	5311235.034	2304097.625	178.981323	Forest
2	5311249.082	2304116.401	178.776047	Forest
3	5311265.206	2304139.947	178.776047	Forest

Number	Coordinate X	Coordinate Y	Elevation	Strata
4	5311281.576	2304159.404	178.776047	Forest
5	5311265.776	2304176.024	178.776047	Forest
1	5320103.829	2304546.687	136.228104	Forest
2	5320116.859	2304569.338	136.228104	Forest
3	5320122.398	2304604.445	136.228104	Forest
4	5320122.933	2304626.687	136.228104	Forest
5	5320131.034	2304658.156	136.237427	Forest
1	5293810.038	2294673.599	149.1361116	Forest
2	5293830.243	2294652.69	150.5233854	Forest
3	5293851.173	2294634.366	151.9106593	Forest
4	5293876.48	2294624.546	153.2979331	Forest
5	5293911.29	2294595.972	154.6852069	Forest
1	5308123.883	2296061.521	169.9452189	Forest
2	5308102.72	2296054.763	171.3324928	Forest
3	5308089.016	2296033.112	172.7197666	Forest
4	5308063.686	2296013.424	174.1070404	Forest
5	5308053.854	2295991.611	175.4943142	Forest
1	5372046.06	2255678.994	115.169	Forest
2	5372021.939	2255657.805	116.83	Forest
3	5371995.004	2255609.487	118.845	Forest
4	5371998.801	2255639.73	118.845	Forest
5	5371969.299	2255593.595	121.551	Forest
1	5321523.658	2300355.964	133.074326	Swampy Areas
2	5321496.018	2300371.621	133.47554	Swampy Areas
3	5321464.367	2300374.317	133.596848	Swampy Areas
4	5321438.498	2300372.726	133.699478	Swampy Areas
5	5321410.993	2300365.812	133.410233	Swampy Areas
1	5310526.644	2297931.433	176.881588	Swampy Areas
2	5310498.36	2297945.1	178.2688619	Swampy Areas
3	5310469.569	2297950.652	179.6561357	Swampy Areas
4	5310438.571	2297955.269	181.0434095	Swampy Areas
5	5310408.304	2297960.997	182.4306833	Swampy Areas

Source: Sahbio Carbono, 2023

In the flooded savannas, we established a 150-meter linear transect for each vegetation and soil type, collecting samples at intervals of 30 meters. This spacing was designed to capture the variability in vegetation and soil characteristics while reducing the risk of spatial autocorrelation between samples. We measured above-ground herbaceous vegetation and leaf litter at each point from one m^2 area quadrant (Photograph 3 1). Soil samples were collected from the center of each quadrant using a soil corer to a depth of 30 cm to analyze soil organic carbon content.

Photograph 3-1. One square meter quadrant for herbaceous vegetation and leaf litter samples

Source: Sahbio Carbono

Similarly, for the REDD+ program, we used a 150 m linear transect, collecting five samples per transect. At each sampling point, we gathered leaf litter from one square meter quadrant and took soil samples from the center of each quadrant to a depth of 30 cm depth to assess soil organic carbon content.

Photograph 3-2. Use of drilling for soil samples and analysis of organic carbon and fine roots

Source: Sahbio Carbono

3.7.2.2 Lab analysis

We dried the herbaceous vegetation and leaf litter samples in an oven at 60°C until reaching a constant weight to determine aboveground dry biomass (See Attachment XXX).

We also dried soil samples at 60°C to ensure proper preservation and stop decomposition before shipping them for analysis. Then, the samples were sieved through a 2 mm mesh to extract fine roots. Finally, the samples were sent to the National Soil Laboratory at IGAC to analyze Easily Oxidizable Organic Carbon (See Attachment XXX).

3.7.3 Natural Savannas and Wetlands

3.7.3.1 Stratification

The naturally flooded savannas in the project's reference region fall into two primary strata: Wetland zones and Natural Grasslands. Various land covers within these strata undergo transformations impacting ecosystem development (See Table 3-16).

Table 3-16. Stratification of natural savanna vegetation and swampy areas

Stratum	Stratum Description	Corine Land Cover related	Coverage Description
Wetland zones	All types of macrophytes associated with freshwater wetlands	Swampy Areas	This coverage includes lowlands that typically remain flooded for most of the year. These areas may consist of flowing watercourses, floodplains, ancient floodplains, and natural depressions where the water table surfaces permanently or seasonally. They also feature hollows where water naturally collects and stagnates, often with muddy bottoms. Within these swamps, there may be small water bodies, some partially covered by aquatic vegetation, each less than 25 hectares in size and collectively comprising less than 30% of the swamp's total area.

Stratum	Stratum Description	Corine Land Cover related	Coverage Description
		Aquatic vegetation on water bodies	This category includes all floating vegetation on water bodies, covering them partially or entirely. It encompasses classified vegetation types such as Pleustophyta, Rizophyta, and Haptophyta. In Colombia, this coverage is associated with eutrophying Andean lakes, lagoons, and water bodies in lowland floodplains.
	Aquatic Vegetation on Water Bodies	Lagoons, lakes, and natural swamps	This category includes natural water bodies or deposits, either open or enclosed, freshwater or brackish, which may or may not connect with a river or the sea. In the Andean region, water bodies (lakes and lagoons) located in high mountains serve as the headwater for rivers. In floodplains, water bodies known as "ciénagas" form and are associated with the overflow areas of large rivers. These "ciénagas" may contain small sandy and muddy islets, irregularly shaped and fragmented, which are included within the water body as long as they do not exceed 30% of its total area.
Natural Grassland	Vegetation units are dominated by plants with a height of 0.3 to 1.5 m	Dense shrubland	Coverage consists of a plant community dominated by typically shrubby elements, forming an irregular canopy, representing more than 70% of the total area of the unit.
		Open shrubland	Coverage consists of a plant community dominated by regularly distributed shrub elements, which form a discontinuous canopy stratum and whose cover represents between 30% and 70% of the total area of the unit.

Stratum	Stratum Description	Corine Land Cover related	Coverage Description
		Dense floodable grassland	It corresponds to a natural cover of dense grassland, which develops in areas subject to periods of flooding, which may or may not present scattered trees or shrub elements.
		Dense floodable grassland without trees	It corresponds to those surfaces dominated by natural herbaceous vegetation with coverage greater than 70% of the total area of the unit in permanently oversaturated soils, which during rainy periods (4-8 months a year in the rainy season from April to November) may be covered by a sheet of water.
		Dense floodable grassland with trees	It corresponds to surfaces dominated by natural herbaceous vegetation with dispersed tree or shrub elements that occupy 2% to 30% of the total area of the unit in soils that remain flooded or waterlogged most of the year.
		Open rocky grassland	It corresponds to areas dominated by open herbaceous natural vegetation that cover between 30% and 70% of the total area of the unit. They develop in areas with predominantly rocky and stony substrates that do not retain moisture.
		Open sandy grassland	These are areas dominated by open herbaceous natural vegetation that cover between 30% and 70% of the total area of the unit. They develop in areas of sandy soil that do not retain moisture.

Source: Sahbio Carbono, 2024. Ideam, 2010

3.7.3.2 GHG emissions reduction/removal in the baseline scenario

We used the above-mentioned land cover categories to analyze changes in natural vegetation cover within the reference region. We conducted a multitemporal land cover change analysis using land cover data based on Colombia's CORINE Land Cover methodology for 2008 and 2018[125]. We cited the results of this analysis in chapter 3.3. We quantified the various land covers specified in the previous table and negative changes as strata transformed into any covered classified as Transformed (See Table 3-17).

We followed the steps outlined in the methodology, BCR 0005 "Quantification of GHG Emission Reductions —Activities that Prevent Land Use Change in Natural Savannas," to determine annual historical changes in the reference region and project area (Table 3-17). We presented the results in xxx and the project's calculation sheet.

Table 3-17. Natural Covers Associated with Natural Savannas and Wetlands and Covers Defined as Transformed

Natural Coverage	Area Ha 2008	Transformed coverage	Area Ha 2018
Natural Grassland + Wetland zones	3,397,060.66	Converted to Other Natural Land Covers	220,691.43
		Converted to Non-Natural Land Covers	
		Continuous urban fabric	136.2
		Discontinuous urban fabric	159.62
		Industrial or commercial areas	158.27
		Airports	16.2
		Mining extraction areas	106.47
		Urban green areas	0.07
		Other temporary crops	13,408.47
		Cereals	65,676.78
		Permanent herbaceous crops	666.54
		Permanent tree crops	32,592.07
		Clean pastures	316,881.81
		Tree-covered pastures	2,127.39
		Overgrown pastures	26,516.72
		Crop mosaic	4,024.17

[125] Ideam, Leyenda Nacional de Coberturas de la Tierra, p 50., Castellanos, Mapa Nacional de Coberturas de la Tierra, periodo 2018, p 50

Natural Coverage	Area Ha 2008	Transformed coverage	Area Ha 2018
		Pasture and crop mosaic	39,673.18
		Mosaic of crops, pastures, and natural spaces	7,770.38
		Pasture mosaic with natural spaces	78,379.07
		Crop mosaic with natural spaces	116.53
		Forest plantation	2,382.22
		Secondary or transitional vegetation	22,534.91
		Artificial water bodies	41.3
Totals			**834,059.80**

Source: Sahbio Carbono, 2024 Ideam, 2010

3.7.3.2.1.1 Annual historical changes in the reference area

We estimate the historical land use change in the reference area using Equation 3-5.

Equation 3-5. Annual historical changes in the reference area

$$SCNC_{yr} = \left(\frac{1}{t_2 - t_1} ln \frac{A_2}{A_1}\right) x \, A_p$$

Where:

SCNCyr = Change in the area under natural vegetation cover in the without project scenario; ha/yr

T2 = Final year of the reference period, year

T1 = Initial year of the reference period,

A1 = Area in natural vegetation cover of the reference area in t1; ha

A2 = Area in natural vegetation cover in the reference area in t2; ha

Ap = Eligible area: ha

We used the SCNC as the historical average change of the project area and the value representing the expected loss of natural vegetation cover in the without-project scenario (See Table 3-18)

Table 3-18. Historical land use changes in the reference area and the percentage of loss of natural coverage per year.

Coverage	Reference Area 2008	Reference Area 2018	%lost yr	SCNClb ha/yr	Eligible area 2021
Natural grassland	3,397,060.66	2,563,000.87	2.46	3,576.09	126,932.50
Wetland zones	108,409.38	43,536.45	5.98	436.57	4,785.29

Source: Sahbio Carbono, 2024

3.7.3.2.1.2 Projection of annual changes in the scenario with Project

In the Sahbio Project, we assume the project scenario will remain constant over time. This assumption is based on the premise that the measures that will be implemented aim to maintain ecosystem stability without significantly altering land use. The project's activities, such as the conservation strategies and training programs, are designed to reinforce existing environmental conditions rather than introduce disruptive changes. Additionally, the regulatory framework and long-term monitoring mechanisms ensure alignment with the project's goals, preventing unintended shifts in carbon storage dynamics or land-use patterns. Thus, the project scenario provides a reliable foundation for the calculations of emissions reduction and long-term carbon credit validation.

3.7.3.2.1.3 Annual historical land use changes in the leak area

We calculated the annual historical land use change in the leakage area using Equation 3-6.

Equation 3-6. Historical land use changes in the leakage area

$$SCNC_{lk,yr} = \left(\frac{1}{t_2 - t_1} ln \frac{A_2}{A_1}\right) x\ A_{lk}$$

Where:

$SCNC_{lk,\ yr}$ = Annual change in the surface of natural vegetation cover in the leakage area; ha.

T_2 = Final year of the reference period; year

T_1 = Initial year of the reference period; year

A_1 = Natural vegetation-covered surface in the leakage area at the start date; ha

A_2 = Natural vegetation-covered surface in the leakage area at the final date; ha

A_{lk} = Leakage area; ha

Table 3-19. Matrix of changes in vegetation cover in the leakage area

Initial Classes Coverage	Final Classes Coverage	Area Ha
Natural Grassland	Cereals	1.412
	Mosaic of crops	2.105
	Mosaic of crops, pastures, and natural spaces	6.431
	Mosaic of pastures with natural spaces	220.906
	Mosaic of pastures and crops	4.408
	Weedy pastures	6.304
	Clean pastures	310.502
	Secondary or transition vegetation	39.021
Wetland zone	Mosaic of pastures with natural spaces	1.94
	Clean pastures	23.021
Total		616.05

Source: Sahbio Carbono, 2024

We used the $SCNC_{lk, yr}$ as the historical average change of the leakage area and the value representing the expected loss of natural vegetation cover in the without leakage area (See Table 3-19 and Table 3-20).

Table 3-20. Historical land use changes in the leakage area and the percentage of loss of natural coverage per year.

Coverage	Leakage area 2008	Leakage area 2018	Leakage area 2021	SCNClkyr ha/yr	SCNCp,lk, yr
Natural grassland	11,281.45	9,921.29	9,921.29	124.97	137.46
Wetland Zones	293.65	318.31	318.31	10.86	11.95

Source: Sahbio Carbono, 2024

3.7.3.2.1.4 *Projection of annual changes in leakage area in the scenario with project*

We calculated the projected annual land use change in the project scenario's leakage area with Equation 3-7.

Equation 3-7. Projected land use change in the leakage area in the project scenario

$$SCNC_{project,lk,yr} = SCNC_{lk,lb}\ x\ (1 + \%\ E_{lk})$$

Where:

$SCNC_{project, lk, yr}$ = Annual change in the surface covered by natural covert in leakage area in the project scenario; ha

$SCNC_{lk, lb}$ = Annual change in the surface covered by natural cover in leakage area in the baseline scenario; ha

$\%E_{lk}$ = Percentage of emissions increase in the leakage area due to the implementation of project activities. We used 10% as the default value allowed in the BCR 0005 methodology.

We used the SCNC project, lk, yr as the historical average change of the leakage area in the scenario with the project and the value representing the expected loss of natural vegetation cover (See Table 3-20).

3.7.3.3 Emission factors

We analyzed laboratory results using Excel tables to determine the stored carbon (tCO_2e/ha) in the different project strata, including aboveground biomass (AGB) and soil organic carbon (SOC), following the BCR 0005 methodology guidelines.

3.7.3.3.1.1 <u>Total biomass carbon emission factor</u>

We determined each stratum's stored carbon (tCO_2e/ha) (Natural Savannas and wetland zones). We used the average of the samples for the biomass in the herbaceous and wetland zones strata. Then, we calculate the tons per hectare and the CO2 equivalent using Equation 3-8.

Equation 3-8. Emission factor of total biomass

$$CFBeq = BT \; x \; CF \; x \; \frac{44}{12}$$

Where:

CFBeq = Carbon dioxide equivalent, content in the total biomass; tCO_{2e}

TB = Total biomass; t / ha

CF = Carbon fraction of the dry matter (0.47)

44/12 = The molecular ratio constant between carbon and carbon dioxide

We calculated the emission factor for total biomass as the sum of the average aboveground biomass (AGB) and leaf litter per stratum. Table 3-21 presents the data, including the average, sample size, standard deviation, and the equivalent carbon for natural savanna and wetland zones.

Table 3-21. Summary of Data for Calculating Equivalent Savannas Carbon (CBF eq) for Each Stratum. SD is the Standard Deviation of the data.

Strata	Natural Savannas	Wetland zones
Average AGB t/ha	2.201	0.697
SD AGB t/ha	1.792	0.326
Sample No. AGB	116.000	10.000
Average Leaf Litter t/ha	0.943	0.598
SD Leaf Litter t/ha	0.559	0.422
Sample No. Leaf Litter	111.000	10.000
Total Biomass	**3.144**	**1.295**
CFBeq CO2eq t/ha	**5.418**	**2.232**

Source: Sahbio Carbono, 2024

We presented the details of the calculations and formulas in Annex xxxx, CALCULATIONS.

3.7.3.3.1.2 Soil Organic Carbon Emission Factor (SOC)

We estimated the soil's organic carbon content with those of Rainford et al. (2021)[126], who assessed soil organic carbon (SOC) storage in the Eastern Plains of Colombia up to a depth of 30 cm. Based on 653 soil samples and digital soil mapping techniques, their study reported SOC values ranging from 7.3 to 107.3 t/ha for the top 30 cm.

Also, we calculated the equivalent organic carbon emissions due to land-use change. We used the BCR methodology, which assumes that SOC is released equally over 20 years after a natural area is transformed by human activities. We calculated the annual carbon emissions rate annually to estimate the potential carbon emissions from soil under a land-use change scenario. We used the following Equation 3-9 cited in BCR 0005 Methodology.

Equation 3-9. Equivalent Organic Carbon Emissions Due to Land-Use Change

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

Where:

SOC eq = Carbon dioxide equivalent content in soils; tCO_{2e}

[126] Rainford S, Martín-López JM and Da Silva M. Approximating Soil Organic Carbon Stock in the Eastern Plains of Colombia. Front. Environ. Sci. 2021 9:685819. doi: 10.3389/fenvs.2021.685819

SOC = Carbon content in soils tC/ha

44/12 = Molecular ratio constant between carbon and carbon dioxide

Table 3-22. Summary of the SOC results obtained for each ecosystem at 30 cm depth. SD is the Standard Deviation.

	Natural Grassland	Wetland Zones
Total SOC t/ha	**38.47**	**35.47**
tCO2eq t/ha	**7.05**	**6.50**

Source: Rainford et al., 2021

We determined the emission factors for each project stratum based on laboratory data analysis and biomass calculations from the plots (See Table 3-23).

Table 3-23. Emission Factors for Each Project Stratum

Strata	CFBeq CO2eq t/ha	SOC COeq t/ha	Total Factor Emission
Natural grassland	5.418	7.05	**12.470**
Wetland Zones	2.232	6.50	**8.73**

Source: Sahbio Carbono, 2024

The calculation details can be found in Annex XXX Calculations.

3.7.3.4 GHG emissions in the analysis period

We calculated the annual emission by land use change in the without-project scenario according to Equation 3-10.

Equation 3-10. Annual emission in the without-project scenario

$$AE_{bl} = SCNC_{bl} \ x \ (CFB_{eq} + SOC_{eq})$$

Where:

AE_{bl} = Annual emission in the without project scenario; $tCO_2/ha/yr$

$SCNC_{bl}$ = Historical changes in the without project scenario, ha/yr

CFB_{eq} = Carbon dioxide equivalent in total biomass; tCO_2/ha

SOC_{eq} = Carbon dioxide equivalent in the soil; tC/ha

Also, we calculated the annual emission by land use change in the project scenario with Equation 3-11.

Equation 3-11. Annual emission in the project scenario

$$AE_{project} = SCNC_{project}\ x\ (CFB_{eq} + SOC_{eq})$$

Where:

$AE_{project}$ = Annual emission in the project scenario; tCO2 ha-1

$SCNC_{project}$ = Land use change in the project scenario; ha yr-1

As the last equations, we also calculated the annual emission from land use change in the leakage area with Equation 3-12.

Equation 3-12. Annual emissions in the leakage area

$$AE_{lk,yr} = SCNC_{lk}\ x\ (CFB_{eq} + SOC_{eq})$$

Where:

$AE_{project}$ = Annual emission in the project scenario; tCO2 ha-1

$SCNC_{project}$ = Land use change in the project scenario; ha yr-1

We present the total annual emissions calculations from land use change in the reference area in Table 3-24.

Table 3-24. Annual emissions from land use change in the reference area without and with the project scenario and in the leakage area.

Strata	AE bl tCO2/ha	AE project tCO2/ha/yr	AE4lk, yr tCO2/yr
Natural grassland	44,595.97	-	1,558.39
Wetland Zones	3,813.60	-	94.87

Source: Sahbio Carbono, 2024

3.7.3.5 Other GHG emissions

In this project, all biomass accounted for in the two analyzed strata consists exclusively of herbaceous vegetation, with no tree component present. As a result, the combustion of woody biomass is not a relevant factor in this context. Since biomass burning is a primary natural source of non-CO_2 gas emissions, its impact is typically estimated using emission factors based on the amount of carbon released. However, because the studied strata lack trees, this section of the project does not involve woody biomass combustion, making CH_4

and N_2O emissions from tree fires inapplicable. Therefore, the guidelines from the IPCC[127] regarding emissions from woody biomass burning do not apply to this project.

3.7.3.6 Expected GHC emissions reduction due to project activities

We estimated the emissions reductions from avoided land use change in natural savannas and wetland ecosystems in the project scenario according to Equation 3-13Equation 3-13.

