PROYECTO FORESTAL ALCARAVÁN ORINOQUÍA

Document prepared by CO_2CERO SAS

Name of the project	*Proyecto Forestal Alcaraván Orinoquía.*
Project holder	*CO2CERO SAS*
Project holder's contact information	*Adress: Cra. 45a #104 B 16. Bogotá (Colombia)* *Telephone: +601 604 72 79* *Email: info@co2cero.co*
Project participants	*The Proyecto Forestal Alcaraván Orinoquía has the participation of 8 reforestation initiatives in the Orinoquia region. These are presented below.*

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Version	*8.0*	
Date	*13/12/2023*	
Project type	*Forest Activities, with Commercial Forest Plantations (ARR)*	
Grouped project	*N/A*	
Applied Methodology	*BCR0001 Quantification of GHG Removals. Afforestation, Reforestation, and Revegetation Version 4.0 of February 9, 2024, and BCR Standard. From differentiated responsibility to common responsibility version 3.2 of September 23, 2023.*	
Project location (City, Region, Country)	*Municipalities of the Orinoquia biome, including Meta and Vichada.* *It is currently located in:* *Puerto Lleras and Puerto Gaitan in Meta.* *Cumaribo in Vichada, Colombia*	
Starting date	11/04/2018	

Quantification period of GHG emissions reduction	The duration of the project will be 20 years, 11/04/2018 to 10/04/2037
Estimated total and average annual GHG emission reduction amount	The net removal of the project over its credit life is 517,005 tCO2e and annual removal of 25,850 tCO2e/year.
Sustainable Development Goals	***SDG 1.*** *End poverty in all its forms everywhere.* ***SDG 2.*** *End hunger, achieve food security and improved nutrition and promote sustainable agriculture.* ***SDG 8.*** *Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.* ***SDG 12.*** *Ensure sustainable consumption and production patterns.* ***SDG 13.*** *Take urgent action to combat climate change and its impacts.* ***SDG 15****. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*
Special category, related to co-benefits	*N/A*

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Initialisms, acronyms and abbreviations

AFOLU	Agriculture, Forestry and Other Land Uses
AP	Project area (by its acronym in Spanish)
DAP	Diameter of breast length (by its acronym in Spanish)
A/R	Afforestation/reforestation (F/R in Spanish)
GHG	Greenhouse gases (GEI in Spanish)
IDEAM	Instituto de Hidrología, Meteorología y Estudios Ambientales del Ministerio de Ambiente y Desarrollo Sostenible de Colombia
IPCC	Panel Intergubernamental de Expertos sobre el Cambio Climático (IPCC por su sigla en inglés)
MADS	Ministerio de Ambiente y Desarrollo Sostenible
SDG	Sustainable development goals
PDD	Project design document
PEMF	Forest Establishment and Management Plan (by its acronym in Spanish)
PRGEI	Greenhouse Gas Removal Project (by its acronym in Spanish)
UPRA	Unidad de Planificación Rural Agropecuaria

1 Project type and eligibility

1.1 Scope in the BCR Standard

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

The project was developed under the application of the BCR Standard From differentiated responsibility to common responsibility V 3.2, taking into account the conditions under which you want to register a GHG project to demonstrate its mitigation results in the framework of meeting the goals, fulfilling the general requirements as follows.

- The location of the project is within a country, in this case within Colombia,
- The start date is defined in which the removal activities begin, less than five (5) years prior to the start of validation.
- The quantification period, when considering a project in the AFOLU sector, complies with the minimum requirement of 20 years.
- The determination of additionality is based on the application of the guidelines of the methodology BCR0001 Quantification of GHG Removals. Afforestation, Reforestation, and Revegetation. V 4.0, by barrier analysis and Biocarbon Guidelines Baseline and Additionality. GHG Projects generate Verfiied Carbon

Credits (VCC) that represent emissions reductions, avoidance, or removals that are additional. Version 1.2, September 27, 2023.

- The project complies with applicable legislation and has a document management mechanism that incorporates the relevant legislation and regulations.
- The project demonstrates actions to reduce current and future climate impacts derived from climate change, implementing forestry production systems, with improvements to biodiversity.

Similarly, the project is developed under the BCR0001 Methodology for Quantification of GHG Removals. Afforestation, Reforestation, and Revegetation, BioCarbon Registry V 4.0. Taking into account the conditions of the project considered as the most appropriate from the technical aspect, likewise, the parameters and calculation methods are adjusted to the variables found and monitored within the project limits.

1.2 Project type

The Proyecto Forestal Alcaraván Orinoquía is an initiative of the Land Use - Forest Land sectoral area, Sector 14. Afforestation and Reforestation, AFOLU, with a general activity of GHG removals by promoting the increase of carbon stocks and a specific forestry activity, with Commercial Forestry Plantations (ARR).

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

1.3 Project scale

According to the BCR Standard From differentiated responsibility to common responsibility Version 3.2, classified as GHG removal activities, they are not subdivided into categories related to the scale of the project.

2 General description of the project

Proyecto Forestal Alcaraván Orinoquía is an initiative of private participants brought together by CO2CERO SAS with a total area of 1,100.81 hectares. Its objective consists in removing greenhouse gases (GHG) through 1.094,43 eligible hectares of forest plantations in the Colombian Orinoquía, for twenty (20) years – starting on 11/04/2018, the date in which reforestation activities, management, and increase of carbon reserves began. The Forestry Project is in the Meta and Vichada departments, but it plans to cover a reforestation area in the Casanare department.

CO2CERO SAS oversees the project, including eight (8) project participants recognized as timber forest producers. Its livelihood will be based on the establishment, maintenance, and strengthening of forest plantation coverage, which will improve the socioeconomic and environmental perspective through the commercialization of wood products for the industrial sector. They will remove GHG emissions in the atmosphere, generating a sense of belonging over their property planted and natural resources.

With the development of the project, we will contribute to the achievement of six (6) sustainable development objectives, developing activities focused on increasing carbon stocks under the axes of Sustainable Economic Development, and Conservation and Environment, reducing poverty, hunger, favoring decent work, resilient communities and protecting the climate and terrestrial ecosystems.

Proyecto Forestal Alcaraván Orinoquía aims to remove 517,005 tCO2e during its crediting period with a reserve of 20% discounted for the risk of non-permanence corresponding to 103,401 tCO2e, and with an annual average of 25,850 tCO2e, considering the equivalent carbon dioxide (tCO2e) removal in the carbon of aerial biomass, underground biomass, dead wood, litter, and soil organic carbon reservoirs.

2.1 GHG project name

Proyecto Forestal Alcaraván Orinoquía

2.2 Objectives

Remove GHG emissions through commercial reforestation within the eligible area of the project located in the departments of the Colombian Orinoquia –with native and introduced species making up the project.

- Promote the positive sustainable forest production and management impacts, generating climate change mitigation actions.

- Guarantee compliance with the regulatory and socio-environmental framework related to the Proyecto Forestal Alcaraván Orinoquía for 20 years.
- Generate a transparent and equitable benefits distribution regarding the resources obtained from the commercialization of avoided GHG emissions within the limits of the project for 20 years.
- Guarantee the participation of all the actors involved in the GHG mitigation initiative, consolidating a continuous flow of information between the parties.

2.3 Project activities

The Project implements GHG removal activities in the sectoral land use - Forest Land, Sector 14. Forestation and Reforestation, AFOLU. Through GHG removal by promoting the increase of carbon stocks based on forestry activities with commercial plantations of *Acacia mangium, Pinus caribaea* and *Eucalytus pellita*, climatized species in areas of the Orinoquia region. The relevant aspects of the species involved in the project are described below.

2.3.1 Acacia mangium

The *Acacia mangium* is a species of tree in the Fabaceae family, commonly known as Acacia. It is native to northwestern Australia and eastern Indonesia. In its wild state it can grow up to 20-30 meters long and 90 centimeters in diameter, with a straight shaft and with no branches almost up to half the total height. Outside its natural habitat it tends to fork, and in poor terrain, it grows 7-10 meters high.

The juvenile germinal leaves are pinnately-compounds. At 4 weeks the axis and peduncle form phyllodes. These phyllodes can be 10-25 centimeters wide. It presents inflorescences in white raceme and when ripening they darken. The seeds are glossy black elliptical (3-5 millimeters) and oval (2-3 millimeters), and are produced after 3-4 months of flowering, and the fruits ripen after 5-7 months of flowering (Reyes et al. , 2018).

The species is part of the heliophilia guild. It is adaptable to the variation of environmental conditions, tolerant to water stress (deficit or excess) and poor soils. The tree can grow in the tropics in conditions of low rainfall and high solar radiation and temperature. It also grows in tropical lowlands with a marked dry period, and in humid and very humid tropical forests. It tolerates acidic soils (pH 4.5-6.5) and has a great capacity to regenerate in abandoned soils. At altitude, the species is distributed between 400-800 meters above sea level, precipitation between 1446-2990mm/year and it grows best between minimum temperatures of 12°C-16°C and maximum of 31°C-34°C. Finally, in long periods of flooding or cold this species suffers from downward death.

This tree is planted commercially to take advantage of its wood. It also has soil recovery properties thanks to its ability to fix nitrogen and produce large amounts of organic matter. It has potential as a structural timber (Reyes et al. , 2018).

2.3.2 Eucalyptus pellita

According to the the APG IV classification system (2016), *E. pellita* is a member of the class Equisetidae, subclass Magnoliidae, order Myrtales, Family Myrtaceae, and Genus Eucalyptus. The tree is found in the humid and subhumid tropics. In Colombia, in the plain region, it has been mainly used as a pole for electricity or fences, with a low level of transformation. It is a medium to large sized tree, usually 20 to 25 m tall, although under favorable conditions it exceeds 35 m. In the best conditions, its shaft grows straight to half the total height of the tree and has a wide and very branched crown.
The bark is of the short fibrous type, rough even in the small branches. The juvenile leaves are opposite and then subopposite, petiolate, lanceolate, then these become alternate leaves, but sometimes return to subopposite, petiolate, occasionally slightly sickle. Growing naturally on the lower coastal slopes of Australia, individuals are found from near the top of Cape York Peninsula to the area between Cainrs and Townsville (between 12° and 18° south latitude) and those south of Brisbane to the Bateman's Bay area on the southern coasts of New South Wales (27°36' south latitude).

Below we can find the environmental characteristics of the various sites where the species naturally develops:

- Average annual rainfall: 1,200-3,000 mm
- Rainfall distribution: Uniform/bimodal
- Length of dry season (consecutive months with less than 40 mm of precipitation): 1-5 months.
- Average maximum temperature of the hottest month: 24-38 °C
- Average minimum temperature of the coldest month: 10-19 °C
- Average annual temperature: 19-29 °C

The best growth of plantations outside the natural range of the species has been observed in well-drained clay loam soils. Also, satisfactory development has been obtained in fertile sands and sandy loam soils, as long as there are fertilization treatments. Yields in the Eastern Plains can vary between 28 and 32 m^3/ha/year in plantations with low silvicultural management and low initial density up to 40 m^3/ha/year in 5-year clonal plantations.

Its use is ornamental. It is one of the most used forest resources in the world for its high diversity of uses such as domestic consumption, firewood, charcoal, structures for buildings, poles, parquet floors, cellulosic pulp, just mines, slope fastening, or fiberboard.

2.3.3 *Pinus caribaea*

According to the APG IV classification system (2016), *Pinus caribaea* belongs to the Equisetopsida class, Pinidae Subclass, Pinales Order, and Pinus Genus. This is an evergreen tree, 20-30 m (up to 45 m) tall with a Diameter at Chest Height of 50-80 cm up to 1.35 m. Its cup is from round to pyramidal and it possesses 3 to 4, rarely 2 or 5, thick, rigid, erect, yellowish green, 15-25 cm fascicles leaves.

The trunk is straight and well-formed, with long, horizontal and falling low branches and ascending upper branches. It doesn't branch out too much. The outer crust is thick and reddish-brown with rough plates and deep vertical and horizontal fissures. Male flowers are in cylindrical catkins, 25 to 45 mm long. The cone is brownish red or brown, cylindrical to conical ovoid, occasionally oblique, 5-12 cm long by 3-8 cm broad. They grow alone or in groups containing 30 to 60 seeds per cone. The seeds are brown, small, around 5-6 mm. The wing is 20 mm, articulated and partially covering the seed. The tree has a wide and deep root system.

As a native to the tropical zone of Central America, the tree is the tropical pine of wider geographical distribution. It grows naturally on the Atlantic coast of the Central American Isthmus. It is found in Nicaragua, Honduras, Belize, Guatemala, Bahamas, and Cuba, in plantations throughout the tropics. Caribbean pine wood from plantations has been used for particleboard, MDF, charcoal, firewood, fence poles, telephone poles, plywood, furniture, structural timber, and paper products. It has an average growth of 25 m^3/ha/year in sites of different quality.

The best yields reported by (INSTITUTO NACIONAL DE BOSQUES, 2017), come from average temperatures of 21-25°C, an average rainfall greater than 1450 mm/year, altitudes between 330-740 meters above sea level, with slopes of less than 45%, preferably on floodplains and sandbanks on the river bank, with good drainage. Soils should not pass a silty texture of 40%. It does not tolerate poorly aerated soils, with little depth and poor drainage. It is recommended to have a base saturation level below 50% and a Cation-exchange capacity of less than 50 milliequivalents per 100 grams of soil.
The species is used for general construction, including windows, kitchen furniture, crafts, poles, pulp for paper, parquet floors, plywood sheets, bridges, carpentry, floors, cabinetmaking, piles and sleepers, ship structures, bodies, tool handles, among many other uses. Additionally, it is used for firewood and charcoal, and for obtaining resin (INSTITUTO NACIONAL DE BOSQUES, 2017).

2.3.4 *Species use justification.*

Table 1, indicates the optimal conditions for the development of the selected species according to the information presented above. It also presents the comparison of the requirements of the species with the characteristics of the project area. This is with the purpose of demonstrating that the three (3) selected species can be adequately developed within the project.

Table 1. Species requirements.

Variable	*Acacia mangium*	*Eucalyptus pellita*	*Pinus caribaea*
Rainfall (mm/year)	1,446-2,990	0 – 1000	0-1,500
Average temperature (ºC)	12-31	24-30	22-26
Altitude (masl)	400-800	500-3,000	350 – 3,500
Soil drainage	Good drainage	Good drainage	Good drainage
Soil depth	Deep	Deep	Deep
Soil texture	Loam and Sandy	Clay and Sandy loam	Sand and Clay
Terrain relief	Slopes from 15 to 25%	Slopes from 15 to 25%	Slopes of 10 to 15%

Source: (CO2CERO SAS, 2022).

On the other hand, Table 2 shows the environmental characteristics present in the municipalities in which the project is developed.

Table 2. Characteristics of the municipalities belonging to the project

Variable	Puerto Gaitán	Puerto Lleras	Cumaribo
Rainfall (mm/year)	1,000-4,000	1,000-3,500	1,000-2,000
Average temperature (ºC)	19-28	24-27	24-25
Altitude (masl)	100-500	250-350	170-400
Soil drainage	Good drainage	Good drainage	Good drainage
Soil depth	Deep	Deep	Deep
Soil texture	Sandy and Clay	Clay and Sandy loam	Sand and Clay
Terrain relief	Flat and concave	Plain, concave, convex and gently undulating	Plain, concave, convex and gently undulating

Source: (CO2CERO SAS, 2022).

The information in Table 1 and Table 2, confirm that the selected species comply with the environmental characteristics of the project area. Therefore, we can say that its use is justified since the species are suitable for the project area and have a management plan that allows sustainable planning for the establishment and use of the plantation.

2.4 Project location

The project is currently located in the eastern part of the country in the Meta and Vichada departments –a total of three (3) municipalities that correspond to Puerto Lleras and Puerto Gaitán in Meta and Cumaribo in Vichada, in Colombia.

1.1 Characteristics and Conditions Prior to Starting the Project

The following chapter describes the diagnostic, physical, and biotic conditions in the influence area of Proyecto Forestal Alcaraván Orinoquía.

1.1.1 Country

Colombia is in the northwestern corner of South America, bordered to the north by the Antillean Sea, to the east by Venezuela and Brazil, to the south by Peru and Ecuador, to the west by the Pacific Ocean, and to the northwest by Panama. It has a total area of 1,141,748 square kilometers. It is composed of 32 departments and 1 capital district (Bogotá), 1,122 local entities (1,103 municipalities, 18 non-municipal areas, and the San Andrés Island) (OFICINA DE INFORMACIÓN DIPLOMÁTICA, 2023).

1.1.2 Orinoquía Region

The Colombian Orinoquía is located to the east of the country, between 5° and 2° North latitude, and 75° and 67° East longitude, with an approximate area of 285,000 km. This region is bordered to the north by the alluvial plains, the eolian plains, and the high plains of the western plains of Venezuela, with the Arauca and Meta rivers as the dividing line. It limits, to the East, with the middle corridor of the Orinoco belonging to the Guayanés mountain ranges of the Amazonas Venezuelan state. It borders, to the South, the Colombian Amazon region with the Guaviare River as its limit. It borders, to the West, the eastern flank of the Eastern Cordillera (Ospina, 2017).

According to the Alexander Von Humboldt Biological Resources Research Institute, the Orinoquía region includes three large biomes and six biomes that correspond to the entire Eastern Plains biome, partially the forests of the lower and middle Andean orobiome, and the tropical humid Zonobiome of the Amazonia-Orinoquia (Romero et al., 2009) The great biome of the Eastern Plains covers 74.4% of the area. It includes helobiomes, peinobiomes, and lithobiomes. These biomes feature a composition of ecosystems ranging from open savannahs with tall grasses and scattered trees or shrubs, and gallery forests; wooded areas

surrounded by savannah areas, to clusters of swampy areas with herbaceous and shrub vegetation and some rocky outcrops.

The forest biome of the low and middle Andes orobiome corresponds to the humid forests of the foothills of the Eastern Cordillera –eastern slope, which correspond to 6.4% of the study area. This includes low and medium-dense basal forests which, structurally and physiognomically, are characterized by the presence of an arboreal stratum with heights reaching 20 to 35 m in height, with some emergent specimens. These forests show two well-defined strata and a large presence of leaf litter on the ground. The biome constitutes the biological corridor of species transiting between the Orinoquía region and the Andean zone.

1.1.3 Project Area Sub-regions

Below is a description of the environmental characteristics of all the departments and municipalities in which the limits of Proyecto Forestal Alcaraván Orinoquía currently exist.

1.1.3.1 Meta Department

It is in the central-eastern region of Colombia, between 1°32'30" and 4°57'30" lat. North and between 71°2'30" and 74°57'00" long., West of Greenwich. It borders on the north with the departments of Cundinamarca and Casanare; Caquetá and Guaviare to the south; Vichada to the east, and Huila and Bogotá –Capital District, to the west. The Meta department covers an area of 85,770 square kilometers, thus, one of the largest in the country.

The vegetation of the plain is made up of grasses and grasslands with shrubs and low trees. On the banks of the rivers are gallery forests, with a vast variety of flora. In the western part of the department, the vegetation is tropical rainforest, Andean forests, and paramo in the highest portions.

1.1.3.1.1 Climatic Aspects

In the Meta department, the height above sea level ranges between 125 and 4,000 meters and the average temperature is 30°C (Gobernación del Meta, 2015). The average temperature of the department varies from 6°C in the paramo areas, to more than 24°C in the plains. In the foothills, the temperature varies between 18–24°C. According to the altitude variation in the department, 1.44% of its surface is paramo, 4.47% is in the cold climate zone, 5.06% in the temperate, and 89.03% is in the warm climate zone.

According to Koeppen and Gerger (1965), the climate of the altillanura in the Colombian Orinoquía corresponds to the warm savannah (Gobernación del Meta, 2015). As per Holdridge's classification, the life zone–where the region is located–corresponds to tropical rainforest.

1.1.3.1.2 Physiography

The Meta department soil is sedimentary, with weathering processes, which, due to the tropical climate, results in poor soils from the intensive washing of minerals and nutrients. Regarding their physical characteristics, the soils have well internal drainage due to their clay-loam to sandy-loam texture, the loose and porous granular structure, and a water table between 7 and 10 meters, depending on the dry season of the year. Chemically, the soils have a pH of 4.5 on the surface, at 5.2 cm to 25 cm depth. The organic matter content is low, likewise, the magnesium, phosphorus, and potassium concentrations, (Gobernación del Meta, 2015). The departmental territory is made up of three large physiographic regions:

- It is constituted by mountainous, in the west of the department, represented by the western flank of the Eastern Cordillera with heights that reach 4,000 m above sea level. The foothills or transition areas, between the mountain range, the plain, and the Serranía de La Macarena, the latter located almost perpendicular to the Eastern Mountain range.
- The plain, an almost flat sector with heights under 200 m above sea level, is in the center and east of the department. It is formed by the western part of the Guyanese shield and eroded materials from the mountain range and deposited by the different rivers that cross it, forming dissected hills, terraces, meadows, and vegones.
- It varies from paramo lands and slopes of the eastern cordillera to the meadows, and warm plains of the Ariari and Guaviare rivers. There, areas of the System of National Natural Parks, also known as (PNN) converge (PNN Páramo de Sumapaz, PNN Cordillera de los Picachos, PNN Tinigua, and PNN Serranía de la Macarena.) It also includes highland landscapes with savannah vegetation, and old-growth forests.

1.1.3.1.3 Hydrography

The Meta water network is complex due to the mountain range, the Serranía de La Macarena, and seasonal rainfalls. These factors result in numerous and plentiful rivers, including the Meta, Gabarra, Duda, Manacacacías, Yucao, Guatiquía, Guayuriba, Ariari, Guacabía, and Guaviare rivers (Gobernación del Meta, 2015). All the rivers originating in

the department drain into the Orinoco River, except the Macaya river, which is part of the Amazon River basin. Below is the information on the most important sub-basins in Table 3.

Table 3. Most Important Sub-basins in Meta

Basin	Sub-basin	Area (km²)
Vichada river	Yucao river	2,432
	Muco river	1,891
	Guarrojo river	1,632
	Tillavá river	6,910
	Iteviare river	1,967
	Uva river	1,015
	Manacacías river	10,146

Source: (CO2CERO SAS, 2022).

1.1.3.2 Puerto Gaitán

Puerto Gaitán is the largest municipality in Colombia, and the second in Meta. It is located at the following coordinates: 3° 05 and 4° 08 North Latitude and 71° 05 and 72° 30 West Latitude. It has an area of 17,499 square kilometers and borders on the north with the Department of Casanare; the Municipalities of Mapiripán and San Martín to the south; the Department of Vichada to the east, and the Municipalities of Puerto López and San Martín to the west.

1.1.3.2.1 Climatic Aspects

Due to its location in the tropical zone, the territory of the Puerto Gaitán municipality is under the influence of the displacement of the Intertropical Convergence Zone, or ITCZ. According to the altitude variation in the municipality, the warm temperate zone covers 100% of its surface. The municipality of Puerto Gaitán has an elevation of 149 meters above sea level.

According to Thornthwaite, its climate is classified as slightly humid. Per Holdridge's bioclimatic classification, as tropical rainforest (Bh-T), determined by a biotemperature above 27°C with maximum values reached in the months of December to April (driest months) of 29.28°C and minimum values in August with 24.88°C (Rangel C. J., 2019).

1.1.3.2.2 Precipitation

Existe reporte de dos estaciones climatológicas en el municipio de Puerto Gaitán (Rangel C. J., 2019), a partir de esos datos se realiza la siguiente descripción:

- **Estación Carimagua:** para la precipitación, el valor promedio anual es de 2,464 mm/año, con una media mensual de 205 mm. El régimen de lluvias es unimodal biestacional. En el periodo de lluvias de abril-octubre la estación recibe 2,100 mm/año, es decir, el 85% de la lluvia total. El mes más lluvioso es junio con 408 mm y el más seco va de noviembre a marzo con 364 mm (suma de los 5 meses). Enero es el mes que menor precipitación reporta (199 mm/mes).
- **Estación Puerto Gaitán:** la precipitación promedio anual multianual de esta estación es de 2,131 mm/año y media mensual de 177 mm/mensual. Al igual que en la estación Carimagua, el régimen de lluvias es unimodal biestacional. En el periodo de lluvias de abril a octubre se reciben 1,821 mm/año (85% del total de las lluvias), siendo el mes más lluvioso junio (330 mm/mes), mientras que en el periodo seco que va de noviembre a marzo se reciben 310 mm que corresponde al 15% restante, esto siendo enero el mes más seco (15 mm/mes).

1.1.3.2.3 Relative Humidity

The classification of the municipality's meteorological scenario corresponds to warm-humid climatic conditions. Despite the elevated temperatures exceeding 32°C, the apparent temperature is affected by a percentage higher than 79% humidity (Mesa-Dishington, 2011).

1.1.3.2.4 Hydrography

The municipality of Puerto Gaitán is part of the Vichada River basin. The sub-basins of the Tillavá, Guarrojo, and Muco rivers are part of the Vichada River basin, per Table 4, which indicates its present extension.

The water system is diverse due to the processes that have caused its water bodies to be dendritic, its channels are short, and their union forms its main drainages, comprising navigable river networks and a habitat for ornamental and consumption fish (Alcaldía Municipal de Puerto Gaitán, 2016).

Table 4. Puerto Gaitán Sub-basins

Basin	Sub-basin	Area (km²)
Vichada river	Muco river	1,891

	Guarrojo river	1,632
	Tillavá river	6,910

Source: (Alcaldía Municipal de Puerto Gaitán, 2016).

1.1.3.2.5 Topography

Puerto Gaitán's geostructure is the physiographic province of the Orinoquia sedimentation megabasin. The following major landscapes comprising this broad geostructure or physiographic province stand out: structural and fluvial erosional hilly relief (Orinoco Altillanura), fluvial erosional structural highlands (Amazonian Altillanura) and alluvial plains (active alluvial flood valleys) (Ministerio de Minas y Energia, 2001).

- **Structural and fluvial erosional hilly and fluvial erosional relief:** The constituent materials comprise Pleistocene alluvial deposits that have been affected by faulting and small folding. Currently, they make up a strongly undulating and dissected relief.
- **Fluvio erosional structural high plateau**: An accumulation surface of the Plio-Pleistocene age that is uplifted by tectonic action in relation to the alluvial plain of the Meta and Guayabero rivers. It was uplifted before the Late Pleistocene as blocks tilted slightly to the east.
- **Alluvial Plain**: It is located throughout the large rivers. These currents have a braided stream pattern fluvial regime; however, when they leave the mountain range, they lose their carrying capacity and the channels widen, the depth decreases, causing overflows and continuous course changes.

Table 5. Puerto Gaitán Topography

Landscape	Relief	Area (ha)	Area (%)
Structural High Plateau	Mesetas and corrugated surfaces	513,017	29.78%
Fluvial-gravitational hills	Hillocks	663,606	38.53%
	Hillocks and hills associated with mixed glacis	320,116	18.58%
Alluvial plane	Flood plane	36,347	2.11%
Valley	Flood plane	85,265	4.95%
	Colluvial-alluvial valleys	104,127	6.05%
Overall total		**1,722,477**	**100%**

Source: (CO2CERO SAS, 2022).

1.1.3.2.6 Soils

There is a predominance of Oxisols in the municipality through the Typic Haplustox Complex, phase 12-25%, moderate erosion, which are located between 150 to 400 meters above sea level (masl). Such soils have developed from clays and have good to moderately excessive natural drainage. These soils show laminar and moderate water erosion. They are used for extensive cattle raising in combination with large extensions of natural pastures of *Braquiaria sp.* (IGAC, 2004).