Equation 3-13. Emission reductions from avoided land use changes in the project Scenario

$$ER_{project} = (t_2 - t_1)\ x\ (AE_{bl} - AE_{project} - AE_{lk})$$

Where:

ER_{projec} = Emission reductions from avoided land use changes in the project

scenario; tCO2e

t_2 = Final year of the reference period; year

t_1 = Initial year of the reference period; year

AE_{bl} = Emission from land use changes in the baseline scenario; tCO2e yr-1

$AE_{project}$ = Emission from land use changes in the project area; tCO2e yr-1

AE_{lk} = Emission from land use changes in the leakage area; tCO2e yr-1

We estimated the ex-ante calculations of GHG emission reductions/removals over the entire quantification period of the proposed project for Natural Savannas Table 3-25 and Wetland Zones.

Table 3-25. Ex-ante calculations of GHG emission reductions/removals over the entire quantification period of the proposed project for Natural Savannas

[127] IPCC (Intergovernmental Panel on Climate Change), 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4: Agriculture, Forestry and Other Land Use, disponible en: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html (consulted 09/09/2024).

Year	GHG emission in the baseline scenario (tCO2e)	Change in hectares	GHG emission in the project scenario (tCO2e)	GHG emissions attributable to leakages (tCO2e)	Estimated Net GHG Reduction/ Removals (tCO2e)
2021	44,595.97	1,094.94	-	1,558.39	43,037.58
2022	43,501.03	1,068.05	-	1,558.39	41,942.64
2023	42,432.98	1,041.83	-	1,558.39	40,874.59
2024	41,391.15	1,016.25	-	1,558.39	39,832.76
2025	40,374.89	991.30	-	1,558.39	38,816.51
2026	39,383.59	966.96	-	1,558.39	37,825.21
2027	38,416.63	943.22	-	1,558.39	36,858.24
2028	37,473.41	920.06	-	1,558.39	35,915.02
2029	36,553.35	897.47	-	1,558.39	34,994.96
2030	35,655.88	875.44	-	1,558.39	34,097.49
2031	34,780.44	853.94	-	1,558.39	33,222.05
2032	33,926.50	832.98	-	1,558.39	32,368.11
2033	33,093.52	812.53	-	1,558.39	31,535.13
2034	32,280.99	792.58	-	1,558.39	30,722.61
2035	31,488.42	773.12	-	1,558.39	29,930.03
2036	30,715.30	754.13	-	1,558.39	29,156.91
2037	29,961.17	735.62	-	1,558.39	28,402.78
2038	29,225.55	717.56	-	1,558.39	27,667.16
2039	28,507.99	699.94	-	1,558.39	26,949.60
2040	27,808.05	682.75	-	1,558.39	26,249.66
2041	27,125.30	665.99	-	1,558.39	25,566.91
2042	26,459.31	649.64	-	1,558.39	24,900.92
2043	25,809.67	633.69	-	1,558.39	24,251.28
2044	25,175.98	618.13	-	1,558.39	23,617.59
2045	24,557.85	602.95	-	1,558.39	22,999.46
2046	23,954.89	588.15	-	1,558.39	22,396.51
2047	23,366.74	573.71	-	1,558.39	21,808.36
2048	22,793.03	559.62	-	1,558.39	21,234.65
2049	22,233.41	545.88	-	1,558.39	20,675.02
2050	21,687.53	532.48	-	1,558.39	20,129.14
2051	21,155.05	519.41	-	1,558.39	19,596.66
2052	20,635.64	506.65	-	1,558.39	19,077.25
2053	20,128.99	494.21	-	1,558.39	18,570.60
2054	19,634.77	482.08	-	1,558.39	18,076.38
2055	19,152.69	470.24	-	1,558.39	17,594.30
2056	18,682.45	458.70	-	1,558.39	17,124.06
2057	18,223.75	447.44	-	1,558.39	16,665.36

2058	17,776.31	436.45	-	1,558.39	16,217.92
2059	17,339.86	425.74	-	1,558.39	15,781.47
2060	16,914.12	415.28	-	1,558.39	15,355.74
Total	**1,144,374.15**	**28,097.13**	-	**62,335.53**	**1,082,038.62**

Source: Sahbio Carbono, 2024

For Natural Grassland, we estimated a reduction of over 40 years of **1,082,038.62 tCO2e** in the proposed project. See Table 3-25, which indicates the total estimated emission reductions/removals during the project's quantification period and the estimated annual average.

Table 3-26. Ex-ante calculations of GHG emission reductions/removals over the entire quantification period of the proposed project for Wetland Zones

Year	GHG emission in the baseline scenario (tCO2e)	Change in hectares	GHG emission in the project scenario (tCO2e)	GHG emissions attributable to leakages (tCO2e)	Estimated Net GHG Reduction/Removals (tCO2e)
2021	3,813.60	228.21	-	94.87	3,718.73
2022	3,585.39	214.55	-	94.87	3,490.53
2023	3,370.84	201.71	-	94.87	3,275.97
2024	3,169.13	189.64	-	94.87	3,074.26
2025	2,979.48	178.29	-	94.87	2,884.62
2026	2,801.19	167.63	-	94.87	2,706.32
2027	2,633.57	157.59	-	94.87	2,538.70
2028	2,475.97	148.16	-	94.87	2,381.10
2029	2,327.81	139.30	-	94.87	2,232.94
2030	2,188.51	130.96	-	94.87	2,093.64
2031	2,057.55	123.13	-	94.87	1,962.68
2032	1,934.42	115.76	-	94.87	1,839.55
2033	1,818.67	108.83	-	94.87	1,723.80
2034	1,709.84	102.32	-	94.87	1,614.97
2035	1,607.52	96.19	-	94.87	1,512.65
2036	1,511.32	90.44	-	94.87	1,416.45
2037	1,420.88	85.03	-	94.87	1,326.02
2038	1,335.86	79.94	-	94.87	1,240.99
2039	1,255.92	75.16	-	94.87	1,161.05
2040	1,180.76	70.66	-	94.87	1,085.89
2041	1,110.11	66.43	-	94.87	1,015.24
2042	1,043.68	62.45	-	94.87	948.81

Year	GHG emission in the baseline scenario (tCO2e)	Change in hectares	GHG emission in the project scenario (tCO2e)	GHG emissions attributable to leakages (tCO2e)	Estimated Net GHG Reduction/Removals (tCO2e)
2043	981.22	58.72	-	94.87	886.35
2044	922.50	55.20	-	94.87	827.64
2045	867.30	51.90	-	94.87	772.43
2046	815.40	48.79	-	94.87	720.53
2047	766.61	45.87	-	94.87	671.74
2048	720.73	43.13	-	94.87	625.86
2049	677.60	40.55	-	94.87	582.74
2050	637.06	38.12	-	94.87	542.19
2051	598.93	35.84	-	94.87	504.07
2052	563.09	33.70	-	94.87	468.22
2053	529.40	31.68	-	94.87	434.53
2054	497.72	29.78	-	94.87	402.85
2055	467.93	28.00	-	94.87	373.07
2056	439.93	26.33	-	94.87	345.06
2057	413.61	24.75	-	94.87	318.74
2058	388.86	23.27	-	94.87	293.99
2059	365.59	21.88	-	94.87	270.72
2060	343.71	20.57	-	94.87	248.84
Total	**58,329.21**	**3,490.46**	-	**3,794.74**	**54,534.46**

Source: Sahbio Carbono, 2024

We estimated a reduction of **54,534.46 tCO2e** for Wetland zones over 40 years of the proposed project. See Table 3-26, which indicates the total estimated emission reductions/removals during the project's quantification period and the estimated annual average. We estimated a reduction of **1,136,573.08 tCO2e** with the present project, avoiding the land use change in the project area and implementing activities to conserve natural ecosystems.

3.7.4 Reed+

3.7.4.1 Activity data

We estimated the reduction of CO_2 emissions due to deforestation in the reference area based on:

- Determination of the reference region (ha).
- Calculate the annual forest area change (CSB) in the reference region based on an analysis of 2010 to 2017 (ha).

- Projection of the reference region trend in the project area.
- Determination of leakage area and calculation of the annual CSB based on analyzing the 2008–2018 periods (ha).
- Calculation of the CSB in the project area under the project scenario (ha): a 100% reduction in deforestation is projected, considering that project activities aim to fully conserve the eligible forest area.
- Calculation of the CSB in the leakage area under the project scenario (ha): a 10% increase in leakage area is projected due to project activities.

We did not analyze forest **degradation** within the framework of the REDD+ project in the reference area, specifically in the departments of Casanare and Arauca. It faced significant challenges due to data limitations and methodological constraints. While deforestation can be quantified by using remote sensing to identify clear forest loss, degradation involves more subtle changes in forest structure, composition, and function that are difficult to detect and measure accurately. The reference area is characterized by a mosaic of vegetation types, including gallery forests that form narrow, linear strips along rivers and streams. These gallery forests present unique challenges for fragmentation analysis. The national land cover maps for Colombia, produced using the CORINE Land Cover methodology adapted for Colombia, are at a scale of 1:100,000. This scale may not adequately capture the fine-scale details of gallery forests, or the subtle changes associated with forest degradation, combined with a minimum mapping unit of 25 hectares. Addressing forest degradation in the Orinoquía region requires developing methodologies that account for the unique characteristics of gallery forests and investing in high-resolution data collection to monitor subtle changes in forest conditions.

3.7.4.2 Estimation of the deforestation rate from the historical average

We analyzed forest-to-non-forest changes between at least two specific dates: the project starts and ten years prior to ensure accuracy in deforestation calculations. We included only areas where the forest was present on the first date (2008) and absent on the second (2018), ensuring certainty that the loss occurred within the analyzed period (gross deforestation). We excluded the forest losses identified after gaps in data availability to prevent overestimating deforestation rates. These gaps may result from factors such as prolonged cloud cover or satellite sensor malfunctions, which could artificially inflate the extent of deforested areas.

3.7.4.3 Annual historical deforestation in the reference region

We estimated the annual historical deforestation in the reference region through Equation 3-14.

Equation 3-14. Annual historical deforestation in the reference region

$$FSC_{R,yr} = \left(\frac{1}{t_2 - t_1}\right) x \ (A_{R1} - A_{R2})$$

Where:

$FSC_{R, yr}$ = Annual change in the surface covered by forest in the reference region; ha

T_2 = Final year of the reference period; year

T_1 = Initial year of the reference period; year

A_{R1} = Forest Surface in the reference region in the initial moment; ha

A_{R2} = Forest surface in the reference region in the final moment; ha

We estimate the annual historical deforestation in the project area by applying Equation 3-15.

Equation 3-15. Annual change in the surface covered by forest in the project area

$$FSC_{A,yr} = \left(\frac{FSC_{R,yr}}{A_{R1}} x \ 100\right) x \ A_{At}$$

Where:

$FSC_{A, yr}$ = Annual change in the surface covered by forest in the project area; ha

$FSC_{R, yr}$ = Annual change in the surface covered by forest in the reference region; ha

A_{R1} = Forest surface in the reference region in the initial moment; ha

A_{At} = Forest surface in the project area, in the moment; ha

We used the Forest surface change (FSC_A), corresponding to the historical rate of reference region deforestation, as the value used to represent the expected forest loss in the baseline scenario (Table 3-27).

Table 3-27. Annual historical change in the surface covered by forest in the reference region and annual historical deforestation in the project area.

REDD +	Coverage Ha 2008	Coverage Ha 2018	% loss of Forest yr	$FSC_{R, yr}$	$FSC_{A, yr}$
Forest	519,864.68	338,653.37	3.486	1,957,082.16	405.15

Source: Sahbio Carbono, 2024

3.7.4.4 Annual projected deforestation in the scenario with the REDD+ project

In the Sahbio Project, we assume the project scenario will remain unchanged despite the planned activities. This assumption is based on the premise that the implemented measures aim to maintain ecosystem stability while enhancing carbon sequestration without deforestation. The project's activities, such as conservation strategies and training programs, are designed to reinforce existing environmental conditions rather than introduce disruptive changes. Additionally, the regulatory framework and long-term monitoring mechanisms ensure alignment with the project's goals, preventing unintended shifts in carbon storage dynamics or land-use patterns. As a result, the project scenario will remain stable over time, providing a reliable foundation for emissions reduction calculations and long-term carbon credit validation.

3.7.4.5 Annual historical deforestation in the leak area

We estimated the annual historical deforestation in the leakage area with Equation 3-16.

Equation 3-16. Annual historical deforestation in the leakage area

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

Where:

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

t_2 = Final year of the reference period; year

t_1 = Initial year of the reference period; year

$A_{1, lk}$ = Forest surface in the leakage area in the initial moment; ha

$A_{2, lk}$ = Forest surface in the leakage area in the final moment; ha

We estimated the annual deforestation in the leakage area in the project REDD + scenario with Equation 3-17.

Equation 3-17. Annual change in the surface covered by forest in leakage area in the project scenario

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

Where:

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

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

%= Percentage of emissions increase in the leakage area due to implementing REDD+ activities. We used a default value of 10% that is allowed in this Methodology (BCR 0002, 2024)[128]

Table 3-28 resumes the annual deforestation in the leakage with and without the REDD + project scenario.

Table 3-28. Annual historical deforestation in the leakage area and Annual change in the surface covered by forest in the leakage area in the project scenario

REDD +	Coverage Lk Ha 2008	Coverage Lk Ha 2018	Leakage Area Ha	FSClk, yr	FSCREED+project,f , yr
Forest	2,782.50	3,174.65	3,174.65	69.69	76.66

Source: Sahbio Carbono, 2024

3.7.4.6 *Emission factors*

We analyzed laboratory results using Excel tables to determine the stored carbon (tCO_2e/ha) in the forest, including leaf litter (AGB LL) and soil organic carbon (SOC), following the BCR 0002 methodology guidelines.

3.7.4.6.1 Total biomass carbon emission factor

We determined the stored carbon (tCO_2e/ha) in the forest using the aerial biomass estimate for the Tropical Wet Forest of Colombia reported by Phillips et al. (2011)[129]. Based on 1,079 plots and two allometric equations, their study estimated aerial biomass at **264.1**

[128] Biocarbon Credi®. Quantification Of Ghg Emission Reductions Redd+ Projects (Bcr0002 V 4.0). Bogotá D.C. Biocarbon Credi, 2024, P 56.
[129] Phillips, Estimación de las reservas actuales (2010) de carbono almacenadas en la biomasa aérea en bosques naturales de Colombia, p 90.

t/ha with a confidence interval of 29.8 t/ha. We applied the methodology cited in Chapter **3.7.2** for leaf litter and used its average and aerial biomass to calculate CO_2e for the project's emission estimations (See Table 3-29).

3.7.4.6.2 Soil Organic Carbon Emission Factor (SOC)

We estimated the soil's organic carbon content with the methodology cited in Chapter **3.7.2.**

Our results align with those of Rainford et al. (2021)[130], who assessed soil organic carbon (SOC) storage in the Eastern Plains of Colombia up to a depth of 30 cm. Based on 653 soil samples and digital soil mapping techniques, their study reported SOC values ranging from 7.3 to 107.3 t/ha for the top 30 cm. (See Table 3-29).

Table 3-29. Summary of Data for Calculating Equivalent Forest Carbon. SD is the Standard Deviation of the data.

	Forest
Aerial Biomass t/ha	264.10
Average Leaf Litter t/ha	2.92
Sample No. LL	50.00
SD LL t/ha	1.12
Average SOC t/ha	39.45

Source: Sahbio Carbono, 2024

We determined the forest's emission factors using laboratory data analysis and biomass calculations (Table 3-30).

Table 3-30. Emission Factor for Forest

	Forest
Total Biomass	267.89
CFBeq CO2eq t/ha	461.66
SOC t/ha	39.45
SOCeq COeq t/ha	7.23
TCeq	**468.89**

Source: Sahbio Carbono, 2024

The calculation details can be found in Annex XXX Calculations.

[130] Rainford S, Martín-López JM and Da Silva M. Approximating Soil Organic Carbon Stock in the Eastern Plains of Colombia. Front. Environ. Sci. 9:685819. 2021.

3.7.4.7 GHG emissions in the analysis period

We estimated the annual deforestation emission in the reference region's baseline scenario with Equation 3-18.

Equation 3-18. Annual emission in the baseline scenario in the reference region

$$AE_{R,bl,yr} = FSC_{R,bl,yr}\ x\ TCO_{2e}$$

Where:

$AE_{R,\ bl,\ yr}$ = Annual emission in the baseline scenario, in the reference region; tCO2 ha-1

$FSC_{R,\ bl,\ yr}$ = Historical annual deforestation in the baseline scenario, in the reference

region; ha

TCO_{2e} = Total carbon dioxide equivalent; tCO2e ha-1

Also, we calculated the annual emissions from deforestation in the baseline scenario of the project area using Equation 3-19.

Equation 3-19. Annual emission in the baseline scenario in the project area

$$AE_{bl,A,yr} = FSC_{A,yr}\ x\ TCO_{2e}$$

Where:

$AE_{bl,\ A,\ yr}$ = Annual emission in the baseline scenario, in the project area; tCO2 ha-1.

$FSC_{A,\ yr}$ = Historical annual deforestation in the baseline scenario in the project area; Ha.

We also calculated the annual emission due to deforestation in the baseline scenario for the leakage area as follows (Equation 3-20).

Equation 3-20. Baseline annual emission in the leakage area

$$AE_{bl,lk,yr} = FSC_{bl,lk,yr}\ x\ TCO_{2e}$$

Where:

$AE_{\text{bl, lk, yr}}$ = Baseline annual emission in the leakage area; year, tCO_2 ha-1

$FSC_{\text{bl, lk, yr}}$ = Baseline annual historical deforestation in leakage area; year, ha

We calculated the emissions from deforestation in the project area as follows: Equation 3-21.

Equation 3-21. Annual emission in the project scenario, in the project area

$$AE_{REDD+project,yr} = FSC_{REDD+project,yr} \; x \; TCO_{2e}$$

Where:

$AE_{\text{REDD+, project, yr}}$ = Annual emission in the project scenario, in the project area; tCO_2 ha-1

$FSC_{\text{REDD+, project, yr}}$ = Annual change in forest cover in the project area in the project scenario; ha

The annual emissions caused by deforestation in the leakage area are Equation 3-22.

Equation 3-22. Annual emission in the project scenario in the leakage area

$$AE_{lk,project,yr} = FSC_{lk,project,yr} \; x \; TCO_{2e}$$

Where:

$AE_{\text{lk, project, yr}}$ = Annual emission in the project scenario, in the leakage area; tCO_2/ha

$FSC_{\text{lk, project, yr}}$ = Annual change in forest cover in the leakage area in the project scenario; ha.

We present the total annual emissions calculations from land use change in the reference area in Table 3-31.

Table 3-31. Annual emissions from deforestation in the reference area without and with the project scenario and in the leakage area.

REDD+	AEr, bl, yr	AE lb, A, yr	AE4lk, yr tCO2/yr	AE lk, project, yr	AE project tCO2/yr RS
Forest	917,665,563.99	189,970.93	32,676.64	35,944.31	-

Source: Sahbio Carbono, 2024

3.7.4.8 GHG emissions reduction/removal in the project scenario

We estimated emissions reduction due to avoided deforestation with Equation 3-23.

Equation 3-23. Emission reduction due to avoided deforestation

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

Where:

$ER_{\text{DEF, REDD+ project}}$ = Emission reduction due to avoided deforestation; tCO2e

We estimated the ex-ante calculations of GHG emission reductions/removals over the entire quantification period of the proposed project for Forest (See Table 3-32).

Table 3-32. Ex-ante calculations of GHG emission reductions/removals over the entire quantification period of the proposed project for REDD+

Year	AElb, A, yr	Change Hectares	AEproject tCO2/yr RS	AElk,yr tCO2/yr	AElk, project,yr	ERdef, reed+project, yr
2021	189,970.93	6,621.89	-	32,676.64	35,944.31	193,238.59
2022	183,349.04	6,391.07	-	32,676.64	35,944.31	186,616.70
2023	176,957.96	6,168.29	-	32,676.64	35,944.31	180,225.63
2024	170,789.67	5,953.28	-	32,676.64	35,944.31	174,057.33
2025	164,836.39	5,745.77	-	32,676.64	35,944.31	168,104.05
2026	159,090.62	5,545.49	-	32,676.64	35,944.31	162,358.28
2027	153,545.13	5,352.18	-	32,676.64	35,944.31	156,812.80
2028	148,192.95	5,165.62	-	32,676.64	35,944.31	151,460.61
2029	143,027.33	4,985.56	-	32,676.64	35,944.31	146,294.99
2030	138,041.77	4,811.78	-	32,676.64	35,944.31	141,309.43
2031	133,229.99	4,644.05	-	32,676.64	35,944.31	136,497.66
2032	128,585.94	4,482.17	-	32,676.64	35,944.31	131,853.60
2033	124,103.77	4,325.93	-	32,676.64	35,944.31	127,371.43
2034	119,777.83	4,175.14	-	32,676.64	35,944.31	123,045.50
2035	115,602.69	4,029.61	-	32,676.64	35,944.31	118,870.35
2036	111,573.08	3,889.15	-	32,676.64	35,944.31	114,840.74
2037	107,683.93	3,753.58	-	32,676.64	35,944.31	110,951.60
2038	103,930.35	3,622.74	-	32,676.64	35,944.31	107,198.02
2039	100,307.61	3,496.46	-	32,676.64	35,944.31	103,575.27

2040	96,811.15	3,374.58	-	32,676.64	35,944.31	100,078.81
2041	93,436.56	3,256.96	-	32,676.64	35,944.31	96,704.23
2042	90,179.61	3,143.43	-	32,676.64	35,944.31	93,447.27
2043	87,036.18	3,033.85	-	32,676.64	35,944.31	90,303.84
2044	84,002.32	2,928.10	-	32,676.64	35,944.31	87,269.99
2045	81,074.22	2,826.04	-	32,676.64	35,944.31	84,341.89
2046	78,248.19	2,727.53	-	32,676.64	35,944.31	81,515.85
2047	75,520.66	2,632.45	-	32,676.64	35,944.31	78,788.32
2048	72,888.20	2,540.69	-	32,676.64	35,944.31	76,155.87
2049	70,347.51	2,452.13	-	32,676.64	35,944.31	73,615.17
2050	67,895.38	2,366.66	-	32,676.64	35,944.31	71,163.04
2051	65,528.72	2,284.16	-	32,676.64	35,944.31	68,796.39
2052	63,244.56	2,204.54	-	32,676.64	35,944.31	66,512.23
2053	61,040.02	2,127.70	-	32,676.64	35,944.31	64,307.69
2054	58,912.32	2,053.53	-	32,676.64	35,944.31	62,179.99
2055	56,858.79	1,981.95	-	32,676.64	35,944.31	60,126.46
2056	54,876.84	1,912.86	-	32,676.64	35,944.31	58,144.51
2057	52,963.98	1,846.19	-	32,676.64	35,944.31	56,231.64
2058	51,117.79	1,781.83	-	32,676.64	35,944.31	54,385.46
2059	49,335.96	1,719.72	-	32,676.64	35,944.31	52,603.62
2060	47,616.24	1,659.78	-	32,676.64	35,944.31	50,883.90
Total	**4,131,532.20**	**144,014.47**	-	**1,307,065.78**	**1,437,772.36**	**4,262,238.77**

Source: Sahbio Carbono, 2024

We estimate the project will reduce **1,136,573.08** tCO2e by preventing land use change in natural savannas. Additionally, it will avoid **4,262,238.77** tCO2e through deforestation prevention within the project area. This results in a total reduction of **5,398,811.86** tCO2e over 40 years. We will adjust accordingly as more hectares are incorporated in each phase.

4 Compliance with Laws, Statutes, and Other Regulatory Frameworks

The SAHBIO Carbono Project aligns with international and national legislation promoting environmental conservation, biodiversity, and climate change mitigation. This document refers to a detailed analysis of applicable regulations, which is included in Appendix X: Applicable Legislation Analysis for further consultation.

4.1 International Regulatory Framework

- United Nations Framework Convention on Climate Change (UNFCCC): Law 164 of 1994. Aligned with CO2 emissions reduction goals.
- Kyoto Protocol and Paris Agreement: Laws 629 of 2000 and 1844 of 2017. Complies with greenhouse gas (GHG) emission reduction targets.
- Convention on Biological Diversity (CBD): Law 165 of 1994. Supports biodiversity conservation.
- Sustainable Development Goals (SDGs): Contribute to Goal 13 (Climate Action) and Goal 15 (Life on Land).

4.2 National Regulatory Framework

- CONPES 4021 of 2020: Policy for deforestation control and sustainable forest management.
- National Climate Change Policy (2017): Aligned with ecosystem conservation and emissions reduction.
- Law 1931 of 2018: Climate change management, including emissions verification and registration guidelines.
- Law 2169 of 2021: Establishes carbon neutrality goals and a 51% GHG emissions reduction target by 2030.
- Resolution 1447 of 2018 (Amended by Resolution 831 of 2020): Regulates the MRV (Measurement, Reporting, and Verification) system for climate change mitigation actions.

4.3 Regional Planning Instruments

- Regional Environmental Management Plan (PGAR) of CORPORINOQUÍA (2013-2025): The project contributes to biodiversity conservation, restoration of degraded ecosystems, and protection of riparian zones.
- Watershed Management and Zoning Plans (POMCA): Aligned with land-use zoning and environmental preservation goals.

5 Carbon ownership and rights

5.1 Project holder

Provide contact information for the GHG Project holder.

Individual or organization	Visso Consultores S.A.S

Contact person	Jorge Girón
Job position	Legal Representative
Address	Calle 81 No. 11-55, Torre Norte Piso 9, Bogotá Colombia
Phone number	+57 3182755169
Email	jgiron@vissogp.com

5.2 Other project participants

Provide contact information for GHG Project participants (add rows if necessary).

Individual or organization	**Terra Spectrum**
Contact person	Juan Posada
Job position	Scientific Director
Address	Chemin de Valerie 8, Pregny-Chambésy, 1292, Geneva, Switzerland
Phone number	
Email	info@terraspectrum.io

5.3 Agreements related to carbon rights

In the context of agreements related to carbon rights, the project has formalized agreements with each of the 124 landowners participating in the project, clearly outlining the conditions for benefit-sharing derived from the sale of carbon credits. It has been agreed that the landowners will receive 65% of the revenue generated from the commercialization of these credits, providing a strong incentive for their continued participation in the project.

This revenue-sharing scheme not only ensures fair compensation for the landowners' contributions to the conservation of savanna ecosystems but also allocates essential funds to sustain these activities throughout the 40-year duration of the project.

To ensure transparency and accessibility to relevant project information, all agreements are thoroughly documented and can be consulted in the attached Annex: Signed Agreements.

5.4 Land tenure

A document titled "Procedure for Land Enrollment" (Annex: MOU) has been established to ensure each property's proper and legal participation in the SAHBIO Carbono Project. This document outlines the requirements and the process necessary for incorporating land into the project, ensuring transparency and legal compliance at every stage.

The procedure includes a thorough analysis of the Risk Management System for Money Laundering and Terrorism Financing (SARLAFT) and a legal review of land ownership and/or tenure. These analyses are conducted before signing agreements that formalize the incorporation of the properties into the project. This approach ensures that all terms and conditions are transparent and properly established, providing legal and operational security for landowners and project managers.

In this context, to legally support the conservation project of the floodplain savannas of the Orinoquía, property tenure has been secured through agreements with the 124 landowners, who have committed their properties to the conservation and sustainable management actions outlined in the project. These agreements are based on legally recognized property titles, validating each owner's participation and ensuring interventions' legal and administrative feasibility within their respective areas.

All property titles are documented and available in the "Property Titles" Annex. This documentation forms the foundation for effectively implementing all planned conservation and sustainable management activities, ensuring respect for private property and transparent collaboration among the project's participants.

6 Climate change adaptation

6.1 Alignment with the Guidelines of the National Climate Change Policy

The SAHBIO Carbono Project aligns with Colombia's National Climate Change Policy, designed for scenarios through 2030 and 2050, with updates every 12 years. This policy evaluates structural aspects to achieve long-term GHG mitigation and adaptation goals. It aims to integrate climate change management into public and private decision-making, advancing a low-carbon, climate-resilient development pathway. It aims to reduce climate risks and leverage opportunities to achieve national carbon neutrality in the long term.

6.1.1 Policy Guidelines

6.1.1.1 Guideline 1: Comprehensive Vision of Climate Change and Territorial Approach

The project focuses on conserving savannas, wetlands, and gallery forests in the Departments of Arauca and Casanare within the Orinoquía region. Developed by local landowners, it reflects strong community involvement in planning and implementation. This approach ensures that local needs and traditional knowledge are incorporated, promoting long-term sustainable management.

Additionally, the project acknowledges that conservation impacts extend beyond environmental benefits, encompassing productive activities and community well-being. By preserving floodplain savannas and gallery forests, the project maximizes multiple ecosystem benefits, including:

Carbon Storage: Floodplain savannas and gallery forests act as carbon sinks, storing significant amounts of CO_2 in vegetation and soil, helping mitigate climate change by reducing atmospheric CO_2 levels.

Hydrological Regulation: These ecosystems strategically regulate water bodies like rivers and lagoons and the climate in the Orinoquía.

Erosion Protection: Vegetation in floodplain savannas prevents soil erosion, maintaining landscape integrity and preventing soil degradation.

This framework is crucial for climate change mitigation and adaptation, ensuring long-term environmental, economic, and social benefits for the Orinoquía region.

6.1.1.2 Guideline 2: Development Focus and Pathway

The generation of carbon credit through the SAHBIO Carbono Project will positively influence development decisions and actions in the departments of Arauca and Casanare. The share of carbon credit revenues allocated to landowners helps prevent the need for economically driven activities that would alter land use and harm ecosystems. Additionally, by promoting sustainable livestock practices, the project fosters low-carbon, climate-resilient development. This practice significantly contributes to reducing greenhouse gas emissions and protecting the biodiversity of the Colombian Orinoquía.

6.1.1.3 Guideline 3: Environmental Sustainability Strategy for Rural Development

The project promotes environmental sustainability by conserving 200,000 hectares of critical ecosystems in rural areas of the country. This strategy strengthens the sustainable development of rural populations and preserves ecosystem services, ensuring the continuity of natural resources essential for local livelihoods.

6.1.1.4 Guideline 4: Integration and Complementarity with Disaster Risk Management

The conservation actions established in the Farm Management Plan complement disaster risk management by enhancing the resilience of the Orinoquía region to extreme climatic events:

Floodplain Preservation: These ecosystems regulate the hydrological cycle by storing excess water during rainy seasons and releasing it during dry periods, which is crucial for preventing floods and droughts.

Natural Forest Conservation: These ecosystems act as natural barriers, stabilizing riverbanks, reducing erosion, and minimizing damage caused by extreme weather events like floods, thus protecting local communities.

6.1.1.5 Guideline 5: Creation of Enabling Conditions

During the planning and activity development stages, landowners' active participation as project stakeholders demonstrates the local community's commitment to climate change management. Generating carbon credits and promoting sustainable practices fosters the technical and financial capacities necessary to ensure the project's viability and success.

6.1.1.6 Guideline 6: Planning, Monitoring, and Evaluation

The 40-year project includes mechanisms for continuous participation of landowners. According to the monitoring plan outlined in Section 16 of this document, periodic evaluations will verify the implementation of conservation activities and measure the project's environmental and social impact. This approach ensures continuous assessment and adjustment of conservation and mitigation strategies, enabling effective tracking and necessary adaptations to optimize results in GHG storage and biodiversity protection.

6.2 Integrated Actions Supporting Efficient Land Use

The project focuses on conserving natural vegetation cover, essential for biodiversity preservation and ecological balance. These actions include protecting natural savannas, wetlands, and forests through various conservation activities, such as the implementation of landscape management tools, fire prevention and control, participation in monitoring and scientific research on fauna and flora, increasing productivity in home gardens and small plots, implementation of silvopastoral systems adapted to savannas and construction of livestock water systems.

7 Risk management

7.1 Environmental Risk

Identification: Environmental risks include natural phenomena (fires, extreme floods, and extreme droughts) and anthropogenic threats (illegal deforestation, agricultural expansion) that may compromise carbon reserves and the permanence of GHG reductions.

Inherent Risk: High due to the vulnerability of these areas to climatic events and uncontrolled human activities.

7.1.1 Mitigation Measures

- Monitoring and Early Warning Systems: Implement systems to detect fires and deforestation quickly, enabling immediate responses and minimizing impacts on carbon reserves.

- Selection of Less Vulnerable Areas: Prioritization of zones less prone to extreme weather events and a coordinated adaptation plan involving local experts.
- Local Patrols and Continuous Training: Collaboration with communities and rangers for regular patrols and conservation training programs.

Residual Risk: Moderate, as mitigation measures significantly reduce risks, although unpredictable natural factors remain.

7.2 Financial Risk

- **Identification:** Financial risks stem from variability in operational, maintenance, and infrastructure costs, as well as fluctuations in the carbon market and potential reputation issues within the sector.
- **Inherent Risk:** High due to operational cost volatility, reliance on consistent funding, and market fluctuations.

7.2.1 Mitigation Measures:

- Rigorous Cost Control: Implementation of strict cost management to minimize financial exposure.
- Reserve Fund Aligned with BCR Standards: Establishment of a reserve fund as per BioCarbon Registry methodology, retaining a percentage of carbon credits to cover contingencies and ensure financial stability.
- Long-term Purchase Contracts and Transparency: Proactively pursuing contracts with strategic buyers and conducting periodic audits to build investor trust.

Residual Risk: Moderate, as the reserve fund and long-term contracts mitigate market fluctuations, though external factors persist.

7.3 Social Risk

- **Identification:** Social risks include lacking support from local communities and regional public order issues, which could affect labor availability and project implementation.
- **Inherent Risk:** High due to public instability and reduced labor availability caused by workforce migration to other sectors.

7.3.1 Mitigation Measures:

- Preservation of Llanero Culture: Activities to strengthen and preserve local traditions and cultural practices, fostering a sense of ownership toward the project.

- Economic Benefits from Carbon Credits: Additional income from carbon credit sales incentivizes local participation and improves economic well-being.
- Training in Social Equity and Gender Equality: Educational programs promoting equity and inclusive opportunities in project activities.
- Training in Sustainable Livestock and Agro-Food Practices: Capacity-building on sustainable and profitable techniques, paving the way for future green certifications.
- Formal Agreements and Community Oversight: Collaboration with community action boards to oversee project areas, enhancing security and fostering community commitment to resource protection.

Residual Risk: Moderate, as measures increase community engagement, though long-term challenges related to regional stability and labor retention may arise.

7.4 Market and Project Risk Management

7.4.1 Market Risk

- **Identification:** Carbon credit sales are subject to market volatility, demand fluctuations for Verifiable Carbon Credits (VCC), and changes in international regulations.
- **Inherent Risk:** High due to price instability and uncertainty in the carbon market.

7.4.1.1 Mitigation Measures

- Focus on International Markets: Targeting credit sales to international markets and highlighting the project's unique features to attract specific buyers.
- High-Quality Standards and Client Diversification: Adopt recognized standards and align them with sustainable development goals (SDGs), diversifying the client base to ensure demand.
- Price Projections and Long-term Contracts: Developing market forecasts and securing long-term contracts to stabilize revenue.

Residual Risk: Moderate, as these measures reduce volatility, though vulnerability to market changes persists.

7.4.2 Project Risk

- **Identification:** Specific risks include failure to meet permanence standards and insufficient resources for monitoring and regulatory compliance.
- **Inherent Risk:** Moderate success relies on strict adherence to management plans.

7.4.2.1 Mitigation Measures

- Detailed Monitoring Plan and Resource Allocation: Implement a monitoring plan with specific indicators and dedicated resources to ensure compliance with BCR standards.
- Hiring Qualified Personnel: Appoint skilled professionals to meet the Project Design Document (PDD) verification requirements.
- Periodic Management Plan Updates: Continuous review to adapt to new conditions and regulatory demands.

Residual Risk: Low, as continuous monitoring and allocated resources enhance compliance.

7.5 Reversal Risk

Explain and justify the measures taken to maintain the project over time. These measures should be reflected in agreements or contracts, clauses or provisions focused on this objective, or through implementing a management plan associated with the risk of reversion.

Demonstrate that you have used the "Risk and permanence" tool appropriately in an appropriate manner. The tool is available on the BCR website; ensure you use the latest version. Present a conclusion about the expected risks (direct and indirect) and the consideration or mitigation measures as part of adaptive management.

Remember the provision stated in sections 14.1.1 and 14.1.3 of the BCR standard Measures Taken to Maintain the Project Over Time.

We signed a **Memorandum of Understanding (MoU) t**o ensure the project's sustainability over time with the landowners, which includes specific clauses and provisions to maintain the project's objectives, address risks, and mitigate potential reversions. These measures are supported using the **Risk and Permanence** tool the BioCarbon Registry (BCR) provided, following the guidelines in sections 14.1.1 and 14.1.3 of the BCR standard. The MoU reflects a commitment by all parties to preserve the integrity of the project and ensure its success over its duration.

Key Provisions in the Memorandum of Understanding

Second Clause: Contributions and Specific Responsibilities of the Landowner

- **g.** Commit to refrain from using the property for any purpose or carrying out activities that conflict with or hinder the project's development.

- **h.** Maintain material possession of the property and ensure it is free from any legal or material disturbances that could affect the project. Additionally, take necessary measures to prevent, mitigate, or address any circumstances that may interfere with the peaceful possession of the property and its use for the project's development.

- **i.** In the event of the landowner's passing (if the landowner is a natural person), the rights and obligations of the agreement shall transfer to their legal heirs.

Fourth Clause: Duration of the Agreement

- The agreement remains in force for the entire project duration, beginning on the date of signing.

Risk and Permanence Tool

The **Risk and Permanence** tool provided on the BCR website has evaluated both direct and indirect risks associated with the project. We used this in its most recent version to:

- Identify potential risks of reversion that could impact the project outcomes.
- Develop adaptive management strategies to address and mitigate these risks effectively.

Identified Risks and Mitigation Measures

Direct Risks:

- **Risk:** Land-use change due to economic pressures or competing land uses.
- **Mitigation:** The MoU explicitly prohibits alternative land uses that could conflict with the project and ensures a legal framework to enforce compliance.

Indirect Risks:

- **Risk:** Loss of landowner involvement due to unforeseen circumstances, such as inheritance disputes.

- **Mitigation:** Provisions in the MoU ensure the continuity of obligations and rights through inheritance clauses, preserving the project's sustainability.

Adaptive Management:

- We will conduct continuous monitoring and engagement with landowners to address evolving challenges.
- Legal and technical support will be provided to landowners to uphold the commitments stated in the MoU.

7.5.1 Loss Event Report

Submit a report within no more than one year after an event that results in the loss or reduction of VCCs issued and registered in the registration platform.

The loss report shall include a conservative estimate of the loss of carbon from previously verified emission reductions/removals due to the loss of carbon stocks from the project based on the monitoring report. The project holder shall demonstrate that the loss estimate is true and accurate in all material respects.

8 Sustainable development safeguards (SDSs)

The **SAHBIO Carbono Project** has been designed to comply with high environmental, social, and economic sustainability standards, ensuring the implementation of measures that minimize negative impacts and maximize benefits for communities and ecosystems. To provide a detailed account of the project's compliance with these safeguards, the **Sustainable Development Safeguards Matrix** (Annex XXX) annex to this document. This matrix outlines the measures implemented to address potential risks and reinforce the project's commitment to sustainability.

In alignment with sustainable development safeguard criteria, the project addresses the following key aspects:

8.1 Environment

8.1.1 Land Use: Resource Efficiency and Pollution Prevention and Management

The project does not promote adverse land-use changes; instead, it fosters the conservation of strategic ecosystems by implementing **Farm Plans** jointly designed with landowners. These plans ensure conservation activities aligned with sustainable land-use practices, preventing soil degradation and minimizing pollution risks. Additionally, landowners voluntarily commit to sustainable land management practices that improve efficiency in resource use while preserving environmental integrity.

8.1.2 Water

The project implements conservation strategies that protect water sources within participating properties. Sustainable land-use practices prevent water pollu**tion** by reducing runoff, minimizing agrochemical use, and preserving natural water filtration systems. These actions enhance the availability and quality of water resources, benefiting local communities and surrounding ecosystems.

8.1.3 Biodiversity and Ecosystems

The SAHBIO Carbono Project prioritizes **biodiversity conservation** by protecting key ecosystems and promoting land-use practices that support habitat preservation. No activities negatively impact biodiversity or disrupt local ecosystems. Landowners participate voluntarily, ensuring conservation efforts aligned with their property management strategies while contributing to broader environmental goals.