Table 6. Puerto Gaitán Soils

Component	Area (ha)	Area (%)
Association: Fluvaquentic Eutropepts; Aeric Tropaquepts; Fluventic Dystropepts	1,312.67	0.08%
Association: Oxic Dystropepts, phase 1-7%; Typic Tropopsamments, phase 3-7%	11,678.04	0.68%
Association: Oxyaquic Dystropepts; Plinthic Tropaquepts; Typic Plinthaquepts	81,010.15	4.70%
Association: Typic Haplustox, phase 3-12%, slight erosion; Oxic Dystropepts, phase 3-7%, light erosion	21,054.76	1.22%
Association: Typic Haplustox, stage 3-12%, light erosion; Ustoxic Dystropepts, stage 3-7%, light erosion.	299,061.20	17.36%
Association: Ustoxic Dystropepts; Ustic Quartzipsamments	109,273.29	6.34%
Complex: Inceptic Hapludox, phase 12-25%; Oxic Dystropepts, phase 7-12%; Typic Troporthents, phase 25-50%	20,578.04	1.19%
Complex: Petroferric Hapludox, phase 12-25%, moderate erosion; Typic Hapludults, phase 7-12%, moderate erosion	134.25	0.01%
Complex: Plinthic Haplaquox; Plnthic Tropaquepts	16,874.21	0.98%
Complex: Typic Haplustox, phase 12-25%, moderate erosion; Typic Hapludox, phase 7-12%	642,893.83	37.32%
Complex: Typic Tropofluvents; Tropic Fluvaquents, flood phase	16,170.08	0.94%
Shore Miscellaneous Association	4,254.70	0.25%
Association: Typic Hapludox, phase 0-7%	362,012.33	21.02%
Association: Ustic Quartzipsamments, phase 1-7%	30,053.29	1.74%
Undifferentiated group: Shore and islets miscellaneous; Typic Tropofluvents, flood stage	1,989.74	0.12%
Undifferentiated group: Typic Tropofluvents; Typic Tropaquepts; Oxyaquic Dystropepts	104,126.90	6.05%
Overall total	**1,722,477.48**	**100%**

Source: (IDEAM, 2017)

On the other hand, the municipality features the following Association: Typic Haplustox, phase 3-12%, slight erosion; Ustoxic Dystropepts, phase 3-7%, light erosion which appear in slightly wavy to broken relief with slopes between 3 and 12%. These soils are deep and have a good medium to moderately fine textures drainage (IGAC, 2004).

1.1.3.2.7 Indigenous Reserves and National Parks

According to the National System of Protected Areas (SINAP), within the municipal area, some of them are part of the National System of National Parks such as the Carimagua Regional District of Integrated Management, the Maiciana Manacal Wetland Recreation Area, the National Reserves of the Civil Society Campoflorido, Manguare, and El Tigrillo.

There are no Forest Reserves under Law 2 of 1959 in the municipality. Finally, the Indigenous Reservations in the municipality are described below in Table 7.

Table 7. Puerto Gaitán Indigenous Reserves

Reservation	Town	Regulation	Area (ha)
Sikuani de Iwiwi	Guahibo	Resolution 2 of 1991	861.03
El Tigre	Guahibo	Resolution 41 of 1983	47,146.54
Waliani	Guahibo	Resolution 143 of 1993	4,638.81
Corocito, Yopalito, and Gualabo	Guahibo	Resolution 80 of 1992	9,865.05
Sikuani de Awáliba	Guahibo	Resolution 1 of 1991	20,785.89
Vencedor-Piriri-Guamito, and Matanegra	Guahibo	Resolution 22 of 1980	39,268.32
Corozal Tapaojo	Piapoco	Resolution 40 of 1983	8,159.65
Sikuani de Domo Planas	Guahibo	Resolution 3 of 1991	37,812.03
Overall total			**356,483.61**

Source: (CO2CERO SAS, 2022) *Adapted: ANT (2022).*

1.1.3.2.8 Wildlife

According to (Forero, 2016), in a study of the Tillavá and Planas river basins, located in Puerto Gaitán, he found that the biodiversity associated with the municipality of Puerto Gaitán is related to the following faunal component.

- **Mastofauna**

The diversity associated with the mastofauna is consistent with the ecosystems in the municipality, mainly associated with natural and permanent artificial cover areas. Some species are exploited by the communities, associated with market demands or dietary

interest. Due to the increasing demand, strategic ecosystems must be protected and conserved, such as the Morichales and/or riparian forests, associated with anthropic forest plantations that facilitate the connection and exchange of populations and individuals. They are shown in Table 8.

Table 8. Puerto Gaitan Mastofauna and Threat Level

Scientific Name	Vernacular Name	Conservation Status
*Pri*odontes maximus	Giant armadillo	Vulnerable
Alouatta seniculus	Red howler monkey	Least concern
Sapajus apella	Tufted capuchin	Least concern
Bradypus variegatus	Brown-throated sloth	Least concern
Sciurus granatensis	Red-tailed squirrel	Least concern
Myrmecophaga tridactyla	Giant antiater	Vulnerable
Hydrochoerus hydrochaeris	Capybara	Least concern
Tapirus terrestris	Tapir	Vulnerable
Odocoileus virginianus	white-tailed deer	Least concern

Source: (CO2CERO SAS, 2022).

In addition, according to the IUCN, the threat status of the most representative species in the area is described. Thus, the *Priodontes maximus, Myrmecophaga tridactyla*, and *Tapirus terrestris* are in a vulnerable state, some of them are shown in Ilustration 1.

Ilustration 1. Mesofauna associated with the project. Source: A. Priodontes maximus. Source: Emilio Constantino. (2022); B. Tapirus terrestris. Source: ínaturalistPa (2022). C. Odocoileus virginianus. Source: Animal Bank, (2019).

- **Ornithofauna**

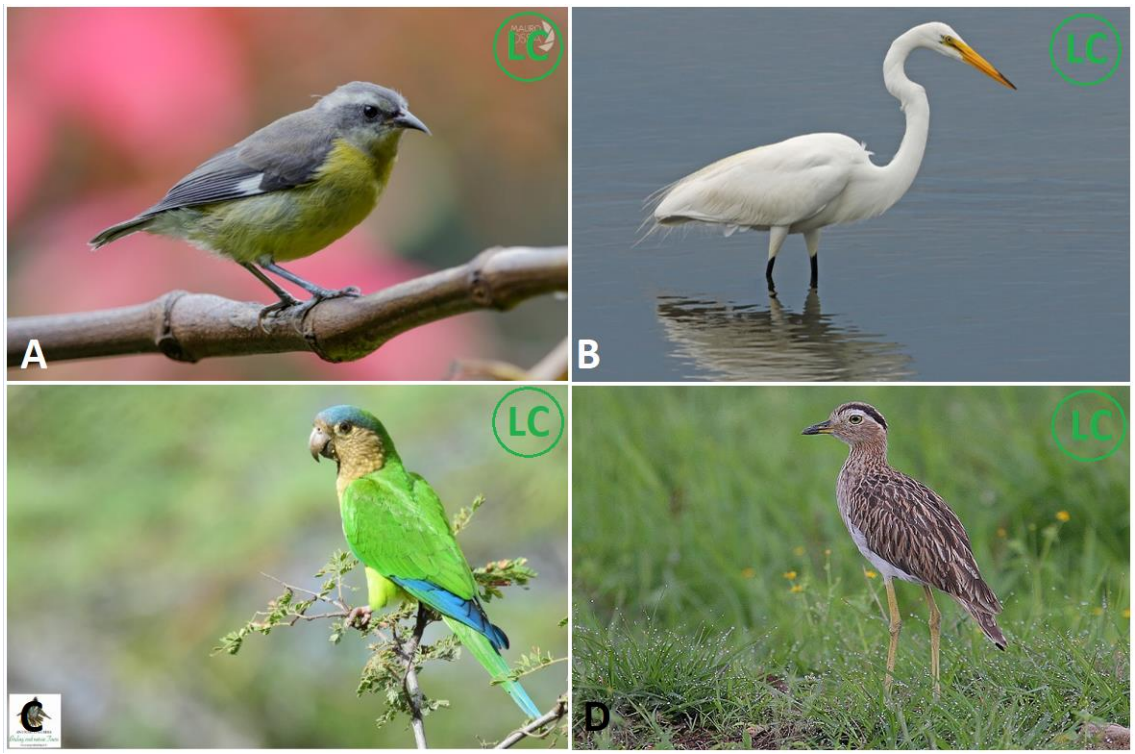
The diversity associated with the ornithofauna is consistent with the ecosystems in the municipality, associated with permanent natural and artificial coverage areas. Some of them are shown in Table 9.

Table 9. Puerto Gaitán Ornithofauna and Threat Level

Scientific Name	Vernacular Name	Conservation Status
Eupsittula pertinax	Brown-throated parakeet	Least concern
Forpus conspicillatus	Spectacled parrotlet	Least concern
Burhinus bistriatus	Double-striped thick-knee	Least concern
Myiophobus fasciatus	Bran-colored flycatcher	Least concern
Chlorostilbon notatus	Blue-chinned sapphire	Least concern
Coereba Flaveola	Bananaquit	Least concern
Ardea alba	Great egret	Least concern
Bubulcus ibis	Cattle egret	Least concern

Source: (CO2CERO SAS, 2022).

Likewise, according to the IUCN, the threat status of the most representative species in the area is described. On the conservation status, is listed as lower risk, however, it does not mean that there are some in a higher vulnerability degree. Some of them shown in Ilustration 2.



Ilustration 2. Ornithofauna Associated with the Project. A Coereba Flaveola. Source: Js. Marcano (2021); B. Ardea alba. Source: Judy Gallagher (2022). C. Eupsittula pertinax. Source: Bogota Birding, (2020); D. Burhinus bistriatus. Source: Colombia Extraordinaria (2019).

- **Ichthyofauna**

The diversity associated with the Herpetofauna and Ichtyofauna is consistent with the ecosystems and water bodies in the municipality, associated with natural coverage areas. Some of them are shown in Table 10.

Table 10. Puerto Gaitán Ichthyofauna and Threat Level

Scientific Name	Vernacular Name	Conservation Status
Brachyplatystoma juruense	Zebra Catfish	Least concern
Pangasius hypophthalmus	Iridescent shark	Endangered
Colossoma macropomum	Tambaqui	Least concern

Scientific Name	Vernacular Name	Conservation Status
Pimelodus grosskopfii	Capaz	Critically Endangered
Eremophilus mutisii	Eremophilus	Least concern
Argyrosomus regius	Meagre	Least concern
Brachyplatystoma tigrinum	Tigerstriped catfish	Least concern

Source: (CO2CERO SAS, 2022).

According to the IUCN, the conservation status of the most representative species in the area is described. The list shows the *Pimelodus grosskopfii* as Critically Endangered species, and the *Pangasius hypophthalmus* as endangered species. Some of they appear in Ilustration 3.

Ilustration 3. Ichthyofauna Associated with the Project. A Brachyplatystoma juruenses. Source: Arrom (2019); B. Pimelodus grosskopfii. Source: Universidad Católica de Oriente (2010).

1.1.3.2.9 Flora

More than 90% of the region corresponds to the tropical savannah ecosystem, an open formation without a uniform tree canopy, where a perennial herbaceous matrix extends continuously and is sometimes covered by low woody plants or scattered palms. One of the most outstanding features of this biome is its tolerance to natural fires, adaptation to intense drought conditions, and flooding according to variable rainfall patterns, and the generalized low soil fertility and strong winds. These ecological factors have conditioned and helped species evolve through morphological, phenological, and functional adaptations. The importance of fire is confirmed through the existence of pyrophilous

woody species (*Curatella americana, Byrsonima crassifolia, Bowdichia virgiliodes, Xylopia aromatica, Miconia sp.*) (Forero, 2016).

Regarding herbaceous vegetation and grasslands, it has a medium density of gallery forests; low open forest with dense understory, little emerging and abundant less than 5 meters tall specimens. Species such as *Xylopia aromatica, Syagrus orinocense, Myrcia subsesilis, Curatella americana* and *Guatteria duckei* are found here. This cover occupies the depositional plateau with well to poorly drained characteristics (Forero, 2016).

According to (Corporinoquia, 2001), several human processes are generating serious effects on biodiversity in the Orinoquía region, therefore, in the department of Puerto Gaitán. This is the outcome of the region's colonization and expansion of the national agricultural frontier for livestock and agriculture; thus, generating the destruction of several foremost habitats for many species. Forests in the foothills and plains continue to be logged to extract timber and to make room for livestock.

Another anthropic process endangering the biodiversity of this region include the floodplains drainage on the Meta River. These swamps are home to species of reptiles and mammals, and vital places for the migration of birds from the temperate regions of the continent, including where fish lay eggs during the rainy season. Species indiscriminate hunting and illegal trafficking also affect biodiversity in the region, thus, endangering some species.

Ilustration 4. Fauna Associated with the Project. Source: A. Attalea insignis. Source: Scott.zona. (2019); B. Gustavia longifuniculata. Source: Gabriel Camilo Jaramillo Giraldo (2018). C. Aniba novogranatensis. Source: Jenn Sinasac (2018).

However, according to (Correa et al., 2006), in their Biodiversity Action Plan of the Orinoco Basin - Colombia, plant species in Puerto Gaitán, with some degree of conservation, are shown in Table 11.

Table 11. Threatened Plant Species in Puerto Gaitán

Species	Vernacular Name	Conservation Status
Attalea insignis	Drude	Endangered
Ficus sp.	Weeping fig	Least concern
Guarea venenata	Cedro	Least concern
Gustavia longifuniculata	Coco picho	Critically Endangered
Inga macarenensis	Guamo rabo de mico	Vulnerable
Pachira quinata	Cedro macho	Least concern
Aniba novo-granatensis	Amarillo, Oloroso	Vulnerable

Source: Retrieved from: (Correa, Ruiz, & Arévalo, 2006).

1.1.3.3 Puerto Lleras

It is located to the Southwest of the Meta department. Its area comprises 2,410 km². Its urban center is located on the left bank of the Ariari river, the municipality is part of the Bajo Ariari subregion. Puerto Lleras borders to the north with San Martín and Fuente de Oro; Puerto Rico to the south; Mapiripán to the east, and Fuente de Oro, San Juan de Arama, and Vista Hermosa to the west. Its population rounds 11,000 inhabitants, most of which belong to the rural sector (Alcaldia Puerto Lleras Meta, 2019).

1.1.3.3.1 Climatic Aspects

The territory of the Puerto Lleras Municipality is located between 250 masl in the Casibare savannahs sector and 350 masl in sectors bordering the Güejar river. Its climate is classified as Tropical Rainy, but no marked seasonality affecting soil-vegetation relations. Its climate is warm humid climate for the Amazon plain area, and foothills near the Güejar mountains (Tacha & Moreno, 2016).

1.1.3.3.2 Precipitation

The maximum annual rainfall is estimated at 3,500 mm, with an average of 2,814 mm. The rainfall regime is monomodal –from April to October, and a dry period –from December to March. June is the month with the highest precipitation and January the month with the lowest precipitation. The maximum multiannual average temperature is 27°C and the minimum is 24°C (Tacha & Moreno, 2016).

1.1.3.3.3 Relative Humidity

The municipality's meteorological scenario classification corresponds to warm-humid climatic conditions. The heat apparent temperature is affected by a higher than 70% and 80% relative humidity, and an evaporation close to 128 mm/year, accompanied with 13 km/h winds and 9 h/day of sunlight (Tacha & Moreno, 2016).

1.1.3.3.4 Hydrography

The Puerto Lleras municipality is part of the Meta and Guaviare River basin. The sub-basins of the Ariari, Manacacias and Guejar rivers are part of the Guaviare River basin, as shown in Table 12, which indicates its extension. The water system is diverse due to the processes that have caused its bodies of water to be dendritic, its channels are short, and their union forms its main drainages, comprising navigable fluvial networks and habitat for ornamental and consumption fish.

Table 12. Puerto Gaitán Sub-basins

Basin	Sub-basin	Area (km²)
Gauviare river	Ariari river	1,527
	Guejar river	801
Meta river	Manacacias river	215

Source: (CO2CERO SAS, 2022).

1.1.3.3.5 Topography

Topographical information from the Colombian Continental, Maritime and Coastal Ecosystems Shapefile generated by IDEAM in 2017, shows the following alluvial fans in priority order: hills landscape, with 131,566.40 ha –corresponding to 51.71%; followed by valleys, with 70,479.56 ha –corresponding to 27.70% of area; third, alluvial plains, with 33,440.73 ha (13.14%), as shown in Table 13.

Table 13. Landscapes and Topography in Puerto Lleras Municipality.

Landscape	Topography	Area (ha)	Area (%)
High plateaus	Plateaus	13,863.68	5.45%
Hills	Hillocks and hills	131,566.40	51.71%
N.A.	N.A.	5,084.84	2.00%
Alluvial planes	Flood planes	7,882.74	3.10%
	Terraces	25,041.32	9.84%
	Terraces level 3	516.66	0.20%
Valleys	Flood planes	44,572.57	17.52%
	Dells	25,906.99	10.18%
Overall total		**254,435.20**	**100%**

Source: (IDEAM, 2017)

1.1.3.3.6 Soils

Some of the municipality's soils include meadow (alluvial) soils, characterized by a deep organic layer. They are well-drained soils, facilitating agricultural activities due to their fertility potential as they are subjected to periodic flooding (Servicio Geológico Colombiano, 2011). Flatlands have moderately deep acid soils, suitable for irrigated rice, improved pastures, corn, sorghum, etc.

Finally, altillanura soils, characterized for their high aluminum saturation, moderately deep, low moisture retention. These soils are primarily used for livestock, with very low yields and for establishing small subsistence crops (Mahecha et al., 2015).

There is a predominance of Oxisols in the municipality through the Plinthic Hapludoxs complex, deep to shallow soils, fine to coarse textures, well to moderately drained, highly acidic, low fertility, aluminum toxicity, susceptible to flooding (IGAC, 2004).

Table 14. Puerto Lleras Soils

Component	Area (ha)	Area (%)
Aquic Dystrudepts, Typic Fluvaquents, Plinthic Petraquepts	14,587.14	5.73%
Fluvaquentic Eutrudepts, Typic Fluvaquents, Aeric Endoaquepts	3,006.99	1.18%
Inceptic Hapludolls, Typic Hapludults, Oxic Dystrudepts	8,512.25	3.35%
N.A.	5,084.84	2.00%
Oxic Dystrudepts, Typic Dystrudepts, Typic Hapludolls	5,252.89	2.06%
Oxic Dystrudepts, Typic Hapludults, Typic Haplaquox	810.30	0.32%
Plinthic Hapludoxs, Typic Paleudults, Oxic Dystrudepts, Typic Dystrudepts	102,352.22	40.23%
Typic Dystrudepts, Typic Kandiudults, Typic Hapludults, Oxic Dystrudepts	20,701.93	8.14%
Typic Fluvaquents, Typic Udifluvents, Aeric Endoaquepts	3,288.23	1.29%
Typic Hapludolls, Typic Kanhapludults, Typic Dystrudepts	13,863.68	5.45%
Typic Hapludults, Oxiaquic Hapludults, Hydric Haplohemists	18,936.01	7.44%
Typic Udifluvents, Aquic Dystrudepts	1,587.52	0.62%
Typic Udifluvents, Typic Endoaquepts, Oxiaquic Udifluvents	56,451.21	22.19%
Overall total	**254,435.20**	**100.00%**

Source: (IDEAM, 2017)

On the other hand, the municipality features the following Association: Typic Udifluvents, with moderately deep characteristics, imperfect to moderate natural drainage, medium to moderately coarse textures, very strong to strongly acid reaction, low fertility (IGAC, 2004).

1.1.3.3.7 Indigenous Reserves and National Parks

According to the National System of Protected Areas (SINAP, for its initials in Spanish), an area –part of the National System of Regional Natural Parks, Laguna de Lomalinda, with about 809.01 hectares, is in the municipal area. There are no Forest Reserves under Law 2 of 1959 in the municipality. Finally, there is no indigenous reservation in the municipality.

1.1.3.3.8 Wildlife

The faunal component assessment is associated with studies conducted in the Manacacias river basin, characterized by being representative of the basins in the municipality, for which the studies of Rangel *et al.* (2019) were used.

- **Mastofauna**

Records were obtained for 179 species of mammals, 124 genera, 34 families, and 12 orders, among which the species best represented include Chiroptera (92 species, 51.4% from the total richness), Rodentia (28 species, 15.6%), and Carnivora (17 species, 9.5%). The family with the largest number of genera (36) and species (62). The family with the largest number of genera (34) and species (63) is *Phyllostomidae* (new world leaf-nosed bats); the genera with the greatest richness were bats feeding on fruits. The habitat with the greatest richness of bat species was the morichal followed by the riverside forest. Fourteen species fall under the near threatened category; thirteen, under Vulnerable (VU); six, under Endangered (EN), and one under Critically Endangered (CR). Some of the threatened species are shown in Table 15.

Table 15. Puerto Lleras Mastofauna and Threat Level

Scientific Name	Vernacular Name	Conservation Status
Artibeus planirostris	Flat-faced fruit-eating bat	Least concern
Odocoileus cariacou	Cervid	Least concern
Artibeus obscurus	Dark fruit-eating bat Animal	Least concern
Dasypterus ega	Southern yellow bat	Least concern
Saimiri cassiquiarensis	Humboldt's squirrel monkey	Least concern
Dasyprocta fuliginosa	Black agouti	Least concern

Source: (Rangel, Gonzalo, Guillermo, & Jarro, 2019).

- **Ornithofauna**

Data on 454 bird species, distributed in 25 orders, 67 families, and 308 genera, are consolidated. The *Passeriformes* (songbirds) order was the richest and most diverse with 24 families, 146 genera and 218 species; followed by *Accipitriformes* (raptors) with two families, 19 genera and 28 species, and *Pelecaniformes* with two families, 20 genera and 24 species. *Tyrannidae* (flytraps), and *Accipitridae* (eagles) were the best represented families. The four (4) most representative genera include *Sporophila*, with eight species, *Setophaga*

with six, *Chordeiles* and *Icterus* with five each. Some of the threatened species are shown in Table 16.

Table 16. Puerto Lleras Ornithofauna and Threat Level

Scientific Name	Vernacular Name	Conservation Status
Oressochen jubatus	Orinoco goose	Near Threatened
Falco deiroleucus	Orange-breasted falcon	Near Threatened
Polystictus pectoralis	Bearded tachuri	Near Threatened
Mitu tomentosum	Crestless curassow	Near Threatened

Source: (Rangel, Gonzalo, Guillermo, & Jarro, 2019)

- **Herpetology**

Altogether, 18 amphibians and 12 reptile species were recorded. The gallery forest represented the greatest richness (10 species) and abundance (89 individuals) in the case of amphibians. Conversely, reptiles, the gallery forest, and the swamp constitute the greatest richness (4 species each) and the gallery forest, the greatest abundance of individuals. According to the IUCN, Puerto Lleras' amphibian species fall under Least Concern (LC), meanwhile, 41.67% of reptile species Least Concern (LC), and the remaining 58.33% fall under no evaluated (NE). Some of the species of these families are shown in Table 17.

Table 17. Puerto Lleras Herpetology and Threat Level

Scientific Name	Vernacular Name	Conservation Status
Scinax wandae	Villavicencio snouted treefrog	Least concern
Boana lanciformis	Basin tree frog	Least concern
Leptodactylus colombiensis	Rana picúa	Least concern
Pseudopaludicola llanera	Lynch's Swamp Frog	Least concern
Paleosuchus palpebrosus	Dwarf Caiman	Least concern
Anolis scypheus	Yellow-tongued Anole	Least concern
Anolis fuscoauratus	Brown-eared Anole	Least concern
Iguana iguana	Common green iguana	Least concern

Source: (Rangel, Gonzalo, Guillermo, & Jarro, 2019)

1.1.3.3.9 Flora

The municipality comprises natural regions characterized for their vegetation and the gallery forests found along the water currents. It is made up of dense and tall trees

intended for conservation and selective exploitation. In addition, it is also composed of natural pasture savannahs and introduced for extensive livestock (Tacha & Moreno, 2016).

Based on the research by Rangel *et al.* (2019) they found four (4) large formations, twenty-one (21) formations, and 22 plant subformations, which include forests, mixed palm groves, grasslands, and scrublands. Forests recorded the largest number of species (401) and individuals (10,180). Grasslands recorded 316 species and 37,746 individuals. Following is a more detailed description of the characteristics of each formation.

- **Mixed palm groves and forests formations**: Mixed palm groves of *Oenocarpus bataua, Iryanthera laevis,* and *Pseudolmedia laevis; Euterpe precatoria* and *Brosimum lactescens* mixed palm groves formation*;* formation of forests with *Protium* and *Caraipa llanorum (Saladillales)* species*; Xylopia sericea* and *Attalea insignis* mixed palm groves formation*; Euterpe precatoria and Mauritia flexuosa* (morichales) mixed palm groves formation.
- **Grassland Formations:** *Axonopus purpusii* and *Schizachyrium brevifolium* grasslands formation*; Rhynchanthera bracteata* and *Schizachyrium brevifolium* grassland formation*; Panicum sp.,* and *Schizachyrium brevifolium* grassland formation*; Axonopus purpusii* and *Axonopus aureus* grassland formation*; Axonopus purpusii* and *Axonopus aureus* grassland formation, and *Axonopus purpusii* and *Aristida capillacea* grassland formation.
- ***Xyris savanensis* and Coleataenia caricoides grassland-rosette subformation*:*** Open rosette grassland dominated by *Xyris savanensis* and *Coleataenia caricoides*. *Burmannia capitata* dominates in the ground layer. *Andropogon lateralis* forms clumps up to 40 cm tall.
- ***Hyptis sp.* and *Clidemia rubra* subformation*:*** Open and low Clidemia scrub. In the herbaceous layer the*, Sida glomerata* and *Rhynchospora nervosa* dominate due to their cover values.
- ***Curatella americana Scrub subformation:*** Medium-sized scrub (1-3m) dominated by Curatella americana. *Andropogon bicornis* clumps of up to 50 cm.

However, according to (Correa et al., 2006) in their Biodiversity Action Plan of the Orinoco Basin - Colombia, the plant species in Puerto Lleras with some conservation degrees are shown in Table 18.

Table 18. Threatened Plant Species in Puerto Gaitán

Species	Vernacular Name	Conservation Status
Attalea insignis	Drude	Endangered
Guarea venenata	Cedro	Least concern

Species	Vernacular Name	Conservation Status
Gustavia longifuniculata	Coco picho	Critically Endangered
Inga macarenensis	Guamo rabo de mico	Vulnerable
Aniba novo-granatensis	Amarillo, Oloroso	Vulnerable

Source: Retrieved from: (Correa, Ruiz, & Arévalo, 2006).

1.1.3.4 Vichada Department

The Vichada Department is in the Orinoquía region –in the far eastern part of Colombia, between the Meta, Guaviare, and Orinoco rivers. It borders with the Meta, Casanare, and Arauca rivers and the Bolivarian Republic of Venezuela to the north. The Guaviare River separates it from the departments of Guainía and Guaviare to the south. It borders with the Meta and Casanare departments to the west, and to the east, with the Bolivarian Republic of Venezuela. Its extension, 100,242 km², represents 10% of the national territory. Vichada becomes a benchmark for Colombia's hydrographic potential (Suarez Moreno & Guevara, 2018). The Vichada department is divided into 4 municipalities, including Puerto Carreño, where the capital city is located, La Primavera, Santa Rosalía, and Cumaribo, 32 Inspections, and numerous populated centers (Gobierno Departamental, 2020).