8.1.4 Climate Change

The project aligns with global and national **climate change mitigation and adaptation goals** by promoting carbon sequestration through conservation activities. By preserving forests, wetlands, and natural ecosystems, the project contributes to **reductions in greenhouse gas (GHG) emissions**, climate resilience, and ecosystem-based adaptation strategies. Additionally, conservation efforts enhance carbon storage capacity, supporting long-term climate benefits.

8.2 Social

8.2.1 Working Conditions and Safety

The project ensures respect for participants' labor rights by promoting **fair and dignified working conditions**. Landowners are responsible for implementing activities under a **voluntary and autonomous** scheme, ensuring fair payment for work performed and preventing labor exploitation. Additionally, **training on good labor practices** has been provided to enhance the safety and well-being of those involved.

8.2.2 Gender Equality and Social Participation

The **project characterization survey** has identified and documented women's participation in conservation activities. The project promotes gender equity through training to empower vulnerable sectors and encourage **balanced participation** in decision-making within the initiative. Landowners and stakeholders are engaged through voluntary agreements, ensuring **inclusive access to opportunities**.

8.2.3 Community Health and Safety

The project does not generate environmental or health risks that could affect local communities. No hazardous materials are used, and no activities are implemented that threaten the local population. Additionally, training in **sustainable practices** includes recommendations to minimize health impacts on the community.

8.2.4 Economic Impact and Financial Sustainability

The project activities are designed to **strengthen local economies** through conservation incentives and the creation of **new economic opportunities** related to ecosystem protection. No market distortions or exclusive economic dependence on the project are generated, as **income diversification** is promoted through sustainable agricultural and livestock practices.

8.3 Governance and Compliance

The project operates under a **robust legal framework**, complying with all applicable **environmental and climate change regulations** at both national and international levels.

8.3.1 Land Rights and Resource Ownership

The project does not involve land purchases or expropriation. All activities occur within **privately owned properties** whose landowners have signed **Memorandums of Understanding** to participate freely and voluntarily. Furthermore, property title verification is fundamental for including properties in the project.

8.3.2 Respect for Indigenous Peoples and Cultural Heritage

No identified Indigenous communities in the project intervention areas with lands or rights could be affected. However, the project aligns with principles of **respect for local**

culture and traditional land use. If areas of cultural significance are identified, appropriate measures will be taken to ensure their **protection and sustainable management**.

8.3.3 Compliance Monitoring and Reporting

The project adheres to **national and international legal standards** concerning land tenure, environmental conservation, and social safeguards. Compliance monitoring includes:

- **Regulatory Compliance Monitoring** to ensure adherence to environmental laws.
- **Stakeholder Consultations** for transparent decision-making.
- **Independent audits are performed** to verify adherence to best practices.

8.4 Continuous Improvement

The SAHBIO Carbono Project is committed to **ongoing monitoring and adaptation** to improve project outcomes and ensure long-term sustainability.

8.4.1 Stakeholder Engagement and Participation

A **Communications Plan** has been established to define the needs of different participants, ensuring their active involvement and strengthening their commitment to conservation actions outlined in the **Farm Plan**. Landowners and stakeholders receive continuous updates and opportunities for engagement.

8.4.2 Capacity Building and Learning

The project integrates **capacity-building programs** to enhance landowners' knowledge of conservation practices, sustainable land management, and financial sustainability. Training includes:

- **Good Labor Practices** to promote fair working conditions.
- **Sustainable Resource Management** to optimize land-use practices.
- **Community Empowerment** through leadership and participation programs.

8.4.3 Adaptive Management Strategies

The project incorporates **performance assessments** and **feedback mechanisms** to refine its strategies and ensure adaptability to changing environmental, social, and economic conditions. Lessons learned from **monitoring activities** are integrated into future project phases to enhance efficiency and impact.

9 Stakeholder engagement and consultation

We conducted a consultation and socialization process with various stakeholders within the SAHBIO Carbono Project framework. This process involved engagement with 19 relevant entities, ensuring that all pertinent parties were informed and had the opportunity to provide feedback on the project.

The consultation focused on presenting the project's objectives, planned activities, and expected benefits. Additionally, we encourage institutions to share their observations and pose any necessary questions about the project. This effort ensures that decisions are inclusive and reflect the needs and expectations of all involved stakeholders.

The following outlines the details of the consulted entities (

Table 9-1).

Table 9-1. Entities consulted in the process of socializing the project with stakeholders

Entity	Address	E-mail	Physical Delivery	Delivery Guide	Delivery Date	Certification Guide	Email Sent	Receipt Confirmation
Alcaldía Cravo Norte, Arauca	Cra 4 # 2 - 62 Barrio el Centro, Cravo Norte, Arauca	alcaldia@cravonorte-arauca.gov.co	23/04/2024	**125090270**	26/04/2024	**3000214581773**	22/04/2024	
Alcaldía Hato Corozal, Casanare	Calle 12 No. 8-13 Palacio Municipal, Hato Corozal ,Casanare	alcaldia@hatocorozal-casanare.gov.co despacho@hatocorozal-casanare.gov.co	23/04/2024	125091720	26/04/2024	**3000214506286**	22/04/2025	confirmado 22/04/2024
Alcaldía La Primavera, Vichada	Calle 4 No. 8-89, La Primavera - Vichada	alcaldia@laprimavera-vichada.gov.co	23/04/2024	125096143	27/04/2024	**3000214506427**	22/04/2026	
Alcaldía Paz de Ariporo	Carrera 6 No. 9-35 Barrio Camilo Torres, Alcaldia Municipal de Paz de Ariporo	despacho@pazdeariporo-casanare.gov.co	23/04/2024	125095418	25/04/2024	**3000214483888**	22/04/2027	
Alcaldía Puerto Carreño	Carrera 9 No. 18-87, Puerto	despacho@puertocarreno-vichada.gov.co	23/04/2024	125093548	29/04/2024	**3000214518326**	22/04/2028	

Entity	Address	E-mail	Physical Delivery	Delivery Guide	Delivery Date	Certification Guide	Email Sent	Receipt Confirmation
	Carreño, Vichada							
Alcaldía San Luis de Palenque, Casanare	Calle 2 N° 5-58 Centro San Luis de Palenque, Casanare	despacho@sanluisdepalenque-casanare.gov.co	23/04/2024	125092789	25/04/2024	**3000214484025**	22/04/2029	
Alcaldía Tame	Calle 15 N°. 14 - 20, Tame, Arauca	contactenos@tame-arauca.gov.co	23/04/2024	125099487	25/04/2024	**3000214484025**	22/04/2030	
Alcaldía Trinidad, Casanare	Carrera 4 No. 5 - 36 Barrio el Centro, Frente al Parque Principal Trinidad Casanare	despacho@trinidad-casanare.gov.co	23/04/2024	125100368	25/04/2024	**3000214483969**	22/04/2031	
Alcaldía Yopal, Casanare	Diagonal 15 N° 15-21 Palacio Municipal, Yopal - Casanare	alcaldia@yopal-casanare.gov.co	23/04/2024	125102241	25/04/2024	**3000214483883**	22/04/2032	
Corporinoquia, Arauca	Carrera 25 No. 15-69 Barrio	sedearauca@corporinoquia.gov.co	23/04/2024	**125104082**	24/04/2024	**3000214581774**	22/04/2033	

Entity	Address	E-mail	Physical Delivery	Delivery Guide	Delivery Date	Certification Guide	Email Sent	Receipt Confirmation
	Guarataros , Arauca							
Corporinoquia, Casanare	Carrera 23 # 18-31, Barrio El Gavan, Yopal - Casanare	atencionusuarios@corporinoquia.gov.co	23/04/2024	125103513	25/04/2024	**3000214483998**	22/04/2034	confirmado 24/04/2024
Corporinoquia, Casanare	Carrera 23 # 18-31, Barrio El Gavan, Yopal - Casanare	atencionusuarios@corporinoquia.gov.co	23/04/2024	125104637	25/04/2024	**3000214483997**	22/04/2035	
Corporinoquia, Sede Vichada	Calle 4 No. 9-72 Barrio Caudal, La Primavera - Vichada	sedeprimavera@corporinoquia.gov.co	23/04/2024	125105491	26/04/2024	**3000214506281**	22/04/2036	
Ministerio de Ambiente y Desarrollo Sostenible	Calle 37 Nº 8-40, Bogotá DC	ariverab@minambiente.gov.co	23/04/2024	125105946	24/04/2024	**3000214462068**	22/04/2037	confirmado 24/04/2024
Gobernación Vichada	Cll 18 No. 7-48 Barrio el centro | Código Postal: 990001	contactenos@vichada.gov.co	23/04/2024	125110596	29/04/2024	**3000214518509**	22/04/2038	

Entity	Address	E-mail	Physical Delivery	Delivery Guide	Delivery Date	Certification Guide	Email Sent	Receipt Confirmation
Gobernación Arauca	Calle 20 - Carrera 21 Esquina Código postal 810001	archivogeneral@arauca.gov.co	23/04/2024	**125108438**	25/04/2024	**3000214581775**	22/04/2039	confirmado 23/04/2024
Gobernación Casanare	Cra. 20 No. 08- 02 Edificio CAD. Yopal , Casanare	correspondencia@casanare.gov.co	23/04/2024	125109077	25/04/2024	**3000214483972**	22/04/2040	confirmado 22/04/2024
Alcaldía de Arauca	Cra. 24 entre calles 18 y 19 Arauca-Arauca.	contactenos@arauca-arauca.gov.co	23/04/2024	**125109427**	25/04/2024	**3000214581776**	22/04/2041	
Parques Nacionales Naturales, Sede Orinoquia	Cr 39 N. 26c -47 Barrio 7 de Agosto, Villavicencio , Meta	atencion.usuario@parquesnacionales.gov.co	23/04/2024	125110059	24/04/2024	**3000214471643**	22/04/2042	confirmado 23/04/2024

Source: Sahbio Carbono, 2024

9.1 Summary of comments received

The following are the responses and conclusions derived from interactions with stakeholders during the consultation process:

- Corporinoquía Arauca

Response: Through Communication 700.11.24-0709 (RESPUESTA RADICADO AR-2024-00924), Corporinoquía requested comprehensive project information.

Action Taken: The Project Design Document (PDD) was sent to provide the required details and address any questions regarding the scope and objectives of SAHBIO Carbon.

- Ministry of Environment

Response: The Ministry requested a meeting held on July 31, 2024.

Outcome: We emphasized implementing robust mechanisms to mitigate risks related to the distribution of benefits to local communities. These mechanisms ensure quality, transparency, and equity across all project phases, guaranteeing adequate and fair compliance.

- Government of Casanare

Response: A meeting was requested and conducted on July 3, 2024.

Outcome: The Government expressed interest and willingness to support the project, committing to collaborating on the region's planned developments. Both parties highlighted the mutual interest in working together to achieve the project's conservation and sustainability objectives.

- National Natural Parks

Response: Two meetings were requested and held on August 22 and 29, 2024.

Outcome: Project SAHBIO Carbono is aligned with initiatives developed by National Parks in collaboration with the Llanero families. Although significant progress has been made in conserving gallery forests and savannas, the long-standing environmental debt from excessive logging and hunting was acknowledged. It was concluded that SAHBIO Carbono could complement and enhance ongoing conservation efforts, contingent on the availability of resources.

This consultation and feedback process with stakeholders has been critical in strengthening partnerships and ensuring that the conservation and sustainable development objectives of SAHBIO Carbono align with local and regional policies and needs.

9.2 Consideration of comments received

Following consultations and meetings with various entities, it is concluded that the SAHBIO Carbono project is fully aligned with the objectives and needs of the institutions involved, reinforcing its feasibility and relevance as a conservation and sustainable development initiative in the region.

Furthermore, the fair distribution of benefits is guaranteed, as clearly outlined in the Memorandums of Understanding signed with the participating landowners. These documents formalize commitments and ensure transparency in the implementation of the benefits derived from the project.

10 Sustainable Development Goals (SDGs)

The project aligns with the Sustainable Development Goals (SDGs) adopted by the Colombian government as a member of the United Nations and as part of the 2030 Agenda, which outlines a plan to achieve these goals within 15 years from 2015.

Recognizing that investments in sustainable development will help address climate change by reducing greenhouse gas emissions and enhancing climate resilience (UN), the project specifically relates to the targets of Goal 5 on Gender Equality, goal 6 on clean water and Sanitation, Goal 13 on Climate Action, and Goal 15 on Life on Land.

The project aims to contribute to Goal 5 on Gender Equality, specifically targeting (5.5) to ensure women's full and meaningful participation and equal opportunities for leadership across all levels of political, economic, and public decision-making. Additionally, it seeks to improve instrumental technology, particularly information and communication technology (ICT). We will pursue these objectives through training programs designed for female landowners and their family members and their involvement in workshops to strengthen governance within the project. Furthermore, training sessions will focus on enhancing knowledge and skills related to climate change mitigation, biodiversity conservation, and sustainable agricultural practices. The evaluation process for this target will monitor the participation of female landowners and other women beneficiaries in achieving project goals or leading specific activities.

We will also focus on SDG 6, precisely target 6.6, which aims to protect and restore water-related ecosystems, including forests, mountains, wetlands, rivers, aquifers, and lakes, by 2020. The project will implement landscape tools to promote this SDG through activities such as the implementation and maintenance of wire fences or natural barriers to demarcate properties and protect key ecosystems, the construction of livestock water systems, and the installation, operation, and maintenance of integrated water storage and management systems in strategic areas, including reservoirs, ponds, windmills, and motor pumps. In this way, we can contribute to the change in the extent of water-related ecosystems over time.

We also propose Sustainable Development Goal (SDG) number 13, precisely target 13.2, which emphasizes integrating climate change measures into national policies, strategies, and plans. Through this project, we aim to provide support via a training plan and a series of conservation activities designed to implement landscape management tools. This procedure includes implementing activities aligned with silvopastoral systems adapted to savannas in natural grasslands. By doing so, we intend to report the total greenhouse gas emissions/removals annually within the project's eligible area to indicate the target 13.2.

The project also contributes to Goal 15, which focuses on Life on Land, precisely target 15.1. As international agreements outline, this target aims to ensure the conservation, establishment, and sustainable use of terrestrial and freshwater ecosystems, particularly forests, wetlands, natural savannas, and arid zones. The project will conserve the natural savannas, forests, and wetlands within the eligible area by implementing a training plan and a battery of conservation activities. This initiative will help protect and sustainably utilize ecosystems and their services. The evaluation procedure for this target will include developing management plans or property plans that identify ecosystem conditions, biodiversity, socio-economic factors, and productivity, as well as ensuring compliance with conservation activities. By implementing these strategies, the project aims to promote sustainable practices that align with global efforts to preserve biodiversity and enhance ecosystem resilience.

For more information, please refer to the annex (Appendix XXXX) on BCR Tools for SDGs[131], which outlines the project's activities associated with each Sustainable Development Goal (SDG) and its monitoring plan (Spanish Version).

11 REDD+ Safeguards

The project complies with social and environmental protection measures to mitigate environmental risks and safeguard landowners within the project area. Additionally, it enhances social and economic benefits while promoting sustainable resource management for participants. To demonstrate compliance with the REDD+ safeguards, we used the tool from BioCarbon Registry V 1.1 (2023)[132].

We implemented institutional safeguards in alignment with legal, consultation, and governance requirements for REDD+ projects. Also, we maintain social and cultural safeguards by respecting traditional knowledge, ensuring fair benefit distribution, protecting territorial rights, and fostering landowner participation—many of whom self-identify as farmers. Free, Prior, and Informed Consent (FPIC) is the only safeguard not applied, as the project does not occur in or impact ethnic community territories.

Regarding environmental and territorial safeguards, the project implements measures for forest and biodiversity conservation, the provision of ecosystem goods and services, environmental and land-use planning, and forest monitoring and enforcement. The following section details how specific activities will address these safeguards to ensure compliance throughout the project's duration.

11.1 Safeguard 1

"That actions complement or are consistent with the objectives of national forest programs and relevant international conventions and agreements." (See

[131] Biocarbon Credi. 2023. Herramienta BCR. Objetivos De Desarrollo Sostenible (ODS). Versión 1.0. junio 27, 2023. 18 p. http://www.biocarbonregistry.co.

[132] Brigard & Urrutia, Biocarbon Registry. Tool To Demonstrate Compliance with The Redd+ Safeguards. Version 1.1. 26 January 2023. Bogotá, Colombia. 20 p. 2023 http://www.biocarbonregistry.

Table 11-1).

Table 11-1. Safeguard 1 for REDD + Projects

Applicable Legal Framework of the National Forestry Policy	Objectives of the Policy / Goals of Forestry Programs	Identification of policy guidelines	Complementarity and Compatibility of the Project
Law 164 of 1994: Approval of the "United Nations Framework Convention on Climate Change (UNFCCC)"	Objective: To stabilize greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system, per the relevant provisions of the Convention.	**National Inventories Development:** Article 4, Section 1(a): Obligates Parties to develop and periodically update inventories of greenhouse gas emissions. **Promotion of Environmental Education:** Article 6: Focuses on education, training, and public awareness of climate change, urging Parties to include these topics in national policies. **Adaptation Plans:** Article 4, Section 1(b): Establishes the need to create and implement national mitigation and adaptation programs for climate change. **Sustainable Development:** Preamble and Article 3 of the Convention: Require Parties to protect the climate system for the benefit of present and future generations, with sustainable development as a central pillar.	RENARE Registry: The project aligns with developing national inventories through its registration in the RENARE System. Annual reporting of greenhouse gas sequestration data is ensured (Annex xxx, RENARE Registration Report). Capacity-Building Plan An annual training plan has been established on conservation, monitoring, and environmentally friendly productive activities as part of the project activities (Annex: Training Plan).
DECREE 2811 OF 1974: National Code of Renewable Natural Resources and Environmental Protection	Achieve the preservation and restoration of the environment and the conservation, improvement, and rational use of renewable natural resources.	**Public Utility and Social Interest:** The preservation and management of renewable natural resources are deemed of	The goal of conserving savanna, wetland, and gallery forest ecosystems will be achieved by developing **Farm Plans** in collaboration with property owners. These plans will include a set of activities with indicators (**Annex:**

Applicable Legal Framework of the National Forestry Policy	Objectives of the Policy / Goals of Forestry Programs	Identification of policy guidelines	Complementarity and Compatibility of the Project
	Prevent and control the harmful effects of exploiting non-renewable natural resources on other resources. Human behavior, whether individual or collective, should be regulated, as well as the activities of public administration concerning the environment and renewable natural resources, as well as the relationships arising from the use and conservation of these resources and the environment.	public utility and social interest.	**Activity Battery**) to enable the effective conservation of the project's eligible areas.
FOREST POLICY, Republic of Colombia **CONPES Document No. 2834, 1996**	**General Objective:** Achieve sustainable use of forests to ensure their conservation, integrate the forestry sector into the national economy, and improve the population's quality of life.	**Forest Ecosystem** Conservation: Promote the conservation of forest ecosystems by creating and managing protected areas, reserves, and biological corridors to safeguard biodiversity and environmental services.	Through the development of farm plans for each participating property, the eligible areas of the project have been identified and categorized according to the various ecosystems (savannas, wetlands, gallery forests) that constitute them. This categorization determines the specific activities required for each ecosystem based on its characteristics. The activity database includes a field referencing the ecosystem impacted by each activity to ensure tailored and effective conservation efforts.
Law 1931 of 2018: GUIDELINES FOR CLIMATE CHANGE MANAGEMENT	**Objective:** To establish guidelines for climate change management in decision-making by public and private entities, with contributions from the Nation, Departments, Municipalities, Districts, Metropolitan Areas, and Environmental Authorities. The focus is on actions for climate change adaptation and mitigation of greenhouse gas (GHG) emissions, aiming to reduce the	**Planning and Management Instruments:** Article 15: Regulates Nationally Determined Contributions (NDCs) with specific emission reduction targets. **Financial and Economic Instruments:**	Financing: The project aims to generate carbon credits as financial instruments for long-term conservation actions. Education: An annual training plan focusing on environmental conservation has been established as part of project activities.

Applicable Legal Framework of the National Forestry Policy	Objectives of the Policy / Goals of Forestry Programs	Identification of policy guidelines	Complementarity and Compatibility of the Project
	vulnerability of the population and ecosystems to climate impacts and promote a transition toward a competitive, sustainable economy and low-carbon development.	Chapter II (Articles 29-32): Introduces Tradable GHG Emission Allowances, regulating their acquisition and enforcing penalties for non-compliance to foster a low-carbon economy. **Education, Research, and Citizen Participation:** **Article 20**: Promotes education, awareness, and citizen participation through programs involving society in climate management.	
Law 2294 of 2023: National Development Plan 2022-2026 "Colombia, Global Power of Life"	Lay the groundwork for the country to become a leader in protecting life through the construction of a new social contract that addresses historical injustices and exclusions, ensures the non-recurrence of conflict, redefines the relationship with the environment, and promotes a productive transformation based on knowledge and in harmony with nature.	Section I: Secure, Reliable, and Efficient Energy Transition to Achieve Carbon Neutrality and Build Climate-Resilient Territories: Promotes carbon neutrality and encourages the use of clean energy.	The activities defined in the project, including those in the individual farm plans and the training plan, aim to conserve greenhouse gases sequestered within the project's area of influence. Through the monitoring plan, the project will determine the tons of CO_2eq sequestered in each participating property.
Law 2169 of 2021: Promoting Low-Carbon Development in Colombia by Establishing Goals, Minimum Measures for Carbon Neutrality, Climate Resilience, and Other Provisions	Establish goals and minimum measures to achieve carbon neutrality, climate resilience, and low-carbon development in the short, medium, and long term within the framework of Colombia's international commitments.	**Carbon Neutrality and Climate Resilience Goals:** Article 5 Sets a goal to reduce greenhouse gas emissions by 51% by 2030 and achieve carbon neutrality by 2050. Article 6: Defines climate adaptation objectives in key sectors (such as water, health, and biodiversity) to strengthen the country's climate resilience.	The activities defined in the project, including those in the individual farm plans and the training plan, aim to conserve greenhouse gases sequestered within the project's area of influence. Through the monitoring plan, the project will determine the tons of CO_2eq sequestered in each participating property.

Applicable Legal Framework of the National Forestry Policy	Objectives of the Policy / Goals of Forestry Programs	Identification of policy guidelines	Complementarity and Compatibility of the Project
		Pillars of the Transition to Low-Carbon Development: Article 3: Identifies pillars including just transition, environmental protection, public-private co-responsibility, and strengthening environmental education, emphasizing the need for an informed citizenry. **Regulation and Promotion of Carbon Markets:** Article 20: Regulates carbon markets, promoting mechanisms for traceability and transparency to enable effective public and private sector participation in emission compensation and reduction.	

Source: Sahbio Carbono, 2024

11.2 Safeguard 2

"Transparency and effectiveness of national forest governance structures, considering national legislation and sovereignty. Provide transparent and consistent information that is accessible to all stakeholders and update it regularly. Be transparent and flexible to allow improvements over time. Build on existing systems, if any."

The SAHBIO Carbono Communication Plan (Annex xxx) establishes strategies to ensure clear, effective, and accessible disclosure of project activities aimed at fostering trust, transparency, and participation among all stakeholders. We will implement the following dissemination mechanisms to comply with this safeguard:

1. **Transparency and Accessibility:** Customized communication channels, such as workshops, meetings, and field visits (Annex xxx: Workshops), will be employed to directly explain to landowners the economic benefits and conservation opportunities, promoting a complete understanding of their role in the project.
2. **Continuous Updates:** Digital platforms, social media, and printed materials will provide regularly updated information on the progress of activities.
3. **Local Events and Training:** For local communities, community meetings and training workshops in sustainable practices will be organized, along with cultural festivities. These initiatives ensure accessible information, respect for the region's cultural context, and integration of Llanero traditions into the project.
4. **Impact Assessment and Results Reporting:** The plan includes annual verification reports and external audits to ensure transparency and compliance with the project's environmental and social objectives.

11.3 Safeguard 3

“Respect for the knowledge and rights of Indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples.”

In the Sahbio Carbono project, the ancestral knowledge of farming communities and the Llanero tradition is essential for implementing mitigation activities. Therefore, every action will respect and acknowledge the landowners' and their families' perspectives on their territory.

As part of our efforts to reduce emissions from deforestation, Activities include “Training and support processes to strengthen sustainable forest management and biodiversity conservation." Education is a key tool for promoting environmental stewardship, particularly for forests and their biodiversity. The goal is to integrate ancestral and traditional knowledge from farming communities with technical and scientific insights, leading to better-informed decisions on land use planning and sustainable forest management.

11.4 Safeguard 4

"Evidence of Compliance with the Safeguard: Full and Effective Participation of Stakeholders"

In SAHBIO Carbono, landowners are the project owners, hosting conservation activities and generating carbon credit. This role was formalized through signed Memorandums of Understanding (Annex xx: Memorandums of Understanding), established in an informed and participatory manner via specific workshops with landowners (Annex xx: Workshops). These workshops ensured landowners fully understood the project's objectives, benefits, and commitments, guaranteeing informed and responsible participation.

As project owners, landowners were actively involved in developing their farm plans through a detailed survey-interview process (Annex xxx: Farm Plans). This process documented the past state of each property, its current condition, and the landowner's future vision for their land. This ensures that the project's goals reflect local aspirations, demonstrating full and effective participation of the local community in the design and definition of the project.

As part of the project, landowners are provided with a conservation activity database (Annex xx: Activity Database) that includes the ecosystem impacted by each activity and its respective indicators. This resource enables each landowner to establish a specific management plan for their property, which will be evaluated based on the activities selected during each monitoring period. This tool allows landowners to manage and assess the progress of their conservation activities according to defined priorities.

11.4.1 Evidence of Compliance

Evidence includes meeting minutes, participant attendance records, photographic documentation, and recordings. This information is available for consultation and demonstrates that the process has been inclusive, respectful, and tailored to local needs, following the principles of Safeguard 4.

11.5 Safeguard 5

"What actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits."

As part of the Sahbio Carbono project, we supported biodiversity conservation in the region through a phased participatory monitoring strategy. We have structured this strategy with three main objectives:

1. Biodiversity characterization within the project area.
2. Identification of High Conservation Values (HCVs).
3. Mitigation of pressures on biodiversity.

We will implement the strategy's phases align with the periods during which specific activities to achieve these objectives, as outlined below:

11.5.1 Phases of the Participatory Monitoring Strategy

11.5.1.1 Phase 1 (2021 – 2026)

- Biodiversity baseline assessment: Gathering and compiling biodiversity data from official sources such as the Alexander von Humboldt Biological Resources Research Institute (IAvH), SiB Colombia, GBIF, and IUCN, as well as from biological characterization, restoration, and sustainable resource use activities conducted on project properties.
- Identification of potential High Conservation Values (HCVs) within the project area.
- Characterization of environmental conditions on project properties related to biodiversity.

11.5.1.2 Phase 2 (2026 – 2031)

- Sharing strategy objectives and transferring experiences and traditional knowledge about biodiversity.
- Identifying HCVs with the participation of landowners.
- Developing a sampling design, selecting variables, methods, and priority monitoring areas, focusing on identified HCVs.
- Identifying pressures on biodiversity, particularly those threatening HCV permanence.

11.5.1.3 Phase 3 (2031 – 2060)

- Implementing participatory monitoring based on the community-approved sampling design.
- Developing mitigation measures to address biodiversity and HCV pressures.
- Implementing mitigation measures to reduce threats to biodiversity.
- Reporting results and progress of the strategy.

11.6 Safeguard 6

"Adoption of Measures to Address Reversal Risks" See Table 11-2.

Table 11-2. Safeguard 6

Associated Risk	Description of the Risk	INHERENT VALUATION			Mitigation
		Probability	**Impact**	**Inherent Risk**	
Human Risk: Deforestation and Land-Use Change	Expanding livestock farming and agricultural activities may pressure landowners to deforest or modify land use.	2	High	High	**- 40-Year Memorandums of Understanding:** These agreements ensure long-term commitment from landowners to conservation. **Individual Farm Plan:** Each plan incorporates the landowner's conservation vision, ensuring sustainable practices and reinforcing the commitment to conservation-based land use. **Sustainable Alternatives:** Promote sustainable livestock practices and economic diversification to reduce pressure for land-use change.
Economic Risk: Lack of Continuous Financial Incentives	Variations in the value of carbon credits or lack of access to markets may lead landowners to lose interest in conservation activities.	2	Medium	Medium	**Market Diversification:** Expand participation in voluntary and international carbon markets to ensure demand and competitive pricing.
Compliance and Monitoring	The risk is that landowners may not carry out conservation activities as established, negatively impacting	3	High	High	**Satellite Monitoring and Evaluation:** Periodic verification of activity effectiveness using satellite

Associated Risk	Description of the Risk	INHERENT VALUATION			Mitigation
		Probability	Impact	Inherent Risk	
	projected carbon sequestration.				tools to assess conservation in specific project areas. **Workshops for Landowners:** Educate landowners on monitoring the effectiveness of their conservation actions. **Conservation Activity Database:** Develop specific activities and indicators each landowner must fulfill, reinforcing accountability.

Source: Sahbio Carbono, 2024

11.7 Safeguard 7

"Actions to reduce displacement of emissions"

11.7.1 Training Plans and Community Involvement

The project includes training programs for landowners and their families, focusing on sustainable land management and preventing deforestation and degradation. We will hold regular informational meetings to discuss project objectives and the negative impacts of forest loss due to the displacement of deforestation drivers. The project is developing community-based monitoring initiatives where landowners actively participate in forest surveillance and biodiversity conservation through conservation activities.

11.7.2 Remote Sensing and Leak Detection

We established a leakage monitoring system, incorporating a satellite-based early warning system to track changes in forest cover. This monitoring system allows for timely decision-making to mitigate risks associated with degradation and the loss of ecosystem services. Geospatial technology (active and passive satellite data) monitors Essential Biodiversity Variables (EBVs), particularly in leakage-prone areas. The use of landscape-scale geospatial tools enables:

- Calculation of deforestation rates.
- Multitemporal analysis and time-series evaluation.
- Pressure assessment through hierarchical analytical processes.
- Applying biodiversity, soil, fire, and water indices to assess environmental impacts.

11.7.3 Forest and Biodiversity Surveillance Measures

The project is designing forest and biodiversity monitoring strategies, involving property owners and local communities in field-based observation and reporting. We developed a Communications Plan (See Annex XXX) to issue early warnings for wildfires and other environmental threats within both the project area and identified leakage zones.

By integrating geospatial monitoring, early warning systems, and community engagement, CO2Bio 2 ensures a proactive approach to monitoring, controlling, and mitigating carbon leaks, contributing to long-term forest conservation.

12 Special categories related to co-benefits

Actions related to climate change mitigation also bring additional benefits beyond reducing or removing greenhouse gas (GHG) emissions. In this regard, the IPCC (2007) states that the term "co-benefits" reflects that most policies designed to address GHG mitigation also have other justifications, often equally important, that influence the adoption of these policies.

We aim to achieve the special category of Palma de Cera. This category meets the conditions defined for each component that constitute additional benefits (biodiversity conservation, community benefits, gender equity, and climate change adaptation).

We framed **The Palma de Cera** category within the context of *Ceroxylon quindiuense*, a species that grows in one of the most threatened ecosystems in the world, the tropical cloud forests. The palm groves of *Ceroxylon quindiuense* constitute one of the most spectacular landscapes of the Colombian Andes. Despite being the national tree of Colombia, the species was categorized as endangered (EN) by Galeano & Bernal (2005). Although large populations remain in some sectors of the Central Andes, their habitat has been significantly reduced, and it is estimated that their populations have decreased by more than 50% over the last three generations.

12.1 Biodiversity conservation

12.1.1 Restoration activities in threatened ecosystems.

The project will contribute to the restoration of strategic ecosystems through actions such as the installation of signage to delimit protected areas and prohibit unauthorized activities, implementation and maintenance of wire fences or natural barriers to mark property boundaries, reforestation with native species of the region, and the release or exclusion of areas for passive restoration. These measures have been designed to align with REDD+ activities and safeguards and with actions to prevent socio-environmental risks and project activities related to the conservation of biodiversity associated with natural savannas and wetlands.

12.1.2 High conservation values

The HCV approach includes six categories: Species Diversity, Landscape-Level Ecosystems, Ecosystems and Habitats, Ecosystem Services, Community Needs, and Cultural Values. These categories address social and environmental priorities shared by various stakeholders[133]. We identified HCV for the project area see Table 12-1.

Table 12-1. Results of HCV assessment

Category of HCV	Presence	Location / Description	Conservation Strategies
HCV 1. Species Diversity (Concentrations of biological diversity with endemic, rare, threatened, or endangered species)	Yes	The region hosts significant biodiversity, including 59 amphibian species, 403 bird species, 22 crustacean species, and more, some endemic or endangered. Notable species include *Pteronura brasiliensis* (EN) and *Tapirus terrstris* (VU), both bioindicators and flagship species.	**Participatory monitoring** to identify key species and their threats, focusing on endangered species.
			Mapping critical habitats using remote sensing technologies to assess changes and detect threats.
			Protect key natural habitats, such as floodplain savannas, by establishing conservation areas.
			Control of agricultural expansion to mitigate impacts on sensitive species like *Oressochen jubatus* (NT).
HCV 2. Ecosystems and Landscape-Scale Mosaics (Large ecosystems with viable species populations under natural distribution and abundance patterns)	Yes	Floodplain savannas, the Civil Society Nature Reserve (RNSC), and Important Bird and Biodiversity Areas (IBA) are essential for aquatic and migratory birds. These areas also support endemic and endangered species.	**Development of ecological corridors** to connect key habitats and ensure species migration, particularly migratory birds.

[133] Watson, E. (ed.). Detección de Altos Valores de Conservación (AVC): Guía para identificar y priorizar acciones para AVC como parte de contextos jurisdiccionales y paisajísticos. HCV Network Ltd. 89 p. 2020.

Category of HCV	Presence	Location / Description	Conservation Strategies
			Satellite monitoring to evaluate the effectiveness of conservation strategies at the landscape scale. **Promotion of the creation of more RNSC and protected areas** to conserve critical ecosystems. **Sustainable management of floodplain savannas** is crucial for local biodiversity and water regulation.
HCV 3. Rare, Threatened, or Endangered Ecosystems, Habitats, or Refuges	Yes	These ecosystems are identified within the project area as crucial for migratory birds and endangered mammals.	**Land-use regulations** to prevent agricultural and livestock expansion in critical areas, such as floodplain savannas. **Protect critical habitats** by creating the project's Species Conservation Areas and conservation zones. **Monitoring key species** like *Pteronura brasiliensis* to assess ecosystem health.
HCV 4. Critical Ecosystem Services (Protection of watersheds, erosion control, among others)	No	No critical ecosystem services were identified within the AIPA boundaries, although they exist in the surrounding area.	**Identification of areas vulnerable to erosion** and loss of ecosystem services, focusing on watersheds. **Design of ecological restoration strategies** for degraded areas, such as floodplain savannas. **Monitoring water quality and availability** through hydrological monitoring systems.
HCV 5. Community Needs (Sites and resources essential for the livelihoods of local communities or Indigenous peoples)	Yes	The Cravo Sur River is a crucial water source for the community within the AIPA, and it depends on these resources for survival.	**Protection of water sources** through community conservation agreements. **Strengthening local capacity** for sustainable water resource management. **Development of sustainable agroforestry systems** to reduce pressure on natural ecosystems and improve food security.

Category of HCV	Presence	Location / Description	Conservation Strategies
HCV 6. Cultural Values (Sites of cultural, historical, or archaeological importance at the global or national level)	Yes	The "cantos de trabajo de llano" from the Orinoquía region is recognized as an Intangible Cultural Heritage of Humanity, highlighting the importance of integrating cultural conservation with biodiversity efforts.	**Integration of traditional knowledge** into conservation strategies, respecting local cultural practices.
			Protection of relevant cultural sites, such as those in the Western Hemisphere Shorebird Reserve Network (WHSRN).
			Promotion of sustainable cultural practices that complement biodiversity conservation efforts.
			Encouragement of sustainable tourism respects both cultural and ecological values.

Source: Sahbio Carbono

12.1.3 Threatened species

The departments of Arauca and Casanare are home to critically endangered species facing severe threats from human activities such as deforestation, agricultural expansion, and illegal hunting. The most vulnerable species in the global IUCN Red List[134] are included in Table 12-2.

Table 12-2. The threatened species of the Reference Area of the project, categorized by their conservation status and taxonomic group

Category	Species Name	Scientific Name	Taxonomic Group	Main Threats
Critically Endangered	Orinoco Crocodile	*Crocodylus intermedius*	Reptile	Illegal hunting for skin, competition for fish resources
Near Threatened	Orinoco Goose	*Neochen jubata*	Bird	Wetland destruction, hunting, agrochemical pollution
Vulnerable	Buff-breasted Sandpiper	*Calidris subruficollis*	Bird	Wetland destruction, hunting, agrochemical pollution

[134] UICN (Unión Internacional para la Conservación de la Naturaleza), Lista Roja de Especies Amenazadas, disponible en: https://www.iucnredlist.org/ (consulted 01/02/2025).

Category	Species Name	Scientific Name	Taxonomic Group	Main Threats
Near Threatened	Bearded Tachuri	*Polystictus pectoralis*	Bird	Annual & perennial non-timber crops, Wood & pulp plantations, Livestock farming & ranching
Endangered	Giant Otter	*Pteronura brasiliensis*	Mammal	Water pollution, wetland destruction
Vulnerable	Lowland Tapir	*Tapirus terrestris*	Mammal	Wetland destruction, hunting, agrochemical pollution
Near Threatened	Jaguar	*Panthera onca*	Mammal	Habitat fragmentation, human-wildlife conflict
Vulnerable	Giant Anteater	*Myrmecophaga tridactyla*	Mammal	Hunting, trapping terrestrial animals, Fire fire suppression
Vulnerable	Yellow-footed Tortoise	*Chelonoidis denticulata*	Reptile	Overexploitation for pet trade and consumption
Vulnerable	Yellow-spotted River Turtle	*Podocnemis unifilis*	Reptile	Wetland destruction, hunting, agrochemical pollution
Vulnerable	Spanish Cedar	*Cedrela odorata*	Plant	Logging and wood harvesting

Source: Sahbio Carbono, 2024

12.1.3.1.1 Key Regional Threats

- Deforestation and habitat loss (logging, agriculture, livestock expansion)
- Water pollution and overexploitation (oil extraction, agrochemicals)
- Illegal hunting pet trade
- Climate change impacts

12.1.4 Conservation Training for Biodiversity Monitoring Under Project Sahbio Carbono

Project Sahbio Carbono actively implements biodiversity monitoring as a key conservation strategy to protect threatened species in the Project Area. The project strengthens conservation efforts through participatory monitoring and biodiversity recording while generating co-benefits for local communities. These activities align with Sustainable Development Goal (SDG) 15: Life on Land, ensuring long-term ecosystem sustainability by engaging communities and stakeholders in tracking species populations and detecting environmental changes.

As part of this initiative, Project Sahbio Carbono will conduct mandatory training sessions on essential biodiversity monitoring methods, focusing on the region's most vulnerable species, including the Orinoco crocodile (*Crocodylus intermedius*), giant otter (*Pteronura brasiliensis*), among others. Participants gain hands-on training in observing and recording local flora and fauna, applying species counting techniques, and creating biodiversity tracking records to assess conservation status and population trends.

By combining scientific monitoring with local engagement, Project Sahbio Carbono will enhance conservation effectiveness and help mitigate significant threats such as deforestation, agricultural expansion, illegal hunting, and habitat fragmentation. Through these actions, Project Sahbio Carbono safeguards critical ecosystems while fostering sustainable environmental stewardship.

12.2 Community's benefits

12.2.1 Sustainable production systems for local development

As outlined in the project's activities, the initiative incorporates training programs to equip community members with the skills and knowledge needed to adopt sustainable agricultural practices and eco-friendly technologies. We designed these training courses to improve the productivity of small farms and ensure sustainability in the unique conditions of the floodplains. Key training components include:

- **Agroecological Techniques to Increase Conuco Productivity:**
  Training in methods that enhance the productivity of small-scale subsistence farming while preserving the ecological integrity of the land.
- **Adapted Livestock Practices for Flooded Savannas:**
  Introduction of livestock management techniques tailored to the challenges of flooded savannas, ensuring productivity while reducing environmental impacts.
- **Sustainable Cattle Water Systems for Flooded Savannas:**
  Implement water systems that optimize resource use, minimize waste, and ensure sustainable water access for livestock in flood-prone areas.