1.1.3.4.1 Climatic Aspects

Based on estimates of potential evapotranspiration and water balance according to Thornthwaite (1948), Rangel-Ch. *et al.* (1995) and Rudas (2010), there exist four megathermal climate types in the Colombian Orinoco, therefore, in Vichada (a) super humid climate with no water deficiency (b) humid and very humid with no water deficiency (c) humid and very humid climates with moderate water deficit, and (d) moderately humid climate with moderate water deficit (Rangel-Ch, Gopar-M, & Minorta-C, 2020).

On the other hand, its temperature has the following characteristics (Rangel C. J., 2019) the average multi-annual monthly maximum temperature is 30.7°C; the average multi-annual monthly temperature is 26.6°C; the average multi-annual monthly minimum temperature is 22.5°C.

1.1.3.4.2 Physiography

Four physiographic groups can be distinguished in the Vichada department (the alluvial overflow plain of the Orinoquía –poorly drained; the high plain of the Orinoquía –well drained; the strip of alluvium from the great rivers, and the Guayanés shield.) Each one shows a wide diversity of biomes such as grasslands, tropical jungle, gallery forests, etc. (Suarez Moreno & Guevara, 2018).

The predominant parent material in the Vichada highlands is clay (17%), followed by sand (12%). Also, sands from the Guayanés shield (11%), mixed sediments containing gravel and shell (10%) and alluvium (9%) were found. The soil textures that predominate in the department include Loamy sand (26%), sandy claim loam (12%) and loam soil (11%). On the other hand, the predominant soil orders are Inceptisols (34%), followed by Oxisols (28%), Entisols (23%), Ultisols (14%), and Spodosols (1%) (Rangel C. J., 2019).

1.1.3.4.3 Hydrography

The Vichada department has 456 km² of water bodies, a 7940 km² area of Potential Flood-Prone Areas (ZPI, for its abbreviation in Spanish) and 17,816 km² of Potential Non-Floodable Areas (Gobierno Departamental, 2020). The department is included in the Orinoco basin, which is recognized as one of the eight strategic ecosystems for humanity (Correa et al., 2006). There exist six (6) main hydrographic basins in the department, which run through it (see Table 19).

Table 19. Main Hydrographic Basins of Vichada

Basin	Main Tributaries
Vichada	Muco river, Guarrojo river, Caño Curimayiba, Caño Cumahobo, Caño Guaturia, Caño Guacamayas.
Tomo	Caño Grande, Caño Cumachao, Caño Urimica, Caño Beberí, Caño Samuro, Elvita river
Tuparro	Caño Malicia, Caño Tuparro, Caño Tuparrito, Caño Arrreita, Caño Tiro
Meta	Caño La Arenosa, Caño La Balsa, Caño La Culebra, Caño Muco, Caño Venado
Guaviare	Siare river, Iteviare river, Caño Corocoro, Caño Viejita, Caño Cumaral, Caño Mesita, Uva river, Cada river
Bita	Caño Bravo, Caño El Pendare, Caño Barro, Caño Maribo, Caño Camariane, Caño Guaturia

Source: (CO2CERO SAS, 2022).

1.1.3.5 Cumaribo

The Cumaribo municipality has an extension of 65,193 km² –one of the largest municipalities in Colombia. It borders with the Santa Rosalía, La Primavera and Puerto Carreño municipalities to the north, with the Guaviare department to the south, The Bolivarian Republic of Venezuela to the east, and with the Meta department to the west. The municipality is made up of 16 inspections, including 60 villages, 21 Indigenous Reservations and the "El Tuparro" National Natural Park (Alcaldía de Cumaribo, 2016).

1.1.3.5.1 Climatic Aspects

Information provided by IDEAM (as it´s initials in Spanish) for the 2007–2011 period was used to characterize the climate. The lowest average monthly temperature is 24.4°C (July). The highest average temperature is 28.4°C (February), with a slight variation of 4.0 °C.

1.1.3.5.2 Precipitation

There is a defined period of rains followed by one of drought (monomodal regime). The rainy season begins in April and ends in November. The annual rainfall average is between 1000 mm and 2,000 mm (Table 20).

Table 20. Average Monthly Precipitation (mm) 2007–2011.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Prom.
P. Max (mm)	146.7	108.4	259.1	515.3	574.0	616.1	442.4	422.6	474.9	537.9	320.7	227.0	387.1
P. Med (mm)	27	49	125	254	351	449	326	299	291	266	187	72	224.7
P. Min (mm)	0.0	0.0	8.6	66.2	179.6	189.5	184.4	158.1	107	129.5	68.3	1.4	91.05

Source: IDEAM Estación Climatológica Ordinaria Gaviotas (1999).

The average rainfall behavior, in recent years (2011), during April, November and December, were above the monthly average, while January, February, March, June, July, August, and October rainfall below average, and May and September showed normal rainfall values, in relation to that average.

1.1.3.5.3 Relative Humidity

There is an annual average of 79.4% relative humidity, with a minimum average of 63% humidity during February and a maximum of 88% in June. Evaporation is lower towards the southwest, where there are transition forests, and to the northeast it is higher, where there are savannah covers. The maximum monthly average is 212 mm in January and a minimum of 97 mm in June (Alcaldía de Cumaribo, 2016).

1.1.3.5.4 Hydrography

The municipal territory and its hydrographic network are part of the Great Orinoco River Basin, which constitute the Tomo, Vichada, Guaviare, Tuparro and Caño Matavén rivers as the main tributaries of the Orinoco River (Ruiz et al., 2005) (Table 21).

Table 21. Municipal area included in each of the basins and tributaries of the Orinoco River.

Hydrographic classification	Area (km²)	Municipal participation
Tomo River Basin	6,564.94	10.07%
Tuparro River Basin	10,502.59	16.11%
Vichada River Basin	15,307.32	23.48%
Guaviare River Basin	22,635.01	34.72%
Caño Matavén Basin	8,227.36	12.62%
Direct tributaries to the Orinoco River	-	-
Caño Zama	293.37	0.45%
Caño Ajota	638.89	0.98%
Caño Ucaro	241.21	0.37%
Others	782,32	1.20%
Total	**65,193.00**	**100.00%**

Source: (Ruiz et al., 2005).

1.1.3.5.5 Topography

The topographic information comes from the Shapefile *Ecosistemas Continentales, Marítimos y Costeros de Colombia* (Shapefile of Continental, Marine and Coastal Ecosystems of Colombia) created by IDEAM in 2017. According to this file, the high plateau landscape covers an area of 2,119,858.70 hectares, accounting for 32.46% of the total area. Following closely is the Low hills landscape, encompassing 2,119,474.79 hectares, which represents 32.45% of the total area. The dominant relief feature in both landscapes is hills and hillocks. The peneplain landscape takes the third position, covering 1,052,840.40 hectares, equivalent to 16.12% of the total area, as indicated in Table 22.

Table 22. Landscapes and reliefs in the project area in the municipality of Cumaribo.

Landscape	Relief	Area (ha)	Area (%)
High plateau	Sand fields	10,247.90	0.16%
	Depressions	28,409.95	0.43%
	Glacis	20,461.17	0.31%
	Hills and undulations	1,622,698.98	24.84%
	Dells	438,040.70	6.71%
Low hill	Glacis	361.97	0.01%
	Hills and hillocks	1,936,506.22	29.65%
	Dells	182,606.59	2.80%
Massif	Hills and hillocks	79,933.09	1.22%
	Tables and slopes	14,464.63	0.22%

Landscape	Relief	Area (ha)	Area (%)
N/A	N/A	130,918.15	2.00%
Peneplain	Flattening	406,827.42	6.23%
	Flattening and peneplain	553,328.13	8.47%
	Residual hills	15,102.88	0.23%
	Hills and hillocks	27,145.47	0.42%
	Dells	50,436.51	0.77%
Alluvial plain	Floodplain	389,876.76	5.97%
	Terraces	136,231.06	2.09%
Valley	Floodplain	487,731.60	7.47%
	Dells	163.01	0.00%
Total		6,531,492.18	100.00%

Source: (IDEAM, 2017)

The relief forms in Cumaribo, as defined by the (Alcaldía de Cumaribo, 2016), can be categorized into three types: alluvial plain, altillanura, and rocky outcrops.

- **Alluvial plain**: These are recent deposits found along the riverbanks, typically 1-1.5 kilometers wide, and they do not exceed a height of 170 meters above sea level. They are known as *playones* and are located alongside the Guaviare, Vichada, Tomo, and Tuparro rivers.
- ***Altillanura***: Located on the right bank of the Tomo River, it goes up to the Guaviare and Orinoco rivers. It is characterized by landscapes of hilly landscapes and small terraces. For the municipality there are two types of *altillanura*: well drained and dissected.
- **Rocky outcrops**: These formations are part of the Guiana shield. They are mostly devoid of vegetation, except for the cracks where it is possible to find epiphytes and other vegetation.

1.1.3.5.6 Soils

According to the (Servicio Geológico Colombiano, 2011), the municipality of Cumaribo is formed by flat, concave, convex to gently undulating soils. These soil types allow the development of diverse landscapes and vegetation, such as meadows, gallery forests and jungle. Additionally, five cartographic units have been recognized in the area: Pedogenized Sediments associated with ferruginous crusts (Qcf), Aeolian Peneplain Deposits (Qpe), Alluvial Channel Deposits (Qac), and Floodplain Deposits (Qll).

Table 23. Soils in Cumaribo.

Component	Area (ha)	Area (%)
Aeric Endoaquepts, Typic Dystrudepts, Typic Psammaquents	43,366.43	0.66%
Aquic Udifluvents	7,140.84	0.11%
Fluvaquentic Endoaquepts, Fluventic Dystrudepts, Aquic Udifluvents	81,644.83	1.25%
Fluvaquentic Endoaquepts, Fluventic Eutrudepts, Chromic Endoaquerts	28.76	0.00%
Fluvaquentic Endoaquepts, Oxyaquic Humudepts, Typic Udipsamments	948.76	0.01%
Fluvaquentic Endoaquepts, Typic Humaquepts, Vertic Endoaquepts	526,079.06	8.05%
Fluvaquentic Humaquepts, Oxyaquic Udifluvents, Aquic Udorthents	438,069.03	6.71%
Fluvaquentic Humaquepts, Typic Quartzipsamments, Plinthic Haplaquox	383,703.67	5.87%
Fluventic Endoaquepts, Typic Endoaquepts	182,606.59	2.80%
Fluventic Endoaquepts, Typic Endoaquepts, Oxic Dystrudepts	147.91	0.00%
Fluventic Humic Dystrudepts, Typic Fluvaquents	414.68	0.01%
Inceptic Hapludoxs, Typic Hapludults, Oxic Dystrudepts	117,930.07	1.81%
Lithic Quartzipsamments, Typic Hapludoxs, Oxic Dystrudepts	27,118.96	0.42%
Lithic Udorthents, Rocky Outcrops, Typic Quartzipsamments	7,509.93	0.11%
Lithic Ustorthents, Rocky Outcrops	7,592.95	0.12%
Rocky Miscellaneous	52,814.13	0.81%
N/A	130,918.15	2.00%
Oxyaquic Kandiudults, Oxyaquic Dystrudepts, Plinthic Kandiudults	20,461.17	0.31%
Oxic Dystrudepts, Typic Udipsamments, Typic Udorthents	361.97	0.01%
Oxic Dystrustepts, Typic Haplustepts, Typic Ustorthents	1,204.51	0.02%
Oxic Humudepts, Typic Udipsamments, Typic Kandiudults, Rocky Outcrops	27,145.47	0.42%
Plinthic Hapludoxs, Typic Paleudults, Oxic Dystrudepts, Typic Dystrudepts	2,059.03	0.03%
Plinthic Kandiustults, Typic Kandiustults, Typic Haplustox	1,622,698.98	24.84%
Typic Dystrudepts, Typic Kandiudults, Typic Hapludults, Oxic Dystrudepts	1,809,973.49	27.71%
Typic Haplustox, Oxic Dystrudepts	5,339.12	0.08%
Typic Humaquepts, Typic Haplaquox, Oxyaquic Haplustox	28,409.95	0.43%
Typic Quartzipsamments, Aquentic Haplorthods, Inceptic Hapludoxs	518,232.03	7.93%
Typic Quartzipsamments, Typic Psammaquents, Typic Endoaquods, Fluventic Endoaquepts	406,860.97	6.23%

Component	Area (ha)	Area (%)
Typic Udifluvents, Fluvaquentic Eutrudepts	20,249.77	0.31%
Typic Udifluvents, Typic Endoaquepts, Oxyaquic Udifluvents	652.34	0.01%
Typic Udipsamments, Typic Udorthents, Xantic Hapludoxs	35,096.10	0.54%
Typic Udorthents, Lithic Udorthents, Typic Udipsamments	14,464.63	0.22%
Typic Ustipsamments, Xanthic Haplustox, Typic Ustorthents	10,247.90	0.16%
Grand Total	**6,531,492.18**	**100%**

Source: (IDEAM, 2017)

The soils are made up of completely sandy and clayey sediments. In the southern part of the municipality there are low fertility soils, ploughed by narrow valleys, which are conducive to the formation of gallery forests. The Cumaribo *altillanura* comprises deep, well-drained soils with occasional short-lived floods. It is located between the plain of the Vichada River and flat *altillanuras* (Servicio Geológico Colombiano, 2011).

1.1.3.5.7 Indigenous Reservations and National Parks

According to information provided by the National Administrative Department of Statistics (DANE) and the (Alcaldía de Cumaribo, 2016), there are 21 indigenous reservations reported within the municipality. The names of the indigenous reservations and the projected population in 2020 are listed in Table 24.

Table 24. Indigenous reservations of Cumaribo, Vichada.

DANE Code	Reservation	Population
1338	El Unuma (a part of it)	3,223
1467	Cali-Barranquilla	154
1467	Carpintero-palomas	591
1468	Chocon	114
1469	Chololobo-Matatu	195
1472	EguaGuarianacana	204
1473	Flores-Sombrero	45
1475	GuacamayaMamiyare	557
1476	Kaguanaruba	319
1477	La Esmeralda	159
1481	Merey La Veraita	198
1483	Muco Mayoragua	331
1484	Rio Muco y Guarrojo	1,542
1485	Rio Siare-Baranco Lindo	410
1486	Rio Tomo y Weberi	1,042

DANE Code	Reservation	Population
1487	San Luis Del Tomo	1,310
1488	Santa Teresita Del Tuparro	1,440
1489	Saracure Rio Cada	1,891
1491	Valdivia	148
1643	Punta Badera	177
1415	Selva De Mataven	14,662
Total		**28,712**

Source: (Alcaldía de Cumaribo, 2016)

Within Cumaribo, El Tuparro National Natural Park stands with an area of 548,000 hectares. The park was created through Resolution 264 of 1980 by the Ministry of Agriculture and then declared a National Monument by Resolution 002 of 1982. That same year, it was declared a Biosphere Reserve by UNESCO (Patiño et al., 2005). The vegetation in El Tuparro National Park consists of natural savannas, which cover 75% of the area, gallery forests, altillanura forests, moriche palms and several granite outcrops communities. The park's altitude is between 80 and 315 meters above sea level, with an average temperature of 27°C, and an average annual rainfall of 2939 mm in the eastern end and 2477 mm in the western end (Patiño et al., 2005).

1.1.3.5.8 Fauna

(Rangel C. J., 2019), in a study describing the terrestrial ecosystems of the transitional forests of Cumaribo, found a relationship in the following fauna component.

- **Mammals**

A total of 16 species, belonging to 16 different genera, 14 families, and eight (8) orders, were documented. The most abundant orders observed were Chiroptera, Artiodactyla, Carnivora, and Primates. Among the families, the Molossidae and Phyllostomidae stood out as the most diverse. Table 25 provides a list of some endangered species.

Table 25. Cumaribo mammalian fauna and conservation status.

Scientific name	Common name	Conservation category
Saimiri cassiquiarensis	Humboldt's squirrel monkey	Endangered
Lontra longicaudis	Neotropical otter	Vulnerable
Panthera onca	Jaguar	Vulnerable
Tayassu pecari	White-lipped peccary	Vulnerable
Myrmecophaga tridacyla	Giant anteater	Vulnerable

Scientific name	Common name	Conservation category
Lagothrix lagothricha	Common woolly monkey	Vulnerable
Leopardus wiedii	Margay	Near threatened

Source: (Rangel C. J., 2019)

- **Birds**

A total of 81 species from 71 genera, 42 families and 24 orders, were observed. The families with the highest abundance were Ardeidae, Psittacidae, Cracidae, Tyrannidae, Accipitridae, and Cathartidae. Among the genera, Ara, Ardea, Buteo, Cathartes, Egretta, Phaethornis, Tityra, and Vanellus were particularly diverse. Some threatened species are listed in Table 26.

Table 26. Bird population in Cumaribo and conservation status.

Scientific name	Common name	Conservation category
Tinamus major	Great tinamou	Near threatened
Tinamus guttatus	White-throated tinamou	Near threatened
Oressochen jubatus	Orinoco goose	Near threatened
Mitu tomentosum	Crestless curassow	Near threatened
Odontophorus gujanensis	Marbled wood quail	Vulnerable
Patagioenas subvinacea	Ruddy pigeon	Vulnerable
Ramphastos	Toucan	Vulnerable
Ramphastos vitellinus	Channel-billed toucan	Vulnerable

Source: (Rangel C. J., 2019)

- **Herpetofauna**

(Rangel C. J., 2019) identified 20 species from 13 genera and seven (7) families. The order Anura had the highest representation among the species. The family with the largest number of species was Hylidae, followed by Leptodactylidae, Microhylidae and Leptodactylidae. On the reptile side, 16 species from 16 genera and 11 families were reported. The order Squamata was the most represented, followed by Crocodilia and Testudinata. The family Colubridae had the highest species diversity. Table 27 presents a list of some threatened species.

Table 27. Cumaribo herpetofauna and conservation status.

Scientific name	Common name	Conservation category
Leptodactylus colombiensis	Rana sobre hoja	Least Concern
Chiasmocleis bassleri	Bassler's humming frog	Least Concern

Scientific name	Common name	Conservation category
Adenomera hylaedactyla	Napo tropical bullfrog	Least Concern
Pseudopaludicola boliviana	Bolivian swamp frog	Least Concern
Uranoscodon superciliosus	Mophead iguana	Least Concern
Lepidoblepharis nukak	Anolis	Least Concern
Anolis fuscoauratus	Slender anole	Least Concern
Tupinambis teguixin	Gold tegu	Least Concern

Source: (Rangel C. J., 2019)

1.1.3.5.9 Flora

(Alcaldía de Cumaribo, 2016) reports five types of vegetation: savannah cover, gallery forests, transition forest, planted forests and wetlands and bodies of water. Below we can find the characteristics of each of these types.

- **Savannah covers:** Formed by pastures, Pampas Grass, Itchgrass, Paja Guaratara, Foxtail Grass, resistant shrubs like Chaparro, Cork Oak, Common guava, Bototo, Corozo, Bay Laurel, and palm associations such as Moriche palm.
- **Gallery forests:** The most common species are American Muskwood, Caraño, Anime, Bay Laurel, Gualanday, Yarumo, Caimo, Guadua, Guamo, Cumare, Dormidera Pavito, Peruvian primrose-willow, Cañaguate and Rubber tree.
- **Transitional forests:** This forest type is only found in this municipality, between the Guaviare and Vichada rivers. It is more representative in terms of density and species diversity compared to riparian forests.
- **Wetlands and bodies of water:** Represented by a complex network of riparian forests and Morichal, which are swampy areas dominated by the Moriche Palm.

On the other hand, according to (Rangel C. J., 2019), there are some plant species in Cumaribo with some degree of conservation. These are listed in Table 28.

Table 28. Threatened plant species of Puerto Gaitán.

Species	Common name	Conservation category
Mauritia flexuosa	Moriche palm	Endangered
Manihot brachyloba	Yuca silvestre	Endangered
Henriettella goudotiana	Tuno	Endangered
Vanilla planifolia	Flat-leaved vanilla	Endangered

Source: (Rangel C. J., 2019).

3 Quantification of GHG emissions removals

3.1 Quantification methodology

The project was implemented following the guidelines outlined in the Methodological document BCR0001 "Quantification of GHG Removals. Afforestation, Reforestation, and Revegetation, BioCarbon Registry, Version 4.0." Considering the project's conditions, which involve commercially managed forest plantations in eligible areas under proper ownership and management, the chosen methodology is the most appropriate from a technical perspective. Similarly, the parameters and calculation methods have been adjusted to the variables found and monitored within the project limits. In addition, the following tools and guides are used:

- Tool Sustainable Development Goals (SDG). Version 1.0. June 2023.
- BCR Tool. Avoiding double counting (ADC). BCR avoid double counting of emissions reductions/removals. Biocarbon Registry. Version 1.0. March 9, 2023.
- BCR Tool. Monitoring, reporting and verification (MRV). BCR carbon credits are quantified, monitored, reported, and verified. Biocarbon Registry. Version 1.0. February 13, 2023.
- No Net Harm Environmental and Social Safeguards (NNH). BCR Tool. BCR project activities do not cause any net-harm to the environment or to local communities and society in general. Version 1.0. March 7, 2023.
- Biocarbon Guidelines. Baseline and Additionality. GHG Projects generate Verified Carbon Credits (VCC) that represent emissions reductions, avoidance, or removals that are additional. Version 1.2. September 27, 2023.
- Permanence and Risk Management. BCR Tool. BCR Project holder take actions to ensure the Project benefits are maintained over time. Version 1.0. March 7, 2023.

3.1.1 Applicability conditions of the methodology

The project complies with the conditions of applicability of the BCR0001 V 4.0 methodology as it is outlined below:

i. The project contributes to the removal of GHG emissions through the development of reforestation and restoration activities.
ii. The project is executed in areas that are not classified as forests according to the definition of IDEAM's Corine Land Cover methodology, (2010) adapted for Colombia, nor natural vegetation different to a forest, at the beginning of project activities and not five years before the project start date. The evaluation of this condition can be found in section 3.7.2.

iii. No flood irrigation systems have been implemented within the project area. This can be verified in folder *12_Forest management establishment plan.*
iv. As the drainage effects are negligible, GHG emissions, other than carbon dioxide, are omitted.
v. The project does not involve rotation activities or soil alterations. The management practices adhere to good conservation and protection practices, with low-impact activities carried out manually. This can be verified in folder *12_Forest management establishment plan.*
vi. The GHG removals quantification in the project scenario is consistent with the methodology, sinks, selected sources, and reforestation activities.
vii. The monitoring of GHG removals in the project scenario is consistent and measurable, generating suitability, integrity, accuracy, and reliability.
viii. The deposits and mandatory sources of emission to be considered within the project have been evaluated in accordance with the methodology's provisions.

Similarly, the project satisfies the conditions of applicability of the tools used by the methodology as follows:

i. **AR-AM-TOOL16** "*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*" has been evaluated in both the baseline scenario and the Project scenario.

- It does not occur in wetland covers, or organic soils according to Annex A of the IPCC GFG LULUCF (2003). This is assessed in section 3.7.2.
- No land management practices or application of chemical, nitrogen synthesis inputs are employed in the project. None of the three combinations in the table (management/inputs) apply. This can be verified in folder *12_Forest management establishment plan.*
- Residues remain on-site and alterations in the soil are limited to site preparation, adhering to good conservation practices and accounting for less than 10% of the area.
- The conservative values of Soil Organic Carbon are used as a determined value by the elapsed years and the inputs in the soil.

ii. **AR-AM-TOOL15** "*Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity*", has been evaluated in both the baseline scenario and the Project scenario.

- This tool is not applicable if the displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or

peatlands. The tool is not applicable because the project area has no peatlands, no wetlands, and no leaks attributable to the project. This is assessed in section 3.7.2.

The other tools used for the development of the project do not contemplate internal conditions of applicability.

3.1.2 Methodology deviations (if applicable)

The project doesn't generate methodological deviations from what is established in the BCR0001 Quantification of GHG Removals. Afforestation, Reforestation, and Revegetation methodology developed by Biocarbon Registry version 4.0.

3.2 Project boundaries, sources and GHGs

The project will be implemented in commercial forestry plantations in the Colombian Orinoquia. Below are the location and limits defined for Proyecto Forestal Alcaraván Orinoquía, considering the methodological and specific requirements of the certification program.

3.2.1 Spatial limits of the project

The project is currently located in the eastern part of the country in the Meta and Vichada departments –a total of three (3) municipalities that correspond to Puerto Lleras and Puerto Gaitán in Meta and Cumaribo in Vichada, per Figure 1. Its geographical location is between the North coordinates: 6°5'20.91"N South: 2°49'20.95"NN, East: 73°46'43.87"W, West: 67°22'50.11 "W (WGS_1984 coordinate system).

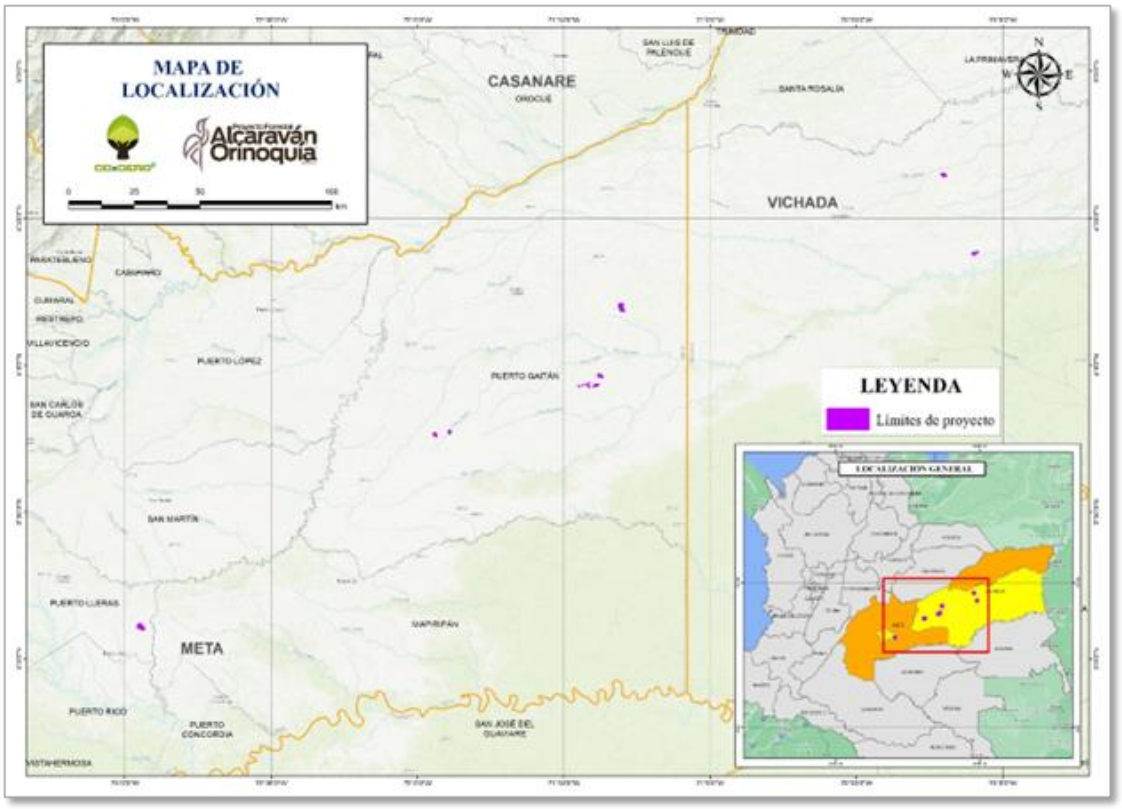


Figure 1. Project Localization.
Source: (CO2CERO SAS, 2022)

The properties of all the participants and their respective locations are described in Table 29. These participants correspond to the links made from the start date of the project until 2022.