Expected Outcomes

By combining these environmentally friendly practices with responsible land management, the project creates opportunities for:

- **Long-term Economic Stability:** Supporting local producers in achieving sustainable livelihoods resilient to environmental and economic challenges.
- **Job Creation:** Fostering employment opportunities through adopting and implementing sustainable production systems.

- **Improved Quality of Life:** Enhancing food security, income stability, and overall well-being within the participating communities.

12.2.1.1 Key features of sustainable production systems include

- Biodiversity Conservation: Promoting farming and forestry practices that protect ecosystems and species.
- Resource Efficiency: Utilizing natural resources like water and soil to reduce waste and environmental degradation.
- Economic Inclusivity: Ensuring local communities benefit economically from these systems, emphasizing equitable opportunities, especially for marginalized groups.
- Climate Resilience: Designing systems adaptable to climate change impacts ensures that agricultural and forestry practices endure under changing conditions.
- Local Knowledge and Innovation: Encouraging indigenous knowledge and innovative solutions tailored to local conditions and needs.

Through these measures, sustainable production systems contribute to the long-term viability of local economies, foster community resilience, and promote environmental stewardship.

12.2.1.2 Increase in the Productivity of Conucos

The increase in the productivity of conucos within natural savannas is centered on implementing sustainable agricultural practices that enhance yields while preserving the ecological integrity of these landscapes. By promoting strategies such as Planting native food species, implementing home gardens for vegetables, greens, and aromatic herbs, implementing crop planning techniques, implementing irrigation systems, implementing organic fertilizers, and so forth, conucos can improve their productivity without causing degradation to natural ecosystems. Additionally, integrating traditional knowledge with modern sustainable technologies enables the efficient use of resources like soil and water. These actions aim to support food security and livelihoods for local communities while ensuring the long-term sustainability of natural savannas through practices that maintain soil fertility, conserve biodiversity, and reduce the pressures of land-use change (See Table 12-3).

Table 12-3. Proposed conservation activities in the implementation of the Conucos

Conservation Activity	Goal	Indicator	Related SDG	Nature of the Activity
Implementation of Improvement of Conucos	Improve food security through the implementation of conucos on properties	Binary Indicator: The property has implemented conucos (Yes/No). **Yes:** The property has implemented conucos. **No**: The property has not implemented conucos.	13: Climate Action. 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands

Source: Sahbio Carbono, 2024

12.2.1.3 *Implementation of activities aligned with silvopastoral systems adapted to savannas*

Implementing silvopastoral systems adapted to savannas and wetlands focuses on integrating trees, forage plants, and livestock to create productive and sustainable landscapes. These systems improve land-use efficiency while supporting ecosystem conservation and enhancing productivity. In natural savannas and wetlands, native tree species provide shade, reduce soil erosion, and contribute to carbon sequestration, addressing environmental and economic goals.

Furthermore, silvopastoral systems increase the availability of high-quality forage, promoting better livestock health and productivity. Simultaneously, these systems enhance biodiversity by creating habitats for native flora and fauna. Key activities may include planting multi-functional tree species, introducing rotational grazing practices, and implementing soil and water management strategies tailored to savanna and wetland ecosystems.

By aligning these activities with sustainable land management goals, silvopastoral systems contribute to climate resilience, reduce deforestation pressures, and improve the livelihoods of rural communities dependent on livestock farming (See Table 12-4).

Table 12-4. Proposed conservation activities in the Implementation of activities aligned with silvopastoral systems adapted to savannas

Conservation Activity	Goal	Indicator	Related SDG	Nature of the Activity
Rotational Grazing Practices	Reduce soil compaction by implementing rotational grazing practices on properties designated by the owner.	Binary Indicator: The property has implemented rotational grazing practices (Yes/No). **Yes**: The property has implemented rotational grazing practices. **No**: The property has not implemented rotational grazing practices.	13: Climate Action. 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands
Planting Shrub Patches and Forage Native Species	Increase biodiversity and improve grazing area conditions by planting shrub vegetation and forage species in areas designated by the owner.	Binary Indicator: The property has implemented the planting of shrub vegetation and forage species (Yes/No). **Yes**: The property has implemented the planting of shrub vegetation and forage species. **No**: The property has not implemented the planting of shrub vegetation and forage species	13 Climate Action. 15 Life on Land	Optional REDD+; Natural Savannas and Wetlands

Source: Shabio Sahbio Carbono, 2024

12.2.1.4 Construction of livestock water systems and reservoirs

The construction of livestock water systems and reservoirs in natural savannas is designed to provide livestock with reliable access to water while minimizing environmental impacts. These systems ensure sustainable water management by capturing and storing rainfall or surface water, which helps maintain soil moisture and supports ecosystem health during dry seasons. Properly planned reservoirs also reduce overgrazing pressure on vulnerable wetlands and water bodies by distributing livestock evenly across the landscape.

Key activities include designing and constructing small reservoirs, watering troughs, and distribution systems that account for the unique hydrological conditions of savannas and wetlands of the Orinoquia region. Integrating these systems with sustainable grazing practices helps prevent soil compaction and erosion, protecting critical water resources and biodiversity. Addressing livestock water needs through well-constructed systems promotes improved productivity, reduces conflicts over water access, and supports long-term ecosystem conservation (See Table 12-5).

Table 12-5. Proposed conservation activities in the construction of livestock water systems and reservoirs

Conservation Activity	Goal	Indicator	Related SDGs	Activity Type
Construction of Livestock Water Systems	Ensure a continuous and accessible water supply for livestock through the implementation of livestock aqueducts and the installation of pipeline systems and drinking troughs in grazing areas designated by the owner.	Binary Indicator: The property has implemented livestock aqueducts (Yes/No). **Yes**: The property has implemented livestock aqueducts. **No**: The property has not implemented livestock aqueducts.	13 Climate Action. 6 Clean Water and Sanitation. 15 Life on Land	Optional REDD+; Natural Savannas and Wetlands
Installation, operation, and maintenance of integrated water storage and management systems in strategic areas, including reservoirs, points, windmills, and motor pumps.	Ensure access to water during drought periods and in remote areas through the installation, operation, and maintenance of integrated systems for efficient water storage and management in areas designated by the owner.	Binary Indicator: The property has implemented the installation, operation, and maintenance of integrated systems for water storage and efficient management (Yes/No). **Yes**: The property has implemented the installation, operation, and maintenance of integrated systems for water storage and efficient management. **No**: The property has not implemented the installation, operation, and maintenance of integrated systems for water storage and efficient management.	13 Climate Action. 6 Clean Water and Sanitation. 15 Life on Land	Optional REDD+; Natural Savannas and Wetlands

Source: Sahbio Carbono, 2024

12.3 Gender equality

In alignment with national laws and the commitment to promoting gender equality, the project's development plans include specific actions to empower women and ensure equal access to economic resources, property, and control over land and other assets. These planned actions address systemic inequalities and promote women's participation in conservation and project-related activities.

12.3.1 Specific Actions in the Development Plans

12.3.1.1 Leadership Training and Role Assignment:

- The plans outline workshops designed to train and assign leadership roles to women within conservation activities.

- These roles will focus on monitoring and managing conservation efforts, ensuring women's participation in decision-making and implementation processes.

12.3.1.2 Capacity-Building in Information Technology:

- The project plans include workshops to train women in information technologies.

- These workshops aim to equip women with skills to support the execution and monitoring of project activities, enhancing their involvement and contribution.

12.3.2 Expected Outcomes

- **Economic Empowerment:** These planned actions will enable women to access economic opportunities and resources equally, contributing to their empowerment.

- **Increased Representation:** By fostering women's participation in leadership and technical roles, the project promotes gender balance and inclusion in traditionally male-dominated areas.

- **Compliance with National Laws:** The development plans align with national legal frameworks that ensure women's rights to economic resources and equitable access to land and other assets.

12.3.2.1 Community Empowerment and Skill Development with a Gender Focus

Strengthens participants' ability to make informed decisions, develop leadership, and foster community cohesion with a gender perspective (Table 12-6).

Table 12-6. Proposed training for community empowerment and skill development with a gender focus (Training plan).

Training	Theme	Related SDGs	Training Type
Leadership and decision-making with a gender perspective for managing community projects.	Gender equality in leadership.	5: Gender Equality	Mandatory: Wax Palm
	Decision-making.		
	Conflict resolution.		
Basic Accounting and Resource Management	Basic accounting and recording of income and expenses.		Optional

Source: Sahbio Carbono, 2024

13 Grouped projects

We anticipated that the project would include the development of a **second instance** as part of its clustered project structure. This second instance will cover **94,579,752 hectares** within the Arauca and Casanare municipalities. These areas are consistent with the properties' geographical, ecological, and administrative regions included in the first instance, ensuring alignment in environmental, social, and regulatory contexts.

13.1 Eligibility Criteria for the Second Instance

We define the following eligibility criteria to comply with section 20 of the BCR Standard, including the second instance.

Geographical Scope:

- The second instance will encompass properties located in the municipalities of Arauca and Casanare within the same ecological region as the first instance.

Baseline Consistency:

- We established the baseline conditions for the second instance using the methodologies and data collection standards applied to the first instance, ensuring methodological consistency.

Activity Alignment:

- Conservation, restoration, and sustainable management practices in the second instance will align with the activities defined in the first instance under the BCR methodologies.

Ownership and Land Tenure:

- Landowners of the properties included in the second instance will provide legal documentation of ownership or long-term control and sign agreements committing to the project's objectives and obligations (For further locations, see Table 13-1Table 13-1.

Table 13-1. Property's location of the second instance of the Sahbio Carbono Project

		Location		
Properties No	Properties Area (Ha)	Department	Municipality	Location
1	390	Arauca	Arauca	La Saya
2	633	Arauca	Cravo Norte	Mochuelo
3	632	Arauca	Arauca	La Saya
4	1057	Arauca	Cravo Norte	Los Caballos
5	638	Arauca	Cravo Norte	Los Caballos
6	843	Casanare	Hato Corozal	El Brillante
7	843	Casanare	Hato Corozal	El Brillante
8	743	Casanare	Paz De Ariporo	Varsovia
9	120	Arauca	Arauca	Maporillal
10	3000	Arauca	Arauca	Feliciano
11	42569	Arauca	Cravo Norte	Lejanias De Juriepe
12	1010	Arauca	Cravo Norte	Lejanias De Juriepe
13	964	Arauca	Cravo Norte	Lejanias De Juriepe
14	455	Arauca	Cravo Norte	Lejanias De Juriepe
15	824	Casanare	Paz De Ariporo	Normandia
16	747	Casanare	Paz De Ariporo	Normandia
17	802	Casanare	Paz De Ariporo	Normandia
18	815	Casanare	Paz De Ariporo	Normandia
19	841	Casanare	Paz De Ariporo	Normandia
20	843	Casanare	Paz De Ariporo	Normandia
21	843	Casanare	Paz De Ariporo	Normandia
22	12076	Casanare	Paz De Ariporo	Normandia
23	834	Casanare	Paz De Ariporo	Normandia

24	797	Casanare	Paz De Ariporo	Normandia
25	841	Casanare	Paz De Ariporo	Normandia
26	13246	Casanare	Paz De Ariporo	Normandia
27	576	Casanare	Paz De Ariporo	Centro Gaitán
28	841	Casanare	Paz De Ariporo	Centro Gaitán
29	769	Casanare	Paz De Ariporo	Centro Gaitán
30	839	Casanare	Paz De Ariporo	Centro Gaitán
31	804	Casanare	Paz De Ariporo	Centro Gaitán
32	840	Casanare	Paz De Ariporo	Centro Gaitán
33	843	Casanare	Paz De Ariporo	Centro Gaitán
34	843	Casanare	Paz De Ariporo	Centro Gaitán
35	818	Casanare	Paz De Ariporo	Centro Gaitán

Source: Sahbio Carbono, 2025

Monitoring and Reporting Capacity:

- The properties in the second instance will be integrated into the monitoring and reporting framework established for the clustered project, ensuring data collection and verification uniformity.

Risk and Permanence Analysis:

- We will conduct a risk assessment for the second instance using the BCR Risk and Permanence tool, ensuring that potential risks are identified and mitigated within the overall project framework.

13.2 Another GHG program

We have not registered The project under any Greenhouse Gas (GHG) program. It is being developed exclusively under the BioCarbon Registry (BCR) Standard.

14 Double counting avoidance

14.1 Commitment to BIOCARBON Registry Standard

The credits generated under the SAHBIO Carbono project will strictly adhere to the standards of the BIOCARBON Registry program, including:

- The issuance of ex-post credits is only after independent verification of results by accredited entities.

- The use of the registry platform ensures traceability and prevents duplication in the issuance, use, or claiming of credits.

14.2 Project Registration and Verification:

The project has been registered on the RENARE platform (Colombia's National Registry for Greenhouse Gas Emissions Reductions), ensuring that:

- There is no overlap with other projects in the area, which have been verified by analyzing maps, coordinates, and geographic boundaries. (Annex xxx)

14.3 Measures to Ensure Transparency:

Once generated, the credits will be subject to the traceability practices established by the BIOCARBON Registry, including:

- The assignment of unique serial numbers allows tracking from issuance to retirement.
- The publication of relevant project and credit information on a public platform to ensure transparency.

15 Monitoring plan

This document outlines the monitoring plan designed to assess changes in project boundaries, activity execution, socio-environmental effects, permanence, and GHG emissions/reductions. The plan follows established methodological guidelines such as BCR 0002 and BCR 0005 and the Monitoring, Reporting, and Verification BCR tool to ensure the generation of accurate and high-quality information during the verification process.

15.1 Description of the monitoring plan

Objective: The monitoring plan aims to provide accurate, reliable, and consistent measurements of greenhouse gas (GHG) emissions reductions and removals and monitor the project's activities. It ensures compliance with project objectives and adherence to international standards.

Monitoring Actions:

- Remote sensing technologies like satellite imagery are used for large-scale land use and vegetation cover monitoring.
- Train field staff in data collection protocols, safety measures, and equipment handling.
- Implement a matrix of development and indicators of the activities proposed for the project.

15.2 Project boundary monitoring

The methodology asks for monitoring the project's geographical boundaries for executed activities. These activities must be integrated into a robust and organized geographic information system (GIS), which will georeferenced the total project areas, including the reference region and leakage area.

Annual verification of land use changes within the project area will follow the methodology described in the section.

15.2.1 Reference region

According to the methodology, the reference region does not require monitoring.

15.2.2 Project area

Monitoring will occur annually for project boundaries and eligible areas, focusing on identifying changes in land cover associated with natural savannas, wetlands, and forests. The classifications must align with the Corine Land Cover methodology for Colombia (IDEAM, 2010)[135].

Actions:

- Digitize project area boundaries using GIS software (QGis V 3.36.3 or any newest).
- Conduct GPS-based field surveys to validate boundaries.

15.2.2.1 Eligible areas

Actions:

[135] Ideam, Leyenda Nacional de Coberturas de la Tierra, p 50

- Validate eligibility through land ownership records and legal compliance checks. The corresponding land covers are Natural Savannas, wetlands, and forests.

15.2.2.2 Leakage area

Actions:

- Annually update maps of leakage areas based on new information.
- Survey surrounding communities to assess indirect project effects.

15.3 Monitoring the project activities implementation

In alignment with project activities aimed at reducing greenhouse gas (GHG) emissions and conserving the biodiversity of natural savannas, wetlands, and forests, we have established a monitoring plan with measurable timeframes for the following actions:

15.3.1 Training Plan

We organized the Training Plan into six thematic categories that address the technical and community aspects necessary for implementing conservation activities and ensuring the project's sustainability. These categories include:

- Risk Mitigation and Adaptation to Climate Change: This category trains participants in techniques and knowledge to address climate change effects and reduce risks associated with environmental degradation.
- Carbon and Biodiversity Monitoring and Quantification: Participants receive training in measuring, monitoring, and recording carbon and biodiversity data to assess impacts on carbon credits and ecosystem conservation.
- Ecosystem Management and Conservation: This training focuses on restoration practices, territorial planning, waste management, and efficient water use to protect biodiversity and promote responsible natural resource management in rural areas.
- Regulatory Compliance and Safeguards: Landowners are trained in environmental regulations and safeguards to respect human rights and adhere to established guidelines.

15.3.2 Conservation activities

- Basic Activities involve implementing landscape management tools essential for establishing a foundation for conservation and sustainable land management.

- Activities for Community Well-being: these activities focus on increasing productivity in conucos through sustainable practices that enhance access to food, aiming to improve food security.
- Advanced Conservation Activities: These activities include implementing silvopastoral systems adapted to natural grasslands and constructing livestock aqueducts and reservoirs to optimize resource use while preserving ecological balance in intervention areas, targeting sustainable production

This comprehensive training plan equips project area owners with the necessary skills and knowledge to actively participate in conservation efforts, ultimately improving regional environmental outcomes.

15.3.3 Natural Savannas, wetlands, and Redd+ Activities implementation monitoring plan

In Table 15-1 and Table 15-2, we list the training plan and conservation activities and identify the program in which they are adopted. Not all activities are mandatory; some are optional. The tables identify which activities fall into the optional category. This approach allows project participants to choose activities that align best with their specific farm plans and objectives.

Table 15-1. Training plan as part of the project activities in the Sahbio Project

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Training	Related SDGs (Sustainable Development Goals)	The character of the Training	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
Training: Risk Mitigation and Climate Change Adaptation	T001	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI001	People who complete the training cycle	How to Prepare and Adapt Your Farm to Climate Change	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Mandatory	Training records, evaluation results, and participant testimonials.	One cycle every year	Sahbio Project	Percentage of participants that complete the training	Training records, evaluation results, and participant testimonials.
	T002	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI002	People who complete the training cycle	Fire Prevention and Control		Mandatory		One cycle every year			
Training: Monitoring and Quantification of Carbon and Biodiversity	T003	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI003	People who complete the training cycle	Measurement and Monitoring of Carbon in Soil and Biomass	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Mandatory		One cycle every year			
	T004	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI004	People who complete the training cycle	Use of Georeferencing Tools and Geographic Information Systems (GIS)		Optional		One cycle every year			
Training: Ecosystem Management and Conservation	T005	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI005	People who complete the training cycle	Ecological restoration practices	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional		One cycle every year			
	T006	To ensure that 90% of the enrolled participants complete the training	Number of people trained	TI006	People who complete the training cycle	Planning and zoning for the conservation of critical areas to protect biodiversity		Optional		One cycle every year			
Training: Regulatory	T007	To ensure that 90% of the enrolled	Number of people trained	TI007	People who complete the training cycle	Training in current conservation	SDG 6: Clean Water and Sanitation	Optional		One cycle every year			

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Training	Related SDGs (Sustainable Development Goals)	The character of the Training	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
compliance and safeguards		participants complete the training				laws and regulations in the region.	SDG 13: Climate Action SDG 15: Life on Land						
	T008	To ensure that 90% of the enrolled participants complete the training	To ensure that 90% of the enrolled participants complete the training	TI008	People who complete the training cycle	Safeguards Compliance Workshops		Optional		One cycle every year			

Source: Sahbio Carbono, 2024

Table 15-2. Conservation activities battery as part of the project activities in the Sahbio Project

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
Conservation activity: Implementation of landscape management tools (forest, savanna and wetland)	C001	Ensure ecosystem protection by installing signage that delineates protected areas and indicates prohibited activities within the property.	Number of properties that implement signage	CI001	Properties with signage	Installation of signage to delimit protected areas and prohibit unauthorized activities	Binary Indicator: The property has implemented signage (Yes/No). Yes: The property has signage. No: The property does not have signage.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Lan	Optional REDD+; Natural Savannas	Evidence supporting the implementation of the activity, such as invoices, contracts, agreements, photographic records, among others	Every year	Sahbio Project	Number of properties that have implemented signage	Report Form on the Implementation of Landscape Management Tools

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
	C002	Ensure the protection of the ecosystem through regular patrols on the property.	Number of properties that implement regular patrolling	CI002	Properties with regular patrolling	Regular patrolling	Binary Indicator: The property has implemented surveillance according to its characteristics (Yes/No). Yes: The property implements surveillance. No: The property does not implement surveillance.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Lan	Mandatory REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that have implemented regular surveillance	Report Form on the Implementation of Landscape Management Tools.
	C003	Protect ecosystems by implementing and maintaining fences or natural barriers on the property.	Number of properties that implement and maintain wire fences or natural barriers	CI003	Properties that implement and maintain wire fences or natural barriers	Implementation and Maintenance of Wire Fences or Natural Barriers to Delimit the Property and Protect Key Ecosystems	Binary Indicator: The property constructs and maintains fences (Yes/No). Yes: The property constructs and maintains fences. No: The property does not	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supporting the implementation of the activity, such as invoices, contracts, agreements, photographic records, among others	Every year	Sahbio Project	Number of properties that have implemented Wire Fences or Natural Barriers to Delimit the Property and Protect Key Ecosystems	Report Form on the Implementation of Landscape Management Tools

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
							construct and maintain fences.							
	C004	Facilitate the natural recovery of the ecosystem by designating areas for passive restoration.	Number of properties with passive restoration	CI004	Properties that implement passive restoration	Release or exclusion of areas for passive restoration.	Binary Indicator: The property performs passive restoration (Yes/No). Yes: The property carries out passive restoration. No: The property does not carry out passive restoration.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that have implemented passive restoration	Report Form on the Implementation of Landscape Management Tools
	C005	Promote ecosystem connectivity through the creation of biological corridors.	Number of properties with biological corridors	CI005	Properties that implement biological corridors	Implementing biological corridors	Binary Indicator: The property implements biological corridors (Yes/No). Yes: The property implements biological	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that implemented biological corridors	Report Form on the Implementation of Landscape Management Tools

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
							corridors. No: The property does not implement biological corridors							
	C006	Preserve ecosystem balance through the control and removal of non-native species.	Number of properties with Control and removal of exotic species.	CI006	Properties that control and remove exotic species.	Control and removal of exotic species.	Binary Indicator: The property controls and removes non-native species (Yes/No). Yes: The property carries out control and removal of non-native species. No: The property does not control and remove non-native species.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that control or remove exotic species	Report Form on the Implementation of Landscape Management Tools

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
	C007	Prevent the occurrence of wildfires affecting the floodplain savanna ecosystems by implementing prescribed burns and/or firebreak construction.	Number of properties that implement prescribed burns and/or firebreaks	CI007	Properties that implement prescribed burns and/or firebreaks	Execution of Prescribed Burns and/or Firebreak Construction for Fire Prevention and Management.	Binary Indicator: The property has implemented prescribed burns and/or firebreaks (Yes/No). Yes: The property has implemented prescribed burns and/or firebreaks. No: The property has not implemented prescribed burns and/or firebreaks.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that implement prescribed burns	Report Form on the Implementation of Landscape Management Tools
	C008	Restore the ecosystem through the planting of native species from the region.	Number of properties that reforested with native species of the region	CI008	Properties that are reforested with native species of the region	Active Restoration with Native Species.	Binary Indicator: The property has implemented active restoration with native species (Yes/No). Yes: The	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Number of properties that were reforested with native species	Report Form on the Implementation of Landscape Management Tools

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
							property has implemented active restoration with native species. No: The property has not implemented active restoration with native species.							
	C009	Establish at least one conservation agreement in strategic areas, promoting the conservation of key ecosystems and sustainable practices.	Number of properties with conservation agreements	CI009	Properties with conservation agreements	Establishment of Conservation Agreements or Memorandums of Understanding Related to Conservation.	Binary Indicator: The property has established conservation agreements (Yes/No). Yes: The property has established conservation agreements. No: The property has not established conservation agreements.	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every year	Sahbio Project	Percentage of properties with conservation agreements	Report Form on the Implementation of Landscape Management Tools

Source: Sahbio Carbono, 2024

15.3.4 Redd+ safeguards monitoring plan

We developed a series of activities with corresponding indicators to monitor compliance with the REDD+ social and environmental safeguards established for Colombia. These safeguards aim to prevent environmental and social risks, thereby protecting landowners' and their families' social, economic, and cultural rights.

Table 15-1 and Table 15-2 outlines the monitoring plan, detailing the projected indicators for each safeguard. We described and evaluated each of the seven safeguards within the project context.

15.3.5 Contribution to Sustainable Development Goals (SGD)

The project aims to contribute to three Sustainable Development Goals (SDGs): Gender Equality (Goal 5), Celan Water and Sanitation (Goal 6), Climate Action (Goal 13), and Life on Land (Goal 15).

For **Goal 5: Gender Equality**, the project aligns with target 5.5, which aims to ensure the complete participation of women and equal opportunities for leadership at all decision-making levels in political, economic, and public life. This will be achieved by creating spaces for meetings with female landowners and women from participating families and including them in governance workshops and training sessions. Additionally, in alignment with target 5.b, which focuses on enhancing the use of enabling technology, information, and communications technology to promote women's empowerment, the project will conduct training workshops for women on using information technologies. These sessions will enhance knowledge and skills in climate change mitigation, biodiversity conservation, and sustainable production practices. Progress will be evaluated by tracking women's participation and their roles in achieving project objectives and activities.

For **Goal 6: Celan Water and Sanitation**, the project aligns with target 6.6, which aims to protect and restore water-related ecosystems, including forests, wetlands, rivers, aquifers, and lakes. The project will implement and maintain wire fences or natural barriers to delineate property boundaries and safeguard key ecosystems. Additionally, it will involve constructing water systems for livestock and installing, operating, and maintaining integrated water storage and management systems in strategic areas, such as reservoirs, water points, windmills, and motorized pumps. These actions aim to promote long-term changes in the extent and health of water-related ecosystems.

For **Goal 13: Climate Action**, the project aligns with target 13.3.2, which focuses on incorporating climate change measures into national policies, strategies, and plans. To achieve this, the project will monitor land-use changes within the project area and track greenhouse gas emissions and removals in the project's eligible areas. It will also conduct workshops on climate change, forest governance principles, and implementing a management plan for ecosystem preservation. Progress toward this goal will be evaluated by tracking training attendance, assessing knowledge gained, monitoring the subsequent implementation of learned practices on individual properties, monitoring land use change, and calculating the emissions or removals of GHG.

For **Goal 15: Life on Land**, the project contributes to target 15.1, which emphasizes the conservation, restoration, and sustainable use of terrestrial and freshwater ecosystems, including forests, wetlands, mountains, and arid areas, in line with international agreements. The project will implement landscape management tools to support activities aimed at conserving ecosystems associated with forests, natural floodable and non-floodable savannas, and natural water bodies. These efforts will ensure the preservation and promotion of critical habitats for biological diversity. Evaluation will involve tracking, developing, or updating management plans for each property with assessments of ecosystem, biodiversity, socioeconomic, and productive conditions and monitoring compliance with conservation activities.

There are indicator Fact sheets for each goal the project will contribute to in the appendix XXX.

15.3.6 Special categories related to co-benefits

The following outlines the procedures related to monitoring co-benefits and the special category of Palma de Cera, as well as the criteria and indicators defined to demonstrate additional benefits and measure the co-benefits of the **Palma de Cera** category.

Actions:

- Biodiversity Conservation: Conduct regular camera trap monitoring and bird surveys to assess wildlife populations.
- Community Benefits: Track income changes through household surveys to measure economic impacts on local communities.
- Gender Equity: Ensure gender-disaggregated data is collected in participation records to promote inclusivity.

In Table 15-3 and Table 15-4, we present information about the monitoring program for cobenefits.

Table 15-3. Training Sessions for Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Training	Related SDGs (Sustainable Development Goals)	The character of the Training	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
Sustainable Productive Systems for Local Development	T009	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI009	People who complete the training cycle	Agroecological Techniques to Increase the Productivity of Conucos	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional	Training records, evaluation results, and participant testimonials.	Every three years	Sahbio Project	Percentage of participants that complete the training	Training records, evaluation results, and participant testimonials.
	T010	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI010	People who complete the training cycle	Livestock Adapted to Flooded Savannas in Natural Grasslands.		Mandatory		Every three years			
	T011	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI011	People who complete the training cycle	Sustainable Water Resource Management and Use.		Optional		Every three years			
	T012	Ensure that 90% of the project participa	Number of people trained	TI012	People who complete the training cycle	Solid Waste Management in Rural Areas.		Optional		Every three years			

		nts attend the training sessions.											
Monitoring of Biodiversity and Threatened Species	T013	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI013	People who complete the training cycle	Methods for Participatory Monitoring and Biodiversity Recording (Threatened Species)	SDG 15: Life on Land	Mandatory		Every three years			
Community Empowerment and Gender Approach	T014	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI014	People who complete the training cycle	leadership and Decision-Making with a Gender Approach for Community Project Management	ESG 5. Gender Equality	Mandatory		Every three years			
	T015	Ensure that 90% of the project participants attend the training sessions.	Number of people trained	TI015	People who complete the training cycle	Basic Accounting and Financial Services.		Mandatory		Every three years			
	T016	Ensure that 90% of the project	Number of people trained	TI016	People who complete the training cycle	Regulations Related to Working		Mandatory		Every three years			

		participants attend the training sessions.				Conditions.							

Source: Sahbio Carbono, 2024

Table 15-4. Conservation Activities for Cobenefits

Type	**Activity ID**	**Goal**	**Indicator or Name**	**Indicator ID**	**Measurement unit**	**Conservation activity**	**Indicator**	**Related SDGs (Sustainable Development Goals)**	**Character of the Conservation Activity**	**Monitoring methodology**	**Monitoring frequency**	**Responsible for measurement**	**Result indicator in the reporting period**	**Documents to support the information**
Food Security	C010	Improve food security through the implementation of conucos on properties.	Number of properties that implement conucos	CI010	Properties that implement conucos	Implementation of Improvement of Conucos	Binary Indicator: The property has implemented conucos (Yes/No). Yes: The property has implemented conucos. No: The property has not implemented conucos.	SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every three years	Sahbio Project	Number of properties with implementation of conucos	Report Form on Conservation Activities of Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
Implementation of Activities Aligned with Silvopastoral Systems Adapted to the Savanna in Natural Grasslands (Savanna and Wetlands)	C011	Reduce soil compaction by implementing rotational grazing practices on properties designated by the owner.	Number of properties that implement rotational grazing practices	CI011	Properties that implement rotational grazing practices	Rotational Grazing Practices	Binary Indicator: The property has implemented rotational grazing practices (Yes/No). Yes: The property has implemented rotational grazing practices. No: The property has not implemented rotational grazing practices.	13: Climate Action; 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every three years		Number of properties with rotational grazing practices	Report Form on Conservation Activities of Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
	C012	Increase biodiversity and improve grazing area conditions by planting shrub vegetation and forage species in areas designated by the owner.	Number of properties that plant shrub patches and native forage species	CI012	Properties that plant shrub patches and native forage species	Planting Shrub Patches and Native Forage Species	Binary Indicator: The property has implemented the planting of shrub vegetation and forage species (Yes/No). Yes: The property has implemented the planting of shrub vegetation and forage species. No: The property has not implemented the planting of shrub vegetation and	SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands	Evidence supports the activity's implementation, such as invoices, contracts, agreements, and photographic records.	Every three years		Number of properties that plant shrub patches and forage species	Report Form on Conservation Activities of Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
							forage species.							
Sustainable Management and Use of Water Resources (Savanna and Wetlands)	C013	Ensure a continuous and accessible water supply for livestock through the implementation of livestock aqueducts and the installation of pipeline systems and drinking troughs in grazing areas designated by the owner.	Number of properties that have livestock water systems	CI013	Properties that have livestock water systems	Construction of Livestock Water Systems	Binary Indicator: The property has implemented livestock aqueducts (Yes/No). Yes: The property has implemented livestock aqueducts. No: The property has not implemented livestock	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands	Evidence supporting the implementation of the activity, such as invoices, contracts, agreements, photographic records, among others	Every three years		Number of properties that have livestock water systems	Report Form on Conservation Activities of Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
							aqueducts.							
	C014	Ensure access to water during drought periods and in remote areas through the installation, operation, and maintenance of integrated systems for efficient water storage and management in areas designated	The number of properties that install, operate, and maintain integrated water storage and management systems in strategic areas, including reservoirs, points, windmills, and	CI014	Properties that have installation, operation, and maintenance of integrated water storage and management systems in strategic areas, including reservoirs, points, windmills, and motor pumps	Installation, operation, and maintenance of integrated water storage and management systems in strategic areas, including reservoirs, points, windmills, and motor pumps.	Binary Indicator: The property has implemented the installation, operation, and maintenance of integrated systems for water storage and efficient management (Yes/No). Yes: The property has impleme	SDG 6: Clean Water and Sanitation SDG 13: Climate Action SDG 15: Life on Land	Optional REDD+; Natural Savannas and Wetlands	Evidence supporting the implementation of the activity, such as invoices, contracts, agreements, photographic records, among others	Every three years		Number of properties with reservoirs, points, windmills, and motor pumps	Report Form on Conservation Activities of Cobenefits

Type	Activity ID	Goal	Indicator Name	Indicator ID	Measurement unit	Conservation activity	Indicator	Related SDGs (Sustainable Development Goals)	Character of the Conservation Activity	Monitoring methodology	Monitoring frequency	Responsible for measurement	Result indicator in the reporting period	Documents to support the information
		by the owner.	motor pumps.				nted the installation, operation, and maintenance of integrated systems for water storage and efficient management. No: The property has not implemented the installation, operation, and maintenance of integrated systems for water storage and efficient management.							

Source: Sahbio Carbono, 2024

15.4 Monitoring the permanence of the project

The BIOCARBON Standard V 3.4 (2024) specifies that for AFOLU sector projects, a 20% reserve is automatically deducted from the total quantified greenhouse gas (GHG) removals or emission reductions during each verification period. This deduction occurs once GHG removals or reductions are registered based on the selected quantification methodology. The credit reserve is calculated and subtracted from the total emissions, ensuring a permanent reserve for each project to address potential reversals.

Of this 20% deduction, 10% is deposited into a reserve account designated for the project, while the remaining 10% of the Verified Carbon Units (VCUs) generated during verification will be placed into a General Reserve Account within the BIOCARBON registry.

15.4.1 Biofisical risk

15.4.1.1 Fires

Given the project area's geographical location and climatic characteristics, along with anthropogenic activities such as biomass burning and expanding agricultural and livestock boundaries, uncontrolled fires frequently devastate vegetation cover—particularly in grasslands, pastures, and natural forests—resulting in significant degradation. Forest fires pose a critical challenge to the implementation of the CO2Bio project.

In the event of a forest fire affecting REDD+ conservation areas within the project, it is essential to document the incident thoroughly. This documentation should include written accounts, photographs, testimonies, and established response procedures. Key steps involve identifying the affected areas and estimating the resulting CO_2 and CH_4 emissions for incorporation into the emissions quantification process.

Property owners shall implement conservation commitments in contractual agreements to mitigate this risk. The following preventative measures are part of Avoid land use change of Natural Savannas and Wetlands and REDD+ activities aimed at reducing the risk of forest fire disasters:

- Removal of biomass that could serve as fuel during a fire.
- Establishment of firebreaks.
- Implementation of fire barriers.
- Avoid burning during critical dry seasons.

15.4.1.2 *Extreme flooding*

Intense and prolonged floods can inundate large areas, disrupt ecological communities, and threaten flora and fauna. In savannas, excessive water can suffocate natural grasslands and other vegetation, while the force of floodwaters often erodes topsoil, reducing its fertility. This erosion displaces shallow-rooted plants and seeds, impairing natural regeneration and diminishing the ecosystem's resilience. For forests, flooding can submerge tree roots for extended periods, weakening or killing trees, which reduces canopy cover and disrupts habitat structures for dependent species.

Flooding also amplifies the risk of contaminant dispersion, particularly in areas where pollutants such as agricultural runoff or industrial waste are present. These pollutants can spread across vast areas, degrading water quality and harming aquatic and terrestrial life. Additionally, sudden or severe flooding events can fragment habitats, isolate populations, and force wildlife to migrate to less suitable areas, increasing resource competition.

15.4.1.3 *Extreme drought*

Prolonged drought periods lead to water scarcity, adversely affecting soil moisture levels and reducing the availability of essential water resources for flora and fauna. This scarcity results in decreased plant growth and productivity, disrupting food chains and diminishing habitat quality for wildlife. In natural savannas, drought exacerbates natural grassland degradation, exposing soils and increasing vulnerability to erosion. Forest ecosystems also experience heightened stress, leading to tree mortality and reduced canopy cover, which can alter microclimates and destabilize the ecosystem further.

Drought conditions increase the likelihood of wildfire as the vegetation becomes dry and more flammable. Fires in drought-affected areas can cause widespread destruction, resulting in loss of biodiversity and the release of significant amounts of carbon stored in vegetation and soil. Additionally, prolonged drought weakens plants, making them more susceptible to pests and diseases, which can further degrade the ecosystem. These cascading effects highlight the importance of addressing drought risks through sustainable land management and conservation strategies tailored to Orinoquia natural landscapes' unique needs.

15.4.2 Socioeconomic risk

15.4.2.1 *Conservation agreements*

Non-compliance with conservation agreements by project area owners in the Orinoquia region poses significant risks to the success of conservation efforts. When owners fail to uphold the agreed-upon measures, critical ecosystems such as forests and natural savannas may suffer degradation from unauthorized activities like deforestation, agricultural expansion, or livestock overgrazing. These actions reduce vegetation cover, disrupt habitat connectivity, threaten biodiversity, and compromise the carbon sequestration potential of the project areas.

Moreover, non-compliance can lead to the loss of financial and technical support for sustainable practices in the region. Conservation projects often collaborate with landowners to maintain funding and achieve measurable outcomes, such as emissions reductions or biodiversity preservation. Violations of agreements may result in penalties, reduced incentives, or withdrawal of project support, further exacerbating environmental degradation.

15.4.2.2 Social appropriation and governance deficit of the project

A lack of social appropriation and governance among project area owners in the Orinoquia region presents substantial risks to the project's success. Without a sense of ownership and commitment to conservation goals, landowners may prioritize short-term economic activities, such as deforestation or agricultural expansion, over sustainable practices. This disconnect can lead to non-compliance with conservation agreements, increased environmental degradation, and failure to meet project objectives, such as carbon sequestration and biodiversity preservation. Additionally, inadequate governance hampers decision-making processes, limiting the ability to enforce regulations, resolve conflicts, or effectively implement adaptive management strategies.

Governance deficits can also weaken collaboration and trust among stakeholders, including local communities, project implementers, and government authorities. Poor governance structures may result in mismanagement of resources, inequitable benefit-sharing, and reduced transparency, all of which can undermine the project's legitimacy. These challenges erode community support and discourage long-term participation, making it difficult to sustain conservation outcomes.

Strengthening governance mechanisms and fostering social appropriation through education, capacity-building, and inclusive decision-making processes are critical for ensuring the project’s resilience and success in the Orinoquia region.

Moreover, addressing historical grievances and ensuring landowners feel heard and valued can significantly improve engagement levels. When communities perceive that their needs and concerns are acknowledged, they are more likely to actively support conservation initiatives.

A summary of the risk management monitoring process for the SAHBIO Carbono Project is included (See Table 15-5).

Table 15-5. Mitigation activities to ensure the permanence of the project

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Rating	Rating risk		Mitigation activities	Procedure
								Value	Level		
1	Fire	Physical	Loss of natural savanna or forest ecosystem due to fire	Binary Indicator: Whether the property has implemented prescribed burns (Yes/No). Yes: The property has implemented prescribed burns. No: The property has not implemented prescribed burns.	4	2	6	5	High	**Prescribed Burning** Prescribed burning is a controlled fire management practice aimed at removing dry vegetation and accumulated fuel in the floodplain savannas of the Orinoquía region, thereby reducing the risk of uncontrolled wildfires. Cause The uncontrolled use of fire as a traditional tool for clearing agricultural lands. **Relationship** The unregulated use of fire leads to unplanned wildfires that extend beyond intended areas, destroying native vegetation cover and altering the structure and functionality of ecosystems. **Objective** To prevent fires that harm floodplain savanna ecosystems by implementing prescribed burns, thus promoting the conservation of native vegetation cover and ecosystem functionality.	To prevent fires that impact floodplain savanna ecosystems by conducting prescribed burns, promoting the conservation of native vegetation cover, and maintaining ecosystem functionality.