Table 29. Location of the Properties Involved in the Project

No.	Participant	Property	Department	Municipality
1	ECOLOGIC SAS	Galapagos	Meta	Puerto Gaitán
2	SULTANA SAS	Sultana	Meta	Puerto Gaitán
3	ENLACE ROJO SAS	Barlovento	Meta	Puerto Lleras
4	ECOSISTEMA PRODUCTIVO MATAEMONTE SAS	Botereña	Meta	Puerto Gaitán
5	LUIS FERNANDO RODRIGUEZ	Naranjales	Meta	Puerto Gaitán
6	INVERSIONES GUARDABOSQUES DE COLOMBIA	La Cabaña	Vichada	Cumaribo

No.	Participant	Property	Department	Municipality
7	CLAUDIA HUERFANO	Villa Claudia	Meta	Puerto Gaitán
8	PUNTA DE GARZAS INVERSIONES FORESTALES	Punta de Garzas	Vichada	Cumaribo

Source: (CO2CERO SAS, 2022)

3.2.2 Carbon reservoirs and GHG sources

The reservoir considered for Proyecto Forestal Alcaraván Orinoquía are described in Table 30, which are consistent with those established by the IPCC.

Table 30. Reservoir considered for the Proyecto Forestal Alcaraván Orinoquía.

Source or reservoir	Included		Justification
	Baseline Scenario	Project Scenario	
Aboveground biomass (AGB)	Yes	Yes	It is the main carbon sink showing the increase of the carbon stock in the forest cover of the project area. It covers tree and non-tree biomass. For the Baseline scenario, the AR-TOOL14 tool specifies that according to carbon contents, it can be counted as zero if the conditions described in numeral 5 are met.
Belowground biomass (BGB)	Yes	Yes	The carbon sink is included as it is the second most important pool and is expected to increase thanks to the project. For the Baseline scenario, the AR-TOOL14 tool specifies that according to carbon contents, it can be counted as zero if the conditions described in numeral 5 are met.
Deadwood (DW)	Yes	Yes	This carbon sink is expected to increase, due to the implementation of project activities. In the baseline scenario, the carbon in these pools is equivalent in proportion to aboveground biomass. Therefore, for the project, it is counted as zero.
Leaf litter (LI)	Yes	Yes	This carbon sink is expected to increase, due to the implementation of project activities. In the baseline scenario, the carbon in these pools is equivalent in proportion to the aboveground biomass. Therefore, for the project, it is counted as zero.

Source or reservoir	Included		Justification
	Baseline Scenario	Project Scenario	
Soil Organic Carbon (SOC)	Yes	Yes	It is expected that throughout the life of the project, its content will increase due to the permanent presence of tree cover.

Source: (CO2CERO SAS, 2022)

The reservoir included are measured, directly or indirectly, for application in the project scenario considered as significant that contain the planted area. Therefore, they are likely to generate GHG removals in the project scenario.

Table 31, identifies the emission sources that align with the ones specified in the BCR0001 V 4.0 methodology.

Table 31. Emission sources considered for Proyecto Forestal Alcaraván Orinoquía

Source	Baseline scenario			Project scenario		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Woody biomass combustion	No	No	No	Yes	No	No

Source: (CO2CERO SAS, 2022)

In both the baseline scenario and project scenario, the emissions of methane and nitrous oxide resulting from the burning of woody biomass will not be taken into account unless they are deemed significant. Specifically, they must contribute more than 5% of the total emissions, as stated in the protocol. Emissions by CH_4 and N_2O will not occur since there is no evidence of activities such as the use of fertilizers, burning for soil preparation or nitrogenous bacteria, or large-scale anaerobic decomposition of organic matter in the project area.

3.2.3 Time limits and analysis periods

The project will monitor changes in carbon stocks from above-ground biomass, below-ground biomass, dead wood and leaf litter, and Soil Organic Carbon from commercial forest plantations within project boundaries. Table 32 shows the time limits and the chronological plan related to the Proyecto Forestal Alcaraván Orinoquía.

Table 32. Chronological plan for the Proyecto Forestal Alcaraván Orinoquía

Chronological Plan	
Project Start Date	April 11, 2018
Historical period	April 11, 2013, to April 11, 2018

Chronological Plan	
Credit period	April 11, 2018, to April 10, 2037
Results period	It will depend on the verifications carried out
Duration of the project	20 years
Verification times	Triennial verifications (3 years) are proposed.

Source: (CO2CERO SAS, 2023)

Furthermore, the section that follows presents the Carbon Stocks Increase resulting from the reforestation activities carried out by the project participants. These activities contribute to the removal of GHG emissions.

3.2.3.1 Project start date

The project's start date is April 11, 2018 (refer to folder *9_Project start date*), which marks the commencement of activities impacting GHG removal within the project boundaries. It corresponds to the initiation of planning work for planting, including the procurement of plant material and substrate. This aligns with the establishment and subsequent execution of reforestation activities by Inversiones Guardabosques de Colombia for *Pinus caribaea* in 2018, as stipulated in the BCR Standard and the BCR0001 methodology, five years before the validation process began.

3.2.3.2 Quantification period of GHG emission removals

The project will have a lifetime period of 20 years, in accordance with the BCR Version 3.2 Standard, in which the removals generated by the reforestation activities will be guaranteed, in compliance with the regulatory and legal framework.

3.2.3.3 Monitoring periods

Triennial verifications are proposed, evaluating the removals generated in those years, with a maximum time lapse of five (5) years, according to the project's own conditions.

3.3 Identification and description of the baseline scenario and additionality for AFOLU projects

Below, is the description of the actions undertaken to identify the baseline scenario and demonstrate additionality for the Proyecto Forestal Alcaraván Orinoquía, according to the methodology BCR0001 and the Biocarbon Guidelines Baseline and Additionality. GHG project generate Verified Carbon Credits (VCC) that represent emissions reductions, avoidance, or removals that are additional, version 1.2 provided by BioCarbon Registry.

3.3.1 *Baseline scenario*

In this section, the identification of the baseline scenario is carried out for demonstrating additionality, following the criteria described by BioCarbon Registry. The following criterion is selected: (c) changes in carbon stocks within the project boundaries, identifying the most likely land use at the start of the project.

3.3.2 *Step 0: Preliminary screening based on the starting date of the A/R project activity*

The project's start date is April 11, 2018 (refer to folder *9_Project start date*), which marks the commencement of activities impacting GHG removal within the project boundaries. It corresponds to the initiation of planning work for planting, including the procurement of plant material and substrate. This aligns with the establishment and subsequent execution of reforestation activities by Inversiones Guardabosques de Colombia for *Pinus caribaea* in 2018, as stipulated in the BCR Standard and the BCR0001 methodology, five years before the validation process began.

3.3.3 *Step 1: Identifying land use alternatives.*

3.3.3.1 *Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity*

To demonstrate the additionality of Proyecto Forestal Alcaraván Orinoquía, it is justified that carbon dioxide equivalent (CO_2e) removals would not have occurred in the absence of the implementation of the initiative according to the most likely use without the project, or due to requirements attributable to actions required by law; thus, generating a positive change to climate change mitigation, based on the evaluation of acceptance by barrier analysis.

To identify the most likely land use scenarios that could arise in the baseline scenario, historical or previous uses are considered according to the covers present within the project area. These scenarios should be traceable, realistic, credible, and in line with national circumstances and policies.

According to the multi-temporal analysis of satellite images for each of the properties and official classified information of the Corine Land Cover methodology modified for Colombia and taking the 2018 land cover layers generated by IDEAM as a base input, the pre-project land cover within the project area is identified. The specific land cover categories are listed in Table 33, following the CORINE Land Cover level III classification.

Table 33. Land cover at the beginning of the project

Cover	Area (ha)	Area (%)
2.3.1. Clean pasture	840.52	76.80%
2.4.4. Mosaic of pasture and natural spaces	253.92	23.20%
Total	**1,094.43**	**100.00%**

Source: (CO2CERO SAS, 2023)

According to Table 34, which identifies the land covers in the Baseline scenario, it is clear that the magnitude of carbon dioxide removals produced by Proyecto Forestal Alcaraván Orinoquía, compared to those generated by the covers of the baseline scenario, would not have occurred in the absence of its implementation; supporting such additionality under the premise in which it is demonstrated that no net benefit to the atmosphere would have been generated with respect to its baseline.

Table 34. Removals generated in the scenario without project.

Cover	Carbon stock (tCO_2e)
2.3.1. Clean pasture	5,379
2.4.4. Mosaic of pasture and natural spaces	1,473
Total	**6,852**

Source: (CO2CERO SAS, 2023)

To determine the carbon dioxide removals generated in the area, the Carbon Stock present in covers proposed by (Yepes *et al.*, 2011), for the scenario without a project, a 6,852 tCO_2e potential is established for the lifetime of the initiative. In contrast, for the Ex-Ante removals, a 517,055 tCO_2e potential is recognized, higher by 510,153 tCO_2e, which further reveals the additionality character of the project (see Table 34).

3.3.3.2 *Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations*

On the other hand, to demonstrate the co-responsibility of the covers present in the baseline scenario and applicable regulation, we established legal and regulatory requirements for an A/R project and the different covers present. This information can be found in *11_Environmental legislation\Environmental legal matrix_ AlcaravanOrinoquia.xlsx*. Compliance with legal and environmental requirements will be monitored during each verification, with a maximum interval of five (5) years. This confirms that all covers meet the necessary legal requirements for development in the area.

The most likely land use scenarios were identified according to the territorial dynamics in the Project. As a result of the spatial diagnosis, satellite information verification, and qualified and applied documentation of the project area, we determined the possible land uses in Table 35.

Table 35. Analysis of possible land use scenarios in the territory

Land use	Manifestation	Tendency	Viability
Pastures for livestock	This is the main production activity of the departments of Vichada and Meta. It is manifested in the form of extensive livestock production.	Being the dominant, basic economic activity of the departments, if livestock is present on a large scale within the project area generating changes in natural covers, it would not constitute an environmentally sustainable process, nor a factor of large-scale economic development. This is due to the low capacity of the cattle population and the lack of technological development.	It is not viable as the factors of environmental economic development are extensive, and there is no environmentally sustainable development. Similarly, the difficulties of territorial capacity make technological development impossible.
Mosaic of pastures, crops, and natural spaces	These are developed through a combined activity of livestock and agriculture, based on monoculture plantations and extensive livestock production.	Being an economic activity that combines pastures with crops, if such a thing occurs on a large scale within the project area, due to its unproductivity by extension, it would not constitute an environmentally sustainable process, nor a factor of large-scale economic development. This is due to the capacity and the difficulties of technological development and inputs.	It is not viable as the factors of economic development are extensive and done in monoculture plantations, without environmentally sustainable development. Similarly, difficulties of territorial capacity make technological development impossible, and the low level associated with its low capture capacity.
Unproductive pastures	It is presented as an unproductive cover for municipal	An increase in pasture cover contributes to a low GHG removals stock. Therefore, it would not generate	It would not generate an appreciable net benefit to the atmosphere from the removal of GHG

Land use	Manifestation	Tendency	Viability
	economic development.	perceptible or tangible economic benefits for project participants.	emissions. This is in association with its low GHG capture capacity.
Commercial reforestation that may include PRGHG	The project area has a wide cover eligible for the establishment of commercial forest plantations with the objective of removing GHG emissions. Additionally, the participants understand the goods and services derived from there.	The design of strategies for the improvement, increase and removal of emissions through natural carbon pools would reduce the negative effects on biodiversity and natural resources. Furthermore, it would establish new financial mechanisms in the participants that pay for results linked to the ecosystem service generated by their plantations.	The increase and improvement of carbon pools together with other GHG removal activities would generate a net benefit to the atmosphere by favoring carbon capture rates and increasing comprehensive removals within the planted trees sinks.

Source (CO2CERO SAS, 2023)

After identifying the potential land uses within the project boundaries, we evaluated their consistency with the environmental, social, technological, and economic contexts, in accordance with the identified dynamics. A quantification analysis of the viability of the defined land use in each context was conducted to determine which alternative is adequate and additional within the territory, and to generate the greatest net benefit to the atmosphere in terms of removal of emissions.

Table 36. Land use viability rates

Land use	Political – Legal	Environmental	Social	Technological	Economic	Result
Pastures for livestock	3	1	2	2	3	11
Mosaic of pastures, crops, and natural spaces	3	2	2	3	3	13
Unproductive pastures	2	3	2	2	1	10
Commercial reforestation	3	3	3	3	2	14

Land use	Political – Legal	Environmental	Social	Technological	Economic	Result
that may include PRGHG						

Source: (CO2CERO SAS, 2023)

The impact quantification is given according to the viability of the land use in regards of the political, environmental, social, technological, and economic context. Values were assigned as follows:

1. Is a context that does not show viability for this land use.
2. Is a context that provides the basic elements for land use to manifest.
3. Is a context that provides all the necessary elements for the use of the land to be carried out.

The results of the analysis are shown in Table 36. It highlights the development of a GHG emissions removal project as the most favorable land use option. This initiative demonstrates the reduction of GHG emissions and contributes to a positive impact on the atmosphere. In contrast, the other alternative land uses evaluated in the study exhibit various limitations at different levels.

3.3.4 Step 2: Additionality analysis for Barrier analysis.

Given the criteria for determining the baseline scenario according to the methodological document, the Proyecto Forestal Alcaraván Orinoquía adheres to the barrier analysis criteria.

The demonstration of additionality in the project was conducted by analyzing the most likely land uses identified through spatial analysis. This analysis was specifically aimed at showcasing the barriers and their impact on the project, aligning with the guidelines outlined in the methodological document, determining that there are barriers that prevent or limit the implementation of the project.

3.3.4.1 Sub-step 2a and 2b: Possible project implementation barriers.

Identifying the commercial reforestation scenario which may include a PRGEI, comparing the possible and alternative uses of the soil, allows to determine and evaluate each of the barriers and sub-barriers established in the BCR0001 V 4.0 Methodology. For this, we used as input the transparent, documented conservative-official documentation of the Mayor's Offices, Governors' Offices, IDEAM, DANE, ICA, MADS, and Scientific Articles, among others. Then, we consolidated the documentation in *Add_AlcaravanOrinoquia_V2.xlsx* in

the sheet *Barriers_analysis* (See *2_Additionality*). There we identify that commercial reforestation that may include PRGHG, pastures for livestock and mosaics of pastures, crops and natural spaces are viable alternatives to develop. However, from this analysis we found out that this option is the one that presents the greatest number of barriers. Nonetheless, these may be overcome through participation in the carbon market, leaving the least number of barriers once the project is applied.

In *Add_AlcaravanOrinoquia_V2.xlsx*, in the sheet *Barriers_analysis* (See *2_Additionality*), those barriers that will be overcome through the participation in the PRGEI project, thanks to the economic, technical, technological, and accompanying benefits, are justified for the use of land for commercial reforestation that may include PRGEI.

3.3.5 Step 4: Common practice analysis

As a complement to the steps described above, an analysis is carried out of the degree to which forestry activity has already spread in the geographical area of the project activity, highlighting that other registered A/R project activities will not be included in this analysis.

According to the Rural Agricultural Planning Unit, the Orinoquia has a high and medium suitability of just over 2 million hectares for the establishment of forest plantations for commercial purposes and only modest growth has been reported, giving a base of 160 thousand hectares. has currently (FEDEMADERAS, 2023). Being only 8% of the total surface suitable for forest plantations and indicating that in the region it is not a common practice within its economic activities and, this industry represents less than 1% of the national GDP.

This may be because, historically, the development of commercial plantations in Colombia has been suboptimal given the low productivity and competitiveness of the forestry sector in the country, which has prevented full use of the different types of benefits in economic and environmental terms. that offer this type of projects (Marín y García, 2019). Furthermore, wood production costs in Colombia are relatively high; while establishment, land or administrative costs are at a level comparable to other wood-producing countries. With some exceptions, productivity per area is significantly lower in most plantations, resulting in a cost per m^3 of wood produced that is 60% higher than international competitors (PROFOR, 2017). Taking advantage of the existing production potential, Colombia has the potential to significantly improve its "performance" with respect to productivity, following what is described by PROFOR (2017), which is why forest plantations must involve different alternatives within their economic activities such as They are A/R projects that have the objective of removing greenhouse gases from the

atmosphere and generate economic benefits, making the development of forest plantations viable.

The implementation of the commercial reforestation initiative with a Project GHG, benefiting from the incentives derived from the sale of carbon credits, will reduce the impact of the identified barriers, thus justifying the project's existence.

From the identification of the barriers present in the scenario with project, we identified seven sub-barriers, primarily related to investment and technology. With the implementation of the Project GHG, we will have the possibility of overcoming six of these barriers, particularly those related to investment. Through the commercialization of carbon credits, we can generate private investment interest without necessarily relying on economic assistance, allowing for quicker capital returns. This would facilitate access to credits thanks to the visibility of the international market. It also allows access by the medium-sized forestry companies that are members of the project. They can establish mechanisms of technical accompaniment through authorized and specialized technical personnel, suitable for the establishment and management of the plantation. This has a positive impact in terms of other possible land uses, thanks to the training carried out for local workers (See *12_Forest management establishment plan*).

It is important to note that we have observed a growth in the carbon market. Such observation has been carried out in accordance to the international emission reduction goals for each nation based on the United Nations Framework Convention on Climate Change principles and its Kyoto protocol. The initiatives of developing countries take an important position within the processes of mitigation of the effects of climate change, characteristic of reforestation activities, as well as favoring financing processes (UNFCC, 2020).

In this context, forestry activities for GHG removal gain value as alternatives and mechanisms to remove these gases from the atmosphere, through commercial forest plantations and other tree-based production systems (crops with planted trees). Moreover, these activities contribute to the economic strength, permanence and increase of the technical capacity of the associated community regarding reforestation activities.

3.4 Leakage and non-permanence

As stated in Section 6 of the AR-TOOL15 V 02.0 tool, leakage of GHG emissions occurs when agricultural or livestock activities that were previously conducted within the project area are displaced due to the project implementation.

According to section 15.3 of methodology BCR 0001, leakage attributable to the displacement of agricultural activities is considered insignificant and can be quantified as zero under condition (b): "Animals displaced to existing, ungrazed pastures, and the total number of displaced animals does not exceed the carrying capacity of the pastureland to which they are moved." To verify compliance with these guidelines and establish that leakage is indeed zero in the Proyecto Forestal Alcaraván Orinoquía, a comparative analysis was conducted between the number of farms with cattle according to the National Agricultural Census of the ICA in the years 2016 and 2023. The purpose was to determine the increase in existing pastures that changed their use to grazing. In Table 37, it can be confirmed that there was a total increase of 6,675 farms with cattle compared to 2016.

Table 37. Comparative analysis between the total number of cattle farms.

Departament	Number of cattle farms 2016	Number of cattle farms 2023
Meta	13,740.00	20,200.00
Vichada	1,539.00	1,754.00
Total general	**15,279.00**	**21,954.00**

Source: (ICA, 2023).

To determine that the carrying capacity of the land has not been exceeded, calculations were made with respect to the total municipal area and the number of cattle censuses by the ICA, calculating the carrying capacity for the years 2016 and 2023. It was concluded that the average value for the municipalities of Puerto Gaitán and Puerto Lleras (0.31 cattle/ha) does not exceed the calculated value for the entire Meta department (0.48 cattle/ha). Likewise, in Cumaribo, the value is 0.01 cattle/ha, which is lower than the departmental average for Vichada (0.05 cattle/ha) (See *5_Carbon calculation\Leakages\Municipal Carrying Capacity_V1.xlsx*).

3.5 Mitigation results

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

The eligibility determines the areas suitable for inclusion in Proyecto Forestal Alcaraván Orinoquía. It complies with the premise that “the project area does not correspond to the category of forest, nor to natural vegetation covers other than forest, at the beginning of the project, or five years before the start date.", as stipulated by the methodology. The following is the eligibility analysis carried out.

3.5.1.1 Methodological description

Below is the methodological description implemented for the eligibility analysis.

3.5.1.1.1 Obtaining satellite images

The satellite images used for the multi-temporal analysis come from sources such as the missions LANDSAT 7, Collection 1, Level 1 annual compound Top-of-atmosphere (TOA) reflectance of greener pixels, organized in scenes of the Paths and Rows 7-58, 6-57, and 5-57.

The images were compiled from the Google Earth Engine platform of the United States Geological Survey, using satellite images from 2013 and 2018, the year in which the carbon project began.

The LANDSAT 7, Collection 1, Level 1 annual compound TOA reflectance images of greener pixels from the Google Earth Engine platform offers processed satellite imagery with the following characteristics:

- Atmospheric correction by calibrated Top-of-Atmosphere reflectance (TOA). The Calibration coefficients are extracted from image metadata. This method improves pixel compression by highlighting the values to a more realistic value using angular correction.
- Originated from all scenes in each period of the years 2013 and 2018 starting from the first day of the year and continuing until the last day of the year.
- All the images obtained in each year are included in the composition, with the greener pixel as the compound value and the one with the highest value for obtaining the Normalized Difference Vegetation Index (NDVI). This allows to highlight the natural covers of forest vegetation, facilitating its interpretation in quantity, quality, and development, based on the measurement of the intensity of the radiation that the vegetation emits/reflects (García & Gutierrez , 2015).

3.5.1.1.2 Description of eligible and ineligible land cover

The Proyecto Forestal Alcaraván Orinoquía demonstrates the consistency of eligibility analyses according to the definition of the CORINE Land Cover methodology adapted for Colombia. It is defined that areas ineligible for the carbon project development meet the definition of "Forest," which refers to "lands primarily occupied by trees that may contain shrubs, palms, bamboo, grass, and lianas, with a predominant tree cover having a minimum canopy density of 30%, a minimum canopy height (in situ) of 5 meters at the time of identification, and a minimum area of one (1.0) hectare; excluding tree cover from commercial forest plantations, palm cultivation, and trees planted for agricultural production".

Meanwhile, eligible areas are those that do not meet this category, showing different land covers than forests and/or natural cover different from forests, at least five years before the project's start date and at the project's commencement date. In order to comply with legislative protection for watercourse buffer zones, areas intersecting with a strip less than 30 meters wide, parallel to the lines of maximum tidal influence on each side of watercourse buffer zones, as indicated by Decree 1076 of 2015, are declared ineligible.

3.5.1.1.3 Land cover analysis

The processing of the information from the satellite images occurs in the GIS software, using a model for edge smoothing and elimination of areas smaller than the minimum cartographic size. The method of interpretation for verification used is called PIAO (PhotoInterpretation Assisté par Ordinateur), which has advantages over digital interpretation, incorporating complex criteria such as structure, texture, arrangement, or location. The method is used to make a final review to the classification result, refining and smoothing model (Chuvieco, 2007).

These multispectral images have a spatial resolution of 30 meters. The main bands used were near infrared (NIR), shortwave infrared (SWIR), red and green. With these, an artificial color can be obtained (false-color image) and with combinations of bands, the vegetation may appear in shades of orange to red, useful for vegetation studies and drainage monitoring (Franco, 2017).

The covers were classified according to the terms and characteristics of the Corine Land Cover methodology modified for Colombia, taking as a base input the 2010-2012 and 2018 land cover layers generated by the IDEAM, for the interpretation of the covers from 2013 and 2018 respectively. By utilizing geographical boundaries and categorizing coverages derived from them, along with the analysis of satellite images and their spectral response, appropriate adjustments were implemented. These adjustments are aimed at enhancing the accuracy of the geographical boundaries and the identification of the existing coverages.

The result of the land cover and its eligibility classification was stored in a geographic database in the Magna Colombia Origen Único system following the guidelines of Resolution 471 of 2020 of the Agustín Codazzi Geographic Institute (IGAC).

The results of the cover analysis at the beginning of the project and 5 years before the start reveal clean pasture covers, mosaics of pastures and natural spaces, and, to a lesser extent, gallery and/or riparian forests, which are ineligible covers for the project.

3.5.1.2 *Project Eligibility*

A total of 1,094.43 eligible hectares were identified for the entire project. Table 38 shows the eligible and ineligible areas according to the analysis carried out. It indicates that the project presents 100% of the total area as eligible.

Table 38. Eligible Area - Not Eligible for the Project.

Eligibility	Area (ha)	Area (%)
Eligible	1,094.43	99.42 %
Not Eligible	6.38	0.57 %
Total planting	**1,100.81**	**100%**

Source: (CO2CERO SAS, 2023).

Figure 2 shows the eligibility map, with the eligible areas being differentiated from the ineligible areas of a specific participant. To corroborate the eligibility of the other participants, see the shapefile (go to *14_GIS\02_SHP\Elegibilidad_2022_V2_5.shp*).

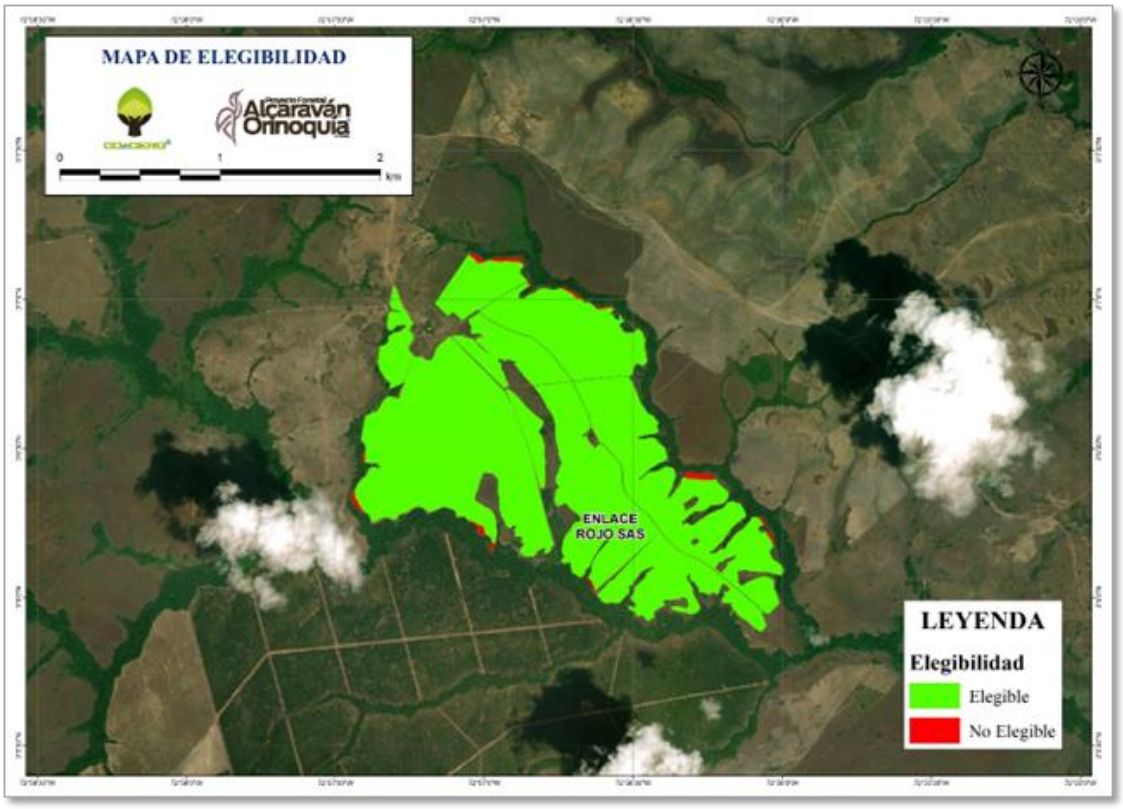


Figure 2. Project Eligibility Map.
Source: (CO2CERO SAS, 2023)

1.1.1 GHG emission removals in the baseline scenario

The calculation of GHG emissions and removals was developed under the guidelines of the BCR0001 V 4.0 Methodology, and the suggested tools.