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Rating	Rating risk		Mitigation activities	Procedure
								Value	Level		
2	Fire	Physical	Loss of natural savanna or forest ecosystem due to fire	Binary Indicator: Whether the property has implemented firebreaks (Yes/No). Yes: The property has implemented firebreaks. No: The property has not implemented firebreaks.	4	2	6	5	High	**Firebreak Implementation** The establishment of vegetation-cleared strips of land in the floodplain savannas of the Orinoquía region was designed to limit the spread of fires and protect critical conservation areas. **Cause** The absence or poor maintenance of firebreaks allows uncontrolled fire spread, affecting areas of high ecological value. **Relationship** The lack of firebreaks or their mismanagement increases the vulnerability of ecosystems to fires, enabling rapid fire propagation, destroying native vegetation cover, and degrading the ecological functionality of floodplain savannas.	To reduce the spread of uncontrolled fires through the implementation of firebreaks, thereby promoting the conservation of native vegetation cover and maintaining ecosystem functionality.
3	Extreme flooding	Physical	The dragging of substrates and plant material, loss of lives, infrastructure, and crops.	The number of reports of unusual flooding.	2	1	2	1	Low	Do not locate houses near water sources, and maintain control over the maximum flood levels on the properties yearly.	Constant communication is maintained with the property owners. In the event of flooding with significant impacts, a report

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Ratin g	Rating risk		Mitigation activities	Procedure
								Value	Level		
											will be made by completing a form.
4	Extreme drought	Physical	Water scarcity, adversely affecting soil moisture levels and reducing the availability of essential water resources for flora and fauna	Porcentaje de puntos estratégicos y viables con reservorios de agua construidos. Fórmula: (Número de puntos estratégicos y viables con reservorios construidos / Número total de puntos estratégicos y viables definidos por el propietario) x 100	2	1	2	1	Low	**Creation of Storage Ponds in Key Locations** Establishing storage ponds in strategic locations to capture and conserve water enables its use. Establishing and facilitating access in areas far from natural water sources. **Cause** Water scarcity during drought is due to the pressure from activities such as livestock farming, which compete for water resources and may lead to soil degradation. **Relationship** The construction of strategic reservoirs allows for water conservation and reduces dependence on vulnerable natural sources, mitigating ecosystem degradation and preventing the need to change land use in	Ensure access to water during drought periods and in areas distant from natural sources by constructing reservoirs at 100% of the strategic and viable points defined by the property owner.

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Rating	Rating risk		Mitigation activities	Procedure
								Value	Level		
										areas with limited access to water.	
5	Conservation agreements	Economic	The property owner fails to comply with the obligations under the contract.	# de Reportes de llamas de atención por incumplimiento	2	2	4	2	Medium	Training in the current conservation laws and regulations in the region. Workshops on compliance with safeguards.	Monitor the conservation activities to ensure compliance with the terms outlined in the contract signed by the property owners.

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Rating	Rating risk		Mitigation activities	Procedure
								Value	Level		
6	Social appropriation and governance deficit of the project	Social	Without a sense of ownership and commitment to conservation goals, landowners may prioritize short-term economic activities, such as deforestation or agricultural expansion, over sustainable practices. Inadequate governance hampers decision-making processes, limiting the ability to enforce regulations, resolve conflicts, or effectively implement adaptive management strategies.	Percentage of enrolled participants who completed the training.	1	2	2	1	Low	The Training Plan is organized into six thematic categories, addressing the technical and community aspects necessary to implement conservation activities and the project's sustainability. These categories are:	Risk Mitigation and Climate Change Adaptation: Training participants in techniques and knowledge to address the effects of climate change and reduce risks associated with environmental degradation. Monitoring and Quantification of Carbon and Biodiversity: Training in measurement, monitoring, and recording techniques for carbon and biodiversity to assess the impact on carbon credits and ecosystem conservation. Sustainable Land Management: Training in restoration practices, land-use planning, waste management, and efficient water use to protect

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Rating	Rating risk		Mitigation activities	Procedure
								Value	Level		
											biodiversity and promote responsible natural resource management in rural areas. Sustainable Agricultural Practices: Training in agroecological and livestock techniques adapted to improve productivity in smallholdings and the sustainability of floodplain savannas, promoting efficient resource use and balancing production with conservation. Regulatory Compliance and Safeguards: Training property owners in environmental regulations and safeguards to ensure respect for human rights and compliance with regulations. Community Empowerment and Skill

No.	Activity	Risk type	Risk	Indicator	Impact	Probability	Ratin g	Rating risk		Mitigation activities	Procedure
								Value	Level		
											Development with a Gender Approach: Strengthening the participants' capacity to make informed decisions, develop leadership, and promote community cohesion with a gender-focused approach.

15.5 Monitoring of the quantification of project emission reduction/removals

Minimum data on activity must be monitored within the project framework:

- Annual land use changes in project areas.
- Annual land use changes in leakage areas.
- GHG emissions during analysis periods.
- Emission reductions from the project.

15.5.1 Monitoring the quantification of project emission reduction/removals for activities that prevent land use change in natural savannas and wetlands

15.5.1.1 Change in annual land use in the project area

Actions:

- Analyze high-resolution satellite imagery annually to detect changes in land use.
- The following equation allows for estimating land use changes in the project area during the monitoring period (Equation 15-1):

Equation 15-1. Land Use changes (by year) in the project area

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

Where:

$SCNC_{project,\ yr}$= Aunnal change in the surface with natural vegetation cover in the project area; ha.

T_1= Initial year of reference period; year

T_2= Final year of the reference period; year

A_1= Natural vegetation cover, the surface in the project area at the beginning of the monitoring period; ha

A_2= Natural vegetation cover, the surface in the project area at the end of the monitoring period; ha

15.5.1.2 Annual changes in land use in the leakage area

Actions:

- Conduct community-based monitoring to identify potential leakage activities that may arise from the project.
- The estimation of the annual land use in the leakage area in the monitoring period is estimated by the following Equation 15-2:

Equation 15-2. Annual changes in the land use in the leakage area

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

Where:

$SCCN_{lk,\ yr}$= Annual change in the surface covered by forest and natural vegetation cover in the leakage area

T_1= Initial year of reference period; year

T_2= Final year of the reference period; year

$A_{lk,\ 1}$= Natural vegetation cover, surface in the leakage area at the beginning of the monitoring period; ha

$A_{lk,\ 2}$= Natural vegetation covers the surface in the leakage area at the end of the monitoring period, ha.

15.5.1.3 GHG emissions in the analysis period

Actions:

- Develop dashboards for annual reporting of GHG reductions/removals, facilitating transparency in results.
- Compare actual project results with estimated reductions and justify any observed variances.
- Equation 15-3 estimates the annual emission from land use change in the project area.

Equation 15-3. GHG emissions in the analysis period

$$E_{project,yr} = SCNC_{project}\ x\ (CBF_{eq} + SOC_{eq})$$

Where:

$E_{project,\ yr}$= Annual emissions in the project area; $tCO_2\ ha^{-1}$

$SCNC_{project}$= Lans use change in the project area; ha $year^{-1}$

CFB_{eq}= Carbon dioxide equivalent in the total biomass; $CO_{2e}\ ha^{-1}$

SOC_{eq}= Soil Organic Carbon; tC ha^{-1}

The following Equation 15-4 estimates the annual emission in the leakage area

Equation 15-4. GHG annual emission in the leakage area

$$E_{lk,yr} = [SCNC_{project,lk}\ x\ (CBF_{eq} + SOC_{eq})] - AE_{lk,bl}$$

Where:

$E_{lk,\ yr}$= Annual emissions in the leakage area: $tCO_2\ ha^{-1}$

$SCNC_{project,\ lk}$= Changes in the land use in the leakage area; ha $year^{-1}$

CBF_{eq}= Carbon dioxide equivalent in the total biomass; tCO_2ha^{-1}

SOC_{eq}= Soil Organic Carbon; tC ha^{-1}

$AE_{lk,\ bl}$= Annual emissions in the leakage area in the baseline scenario; tCO_2e

15.5.1.4 Project emissions reduction

Emission reductions from avoided land use changes in natural savannas and wetlands during the monitoring period are going to be estimated according to the following Equation 15-5:

Equation 15-5. Reduction of emissions due are the project activities

$$ER_{project,mp} = (t_2 - t_1)x\ (AE_{lb} - AE_{project,mp} - AE_{lk})$$

Where:

$ER_{project, mp}$= Emission reduction from avoided changes land use in monitoring period; tCO_2eyr^{-1}

T_1= Initial year of reference period; year

T_2= Final year of the reference period; year

AE_{bl}= Emissions by land use changes in the baseline scenario; tCO_2e

$AE_{project, mp}$= Emission by land use changes in the project area in the monitoring period; tCO_2e

AE_{lk}= Emission by land use changes in the leakage area in the monitoring period; tCO_2e

Quantify the net GHG emission reductions and removals, summarizing the key results using the table below.

Year	***Baseline emissions/removals (tCO_2e)***	***Project emissions/removals (tCO_2e)***	***Leakage emissions (tCO_2e)***	***Net GHG emissions/removals (tCO_2e)***
Year A (DD-MM-YYYY--DD-MM-YYYY)				
Year…				
Total				

15.5.1.5 Comparison of actual emission reductions with estimates in the project document

We will state the estimated ex-ante GHG emission reduction/removals and compare actual values of the emission reductions/removals achieved during the monitoring period with estimations in the registered Project Document. We will report the percentage difference and justify the difference.

15.5.1.6 *Remarks on the difference from the estimated value in the registered project document*

We will explain the cause of any increase in the emission reductions/removals achieved during the current monitoring period, including all information (i.e., data and/or parameters) different from that stated in the registered project document.

15.5.2 Monitoring the quantification of project emission reduction/removals for activities that prevent deforestation REDD+

15.5.2.1 *Annual deforestation in the project area*

The deforestation in the project area during the monitoring period will use the following Equation 15-6:

Equation 15-6. Annual deforestation in the project area

$$FSC_{REDD+project,yr} = \left(\frac{1}{t_2 - t_1}\right) x \left(A_{REDD+project1} - A_{REDD+project\ 2}\right)$$

Where:

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

t_2 = Final year of the reference period; yr

t_1 = Initial year of the reference period; yr

$A_{REDD+\ project\ 1}$= Forest surface in the project area at the beginning of the monitoring period; ha

$A_{REDD+project\ 2}$ = Forest surface in the project area at the end of the monitoring period; ha

15.5.2.2 *Annual deforestation in the leakage area*

The annual deforestation in the leakage area during the monitoring period will be estimated using Equation 15-7.

Equation 15-7. Annual deforestation in the leakage area

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

Where:

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

t_2 = Final year of the reference period; year

t_1 = Initial year of the reference period; year

$A_{lk, 1}$= Forest surface in the leakage area at the beginning of the monitoring period; ha

$A_{lk, 2}$= Forest surface in the leakage area at the end of the monitoring period; ha

15.5.2.3 GHG emissions in the monitoring period due to deforestation REDD+

The annual emission due to deforestation in the project area will be estimated with the following Equation 15-8:

Equation 15-8. GHG emissions in the monitoring period due to deforestation

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

Where:

$AE_{REDD+\ project,\ yr}$= Annual emission in the project area; tCO_2 ha

$AD_{REDD+\ project,\ yr}$ = Annual deforestation in the project area; ha

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

The annual emission due to deforestation in the leakage area is estimated as follows in Equation 15-9:

Equation 15-9. Annual emissions due to deforestation in the leakage area

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

Where:

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

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

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

$AE_{lb,lk,yr}$= Annual emission in the leakage area, in the baseline scenario; tCO_2 ha-1

15.5.2.4 *Quantification of the project emissions reduction due to deforestation*

Emission reductions from avoided deforestation in the monitoring period are estimated according to the following Equation 15-10:

Equation 15-10. Emission reduction due to avoided deforestation

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

Where:

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

t_2 = Final year of the monitoring period; year

t_1 = Initial year of the monitoring period; year

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

$AE_{REDD+project}$ = emission by deforestation in the project area; tCO_2 ha-1

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

15.5.2.5 *Comparison of actual emission reductions with estimates in the project document*

We will state the estimated ex-ante GHG emission reduction/removals and compare actual values of the emission reductions/removals achieved during the monitoring period with estimations in the registered Project Document. We will report the percentage difference and justify the difference.

15.5.2.6 *Remarks on a difference from an estimated value in the registered project document*

We will explain the cause of any increase in the emission reductions/removals achieved during the current monitoring period, including all information (i.e., data and/or parameters) different from that stated in the registered project document.

15.6 Data and parameters for quantifying emission reductions

15.6.1 Fixed Data and Parameters

Actions:

- Establish permanent sampling spots for field data collection in Natural Savannas and Wetlands, including biomass measurements and soil carbon sampling.
- Establish permanent sampling spots for field data collection in Natural forests, including soil carbon sampling.
- Measure biomass growth using standardized protocols.
- Monitor soil organic carbon (SOC) through periodic soil sampling and laboratory analyses.
- Recalculate the emission factors to ensure the data certainly
- Document sources and assumptions for fixed parameters in the monitoring report.

15.6.2 Monitored Data and Parameters

15.6.2.1 Selecting Satellite Images

- **Sentinel-2 (Copernicus):**

  Spatial resolution: 10 meters for RGB and NIR bands (Bands 2, 3, 4, and 8).

  Revisiting frequency: 5 days (using both Sentinel-2A and 2B satellites).

  Free and easily accessible through platforms like the Copernicus Open Access Hub or Google Earth Engine.

  Advantage: Excellent quality for capturing land cover details with a broad spectral range.

- **Planet Scope (Planet):**

  Spatial resolution: 3 meters.

  Revisiting frequency: Daily.

  Commercial access, though some regions may obtain images for free through academic or governmental programs.

  Advantage: Ideal for small areas or projects requiring fine details.

- **Landsat 8/9:**

  Spatial resolution: 30 meters.

  Revisiting frequency: 16 days.

  Free through platforms such as USGS Earth Explorer.

  Complementary use: Although lower resolution, it can be helpful for validation or temporal analysis when combined with higher-resolution imagery.

15.6.2.2 Complementary Layers

- **Digital Elevation Models (DEM):**

  For topographic analysis, SRTM (30 meters) or ALOS PALSAR DEM (12.5 meters). It helps distinguish land cover types associated with slopes or elevations, such as mountain forests.

- **Reference vector layers:**

  Boundaries of protected areas, rivers, and roads are available on platforms such as IDEAM or Geoportal IGAC in Colombia. Facilitate validation and segmentation.

15.6.2.3 Temporal Considerations

- Select images from periods with low cloud cover, preferably during Colombia's dry season (varies by region; January of each year for the Project).
- Use multi-temporal compositions to minimize errors caused by cloud cover.

15.6.2.4 Software and Tools

- Use tools like QGIS, ArcGIS Pro, or Google Earth Engine for image processing.
- Implement supervised classification methods, such as Random Forest or Support Vector Machines (SVM), to map land covers according to CLC categories adapted for Colombia.

15.6.2.5 *Adaptation of CLC to Colombia*

- The CLC standard must always be adapted to local conditions in level three of the classification-based National Land Cover Legend. CORINE Land Cover methodology adapted for Colombia Scale 1:100,000 (IDEAM, 2010).

Complete the table for all data and parameters monitored during the project quantification period.

Data / Parameter	
Data unit	
Description	
Measured /Calculated /Default:	
Source of data	
Value(s) applied	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	
Monitoring frequency	
Measuring/ Reading/ Recording frequency	
Measurement/Calculation method (if applicable)	
QA/QC procedures applied	

16 Design of Q/A Procedures

16.1 Quality Management and Assurance System

To ensure the integrity and quality of information in the SAHBIO Carbon project, Visso Consultores and Terra Spectrum have implemented policies, manuals, and systems dedicated to adequately managing data and information. These guidelines are based on the firm commitment of the project management, formally expressed in document VS-SC-001: *Quality Policy Statement for the SAHBIO Carbon Project*, which reflects the organization's efforts in achieving excellence and continuous improvement.

16.2 Management of Environmental and Social Information Quality

- **Objective:** Maintain a management system to ensure that the information accurately reflects the project's environmental and social activities and conditions and correctly handles information related to the SAHBIO Carbon project.
- **Activities:**
    - **Collection and analysis of environmental technical data:** Terra Spectrum will carry out data collection, analysis, and environmental measurements, including soil, vegetation, and water sampling, using EADN technology, hyperspectral imaging, and bioacoustics. These activities will comply with Terra Spectrum's established quality assurance policies, certifications, and accreditations (Annex 2).
    - **Social assessment:** Following the *Procedure for Property Involvement*, VISSO, through Fundación Corocoras as the local field liaison, organized workshops and conducted surveys with landowners and local communities. Additionally, legal documentation of the property was collected to conduct social analysis, assess the socioeconomic impact in the project's area of influence, and gather feedback.
    - **Documentation:** VISSO maintains records of all data, meetings, and workshops, which are documented and reviewed by the technical team before being digitized and stored in TEAMS.

16.3 Quality Control and Assurance Protocol

- **Quality Verifications:** Periodic inspections will be conducted by verification entities to determine the accuracy of the collected data.

- **Data Review:** Periodic analysis of the collected data to identify potential errors or inconsistencies and apply the necessary corrections.

- **Security Storage:** Ensuring that all data is backed up in two cloud locations to prevent information loss.

16.4 DETAILED ROLE AND RESPONSIBILITY ASSIGNMENT

- **VISSO Project Management:** General project oversight, communication management between groups, and leadership in strategic decision-making.

- **Terra Spectrum Technical Team:** Responsible for executing environmental data collection and analysis.

16.5 PROJECT BOUNDARY DEFINITION AND REVIEW

- **Project Boundaries:** By the *Procedure for Property Inclusion Assessment* developed by Terra Spectrum, a description of the geographical boundaries will be conducted based on GPS data and detailed maps. This will be done through the *Physical Component Analysis* performed by a surveyor, who will compare legal property documents, maps provided by the *Instituto Geográfico Agustín Codazzi (IGAC)*, blueprints supplied by property owners, and property boundaries. This comprehensive analysis ensures the accuracy of territorial information, which is essential for project planning and execution.

16.6 Request, Complaint, And Claim Management System (PQR)

To effectively manage requests, complaints, and claims, we have developed and formalized the document *VS-SC-002: Management of Requests, Complaints, and Claims (PQR)*. This document establishes the procedures and service channels to ensure a response to these requests. This operational framework is essential for maintaining efficiency and transparency in stakeholder interactions. The process includes:

- **PQR Registration:** The technical team will serve as the first point of contact for receiving PQRs from stakeholders in the project area. This includes direct communication methods such as phone calls and emails.

- **Review Process:** The technical team will conduct a preliminary assessment to determine the urgency and type of request.

- **Escalation to Project Management:** PQRs will be forwarded to project management for processing, including all relevant documentation and a summary of the preliminary assessment.

- **Resolution Communication:** Once the technical team and project management have determined a response, stakeholders will be informed of the resolutions via email, ensuring that responses are clear and well-communicated.

16.7 Information Protection

16.7.1 Information Management System

The document *VS-SC-003: Information Management System (IMS)*, developed for the SAHBIO Carbon project, is designed to manage and maintain critical, confidential information and data. This system provides a framework that encompasses everything from property legal information to technical and social data, ensuring all information assets' integrity, confidentiality, availability, and traceability.

The IMS incorporates procedures for collaboration among VISSO personnel and data exchange with partner companies and is applied across all project operation locations. This system aims to ensure the secure handling of information through role-based access controls and the principle of least privilege. Additionally, to ensure that intellectual property (IP) rights are respected and properly managed to foster innovation, collaboration, and the ethical use of project information and resources, the project includes the document *VS-SC-004: Internal Intellectual Property Policy.*

16.8 Documents, Policies, And Manuals

Annex	Documented
Annex A	VS-SC-001: *Quality Policy Statement for the SAHBIO Carbon Project*
Annex B	TS Quality Document
Annex C	*Procedure for Property Inclusion Assessment*
Annex D	VS-SC-002: *Requests, Complaints, and Claims (PQR) Management*
Annex E	VS-SC-003: *Information Management System (IMS)*
Annex F	VS-SC-004: *Internal Intellectual Property Policy*
Annex H	VS-SC-005: *Procedure for Property Involvement*

Appendix 1. Post-registration changes summary.

Provide a concise overview of the post-registration modifications proposed in this version of the GHG Project Document and, where applicable, a chronological record of all post-registration changes to the project activity that the BCR Technical Committee has approved following its registration for all post-registration changes, including justifications, the impact of the changes on relevant BCR requirements, and any supplementary information about the modifications.

All post-registration changes shall follow the provision in section 14.5 of the BCR Standard Operating Procedures.