Section 5 of the AR-TOOL14 *"Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities",* states that the carbon content of tree biomass in the baseline scenario can be considered negligible or zero. Similarly, in section 15.1 of the BCR0001 Version 4.0 methodology, this condition applies under the following circumstances:

1. Trees present before the project are not harvested, cleared, or removed throughout the duration of the project.
2. Trees present before the project implementation do not suffer mortality because of competition from trees planted by the project, nor are damaged because of implementation of the project activity, at any time during the duration of the project.
3. The trees present before the project are not inventoried along with the project trees that are monitored to estimate carbon stocks, but their existence continues, according to the baseline, which is monitored throughout the duration of the project.

Moreover, changes in carbon stocks in the baseline scenario can be considered null if the following conditions are met:

1. Evident decrease in the depth of the surface soil, evidenced, for example, by the exposure of the roots, presence of pedestals and exposure of the horizons of the subsoil.
2. The presence of ravines, laminar or furrow erosion, landslides, or other forms of mass movement.
3. The presence of locally known plant species as indicators of low soil fertility.
4. The soil is composed of bare sand dunes or other bare lands.
5. The terrain is made up of contaminated soil, areas degraded by mining, or highly alkaline or saline soils.
6. The land undergoes periodic cycles (e.g. slash-and-burn or thinning and regeneration cycles), whereby the biomass ranges from a minimum to maximum value at the baseline.

7. Compliance with conditions I, II and II, is necessary to count the stock of tree biomass as zero.

Considering the above, the carbon contents in the biomass present in the baseline scenario are considered null since it meets these conditions, as evidenced in the forest inventory data and satellite observations. The baseline scenario pertains to variations in carbon stocks found in each cover that would be present in the absence of the carbon project. In this particular case, it refers to the carbon stocks of grasslands that existed prior to the project's implementation and in its absence.

1.1.2 GHG emission removals in the project- scenario

According to the BCR0001 Version 4.0 methodology, the emissions attributed to the removal of herbaceous vegetation, the use of fossil fuels, the application of fertilizers, the use of wood, the decomposition of leaf litter and fine roots, the construction of access roads within the project area, and the transportation, which are generated by the project activities, are considered negligible. Therefore, they are quantified as zero. The actual net estimate of carbon sinks removals was as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_t - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$	Actual net GHG removals by sinks, in year t; tCO_2-e
ΔC_t	Change in the carbon stocks in the Project, occurring in the selected carbon pools, in year t; tCO_2-e
$GHG_{E,t}$	Increase in non-CO_2e GHG emissions within the project boundary as a result of the implementation of the project activity, in year t, as estimated in the tool AR-TOOL08; tCO_2-e

To calculate the actual net GHG removal, the steps described in Section 5.5 of the AR-ACM0003 methodology, the BCR0001 V 4.0 methodology and the AR-TOOL14 were taken into account. The first step is to quantify the changes in the carbon stocks of the trees and shrubs that are part of the project.

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{A,t}$$

Where:

$\Delta C_{P,t}$	Change in the carbon stocks in the Project, occurring in the selected carbon pools, in year t; tCO_2-e
$\Delta C_{TREE\_PROJ,t}$	Change in the carbon stock of tree biomass in the Project, in year t; tCO_2-e
$\Delta C_{\text{SHRUB}\_PROJ,t}$	Changes in the carbon stock of shrub biomass in the Project, in the year t; tCO_2-e
$\Delta C_{DW\_PROJ,t}$	Change in the carbon stock in dead wood in the project, tCO_2-e
$\Delta C_{LI\_PROJ,t}$	Change in carbon stock in leaf litter in the project, tCO_2-e
$\Delta SOC_{A,t}$	Changes in the carbon stocks in soil organic carbon in the project and the respective areas that meet the conditions of applicability of the tool, tCO_2-e

According to Section 5.7 of the AR-ACM0003 methodology, the net anthropogenic removal of GHGs by sinks was estimated according to the difference between current carbon removal by sinks, removal of sinks at baseline, and GHG emission from leakage, as follows:

$$\Delta C_{PROJ,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{PROJ,t}$	Net anthropogenic GHG removals by sinks, in year t; tCO_2-e
$\Delta C_{ACTUAL,t}$	Actual net GHG removals by sinks, in year t; tCO_2-e
$\Delta C_{BSL,t}$	Baseline net GHG removals by sinks, in year t; tCO_2-e
LK_t	GHG emissions due to leakage, in year t; tCO_2-e

To calculate the annual removals of Proyecto Forestal Alcaraván Orinoquía, the contribution generated by the calculated forest plantations is determined, including the project areas, under the premise of generating removals with a linear behavior.

1.1.2.1 *Estimation of carbon removals in trees and shrubs*

The estimation of the carbon stocks in the trees of the project is calculated from the establishment of plots in the field. The plots are established according to the parameters set out by the stratification and sample design section of the BCR0001 V 4.0 methodology. Similarly, to comply with the methodological requirements, the average sampling error for the plots is calculated with a 95% confidence level. The plot size is determined based on the tree density in the plantation, with an area of 400 m² and a circular design, except for the participant Punta de Garzas Inversiones Forestales, whose plots have an area of 420 m² (See 5_*Carbon calculation*).

According to the methodology, the estimation of carbon in trees is carried out as follows:

$$C_{TREE_{j,i,t}} = V_{TREE_{,j,i,t}} \times D_j \times BEF_{,j} \times (1 + Rj) \times A \times \frac{44}{12}$$

Where:

$C_{TREE_{,j,i,t}}$	Carbon of trees of species *j*, in stratum *i* in year *t*; *t* of dry matter (d.m.)
$V_{TREE_{,j,i,t}}$	Timber volume of species *j*, in stratum *i* at a point in time in year *t*, estimated using the data resulting from the equation, for the annual volume tables; m^3.
D_j	Density (with bark) of species *j*; *t* d,m; m^{-3}
BEF_j	Biomass expansion factor for conversion of shaft wood to above-ground biomass, for species *j*; dimensionless
Rj	The root-above ground biomass ratio for species *j*; dimensionless
j	1, 2, 3, ... species
A	Area of the strata; ha

1.1.2.2 *Volume estimation*

The equations used for the volume estimates come from reliable sources for commercial plantations in the Colombian Orinoquia, in sites with climatic and topographic conditions similar to those of the project area. These estimations are presented in Table 39. Volume equations used by species. For all species, an allometric equation was used to obtain the value of the conservative volume, taking as references the dasometric variables measured in the field (DHB) and total height (Ht) of each of the monitored individuals.

Table 39. Volume equations used by species

Species	Formula	Units	Source
Acacia mangium	$V = \frac{\pi}{40000} \times h \times \left[b_0{}^2 + b_0 b_1 dhb + \frac{b_1{}^2 dhb^2}{3}\right]$	***V:*** cubic meters (m^3) ***h:*** Height (m) ***DHB:*** centimeters (cm) ***bo:*** 0.71761 ***b1:*** 1.11427	Lema Tapias, Á. (2002). Gonzalez, C. (1983).
Pinus caribaea	$V = \frac{\pi}{40000}\left[hb_0{}^2 + 2b_0 b_1 dhb + b_1{}^2 dhb^2\right] - \frac{h^2}{h}\left[b_0 b_1 da + b_1{}^2 dhb^2\right] + \frac{h^3}{3}\left[b_1{}^2 \times \frac{dhb^2}{h^2}\right]$	***V:*** cubic meters (m^3) ***DHB:*** centimeters (cm) ***h:*** Height (m) ***bo:*** 2.15296 ***b1:*** 1.07238	REFOCOSTA (2021)
Eucalyptus pellita	$V = 0.0000051265 \times dhb^{1.8753} \times h^{0.9888}$	***V:*** cubic meters (m^3) ***DHB:*** centimeters (cm) ***h:*** Height (m)	(Nieto V. , Giraldo, Sarmiento, & Borralho, 2016)

Source: (CO2CERO SAS, 2023).

The volume estimation methods and equations used by REFOCOSTA (2021) were specially adjusted by the company Silvano S.A.S., a company with expertise in forest measurement. These models were developed with data obtained by the destructive method of REFOCOSTA plantations in Villanueva, Casanare, a municipality to the Orinoquia region, where the project is implemented. Therefore, it is consistent with the conservative selection, so it does not incur a discount for uncertainty management.

The *Eucalyptus pellita* species equation developed by Nieto *et al.* (2016) comes from scientific research developed in the municipality of Villanueva, Casanare, in areas with climatic and soil conditions similar to the project area. The research included a design of 18 randomly selected blocks in different strata based on the plantation year. Similarly, Lema Tapias, Á. (2002) developed his equation based on data collected throughout the country. Therefore, it is consistent with the conservative selection, so it does not incur a discount for uncertainty management.

This is consistent with Annex 24 of EB 67 (A/R Methodological Tool *"Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities").* The volume equations are derived from trees in soil and climatic conditions similar to the project conditions, so they can be used to estimate removals by timber volume.

1.1.3 Parameters for estimating removals

The data used for the carbon stock estimates is consistent with the conservatism principle, guaranteeing the application of data by default. Data selection was based on the methods proposed by the IPCC and the BCR0001 Version 4.0 methodology. For each species, priority was given to local studies that were reviewed by experts and conducted in areas with similar climatic conditions and soils as the project area. Scientific articles and technical reports of significance were considered as valuable sources of information. Furthermore, the values indicated in the document "*Guidelines for the selection of equations, parameters and data to calculate GHG removals by forestry activities*" from BioCarbon Registry were considered, as this is a compilation document of relevant, coherent, accurate and transparent data and parameters most used in Colombia. Table 40 lists the values used in the project.

Table 40. Parameters used for carbon estimation

Parameter	Species	Value	Source
Basic density (Dj)	*Acacia mangium*	0.49	(Rodríguez & Ramìrez, 2008)
	Pinus caribaea	0.48	(BioCarbon Registry, 2020) Citing Pino *et al.* (2007)
	Eucalyptus pellita	0.64	(Hamlet, 2006)
Biomass Expansion Factor (BEF)	*Acacia mangium*	1.68	(Rodrìguez & Ramìrez, 2008)
	Pinus caribaea	1.24	(BioCarbon Registry, 2020)
	Eucalyptus pellita	1.19	(BioCarbon Registry, 2020)
Root-to-Above ground Biomass Ratio (Rj)	*Acacia mangium*	$\frac{e^{(-1.085+0.9256*\ln A)}}{A}$ A: above-ground biomass	AR-AM TOOL 14, CDM Meth (V 4.2)
	Pinus caribaea	$\frac{e^{(-1.085+0.9256*\ln A)}}{A}$	AR-AM TOOL 14, CDM Meth (V 4.2)

Parameter	Species	Value	Source
		A: above-ground biomass	
	Eucalyptus pellita	$\frac{e^{(-1.085+0.9256*\ln A)}}{A}$ A: above-ground biomass	AR-AM TOOL 14, CDM Meth (V 4.2)
Carbon Fraction *(CFj)*	*Acacia mangium*	0.55	(BioCarbon Registry, 2020) Quoting (Rodríguez & Ramírez, 2008)
	Other species	0.47	IPCC (2003,2006)
CO_2/C ratio	All species	$\frac{44}{12}$	IPCC (2003,2006)

Source: (CO2CERO SAS, 2023).

The biomass expansion factor and carbon fraction are default values taken from the IPCC Guidelines for National Greenhouse Gas Inventories (2003), while the "Root-to-shoot ratio" is taken from the IPCC Guidelines for National Greenhouse Gas Inventories (2006). These are conservative values and they comply with the recommendations of the BCR0001 V.4.0 Methodology.

1.1.4 Estimation of carbon removals in dead wood and leaf litter

Carbon in dead wood and leaf litter was calculated from what was proposed in the tool "AR-TOOL12 Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities" of the methodology "Afforestation and reforestation of lands except wetlands Version 2.0". The tool proposes a conservative default value that relates the carbon content (in dead wood and litter) as a percentage of the total carbon of tree biomass, using the expression:

$$C_{DW,i,t} = C_{TREE,i,t} \times DF_{DW}$$

Where:

$C_{DW,i,t}$ Carbon stock in dead wood in stratum *i* at a given point of time in year *t*; tCO_2-e

$C_{TREE,i,t}$ Carbon stock in the tree biomass in stratum *i* in a given point of time in year *t*; tCO_2-e

DF_{DW}	Conservative default factor expressing carbon stock in dead wood as a percentage of the carbon stock in tree biomass, percentage.
i	1, 2, 3, … strata of tree biomass
t	1, 2, 3, … years since the project began

Estimates are made following the provisions of the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities Version 03.0".

If no measurements based on sampling were made for the estimation of the carbon stock in dead wood and leaf litter, the method described in the tool shall be used. For all strata, the carbon stock in the litter is estimated as indicated in equation 15 of the tool:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI}$$

Where:

$C_{LI,i,t}$	Carbon stock in litter in stratum i at a given point of time of year t; t CO_2-e
$C_{TREE,i,t}$	Carbon stock in trees biomass in stratum i at a given point of time in year t; t CO_2-e
DF_{LI}	Conservative default factor expressing carbon stock in litter as a percentage of the carbon stock in tree biomass.
i	1, 2, 3, … tree biomass strata
t	1, 2, 3, … years since the start of the project

The value of the conservative default factor expressing carbon stock in litter and dead wood as a percentage of the carbon stock in tree biomass (*DF*), has been selected according to the table provided in the tool (Table 41).

Table 41. Default values used for DW and LI estimation

Parameter	Value	Source
$\boldsymbol{DF_{DW}}$	6%	AR TOOL 12
$\boldsymbol{DF_{LI}}$	1%	AR TOOL 12

Source: (CO2CERO SAS, 2023).

Because the project lots are in similar altitudinal ranges and rainfall, the value of 6% was used for dead wood corresponding to tropical biomes with elevations less than 2,000 masl, and rainfall greater than 1,600 mm/year. For litter, a conservative value of 1% was added. The equivalent removals can be seen in the respective monitoring reports made for the project (*See 13_ Monitoring report*).

1.1.5 Estimation of carbon removals in Soil Organic Carbon

The estimation of Soil Organic Carbon stocks (SOCs) was following the guidelines provided by the Tool for estimating changes in Soil Organic Carbon stocks resulting from the implementation of A/R CDM project activities, version 01.1.0. As the tool suggests, it is assumed that the implementation of the project activities increases the organic carbon content in the soil, from levels in the no-project scenario to a level that equals the steady state of the organic soil content, under natural cover conditions. The increase in the SOC in the project scenario takes place at a constant rate over a period of 20 years from the year of planting. The project meets the conditions of applicability of this tool in the project area.

The areas of land, in which the plantations are developed, do not fall into the wetland category, do not contain organic soils, and are not subject to any of the soil management practices and application of inputs listed in Tables 1 and 2 of the tool.

Considering the land covers described in the eligibility analysis, which correspond to the humid tropical-weather region, none of the combinations in the table (management/inputs) are applicable to the project activity. Residues remain on site and soil disturbances are limited to good conservation practices, primarily focused on site preparation and kept below 10%. No additional site preparations are carried out.

The initial stock of Soil Organic Carbon (SOC), at the beginning of the project, is estimated by the following expression:

$$SOC_{INITIAL,i} = SOC_{REF,i} \times f_{LU,i} \times f_{MG,i} \times f_{IN,i}$$

$SOC_{INITIAL,i}$ SOC stock at the beginning of the A/R CDM project activity in stratum i of the project areas; $tCha^{-1}$

$SOC_{REF,i}$	Reference SOC stock corresponding to the condition of natural covers, by climate region and soil type applicable to stratum *i* of the project areas; tCha^{-1}
$f_{LU,i}$	Relative stock change factor for the use of reference land in stratum *i* of the land areas; dimensionless
$f_{MG,i}$	Relative stock change factor for baseline management regime in stratum *i* of the land areas; dimensionless
$f_{IN,i}$	Relative stock change factor for baseline input regime in stratum *i* of the land areas; dimensionless
i	1, 2, 3, … strata; dimensionless

The variables that determine soil carbon at the start of the project are determined by default. They are presented in Table 42. Then, the rate of change in soil organic carbon before it stabilizes is estimated with the expression[1]:

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years}\ for\ t_{PREP,i} < t < t_{PREP,i} + 20$$

Where:

$dSOC_{t,i}$	The rate of change in soil organic carbon in stratum *i* of the Project areas, in year *t*; t C ha^{-1} yr^{-1}
$SOC_{REF,i}$	It corresponds to the natural condition of soils with similar characteristics; t C ha^{-1}
$SOC_{INITIAL,i}$	SOC stock at the beginning of the Project in stratum *i*; t C ha
$SOC_{LOSS,i}$	Loss of SOC caused by soil disturbances, attributable to project activities in stratum *i*; t C ha
$t_{PREP,i}$	The year in which the first soil disturbance occurs in stratum *i*, of year *t*

[1] Equation taken from the CDM tool – the AR-ACM0003 Methodology

i 1, 2, 3, … strata of the Project area

t 1, 2, 3, … years since the start of A/R project activities

The loss of Soil Organic Carbon is less than 10% of the area of the strata, which is why SOC losses are taken as zero. Based on the above, a carbon change rate of 0.7050 t C ha yr^{-1} was calculated (See Table 42).

Table 42. Parameters used for soil organic carbon

Parameter	Symbol	Factor	Source
Soil Organic Carbon content reference value	SOC_{REF}	47	Table 3. Tool 16
Land use	$f_{LU,i}$	1	Table 6. Tool 16
Management	$f_{MG,i}$	0.7	Table 6. Tool 16
Inputs	$f_{IN,i}$	1	Table 6. Tool 16
SOC at the start of Project activity	$SOC_{INITIAL}$	32.9	Eq 1. Tool 16
SOC lost due to Project activity	SOC_{LOSS}	0	Eq 3. Tool 16
Rate of change in Soil Organic Carbon in strata	$dSOC_{t,i}$	0.705	Eq 6. Tool 16

Source: (CO2CERO SAS, 2023).

Additionally, changes in soil organic carbon in all strata are calculated based on the following expression:

$$\Delta SOC_{AL,t} = \frac{44}{12} \times \sum_{i} A_i \times dSOC_{t,i} \times 1\ year$$

Where:

$\Delta SOC_{AL,t}$ Change in soil organic carbon of areas that meet the conditions of applicability of the AR Tool16 of the AR-ACM0003 Methodology, in year t; tCO_2-e

A_i Total area of the strata; has

$dSOC_{t,i}$ Rate of change of soil organic carbon in stratum i; t C ha^{-1} yr^{-1}

i 1, 2, 3, … strata of the Project area.

Equivalent removals can be seen in the monitoring report (See *13_ Monitoring report)*. According to the parameters presented, the loss of Soil Organic Carbon is less than 10% of the area of the strata, which is why it was taken as zero.

3.5.1 Estimates of GHG emissions other than CO_2

Within the project area, there have been no fires affecting more than 5% of the total planted area. Hence, emissions attributed to fires can be considered to be zero. To manage the relative information, if an event of this type occurs, the PC – P05 – F04 format of new planted areas and disturbances would be used. This format is designed to report events that affect the stability of the plantation and events of a natural and anthropic nature (See *14_GIS\02_SHP\intersect_fire_AP.shp*).

3.5.2 Conservative values selection and Uncertainty Management

The data used for the estimates of the carbon stock follow the conservatism principle in accordance with the IPCC guidelines, giving priority to data with local and regional developments, over national and international ones. The values taken into account are based on scientific publications for each species, our own developments for other PRGEI located in the Colombian Orinoquía, and other applicable bibliographic sources.

As evidenced in Section 4.2, all data and parameters used in the determination of removals come from conservative, relevant, coherent, accurate and transparent parameter sources. They are specific to each of the species, prioritizing local studies reviewed by experts, and areas of climatic conditions and soils similar to those of the project area. Scientific articles and technical reports of importance were consulted for these. Furthermore, the values indicated in the document "*Guidelines for the selection of equations, parameters and data to calculate GHG removals by forestry activities*" from BioCarbon Registry were taken into account. Therefore, discounts that must be applied according to the quality and origin of the data used are not considered.

The data and parameters used in this analysis align with the emission factors, activity data, GHG emissions projection variables, and other parameters used in the construction of the national GHG inventory. However, by not applying discounts for uncertainties for quality and applicability of GHG models, the uncertainty is estimated according to section 6.2 *"Direct estimation of change by re-measurement of sample plots*" of the CDM methodology tool AR-TOOL14 and section 14 of Methodology BCR0001 V 4.0. The method is used for the estimation of carbon stocks in trees as presented in the section *Estimation of the change by measurement*, and for the management of the uncertainty of the Monitoring Report. The report indicates that the estimate of the carbon stocks stored by the project has low uncertainty due to values below 10% with a result 9,89% (See *5_Carbon*

calculation\Ex-Post\Expost_AlcaravanOrinoquia_V4.xlsx\Sheet Uncertainty), calculated based on the following expression:

$$u_{\Delta c} = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^{M} Wi^2 \times \frac{S_{\Delta,i}^2}{ni}}}{|\Delta b_{TREE}|}$$

Where:

$u_{\Delta c}$	Uncertainty in ΔC_{TREE}
t_{VAL}	Two-sided Student's *t*-value for a confidence level of 90 percent and degrees of freedom equal to *n* – *M*, where *n* is total number of sample plots within the tree biomass estimation strata, and *M* is the total number of tree biomass estimation strata
W_i	Ratio of the area of stratum i to the sum of areas of biomass estimation strata; dimensionless
$S_{\Delta,i}^2$	Variance of mean change in tree biomass per hectare in stratum i; (t d.m. ha^{-1})^2
n_i	Number of sample plots, in stratum i, in which tree biomass was re-measured
Δb_{TREE}	Mean change in tree biomass per hectare within the biomass estimation strata; t d.m. ha^{-1}

Mean change in tree biomass per hectare in a stratum and the associated variance are estimated as follows:

$$\Delta b_{TREE.i} = \frac{\sum_{p=1}^{ni} \Delta b_{TREE,p,i}}{ni};$$

$$S_{\Delta,i}^2 = \frac{ni \times \sum_{p=1}^{ni} \Delta b_{TREE,p,i}^2 - (\sum_{p=1}^{ni} \Delta b_{TREE,p,i})^2}{ni \times (ni - 1)}$$

Where:

$S_{\Delta,i}^2$	Variance of mean change in tree biomass per hectare in stratum i; (t d.m. ha^{-1})^2
n_i	Number of sample plots, in stratum i, in which tree biomass was re-measured

$\Delta b_{TREE,i}$ Mean change in tree biomass per hectare in stratum i; t d.m. ha-1

$\Delta b_{TREE,p,i}$ Change in tree biomass per hectare in plot p in stratum i; t d.m. ha-1

3.5.3 *Quantification of removals generated in the Ex-Ante project scenario*

The Ex-ante estimation was conducted by gathering secondary information on the average annual growth in height and diameter of the selected species. The growth increments used were taken from the project's inventory by averaging the growth in heights and diameters of the species. Data specifically taken from the department of Meta and Vichada, which are the more relevant to the project, was reported. To prevent overestimation of removals, conservative parameters were employed in the estimation process (See Table 43).

Table 43. Average Annual growth in DHB and H.

Species	AAI DAP (cm)	AAI H (m)	Source
Acacia mangium	1.69	1.72	Project's inventory
Eucalyptus pellita	1.68	1.71	Project's inventory
Pinus caribaea	1.68	1.69	Project's inventory

Source: (CO2CERO SAS, 2023).

The volume estimation was developed using the equations reported in Table 39. This was done understanding that the forest species were planted specifically to provide raw material to the timber harvesting market. The plantations were subjected to silvicultural management practices such as thinning and harvests, which result in reductions in GHG removals. Below, a summary of the management given to each of the plantations that are part of this project is presented.

Table 44. Thinning and harvesting of forest species

Species	Thinning (%)	Year	Harvest shift (years)
Acacia mangium	50	7	15
	30	12	
Eucalyptus pellita	60	6	14
	20	10	
Pinus caribaea	50	7	21
	30	12	

Source: (CO2CERO SAS, 2023).

The quantification of carbon for the expected removals in twenty years of duration of the project, was generated according to section 4.2 of AR-ACM003 methodology, version 2.0. The results are summarized in Table 45, these estimates were made for the area identified as eligible, and for the carbon sinks that have been contemplated during the establishment of the project.

Table 45. Ex-Ante GHG removals of the project.

Year	Baseline removals (tCO_2e)	Project removals by sinks (tCO_2e)			Leaks (tCO_2e)	Total net removals (tCO_2e)	
		Incremental removals	Accumulated removals	Buffer		Incremental removals	Accumulated removals
2018	-	636	636	127	-	509	509
2019	-	2,490	3,126	498	-	1,992	2,501
2020	-	5,161	8,287	1,032	-	4,129	6,630
2021	-	10,044	18,331	2,009	-	8,035	14,665
2022	-	15,611	33,942	3,122	-	12,489	27,154
2023	-	1,180	35,122	236	-	944	28,098
2024	-	18,975	54,097	3,795	-	15,180	43,278
2025	-	27,312	81,409	5,462	-	21,850	65,128
2026	-	32,513	113,922	6,503	-	26,010	91,138
2027	-	0	113,922	0	-	0	91,138
2028	-	33,577	147,499	6,715	-	26,862	118,000
2029	-	44,744	192,243	8,949	-	35,795	153,795
2030	-	54,257	246,500	10,851	-	43,406	197,201
2031	-	42,308	288,808	8,462	-	33,846	231,047
2032	-	11,926	300,734	2,385	-	9,541	240,588
2033	-	51,905	352,639	10,381	-	41,524	282,112
2034	-	29,748	382,387	5,950	-	23,798	305,910
2035	-	35,089	417,476	7,018	-	28,071	333,981
2036	-	41,431	458,907	8,286	-	33,145	367,126
2037	-	58,098	517,005	11,620	-	46,478	413,604
Total	-	**517,005**		**103,401**	-	**413,604**	

Source: (CO2CERO SAS, 2023).

The net removals of the project in its credit life based on Ex-Ante calculations is 517,005 tCO_2e. However, with the 20% permanence discount, the total estimated potential of the project until 2037 is 413,604 tCO_2e (See *5_Carbon calculation\Ex-Ante\ExAnte_AlcaravanOrinoquia_V3.xlsm*).

3.5.4 *Quantification of removals generated in the Ex-Post project scenario.*

Based on the monitoring information collected from the inventories in the different identified strata of the project, the project area's GHG emission removals are calculated applying the specified parameters. The number of removals for each area and their respective sink is determined.

In section 9.4 of the Monitoring Report (See *13_ Monitoring report\02_Monitoring report\MR_AlcaravanOrinoquia_V8.pdf*), and in the *5_Carbon calculation/Ex-post* folder, we can find the Ex-post calculation of the net removals of Proyecto Forestal Alcaraván Orinoquía, with the amount of reduction of GHG equivalent emissions (tCO_2e). This calculation summarizes the current verified net removals.

To obtain the total number of avoided removals throughout the project implementation period, we need to consider the selected sinks, as explained earlier, along with the reductions caused by the risk of non-permanence (buffer). Further details can be found in the Monitoring Report section (See *13_ Monitoring report\02_Monitoring report\MR_AlcaravanOrinoquia_V8.pdf*).

4 Compliance with applicable legislation

In order to establish, implement and maintain procedures to identify, access and monitor the applicable legal requirements, we have implemented the established legal and regulatory requirements for the execution of an A/R-type Climate Change Mitigation project. This information can be found in the document titled *11_Environmental legislation\Environmental legal matrix_ AlcaravanOrinoquia.xlsx*. Compliance with legal and environmental requirements will be monitored during each verification, with a maximum of 3 years. Presented below are the environmental legal requirements that apply to the project.

4.1 National policies and standards

- National Code of Renewable Natural Resources and Environmental Protection (Decree-Law 2811 of 1974)

It regulates the management of forest soils by their nature and the forests they contain, which for the purposes of the code are called forest areas (Article 202).
Chapter II of Title III of the Code establishes matters relating to forest exploitation. The title is later regulated by D.1791/96.

The project manager, and each of the project participants, are responsible for carrying out an annual review of the Forest/Non-Forest areas, in order to comply with everything related to the forest areas, within the limits of the project.

- National Forestry Development Plan (CONPES Document 3125 of 2001)

It was designed with the purpose of improving the management of forest resources, enahncing the living conditions of the populations that have historically been occupying the country's forest lands, and offering viable productive alternatives that contribute to the economic development of the country and the peace process, as well as to meet international commitments in this regard.

The project constitutes a regional productive activity, generating development in the project areas. The project manager periodically reviews the standard, considering the obligations arising from any change or related regulation.

4.2 Sectoral rules

- Law 1377 of 2010

This law focuses on regulating commercial reforestation activities, specifically defining and establishing regulations for forest plantations and agroforestry systems intended for commercial purposes.

Applicability: This project follows the parameters defined for commercial plantations in Law 1377 of 2010:

1. Registration: Forest plantations have the respective registration in the ICA or are in the process of obtaining them (See *11_Environmental legislation\Records ICA*).
2. Free use and mobilization: Since the plantations have not been used yet, this permit has not been requested at this point.
3. Protection of natural forests and strategic ecosystems: The commercial plantation of the project proponents meets this parameter, which is verified in the project eligibility analysis (See Figure 2).

Potential areas for developing commercial reforestation activities: More than 50% of the plantations have been established in areas with low or no suitability for the development of commercial reforestation activities.

- Decree 2803 of 2010

It regulates Law 1377 of 2010, regarding the registration of forest crops and agroforestry systems for commercial purposes, protective-producing plantations, and the mobilization of forest products.

Applicability: The plantations present in the project area are commercial and include Eucalyptus, Acacia and Pine species, which have been registered according to the procedure described in Decree 2803 of 2010 (See *11_Environmental legislation\Records ICA*).

- Law 299 of 1996

The conservation, protection, propagation, research, knowledge, and sustainable use of the resources of the Colombian flora are strategic for the country and constitute a priority within the environmental policy.

Applicability: The water margins and the natural forest cover in the project area are protected, including the gallery forests and all the vegetation present 30 meters on each side of the water sources, as shown in Figure 3. Those areas intercepted with this margin are ineligible.

- Resolution 1447 of 2018

It regulates the national-level system for monitoring, reporting, and verifying mitigation actions as stated in article 175 of Law 1753 of 2015. It also includes additional provisions.

Applicability: The project is in the process of certification with the BCR0001 V4.0 Methodology of the BioCarbon Registry. However, according to the resolution, the reference scenario is a type of baseline that represents GHG emissions measured in tons of CO_2e that would occur in the absence of policies, plans, strategies, or initiatives for GHG mitigation in the period in which climate change goals or commitments are established. As for the baseline, the decree defines it as the scenario that represents the GHG emissions that would occur in the absence of a mitigation initiative.

Currently, the only approved reference scenario for Colombia is the Amazon biome reference scenario. This scenario does not include reforestation activities and additionally, only covers reduced emissions for the period 2013-2017. The project is a reforestation activity that is not found within the Amazon biome. Therefore, it complies with the provisions of the resolution under the technical parameters defined for this type of initiatives.

- Decree 926 of 2017

This decree modifies the epigraph of Part 5 and adds Title 5 to Part 5 of Book 1 of Decree 1625 of 2016, which serves as the sole regulatory document in tax matters. Additionally, it adds Title 11 to Part 2 of Book 2 of Decree 1076 of 2015, which serves as the sole regulatory document in the environment and sustainable development sector. The purpose of these modifications is to regulate paragraph 3 of article 221 and paragraph 2 of article 222 of Law 1819 of 2016.

Applicability: The project will be certified through the BCR V3.2 Standard and the BCR0001 V 4.0 methodology. It also can be used by passive agents of the national territory for the non-causation of the carbon tax, since it complies with the characteristics of GHG removals to certify the carbon neutral condition:

1. It comes from a GHG mitigation initiative developed in the national territory: The project is carried out in the departments of Meta and Vichada.
2. It comes from GHG mitigation initiatives formulated and implemented through certification programs or carbon standards, which must have a platform for public registration of GHG emission reductions and removals.
3. It was generated from the implementation of a methodology developed by certification programs or carbon standards.
4. It does not come from activities that are developed by mandate of an environmental authority to compensate for the impact produced by the work or activity subject to an environmental authorization: The project proponents do not carry out reforestation as compensation for other activities.
5. It is certified by the certification program or carbon standard.

- Decree Law 2811 of 1974

This decree determines the forest reserve areas (protective and producing) and prohibits the allocation of vacant lands in them, except for reasons of public utility and social interest. It also defines forest uses (persistent, unique, and domestic).

Applicability: The project area is not within the protective and producing forest reserve areas (See Figure 3).

- Law 1333 of 2009

This Law establishes the environmental sanctioning procedure.

Applicability: According to what was indicated by the project proponents and the environmental legal analysis carried out, the area of influence of the project has no environmental sanctioning process in force.

- Single Regulatory Decree 1076 of 2015 (MADS)

By means of which the Single Regulatory Decree of the Environment and Sustainable Development Sector is issued. The Decree defines the following:

> *Forest plantations play a fundamental role as sources of renewable energy and supply of raw materials. They maintain ecological processes, generate employment and contribute to national socio-economic development, which is why their implementation should be encouraged and stimulated.*
>
> *Forest plantation companies: These are those dedicated to the establishment and management of forest plantations.*
>
> *Industrial or commercial Producing Forest Plantations: These are those that establish themselves in producing forest areas with the sole purpose of allocating them to forest use.*

Applicability: The project collects forest plantations for timber and protection purposes, which are developed under current standards and regulations. Similarly, the project proponents do not have water concessions.

- ARTICLE 2.2.1.1.12.2. Of the Single Regulatory Decree 1076 of 2015

As of October 8, 1996, it is mandatory to register all forest plantations, living fences, windbreaks, and shade barriers with the respective corporation overseeing the area. The project activities align with the requirements stated in the regulation.

Applicability: To demonstrate that the project complies with the environmental restriction zones described in Decree 1076 of 2015 of the Ministry of Environment and Sustainable Development, a map was made (See Figure 3) in the following areas are shown:

- Areas registered in the RUNAP (Single National Registry of Protected Areas, 2018).
- Forest reserves designated under Law 2 of 1959, including any exclusions up to 2018.
- Wetland areas of international importance subscribed to RAMSAR.

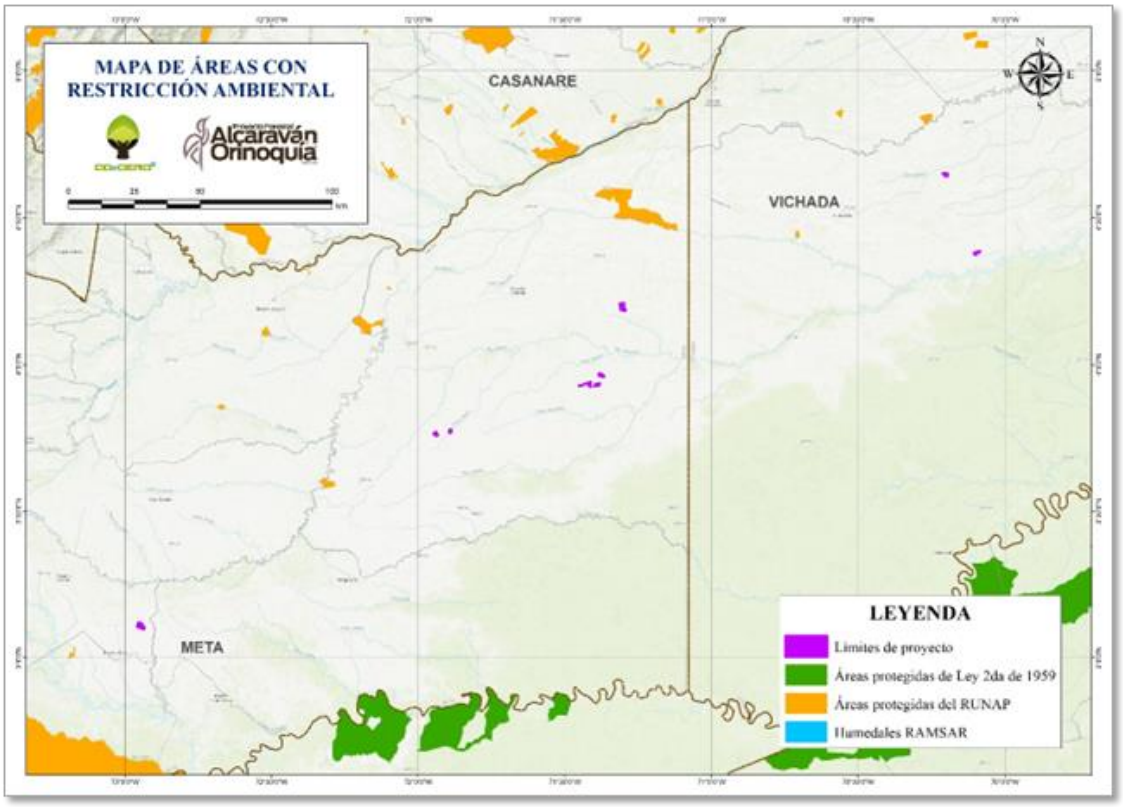


Figure 3. Map of Areas with Environmental Restriction.
Source: (CO2CERO SAS, 2022).

- Resolution 500.41.13-1571

This resolution modifies resolution 200.41.11-1130 of 2011, which establishes the general criteria for the implementation of forestry, agricultural, and agro-industrial projects within the jurisdiction of CORPORINOQUIA.

Applicability: The criteria under which forestry activities are developed for the forestry projects involved are identified in the management plans and eligibility analysis.

5 Carbon ownership and rights

The Proyecto Forestal Alcaraván Orinoquía is owned by CO2CERO SAS, a private company that offers innovative solutions to different actors in the environmental and agricultural sector in Colombia, along with eight (8) reforestation initiatives in the Orinoquía region.

5.1 Project holder

CO2CERO SAS is the entity proposing the project (see Table 46), a private company offering innovative solutions to different actors in the environmental and agricultural sectors in Colombia. Some of the services it offers include the development of carbon projects in the forestry sector and other land uses, the execution of sustainability consultancies associated with workshops planting, green markets, calculation of the carbon footprint, environmental education, and sustainability certifications accompaniment.

Table 46. Project Manager Information

Individual or organization	CO2CERO S.A.S
Contact Person	EDGAR MAURICIO RODRÍGUEZ
Job position	Legal Representative
Email	info@co2cero.co
Address	Carrera 45 A No 104B – 16, Bogotá
City and Country	Bogotá D.C., Colombia
Cellphone Number	601+ 604 72 79

Source: (CO2CERO SAS, 2022)

5.1.1 CO2CERO SAS Organizational Structure, Responsibilities, and Powers

Below is the organizational structure, responsibilities, and powers of CO2CERO SAS.

5.1.1.1 Responsibilities

- Establishes rules and conditions that must be considered in managing and commercializing in the market, the Carbon Credits generated by the climate change mitigation projects.
- Regulates the remuneration and the payment method in favor of CO2CERO for executing the activities established in the agreements between the parties.
- Maintains–in its structure–the technical, organizational, and administrative conditions related to the mitigation project operation, necessary for the Climate Change Mitigation Project to always comply with the certification requirements indicated by the entity(ies) validating, verifying, and certifying the project to periodically obtain the certification of the new Carbon Credits.

Figure 4 shows the organizational structure related to the GHG mitigation project.

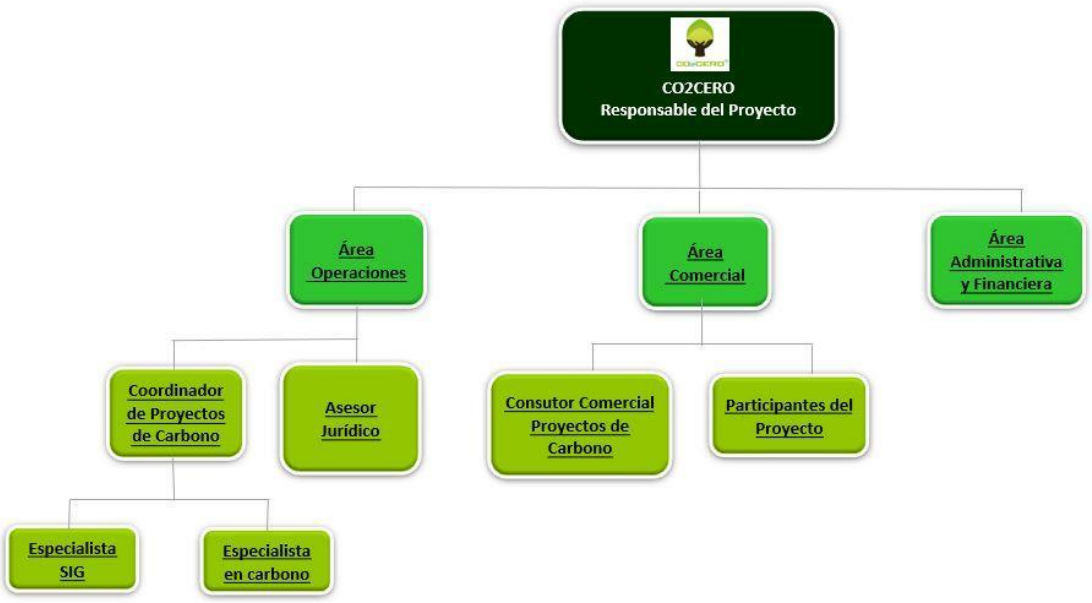


Figure 4. Organizational Structure Carbon Projects Area
Source: (CO2CERO SAS, 2023)

5.1.2 Operations Department

5.1.2.1 Responsibilities

- Coordinates the development of the technical components required for the formulation, validation, verification, and certification of the Climate Change Mitigation Project, considering the requirements established by the standard or referential used for project design.
- Ensures the management system implementation mitigation project information quality.
- Establishes, implements, and keeps procedures documented for managing information on GHG emission reductions, which guarantee the following:
- Errors and omissions identification and treatment –found in the GHG removals quantification.
- Presents the actions taken to correct errors and omissions identified. Likewise, it manages the routine reviews/audits results, ensuring that they do not occur again.
- Ensures that the necessary technical information is available for emission reductions reporting and monitoring.
- Configures and delivers the information on the different forest plantation owners that constitute the Climate Change Mitigation Project, according to the inventory

of carbon credits from each one, per the results of the audit conducted by the Validation and Verification Body (VVB) and the sales made.

- Makes available to project participants a report containing information regarding:
    i. The negotiations status, the carbon credits sales, and the amount received as payment in the previous month.
    ii. The new carbon credits certifications issued by the certifying entity.
    iii. The audits results and conclusions conducted by the VVB.
    iv. The way in which the percentage of the new certified credits assigned to CO2CERO were used to pay for the exchange, promotion, and publicity for positioning the project and making the sale of the credits viable.

5.1.2.2 Skills

Professional with a background in engineering, a master's degree in the environmental field. Experience and knowledge in commercial issues, project development, and personnel management. It must have the ability to plan, organize and control the activities of CO2CERO operations to support and generate greater profitability. Minimum 5 years of work experience in the sustainability sector.

5.1.2.3 Carbon Project Coordination

5.1.2.4 Responsibilities

- Guides technical issues related to certification to maintain the Climate Change Mitigation characteristics and its benefits.
- Based on the information provided by the participants, a Project Document containing at least the following components:
    i. Mitigation project name
    ii. Project objectives
    iii. Responsible for the mitigation project
    iv. Personnel organizational structure, responsibilities, and competencies conducting the project activities.
    v. Mitigation projects start date (mm/dd/yyyy).
    vi. Mitigation project period (in years).
    vii. Ownership detailed description or the right to use the land.
    viii. Agreements related to carbon rights.
    ix. Environmental characteristics of the area in which forestry activities take place.
    x. Additionality analysis full description

xi. Description of the activities in the forestry sector constituting the forestry mitigation project.
xii. Description of the species(s) used in forestry activities and justification for their use.
xiii. Species management cycle(s) and forestry activity periods.
xiv. Planting plan (species name, area, density, planting date, and geographic coordinates of the planting site) for activities including species planting.

5.1.2.5 Skills

Forestry Engineer or Biologist. Knowledge related to the development of forestry projects and forest carbon standards. A 5-year minimum experience in the formulation of climate change mitigation projects and carbon markets.

5.1.2.6 Carbon Projects Specialist

5.1.2.7 Responsibilities

- Processes technical forestry information to obtain GHG removals within the delimited project areas.
- Consolidates the spatial and documentary information necessary for the validation, verification, and certification process of GHG removals, guaranteeing its quality and veracity. Evidences the following information within this consolidated:
  A. Area with forestry activities (in hectares).
  B. Location of the initiative and the forest plots involved in it.
  C. Land cover at the beginning of forestry activities according to the Corine Land Cover methodology adapted for Colombia.
  D. Information on land tenure and use rights.
  E. Forest species (including scientific and vernacular name).
  F. Evaluates the quality of all the deliverables prepared for the validation and verification process advanced by the VVB.
  G. Structures the project design document and its related information.
  H. Characterizes the state of land tenure for all the participants and their respective properties.

5.1.2.8 Skills

Professional forestry, environmental or related careers. Knowledge in Information and Quality Systems management, data processing software and advanced level text. Proficient in issues related to sustainability and the environment, spatial reasoning. Affinity for formulating and designing projects, including structuring schedules and costs

related to the initiatives. Ability to transfer verbal and written information linked to the regulatory and technical environment of the project.

5.1.2.9 GIS Specialist

5.1.2.10 Responsibilities

- Describes in detail the project location, including maps and cartographic files.
- Determines the project geographical limits, including them in a Geographic Information System (GIS) and each of the lots included in the forestry activities, georeferenced in such a way that the activities monitoring can be conducted for all the lots or management areas included in the mitigation project.
- Conducts the project areas eligibility analysis using satellite images multitemporal analysis, through which changes in land use coverage are determined (based on the Corine Land Cover categories adapted for Colombia).
- Based on the eligibility analysis, confirms, and demonstrates that the areas in which the forestry activities take place comply with the following:

  i. They are covered by forests, at least ten (10) years before and at the start date of the project, for actions related to reducing GHG emissions due to REDD+ activities.
  ii. They are not covered by forests or natural vegetation covers, other than forest– for at least ten (10) years before, and at the start date of the project–for forest plantations, agroforestry systems, silvopastoral systems and other landscape management tools.
  iii. For the activities described in paragraph (b), identifies the land cover for each plantation lot in all the dates in which the activities in the forestry sector are established.
  iv. Designs and controls the management of the Project's technical information, organized, and stored in an Information System, made up of two components: Spatial Information Management consisting of a GIS Geographic Information System and storage.

- Technical forestry information processing, organized in a documentary information system, through which technical forestry information is stored. This filing system includes documents in Microsoft® formats (Excel and Word), duly structured, in such a way that the quality and veracity of the information is guaranteed. This filling system shall contain the following:

i. Area with forestry activities (in hectares).
ii. Geographic coordinates (should use the official coordinate system for Colombia: Magna Sirgas, preferably flat coordinates) of each forest lot or management unit.
iii. Land cover at the beginning of forestry activities (Corine Land Cover Standard adopted for Colombia).
iv. Information on land tenure and use rights.
v. Forest species (including scientific and vernacular name.)

5.1.2.11 Skills

Forestry engineer, environmental engineer, and related fields. A minimum of 3 years' experience in geographic information systems management, either through specific work experience or postgraduate studies. Advanced management level in Geographic Information Systems, ArcGIS or QGIS software, either through work/academic experience or through courses. Proficient in satellite image interpretation, GPS handling, experience in CORINE Land Cover methodology adapted for Colombia.

5.1.2.12 Legal Adviser

5.1.2.13 Responsibilities

- Establishes formal agreements with project participants.
- Signs contracts and other documents with the members of the climate change mitigation project, stipulating the provisions related to its operation, administration, and management.
- Describes in detail the ownership or right to use the land, demonstrating that the project participants have the rights to the area in which the forestry activities are conducted, during a term equal to the project timeframe. Establishes, implements, and maintains procedures for:

  i. Identification and access to environmental legal requirements,
  ii. Requirements implementation to forestry activities in the mitigation project and their compliance.
  iii. Executes procedures for the compliance with environmental legal requirements periodic evaluation.
  iv. Generates a report on compliance with the initiative environmental legal requirements.

5.1.2.14 Skills

Professional in law, politics and legislation, public relations, or related fields. Legal knowledge in commercial and fiscal legislation, property rights, and land ownership. Experience in land title, tenure, and ownership studies related to environmental projects, including the findings and conflicts resolution with external entities, auditing, and project control.

5.1.3 Carbon Projects Marketing Department

5.1.3.1 Responsibilities

- Designs and implements the strategy for the marketing and sale of Carbon Credits in local and international markets.
- Directs the personnel integrating the sales force. It is responsible for advancing commercial contacts to market and sell the Carbon Credits, generated/verified, and certified for the Climate Change Mitigation Project.
- Conducts marketing and advertising efforts, such as preparing brochures, slides, reports, interviews, publication in the media, forums, and events. In addition, visits potential clients and performs management using electronic means, all of which must be kept in documentary support through a monthly report that will be available to project participants.
- Manages the subscription of the contractual documents to legalize the sale of the Carbon Credits, including paying and managing the portfolio recovery to deliver the corresponding resources to each Project participant.
- Generates and keeps updating the carbon credits inventory, according to the amounts and percentages that the VVB verifies, and the certifier confirms to the forest plantations participating in the Climate Change Mitigation Project.

5.1.3.2 Skills

Professional with training in administration, engineering careers, or similar fields. Commercial matters knowledge and experience. Training in sales and commercial management. Basic technical knowledge in forest operations, wood products, forest compensation (legal framework), and sustainability. Plans, organizes, directs, controls, and efficiently coordinates the company's marketing department. In addition, it designs strategies to achieve the projected sales through the development of sales activities and customer segmentation. Excel management, general Office usage, and CRM software. Minimum 1 year experience in similar positions.

5.1.4 *Financial Department*

5.1.4.1 *Responsibilities*

- Designs and manages the accounting system for certified and marketed Carbon Credits.
- Records the actions on each operation and honors the legally applicable tax charges.
- Collects and distributes the income from the sale of Carbon Credits among the different forest plantation owners comprising the Climate Change Mitigation Project, according to the participation percentage assigned to each member, the results of the audit conducted by the VVB, and the review of the Project's certifying entity.
- Verifies the cash flow conditions of all the sales business, subtracting the resources corresponding to CO2CERO due to the execution of the administration and commercialization activities.

5.1.4.2 *Skills*

Professional in business administration, economics, finance, or related fields. Background in accounting, financial mathematics, and commercial and tax legislation. Minimum 3 years' experience in administrative activities. Background in creating, interpreting, and socialization results indicators focused on finance and economic performance.

5.2 Other project participants

Proyecto Forestal Alcaraván Orinoquía has eight (8) reforestation initiatives in the Orinoquía region. Below is the general information of all the participants:

Table 47. Proyecto Forestal Alcaraván Orinoquía Participants

Organization Name/Participant	Legal Representative Name	Email	Address	City and Country	Cellphone Number
ECOLOGIC SAS	Mauricio Rodríguez Castro	info@co2cero.co	Carrera 45ª No 104B – 16	Bogotá D.C., Colombia	6016047279
SULTANA SAS	Pablo Macias	pablo.macias@eco-logic.com.co	Cra 45ª No. 104B - 16	Bogotá D.C., Colombia	3505475219
ENLACE ROJO SAS	Néstor Elberto Hurtado	nelhuca1964@hotmail.com	Cll 160 No. 58 75 TO 9 AP 102	Bogotá D.C., Colombia	3112362605

Organization Name/Participant	Legal Representative Name	Email	Address	City and Country	Cellphone Number
ECOSISTEMA PRODUCTIVO MATAEMONTE SAS	Jerónimo Torres Santiago	mataemonte@unicorn.com.co	Cll 12 B No. 27 32	Bogotá D.C., Colombia	3164704581
LUIS FERNANDO RODRIGUEZ	Luis Fernando Rodríguez	portalelectronico@pressaplique.com	Cll 64 No. 113ª -32	Bogotá D.C., Colombia	3124541813
INVERSIONES GUARDABOSQUES DE COLOMBIA SAS	William Alonso López Rivera	ingcolsas@hotmail.com	Cll 32 No. 34-15	Bogotá D.C., Colombia	3107791130
CLAUDIA HUERFANO	Claudia Huérfano	huerfanoclaudia@gmail.com	Av 23 No. 15-23	Acacias, Colombia	3202342074
PUNTA DE GARZA INVERSIONES FORESTALES	María Sandy Bravo	Normac17@hotmail.com	Cra. 47 No. 106-08	Bogotá D.C., Colombia	3118648015

Source: (CO2CERO SAS, 2022)

Project participants are individuals or legally constituted entities that demonstrate land use rights in the properties involved in the project. Below are their responsibilities:

- Provide CO2CERO with forest establishment and management plans, financial analyses, and all other aspects related to their plantations necessary for the formulation and monitoring of the Climate Change Mitigation Project.
- Provide CO2CERO with a record of annual forest activities, indicating the planted species, the coordinates of the plot where the planting was done, as well as the area and establishment dates.
- Report information related to disturbances that occurred during that period, with disturbances being understood as any event that has affected the plantation, including fires, pests, acts of violence, illegality, or criminal acts. It must be reported which areas were affected and the actions taken to prevent their recurrence. In applicable cases, copies of complaints filed with the relevant authorities must be provided.
- Contribute the necessary aspects for conducting CAB audits on their properties related to the reviews, audits, or recertifications required for the operation of the forest plantation certification and the Climate Change Mitigation Project.
- Comply with and adopt the instructions given in the audit findings issued by CO2CERO and CAB within the deadlines set by the auditors in accordance with CAB regulations or the Project Document prepared by CO2CERO, as applicable.
- Submit a written report within a maximum of seven (7) calendar days following the occurrence of any encumbrance, lien, filing of a lawsuit, or any other precautionary measure imposed in a judicial or administrative process on the

property, plantation, machinery, or improvements that are part of the project and that is known to them.

- Provide all information and documentation that CO2CERO may require related to the project and Climate Change Mitigation Project or of a legal nature that may become necessary for marketing management.

5.3 Agreements related to carbon rights

Project participants are governed by a contract for the linking, administration, and marketing of carbon credits. The contractual purpose is to establish the rules and conditions that shall be considered for CO2CERO to link Proyecto Forestal Alcaraván Orinoquía, manage it, and commercialize the carbon credits that the plantation sells in the market. Likewise, the remuneration and payment method payable to CO2CERO SAS –for executing the activities established in the contract, will be regulated.

Proyecto Forestal Alcaraván Orinoquía allows linking autonomous and independent forestry projects if they meet the Greenhouse Gas Emission Compensation scheme (GHG) requirements of the forestry sector –designed and certified. After linking new forestry projects to the GHG Removal Project, the VVB will conduct the necessary validations to issue the verification statement –regarding the carbon amount sequestered by forest plantations, which may subsequently be sold on the market as goods called "*CARBON CREDITS*", so that third parties can offset the greenhouse gas emissions they generate.

Activities in Proyecto Forestal Alcaraván Orinoquía, and, therefore, the removals that will be counted as carbon credits, shall be part of continuous actions, guaranteeing their presence in the short, medium, and long term. The person in charge of the project and the participants of the Greenhouse Removal Project (PRGEI, for its acronym in Spanish) shall guarantee the forestry activity continuity for the project timeframe, per the conditions of the BCR Version 3.2 Standard, and the BCR0001 V 4.0 Methodology. On the other hand, after linking new plantations to the PRGEI, the VVB will validate and verify the carbon reserves, which can later be sold on the market. Contracts signed between the parties are in folder *1_Agreements*, in which the business and commercial relationship between the person in charge of the project and the other participants is recorded.

5.4 Land tenure

Land tenure rights are verified under the administrative management process, based on the "*Legal requirements and land tenure*" procedure, part of CO2CERO SAS management system. This procedure ensures that all land within the project boundaries has land use rights for no less than the project timeframe.

The *15_Land tenure* folder subfolders contain the project participants, where the supports of their land tenure for all are recorded. The ownership, real estate registrations, and granting of the properties designation used for Proyecto Forestal Alcaraván Orinoquía, according to all the participants, are shown in Table 48.

Table 48. Land Ownership in Participants' Properties

Participant	Property	Property Certificate/Deed	Property Designation
ECOLOGIC SAS	Galapagos	234-6076	Owner
SULTANA SAS	La Sultana	234-8705	Owner
ENLACE ROJO SAS	Barlovento	236-29048	Owner
ECOSISTEMA PRODUCTIVO MATAEMONTE SAS	La Porfia La Botereña	234-9602	Shared Ownership
LUIS FERNANDO RODRIGUEZ	Naranjales	234-28921	Owner
INVERSIONES GUARDABOSQUES DE COLOMBIA SAS	La Cabaña	540-1819	Owner
CLAUDIA HUERFANO	Villa Claudia	234-12891	Owner
PUNTA DE GARZA INVERSIONES FORESTALES	Punta de Garzas	540-1324	Owner

Source: (CO2CERO SAS, 2022).

6 Climate change adaptation

The United Nations Framework Convention on Climate Change (UNFCCC, 2002) defines climate change in Article 1 as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." Based on this definition, compliance actions are proposed in the development and implementation of the Proyecto Forestal Alcaraván Orinoquía, following the guidelines set out in the national and international framework for climate change adaptation.

Continuing with the above approach, it is important to mention that the Proyecto Forestal Alcaraván Orinoquía aligns with the National Climate Change Policy (2017), promoting the increase of carbon reserves and contributing to mitigation actions. In this way, it supports its objective of advancing towards a climate-resilient and low-carbon development path (Murillo, 2016). Furthermore, the project is integrated with the strategic lines mentioned below:

- Low Carbon and Climate-Resilient Rural Development: Promoting the planting of tree species adapted to the soils of the Orinoco, as shown in Table 1 y Table 2, creates climate-resilient forest production systems consistent with the region's ecological conditions and facilitates the preservation of natural ecosystems for the movement of associated species and adaptation to climate change. It generates species resilient to high temperatures, droughts, or floods, which are monitored in accordance with the mitigation measures outlined in the project's risk management (See *13_ Monitoring report\02_Monitoring report\MR_AlcaravanOrinoquia_V8.pdf/Risk Management*).
- Ecosystem Management and Conservation and Their Ecosystem Services: Contributing to the reduction of ecosystem degradation and fragmentation while enhancing the capacity to provide ecosystem services, such as providing habitat for species categorized as threatened according to the IUCN characteristics of the region See *1.1 Characteristics and Conditions Prior to Starting the Project*/sections on flora and fauna described by municipality) and carbon capture through greenhouse gas removal (See *13_ Monitoring report\02_Monitoring report\MR_AlcaravanOrinoquia_V8.pdf\ Quantification of removals generated in the Ex-Post project scenario*.).

Furthermore, in 2020, Colombia submitted its updated Nationally Determined Contribution (NDC) to the United Nations, outlining its commitments to mitigate and adapt to climate change by 2030 (WWF, 2021). These commitments include a 51% reduction in greenhouse gas emissions and a cap on gross deforestation not exceeding 50,000 hectares annually.

The Proyecto Forestal Alcaraván Orinoquía positively contributes to the aforementioned goals, as it reduces pressure on natural forests and serves as a carbon sink. The project aims to remove approximately 517,005 tCO2e over its 20-year lifespan, with an annual removal of 25,850 tCO2e. This is a reliable indicator of its contribution to climate change (Refer to *3.5.3 Quantification of removals generated in the Ex-Ante project scenario*).

It's worth noting that the project follows key principles for climate change management and adaptation, including relevance, comprehensive coverage, coherence, accuracy, transparency, and a conservative approach, as outlined in ISO 14064-2 and described in the standard's version 3.2. Furthermore, the departments associated with the project (Vichada and Meta) are part of the Regional Climate Change Node of the Orinoquia, established by Decree 298 of 2016. These nodes were created to promote, support, and facilitate the implementation of policies, strategies, plans, programs, projects, and measures related to climate change at the regional level. The project, through its

greenhouse gas mitigation actions, contributes to the action plan generated by the node and supports the fulfillment of climate change adaptation within the municipalities.

On the other hand, according to Corporinoquia (2001), anthropogenic processes, primarily the colonization and expansion of the national agricultural frontier in the municipalities of Puerto Gaitán and Puerto Lleras, are leading to the destruction of habitats native to the region, contributing to biodiversity loss and the loss of ecosystem services. Climate change adaptation seeks to improve the conservation conditions of these two factors (Uribe, 2015). This is why the project's activities serve as a means to counter these adverse factors that harm the territory and contribute to the conservation of species located within the project's boundaries. This, in turn, improves connectivity between ecosystems and natural coverages (Gurrutxaga & Lozano, 2007), and contributes to the mitigation of global climate change through greenhouse gas capture. Additionally, the project constitutes essential pillars for sustainable forest management and the monitoring of vegetation cover, providing marketable raw materials within the local market and directly affecting the mitigation of adverse effects or natural phenomena associated with soil degradation and desertification (Prado, 2019).

In conclusion, the project will achieve the restoration, rehabilitation, conservation, increase, and improvement of carbon reservoirs through commercial reforestation activities. This benefits carbon capture, the creation of microclimates, the establishment of biological corridors, and habitat provision. Forest plantations will also act as protection for riparian forests and their associated watercourses and for the overall landscape (Pirard, Del Secco, & Warman, 2016).

7 Risk management

Risk management is derived into three dimensions, corresponding to environmental, social, and financial aspects in accordance with what is described in the Permanence and Risk Management BCR Tool, BCR Project holder take actions to ensure the Project benefits are maintained over time. Version 1.0. March 7, 2023. These risks are considered and evaluated in order to identify potential threats that may arise during the project's execution. Below is a brief description of the analyzed dimensions:

- Environmental Risk: According to (ISO, 2018), these are hazards and threats that have the potential to negatively affect the environment, ecosystems, and/or natural resources. These risks include events such as natural disasters, water pollution, loss of biodiversity, among others.

- Social Risk: Refers to conditions or trends that have the potential to adversely affect the quality of life, social cohesion, or stability of a society (World Economic Forum, 2020).
- Financial Risk: The possibility of suffering economic losses due to adverse fluctuations in prices, changes in exchange rates, or the occurrence of adverse events in financial markets (Basel Committee on Banking Supervisión, 2018).

In order to assess the impact of the risks, they were categorized based on the level of control by competent authorities and the eight project participants, as can be seen in Table 49. The level of control will be defined according to the area in which the impact may occur.

Control Area: Corresponds to the physical space where the plantations are established to carry out the Proyecto Forestal Alcaraván Orinoquía.

Influence Area: Refers to the area in which significant environmental impacts that may be caused by the execution of the Project will manifest themselves, affecting the biotic, abiotic, and socioeconomic factors (ANLA, 2018).

Table 49. Level of Risk Control for the Proyecto Forestal Alcaraván Orinoquía

Level of control		
Rating	**Description**	
A	It is within its control area	Being within the control area allows the creation of mitigation, prevention, or correction mechanisms.
B	It is within its influence area	There is no direct control over the risk, but influence can be exerted on those who do.
C	It is outside its influence area	There is no direct or indirect control or influence over the causes of the risks.

Source: (CO2CERO SAS, 2023).

Based on the level of control over each risk, in addition to the environmental and socioeconomic assessment conducted (Refer to *13_Monitoring report\04_NNH\01_Environmental aspect and 02_Socioeconomic aspect*), the risk level is determined, resulting in the classifications shown in Table 50.

Table 50. Risk level of Proyecto Forestal Alcaraván Orinoquía

Rating	Level	Description
3	High Risk	The associated reversion risk can impact more than 10% of the carbon benefits accumulated by the project up to the verification point.
2	Medium risk	The associated reversion risk impacts between 10 and 5% of the issued VCC.
1	Low risk	Less than 5% of the VCC are released.

Source: (CO2CERO SAS, 2023).

In accordance with the above and based on the identified risks, which are described in *13_Monitoring report\05_Risk management\Risk_Management_Alcaravan_V1.xlsx*, it is necessary to implement the relevant measures for each risk arising from each of the three dimensions. Additionally, it is essential to establish a forest management system for monitoring, evaluation, and ongoing management in response to any present, potential, or unforeseen threats. Therefore, this system will include the relevant mechanisms for structuring the Environmental, Social, and Financial Risk Management System.

You can refer to (*13_Monitoring report\05_Risk management\Risk_Management_Alcaravan_V1.xlsx*) for the risk assessment, considering the type of control and its representative level, along with the established mitigation measures and their corresponding indicators.

7.1 Reversal Risk

CO2CERO SAS, as the holder of the Proyecto Forestal Alcaraván Orinoquía, has taken a series of actions to ensure the project's continuity and proper execution within the specified 30-year timeframe. To achieve this, contracts were established with the legal representatives involved in the project, outlining the respective responsibilities of the parties involved in the project. This was done to ensure transparency and effective management in the project's implementation (refer to *1_Agreements*).

Additionally, in accordance with the BCR V 4.0 methodology and the BioCarbon Registry's Permanence and Risk Management tool Version 1.0, the project will maintain a reserve of 20% of the total greenhouse gas emissions removals quantified for each verified period. This reserve is designed to secure a portion of the credits in the event of any unforeseen circumstances.

For the environmental component, there are communication and early warning mechanisms in place to promptly detect potential threats that may have negative impacts on the environment. These measures are coordinated with relevant authorities. The objective is to establish the principles for the development of a forest management system based on continuous monitoring and early and effective intervention to mitigate, correct, or prevent, as applicable, the direct cause of each barrier, risk, or threat.

Regarding the social and financial component, the measures will be aimed at preventing risks through constant, transparent, and effective communication between the holder of the forest project and its clients. Technical tools that are highly useful and relevant will be used during various processes.

8 Environmental Aspects

In order to analyze the foreseeable effects on biodiversity and ecosystems within the project boundaries, an environmental assessment was conducted based on effect categorization using the methodology developed by Conesa (2010). This methodology assigns an importance value to each effect using value scales for the criteria established by it, allowing them to be classified into different ranges based on their nature. The parameters of this methodology were adapted to fit the specific characteristics of the project.

For the Proyecto Forestal Alcaraván Orinoquía, seven (7) criteria were analyzed for negative effects and five (5) for positive effects. For the latter, there is no rating for recoverability and reversibility criteria, as indicated by Conesa's methodology (2010). The criteria evaluated for all effects included their nature, intensity, extent, persistence, and timing. The explanation of these criteria, as well as the ratings assigned to each effect, can be found in the folder (*13_ Monitoring report\04_NNH\01_Environmental aspect*).

Table 51. Rating and environmental importance level of the effects determined in the environmental assessment.

Effect	Rating	Environmental level of importance
Increase in forest mass	33	Positive: High
Provision of habitats for wildlife	27	Positive: High
Reduction in pressure on natural ecosystems	25	Positive: Medium
Soil erosion reduction	33	Positive: High
Flood reduction	27	Positive: High
Biological corridor	33	Positive: High

Effect	Rating	Environmental level of importance
Generation of noise and atmospheric pollution due to the use of vehicles and machinery	-19	Negative: Irrelevant
Increased risk of forest fire spread	-39	Negative: Critic
Use of agrochemicals	-29	Negative: Moderated
Outbreaks of pests and diseases	-23	Negative: Moderated

Source: (CO2CERO SAS, 2022).

Finally, for the Proyecto Forestal Alcaraván Orinoquía, six (6) positive effects and three (3) negative effects were determined, with five (5) positive effects classified as having a high level of environmental importance and one (1) with a medium level of environmental importance. Similarly, for the negative effects, one (1) was deemed irrelevant, two (2) were moderate, and one (1) was critical in terms of their level of importance (Table 51).

9 Socio-economic aspects

This section describes the significant socio-economic characteristics of the Proyecto Forestal Alcaraván Orinoquía for both direct and indirect beneficiaries and the area of influence. Initially, general aspects are broken down at the regional, departmental, municipal, and rural levels to understand the territorial dynamics where the project is located and how its activities can promote or generate local development on both a smaller and larger scale. This consideration takes into account the project's importance in mitigating climate change through the implementation of sustainable business models and its various co-benefits.

Emphasis is placed on understanding the concept of territory, as defined by scholars such as Díaz Argueta and Ascoli Andreu (2006), Cárdenas (2002), and Ferraro and Costamagna (2000), as referenced in (Morachel Bustos & Carvajan Suaréz , 2019) Territory is seen as geographically delimited spaces that share social, environmental, cultural, and economic characteristics where social and productive relationships take place. Within these spaces, much of human activity unfolds, and individuals develop a sense of belonging, leading to processes inherent to local progress. Territories generate static and dynamic advantages for businesses and are a determinant factor in the competitiveness of a local production system.

Additionally, as highlighted by Alburquerque (2004a), also referenced in (Morachel Bustos & Carvajan Suaréz , 2019), territory provides natural resources essential for local economic development, as there are endogenous resources in proximity to small and medium-sized

enterprises (SMEs). Productive innovation fosters stronger networks between these SMEs, their customers, and suppliers. It also encourages the establishment of new companies that support and reduce operating costs, leading to economies of scale within the territory. As a result, these entities can better address changing market dynamics while ensuring environmental, economic, social, and cultural sustainability, applying network and interterritorial articulation logics.

9.1 Orinoquía region

According to (Mundial, 2021), the Orinoquía region is home to 1.3 million people, including 12 ethnic groups, which highlight the diversity of thought and worldviews in this region, not limited to the commonly recognized image of the "llanero," a term used to refer to its inhabitants. (Colombia S. i., S.F) Despite its vast expanse, the region has a relatively low population density compared to other regions of Colombia. The population is concentrated mainly in the capital cities or in municipalities with cattle ranches and oil wells or springs. However, there is also a significant percentage of people living in the plains, including several indigenous communities.

According to (Mundial, 2021), the region is suitable for extensive cattle ranching and agriculture due to its landscape characterized by steppes, extensive savannas, gallery forests, and wetlands, which represent 34% of the country's total wetlands, showcasing its immense water wealth that translates into a great diversity of ecosystems, species, and biodiversity. All this natural and cultural capital supports the region's economic development, allowing it to lead national rankings in agricultural production. The Orinoquía departments (Meta, Arauca, Vichada) contribute 7% of the national GDP, particularly excelling in the production of rice, palm oil, livestock, fruits, cocoa, cassava, plantains, and maize.

On the other hand, (Purdue, 2018) suggests that in recent years, the Orinoquía region has been leaning towards new sustainable economic models such as rural tourism and the development of value chains in agriculture, presenting significant potential while also facing numerous challenges that have surfaced after nearly sixty years of civil war. These challenges include low labor productivity, overexploitation of natural resources, and a scarcity of services that hinder entrepreneurial communities from improving their economic situation.

Furthermore, the region has been a focal point of economic development in the country over the past decade and is a significant source of rural labor. However, it faces a variety of challenges, including the high cost of promoting projects due to deficiencies in urban

and rural road infrastructure, as well as river transport. Additionally, the region and its population have had to contend with various armed conflicts (Clavijo, 2018).

9.1.1 Departments

- *Meta:*

The department (Meta) has 29 municipalities and a population of 1,113,810 habitants (turismo, 2023) Over the last twenty years, its economy has been the most significant in the Orinoquía region.

Additionally, (DAP, 2020) refers to the social conditions in the department, where the multidimensional poverty index (MPI) is 51.06% overall, with 45.2% in urban areas and 75.04% in rural areas. This highlights that the problem is more concentrated in the rural sector of the department. The department also faces challenges in terms of low educational achievement and illiteracy, with an MPI of 64.0% and 16.7%, respectively. In terms of school attendance, the department has an MPI of 8.5%, while the school dropout rate has an MPI of 27.8%. Barriers to access to early childhood care services have an MPI of 17.3%, and child labor is at an MPI of 5.1%. Additionally, health insurance coverage has an MPI of 27.5%, and barriers to health services have an MPI of 7.8%. High economic dependency has an MPI of 41.3%, and informal employment stands at an MPI of 90.2%. Access to improved water sources has an MPI of 22%, while proper sanitation has an MPI of 9.9%. Inadequate housing, including inadequate walls and floors, has MPIs of 5.1% and 8.1%, respectively, and overcrowding has an MPI of 18.5%.

The following information is taken from (Planeación, 2011), which mentions that in the past, the Meta's economy was characterized by extraction in the mining, agricultural, and livestock sectors, with limited access to new markets and low internal consumption due to the low population density and the majority of the population being in strata 1, 2, and 3, with empirical entrepreneurial levels. In the early 21st century, extensive cultivation of maize and soybeans began in the Altillanura region of Meta, with the planting of 25,000 hectares. This marked the emergence of the agro-industrial economy in that region, supplementing developments in other subregions of the department.

"In the analysis of the behavior of economic activities and their percentage participation in GDP, the activity of oil and natural gas extraction went from having a percentage participation of 20.7% of the total in 2000 to 46.1% in the projected GDP for 2009. Another activity with a significant increase is civil engineering construction, which goes from 2.9% to 7.0%. The trend of relative decline in activities related to the agricultural and commercial sectors is notable. The commercial sector, in particular, went from a

participation percentage of 10% in 2000 to 3.8% in 2009, clearly illustrating the behavior of the department's economic activities and its dependence on the oil sector" (DNP, 2011).

Additionally, as mentioned by (Colombia U. N., 2013), unlike Arauca and Casanare, Meta's economy is not solely dependent on oil extraction. Instead, it engages in various economic activities, including agriculture, livestock farming, service provision, and petroleum activities. Agriculture and industry are the most important sectors in terms of their contribution to Meta's GDP. Rice is the most significant agricultural product in the department, followed by oil palm, which saw a doubling of cultivation during the period 2001-2007. In 2009, the initiation of "six biofuel production projects, three for biodiesel and three for ethanol," was projected, which would strengthen the labor and economic demand of the sector. However, as of the current date, these projects remain in the planning stage.

- *Vichada:*

According to (IGAP, 2016), Vichada is the second largest department in Colombia after Amazonas. It comprises four municipalities: La Primavera, Santa Rosalía, Cumaribo, and Puerto Carreño, which are among the largest in the country. In 2018, DANE estimated its population at 77,276 inhabitants (0.2% of the national total), with 45.6% residing in urban areas and the remainder in rural areas. Unemployment increased from 10% in 2012 to 12% in 2016, a rate higher than the national average (8.9%). The department has a border dependency situation with Venezuela, leading to internal conflicts. Additionally, local inflation is high compared to the national average because goods are transported from the central part of the country through infrastructure-challenged roads, hindering economic activity (IGAC, 2016).

Human settlements in Vichada are composed of colonizing populations, migrants from other parts of the country, and ethnic groups. Approximately 35.4% of Vichada, equivalent to around 3.5 million hectares, is neither for production nor for environmental conservation; these are areas with special regulations where 39 indigenous reserves are located, with restricted use. Thirty-seven of these reserves are located in the southern part of the department. The Selva de Matavén reserve, inhabited by Cubeo, Curripaco, Piapoco, Piaroa, and Puinave ethnic groups, is the largest, covering 1.8 million hectares, followed by the Alto Unuma reserve (488 thousand hectares), Santa Teresita del Tuparro (206 thousand), and Saracure-Cadá (185 thousand) (IGAC, 2016).

The department's primary economic base is extensive cattle ranching, mainly in La Primavera. Additionally, its population has been involved in the production of manioc, cashew-related products, cheese presses, and crafts such as hammocks and casting nets.

On the other hand, projects related to the development and commercialization of biofuels, oil exploration, mining excavations, sport fishing, and tourism have begun to boost the department's economy (IGAC, 2016).

According to the Soil Study and Land Zoning of Vichada conducted by the Agustín Codazzi Geographic Institute (IGAC), 36% of the department (3.6 million hectares) has areas suitable for agricultural, livestock, and forestry production. These are lands where activities related to crops, cattle breeding, and forest resource utilization can be carried out in a planned and sustainable manner to prevent natural resource degradation (IGAC, 2016).

9.1.2 Municipalities

- *Puerto Gaitán:*

According to (DANE, 2019), the municipality of Puerto Gaitán has a population of 41,017 inhabitants from different parts of the country. Its high population growth began in 2008 when a Canadian-Venezuelan oil company activated one of the largest oil wells in the country (Vanegas J. A., 2020), along with the Pacif Rubiales company, where salary conditions ranged from 2 to 4 million pesos. As a result of this situation, Puerto Gaitán went from being one of the poorest municipalities in the department to one of the wealthiest in the country (BCC, 2015), leading to an expansion in the municipality's commercial chain (restaurants, hotels, pool halls, bars). However, following the fall in oil prices in mid-2014 and the departure of Pacif Rubiales, the local economy began to shrink, leading to internal social conflicts. Residents went on strike due to the various layoffs in the following years, and there was also a reduction in infrastructure investment and an increase in insecurity due to rising crime rates (BCC, 2015).

In terms of the economy, cattle farming in communal savannahs gained strength in the 1960s, with large areas dedicated to extensive cattle breeding for raising. This became the most important commercial activity, which continues to this day but on a smaller scale.

The highest economic factor in Puerto Gaitán depends on oil wells, which has led to a major economic crisis due to the reduced extraction of fossil resources, decreased investment, and a decrease in the workforce. Consequently, the municipality has sought to focus its resources on other sectors such as tourism, with major festivals like the traditional Cachama Festival dedicated to Llanera culture and fishing. Additionally, national and municipal governments have encouraged the expansion of large-scale agribusiness for crops like palm oil, rubber, and soybeans (BCC, 2015).

On another note, (Vanegas J. Á., 2020) mentions that Puerto Gaitán was one of the municipalities founded due to incidents involving the FARC guerrillas, which led to confrontations between the army and the guerrillas, resulting in violence and land expropriation, especially affecting the indigenous population. This period is marked by events such as the "guahibadas," which refers to indigenous massacres (Vanegas J. Á., 2020). Despite many unfulfilled promises of rural development and after the fall in oil prices, the population continues to struggle to build a life and dignified work beyond extractive economies and the war that plagued the region.

- Puerto Lleras:

According to DANE (2018), the municipality of Puerto Lleras has a population of 11,300 habitants. It is one of the municipalities that faces significant challenges at the global, urban, and rural levels, with multidimensional poverty rates of 85% and a high rate of informal employment at 99%. It ranks fifth among municipalities with the highest rates of illiteracy and low educational achievement (DNP, Meta, 2020).

In Puerto Lleras, as of 2015, of the nine main categories contributing to municipal added value, seven are present. The cultivation of other agricultural products accounts for nearly 23%, followed by livestock production and hunting at 22%. The construction of civil engineering works contributes 14%, while the sector of hotels, restaurants, and bars accounts for around 3%, ranking last in terms of contributions to municipal added value. The sector of business service activities also contributes approximately 3% (DNP, Meta ,2020).

In the urban context, the predominant activity in the municipality is commerce, carried out through nightclubs, supermarkets, miscellaneous stores, hardware stores, workshops, ice cream parlors, restaurants, clothing stores, among others. However, in general terms, the municipality's economy is based on agriculture and livestock. The agricultural production in the municipality is primarily in the hands of small and medium-sized producers, with large producers being the minority. The territory is distributed in the agricultural sector as follows: the riverbanks of the Ariari River (floodplains) are mainly used for agriculture, while the hilly and savannah areas are used for livestock activities (Alcaldia de puerto lleras, 2017).

- *Cumaribo:*

The municipality of Cumaribo stands out as the largest in Colombia, covering an area of 65,674 square kilometers. According to the 2018 population census by DANE, it has a population of 72,691 inhabitants, of which 69,801 reside in rural areas, mainly consisting

of indigenous people and farmers. Despite being the largest municipality in Colombia, it had far fewer inhabitants in the past. During the cocaine boom in the 1980s, the town began to attract immigrants from Colombia, Ecuador, and Venezuela, becoming one of the main sources of income for the municipality (Borrero, 2021).

Despite the peak in the cocaine trade, there has been little municipal and territorial development. This is primarily due to the vast expanses of land and the challenging access to them, with dirt roads as the primary means of transportation. While the municipality has access to air and river transport, the costs associated with these modes of transportation are high. This leads to increased prices for goods and services, resulting in higher overall costs for the commercialization, export, and import of agricultural products such as corn, panela (a type of sugar), and cattle (PDM, 2020).

9.1.3 Villages

The Alcaraván Forest Project is currently located in the following areas of influence at the village level in the mentioned municipalities, namely: Puerto Lleras, Planas, Rubiales, Cumaribo, and Santa Helena. During the information search, primary sources were consulted by project participants, mentioning that the main source of income for these villages comes from employment with oil companies, followed by forest plantations of species such as acacia, pine, eucalyptus, and rubber, as well as monocultures of palm oil that have been strengthening in the region. Lastly, there is a lower demand for taking care of cattle farms and agriculture. On the other hand, there isn't much secondary information available regarding the socio-economic aspects of these villages, which means that there is not a detailed understanding of the social and economic aspects of the areas of influence. However, one of the reforesters, along with their social team, conducted a social and economic characterization in the Santa Helena village in 2020. This was done in order to identify the needs of the territory and its inhabitants, and based on the results obtained, to provide actions that contribute to improving the quality of life of the population, environmental conservation, and local territorial development (See Annex in *13_Monitoring report/4_NNH/02_Socioeconomic aspect/Characterization_socioeconomic_Santa Helena.pdf*).

Table 52. Summary of the classification according to the territorial organization of the Proyecto Forestal Alcaraván Orinoquía

Clasificación de acuerdo con el orden territorial				
Region	**Departament**	**Municipality**	**Village**	**Reforesters**
Orinoquía	Meta	Puerto Gaitán	Santa Helena	Ecologic SAS
	Meta	Puerto Gaitán	Planas	Sultana SAS
	Meta	Puerto Lleras	Puerto Lleras	Enlace Rojo SAS

Clasificación de acuerdo con el orden territorial				
Region	**Departament**	**Municipality**	**Village**	**Reforesters**
	Meta	Puerto Gaitán	Planas	Ecosistema productivo mataemontes SAS
	Meta	Puerto Gaitán	Rubiales	Luis Fernando Rodriguez
	Vichada	Cumaribo	Cumaribo	Inversiones Guarda Bosques de Colombia SAS
	Meta	Puerto Gaitán	Planas	Claudia Huerfano O
	Vichada	Cumaribo	Cumaribo	Punta de Garzas Inversiones Forestales

Source: (CO2CERO SAS, 2022).

It is worth mentioning that the information obtained allows for an analysis of the importance and impact that the project can have on the territory over time. This represents an effort in sustainable forest management with various social, environmental, and economic co-benefits, not only for the participants but also for the associated collaborators and the communities near the area of influence.

Lastly, it's important to emphasize that the success of any project aiming to generate direct and indirect benefits for both participants and the area of influence relies on effective communication, joint community participation, and collective decision-making. Over time, these efforts can strengthen relationships that lead to the emergence of new initiatives for responsible production chains that consider environmental sustainability and human well-being. As highlighted by (Palmberg-Lerche, 1999) when suitable strategies are employed that address both improvement and conservation aspects, the progress achieved will be long-lasting and can continue to grow for future generations.

9.2 No Net Harm

Below, the predictable effects on the socio-economic aspect within the project boundaries are presented. For this purpose, the environmental assessment is used as a reference, categorizing the effects based on the methodology developed by Conesa (2010) adapted to the social and economic component. This allows for a general overview of the analysis of the identification of effects through a weighted value that indicates the degree of negative or positive impact on the project's development.

For the assessment, six (6) analysis categories were chosen, which have been adopted by various theoretical references such as the UN, FAO, SDGs, World Bank, UN Women, among others. This helps to understand on a larger scale what type of impact is being

generated at the social and economic levels. However, for a more detailed analysis, within each category, the effects to be rated and evaluated are broken down, totaling seventeen (17) in Table 53. For the rating of effects, six (6) criteria were considered: direct effect, indirect effect, scope, magnitude, timing, and persistence. The explanation of these, as well as the rating given to each effect, can be found in the folder (*13_ Monitoring report\04_NNH\02_Socioeconomic aspect*).

Table 53. Identification of analysis categories and their social and economic effects

Component	Analysis categories	Effects
Social	Well-being	Project basic services
		Project housing infrastructure
		Health
		Food security
		Education
		Solid waste management
		Family quality of life
	Gender inclusion	Gender equality
	Security	Occupational safety
		Public safety
	Terrotory	Community relations
		Land use and limitations
		Change of ownership
Economic	Productive chains	Carbon market devaluation
		Economic growth
	Employability	Local labor hiring
		Labor dropout

Source: (CO2CERO SAS, 2022).

According to the results obtained in Table 54, it is determined that the Proyecto Forestal Alcaraván Orinoquía, from a socio-economic perspective, has a total of seventeen (17) identified effects, of which there are seven negative, five (5) classified as critical, and two (2) as moderate. On the other hand, there are eleven (11) positive effects (Refer to *13_ Monitoring report\04_NNH\02_Socioeconomic aspect\Socioeconomic_evaluation_Alcaravan_V3.xlsx*). Based on the results of this analysis, it is observed that the project during its execution period can generate significant and rewarding changes, not only for the direct beneficiaries but also, to a lesser extent, it influences the territory and its local development, creating new models of employability and value chains, with a significant impact on the environment and social and economic components. Therefore, it is important to promote awareness of the role and commitment of the participants in the implementation of sustainable forest chains and their

articulation with neighboring communities, where it has been evident that a good community relationship allows for greater public safety, more efficiency in achieving project objectives, and an improvement in the quality of life of the affected population.

Table 54. Calificación y nivel de importancia socioeconómica de los efectos determinados en la evaluación.

N°	Effect	Rating	Socioeconomic level of importance
1	Project basic services	24	Positive: High
2	Project housing infrastructure	20	Positive: Medium
3	Health	26	Positive: High
4	Food security	28	Positive: High
5	Education	20	Positive: Medium
6	Solid waste management	-26	Negative: Critic
7	Family quality of life	20	Positive: Medium
8	Gender equality	28	Positive: High
9	Occupational safety	-26	Negative: Critic
10	Public safety	-22	Negative: Moderated
11	Community relations	20	Positive: Medium
12	Land use and limitations	-26	Negative: Critic
13	Change of ownership	-24	Negative: Critic
14	Carbon market devaluation	-22	Negative: Moderated
15	Economic growth	26	Positive: High
16	Local labor hiring	26	Positive: High
17	Labor dropout	-24	Negative: Critic

Source: (CO2CERO SAS, 2022).

10 Consultation with interested parties (stakeholders)

Below, the processes used to achieve the implementation of the Proyecto Forestal Alcaraván Orinoquía by the stakeholders are described.

10.1 Project idea

Consolidation of the idea of the Proyecto Forestal Alcaraván Orinoquía arises from the technical developer and reforesters, as a result of an analysis of the normative, legal, and technical framework, which ensures that the project will provide benefits to the participants, environmental protection, greenhouse gas mitigation, and will be permanent for a period of 20 years. In order to ensure a responsible and committed workflow, both

parties establish a temporary contract, where they commit, through their skills, to contribute to the fulfillment and achievements of the project.

Steps for the development of the project idea

Initiative: Typically, the promotion or dissemination of forest plantation projects arises from events or gatherings where discussions about the importance of sustainable initiatives with commercial purposes, which can also generate carbon certificates for climate change mitigation, take place.

As such, the initial contact between the interested parties is made through phone calls, WhatsApp messages, or emails, followed by a more detailed conversation about the initiative, its location, and the participants. If the participant is interested, a further briefing is conducted about what the AR project entails, the types of actions involved, the benefits, addressing questions and concerns, and explaining the commitments associated with joining the initiative (Refer to *1_Agreements\01_Manifest of interest).*

Prefeasibility: Once the project design is approved, the technical team proceeds with the prefeasibility study, allowing for a preliminary analysis of the proposal to determine if it is viable for development.

Checklist: Each participant is provided with a checklist of documents and requirements needed for the project's development. This is done to validate the information, including the legal aspects such as land ownership analysis, to prevent any potential reversals in activities during the execution phase.

Temporary Contract: During this phase of communication among partners, the percentages of participation related to management and technical implementation, payment mechanisms, benefit transfer, project's general objectives, and certification program based on alternative analysis, commitments, and responsibilities are defined (Refer to *1_Agreements\02_Temporal agreement).*

10.2 Project socialization

It is important to note that for AR projects, it is not a requirement to conduct prior socialization with the communities adjacent to the project. This is because it is a private property where the initiative can be implemented, ensuring that no harm will be done to the well-being of the population or the natural environment. However, it is emphasized that having an effective relationship with the community is crucial to strengthen social ties, which can be beneficial for the project over time.

As forest projects continue to develop, there is an increasing emphasis on the importance of the social component, which is a cross-cutting axis for sustainability efficiency and effectiveness. Therefore, the Alcaraván Orinoquia Forest Project, through its voluntary actions, seeks to promote activities that generate well-being for both direct and indirect beneficiaries while responsibly impacting the environment. In the context of the socializations that have been carried out with the participants, it has been found that they have undertaken social actions with and without the project, as evidenced by the results shared by Ecologic SAS.

With the above, it is evident that the project has a vision beyond the economic aspect, focusing on new sustainable development models, considering the importance of preserving and protecting native forests and generating actions that benefit populations that often have unmet basic needs, especially in rural areas.

Ilustration 5. Community work carried out by the company Ecologic SAS in collaboration with the community of the Santa Helena village. Source: ECOLOGIC SAS. (2022)

10.3 Handling of requests, complains, claims and suggestions

In order to strengthen the formal communication channels between the technical developer and the participants, a (Requests, Complaints, Claims, and Suggestions) email address for forest projects (PQRS.Forestal@co2cero.co) has been created. Its purpose is to address questions, complaints, claims, and/or suggestions from the participants directly involved in the development of Forest Projects (A/R), ensuring that they receive the appropriate response. This allows for the ongoing recording of requests, commitments, and actions. Currently, it is in the process of being socialized, and it is emphasized that as of the present date, there have been no requests received.

11 Sustainable Development Goals (SDGs)

The sustainable development goals constitute the global goals for the eradication of poverty, protection of the planet and ensuring the well-being of humanity, by demonstrating measurable progress by 2030. Sustainability is a fundamental axis in the implementation of actions that are transversal to the three pillars of these objectives, within which equity is proposed in social, environmental, and economic terms.

Proyecto Forestal Alcaraván Orinoquía is proposed as a suitable solution to address national challenges, rural needs, and contribute to achieving specific sustainable development goals. This initiative focuses on activities that aim to increase carbon storage, promote sustainable economic development, and conserve the environment. It demonstrates contributions to six out of the fifteen specific targets set within the sustainable development goals framework.

End poverty in all its forms everywhere

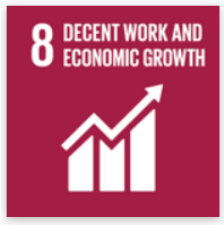
By enhancing capacities in initiative management, financial management, and leadership, we aim to strengthen secure land tenure rights by providing appropriate legal documentation and considering the rights associated with land ownership.

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Through the consolidation of productive chains associated with timber and non-timber forest products that have emerged from the installation of forest plantations, we intend to improve the level of productivity within the production units. This will be

achieved through training activities focused on poultry management, forestry practices, and the utilization of technological tools for optimized work.

Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all



The activities of establishment, management and protection of forest plantations and beekeeping seek to involve through employment generation, equity to the resident population of the municipalities belonging to the project. We aim to improve sustainable production chains and existing economic activities through the evaluation of their productivity, processes and goals achieved, strengthening and projecting their behavior into the future.

Making cities and human settlements inclusive, safe, resilient and capable of sustainable production.

Reforestation activities will promote responsible production and consumption, through training in the management and use of pesticides, solid waste, environmental education talks, and management of agricultural machinery.

Take urgent action to combat climate change and its impacts

Through the implementation of commercial reforestation areas, the project has generated recovery, rehabilitation, conservation, increases and improvement of carbon sinks. This has favored carbon capture, the generation of microclimates, and the establishment of biological corridors and habitats for faunal species. Additionally, the planted areas serve as physical barriers to safeguard the riparian forest and its associated water flows, contributing to the overall landscape preservation.

Protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss

The establishment of forest species adapted to the soils of the Orinoquía is encouraged. It facilitates the permanence of natural ecosystems for the transit and permanence of associated animal species. Moreover, the project will constitute the essential pillars for sustainable forest management, monitoring of covers, stopping deforestation and degradation activities, providing commercial timber raw material, and stopping the loss of biodiversity. It has a direct effect on the mitigation of adverse effects or natural phenomena associated with soil degradation and desertification. On the other hand, the production is supported by beekeepers, who take advantage of the beekeeping product and in turn strengthen the ecosystem benefits through the pollination of species, inside and outside the project area.

The establishment, management, and protection activities of the Proyecto Forestal Alcaraván Orinoquía contribute positively to the achievement of sustainable development goals. These contributions can be observed in the report *13_Monitoring report\03_SDG\BCR TOOL SDG_Alcaravan_V4.xlsm*. The report provides information on the specific sustainable development goals, indicators, baselines, annual and overall targets, activity types, and project contributions. Supporting documentation can be found in the mentioned file, organized by SDG number, with each folder containing documents related to specific indicators, reference values, and verification years.

12 Grouped projects (if applicable)

The Proyecto Forestal Alcaraván Orinoquía is not a grouped project.

13 Other GHG program

N/A

14 Double counting avoidance

Following international objectives and the guidelines provided in the BCR V 3.2 Standard, and in order to prevent double accounting, a search is conducted for the boundaries of forest projects registered in certifying programs such as Verra, Biocarbon Registry, Cercarbono, and COLCX up to the year 2023. After processing the obtained shapefiles in

ArcGIS software, the result shows that there are no overlaps of nearby project boundaries with those of the Proyecto Forestal Alcaraván Orinoquía (See Figure 5).

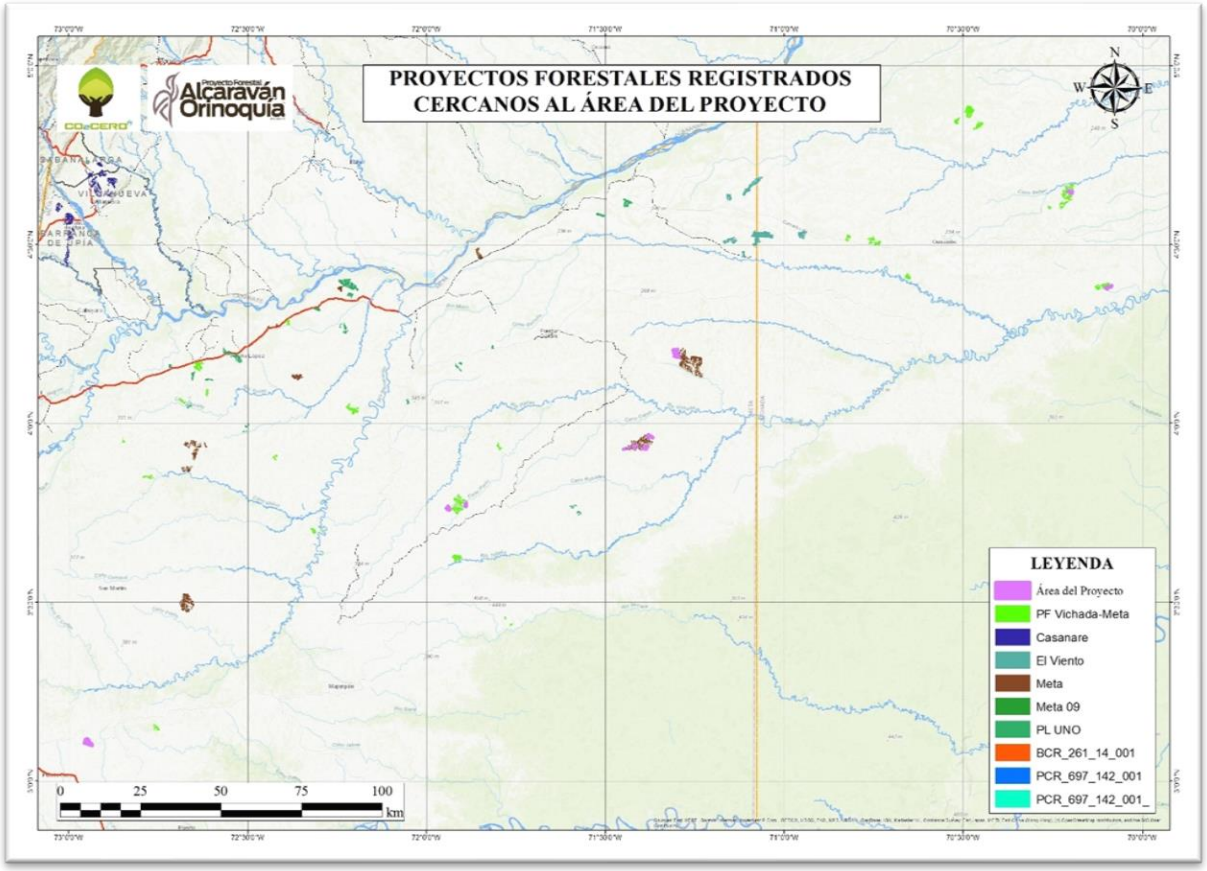


Figure 5. Forest Projects registered near the Project Area.
Source: CO2CERO SAS. (2023).

15 Monitoring plan

The monitoring plan must describe the procedure used by the project manager to track project activities of GHG removals/emissions attributable to the project's forestry activities.

To fulfill this requirement, we adhered to the guidelines outlined in the methodology employed for removals calculation (BCR0001 V 4.0). Our approach encompassed the inclusion of monitored data and parameters, the methodologies employed for data generation (including appropriate collection and archiving procedures), as well as the processes associated with sampling models and quality control.

According to the methodology, the Monitoring Plan must provide all the necessary information to:

a) Verify the conditions of applicability of the methodology
b) Verify changes in carbon stocks in selected sinks
c) Verify project emissions and leakage

The data needed for carbon estimates adheres to widely accepted principles and practices for commercial plantation management and forest inventories. The monitoring plan features the following aspects:

a) Monitoring project boundaries
b) Monitoring the implementation of forestry activities
c) Monitoring forestry biomass management and growth
d) Monitoring the quantification of net project removals

15.1 Monitoring project boundaries

The project's geographical boundaries constituted by the eligible areas on which the forestry activities are developed, have been incorporated in the Geographic Information System (GIS). This involves georeferencing each of the lots with their respective ID, recording the initial vegetation cover for each parcel, and documenting the areas within different forest systems, among other things. This approach enables the monitoring of forestry activities for each of the lots or geographical areas included in the project. The activities undertaken for effective management and monitoring of these areas include:

a) Reviewing all areas and boundaries of the project by evaluating reforestation activities by site (lot).
b) Georeferencing (latitude and longitude) each polygon by species and stratum, using a GPS.
c) Recording the position of each site, through GPS, in the Geographic Information System and calculating the planted area in each stratum.
d) Verifying periodically the correspondence of the boundaries defined for the project and the eligibility analysis of the areas in the project.

The information concerning the boundaries of the mitigation project, specifically the areas where planting has occurred or is planned, undergo periodic evaluation and verification using GPS field demarcation. These boundaries are represented in the Geographic Information System to ensure that the project area is up-to-date. By identifying updated areas and defining project boundaries, the initially detailed strata will be improved. Modified limits, if applicable, will be available during each project follow-up audit. In cases

where carbon credits need to be deducted due to limit changes, these will be properly deducted from the calculations.

Similarly, changes in the areas will be documented through field analysis with the information obtained through GIS. The analysis entails listing the areas by system, species, and year of planting, affected by disturbance events. The data and parameters used to monitor project boundaries are presented in Table 55.

Table 55. Variables used to monitor project boundaries.

Variable	Unit of Measure	How it is obtained	Registration frequency	Cover/Other measures or number of data collected	Remarks
Stratum	Stratification map	C	Periodically	100% of the area	Identifier of each stratum by means of species planted and sowing year.
Polygons of the areas included in the project. GPS coordinates	Latitude and Longitude	m	Annually (every 3 years maximum)	100% of the area	Verified annually. Constituted by the coordinates (latitude and longitude) of each polygon included in the project, identifying the areas affected by natural or anthropic disturbances.
A_{ikt}	Hectares	c	Annually (every 3 years maximum)	100% of the area	Polygons of the areas included in the project, during time *t*, in stratum *i*, in the forest system *k*.
A_T		c	Annually (every 3 years maximum)	100% of the area	Total area at time *T*. The area of the project boundaries will be measured and documented. Project boundary maps will be available at each follow-up audit. It corresponds to the sum of the areas at the boundaries in period *T*.
$Adist_{ikt}$		c	Every 3 years maximum	100% of the affected area	Areas affected by natural phenomena (pests, fire, etc.) or anthropic activities (interventions or deforestation), by stratum *i*, by forest system *k*, at time *t*.

Source: (CO2CERO SAS, 2023). *Where M: measured, C: calculated; E: Estimated and D: Default

15.2 Monitoring the implementation of project activities

In accordance with forestry practices, the activities for monitoring their implementation are as follows:

- Ensuring that soil preparation and site selection adhere to the guidelines outlined in the establishment and management plans, as well as the project document.
- Reviewing and updating annually the planted areas, by species and stratum.
- Evaluating the survival of plantations and identificatory any decreases in areas or events that lead to the decline of biomass.

Table 56. Variables used to monitor the execution of plantation activities.

Variable	Unit of Measure	How it is obtained	Registration frequency	Coverage/Other measures or number of data collected	Remarks
ID - Ref. SIG	Alphanumeric	Defined	Continuously	100% of the area	For each established forest stratum and system, associated with an alphanumeric identifier.
Localization	Geographical coordinates	m	Continuously	100% of the area	Using GPS to identify the geographical coordinates of each lot included in the project.
A_ikt	Hectare	c	Continuously	100% of the area	Polygons of the areas planted during time *t*, by stratum *i*, in forest model *k*.
Site Preparation	Hectare	m	At the beginning of each establishment	100% of the area	Area intervened for the establishment of plantations.
Species planted by each stratum	N/A	Defined	Annually	100% of the area	Species planted by each stratum, within the boundaries of the project.
Survival	Trees/ha	m,c	Three months after planting and annual	100% of the area	The survival rate per established hectare is calculated for each stratum, species and forest system.
Date of planting	Alphanumeric	m	At the beginning of each establishment	100% of the area	Date of planting of each lot (site).

Source: (CO2CERO SAS, 2023). *Where M: measured, C: calculated; E: Estimated and D: Default

After completing the monitoring activities for forestry practices, information related to soil preparation and site selection is obtained. This information is based on the principle of restriction of planting in plantation protection areas or natural forest. This is achieved

through eligibility analysis, which ensures compliance (See *3_Eligibility*) and shows the environmental restrictions for the corresponding areas.

For the participants, compliance with environmental restrictions for the installation of plantations is determined through multi-temporal analysis. Additionally, field visits display the activities carried out in plantations, such as fire barriers and cleaning, which corresponds to what was proposed in the management plan.

To ensure accurate updates on planted areas, the monitoring of boundaries is taken into consideration. Additionally, the year of sowing is used as a base factor to determine the age of each of the strata. As part of the carbon calculations, a unique identifier is generated, incorporating species and year of planting, which ensure clarity of the data, and characterized as the stratum. In the event of a disturbance or change in the effective areas, a report is filled out with the details of new planted areas and disturbances, provided directly by the reforestation team. This guarantees the authenticity and transparency of the information presented.

15.3 Monitoring crop management and growth

CO2CERO S.A.S established a Protocol for the measurement for the permanent growth of plots. This was done hand in hand with ECOLOGIC SAS, and it was based on the Guide for the quantification of biomass and forest carbon, the generation of models, and the use of tools developed by Corporación Autónoma de Cundinamarca for its estimation, which is summarized below. Table 57 lists the materials needed for a crew and their respective uses. The following sections of the document present the general guidelines used.

Table 57. Materials for forest management and growth measurements.

Item	Quantity	Use
Tape measure	1	• To measure the 1.3 height to mark the DHB of the tree. • To confirm plot radii.
Diameter tape	1	• To directly measure the DHB of the tree.
PVC pipe or a 1.3-meter stake	1	To establish the permanent parcel center.
Rope or pita fiber	• Graduated • Ungraduated	• Graduated: to verify radii of the circle to determine whether a tree enters the plot. • Ungraduated: for different uses that arise in the field.
Data forms	Variable	To collect date of field plots

Item	Quantity	Use
GPS	1	Geopositioning of the plot in Degrees-Minutes-Seconds format (WGS-84)
Velcro	Variable	Place the velcro at chest height (1.3 meters), to be able to paint the tree on a straight circumference, before measuring it, so that it does not alter the value of the diameter at chest height (DHB)
Yellow asphalt paint	Variable	• The circumference should be painted on the Velcro. It should facilitate the location and ensure the mark is straight. • On this mark the DHB should always be measured. • Identify numerically and alphabetically all the trees in the plot. Ex: # Individual + plot name* = 1M • Identify the name of the plot. In Annex 1 of the forest monitoring lists is the nomenclature to be used for each property.
Height measuring equipment (Clinometer)	1	To measure the height of the tree at a known horizontal distance.

Source: (CO2CERO SAS, 2023).

15.4 Stratification

Because there are differences in the biomass, present within the project area, which are attributed to the different species and periods of plantation establishment, the stratification process is implemented with the purpose of improving the accuracy of the project's biomass estimates.

The strata present in the baseline scenario are shown in 3.3.3 Step 1: Identifying land use based on the analysis developed in the Eligibility component. On the other hand, for the project scenario, stratification is based on planting and forest establishment plans, consisting of the forest species planted and the year of planting.

15.5 Sampling plots

The definition of the number and location of the plots was carried out under the eligible project area, based on a systematic sampling design. To find the number of plots needed for the project, a preliminary sampling is executed according to the number and area of

each stratum by adapting what is suggested in the CDM Tool AR-TOOL 0003. After obtaining the number of plots, they are distributed in the study area on the base cartography of the project.

The plot size measures 400 square meters, except for the participant Punta de Garzas Inversiones Forestales, whose plots measure 420 square meters. The GPS is used to get to the plot 15 meters before reaching the destination. From there, the remaining 15 meters are traversed using a decameter and compass, while maintaining the same course, to ensure accurate arrival at the center of the plot. The center of the plot is marked with a PVC pipe, stake, or central tree, as determined by the professional in charge, and the plot number is indicated there. The plot center is situated to the north, and the first tree lies within an 11.28-meter radius to the north (see Figure 6). For Punta de Garzas Inversiones Forestales, circular plots with an 11.56-meter radius were chosen. It should be noted that the project may result in the standardization of plot type and size.

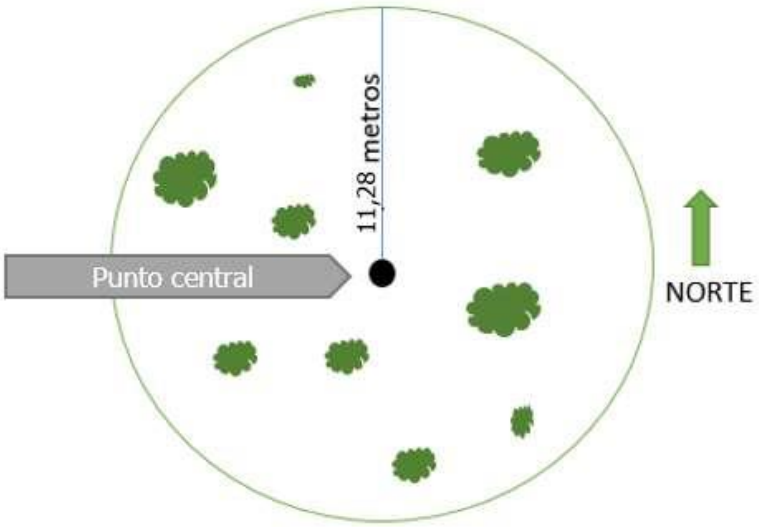


Figure 6. 400 m2 plot diagram.
Source: (CO2CERO SAS, 2023)

To mark the trees, we begin by placing the Velcro at chest height (1.3 meters). Then, we to paint a straight circumference around the individual, before measuring it. Next, with the same paint, we mark on a straight line the exact spot where the measurement was taken. This serves as a reference for all subsequent measurements of the tree's DHB.

15.6 Measurements and estimation of changes in carbon content

The following attributes will be recorded for each tree without exception:

a. Number of the tree with paint: a paint mark indicating where the DHB was measured on the tree should also remain on the shaft.
b. Attributes (crooked, sick, forked, with ants, etc.). In case the tree does not present anything noticeable it will be registered as "normal".
c. Observations or annotations on the plot, if relevant (presence of obvious diseases or pests, significant presence of regrowth or regeneration of forest species other than that consigned for the property, etc.).

The trees are measured and marked in a sequential order, starting from an arbitrary north point. To accomplish this, they were all chosen and marked by following a zigzag pattern, returning to the starting point once the line was completed (Figure 7).

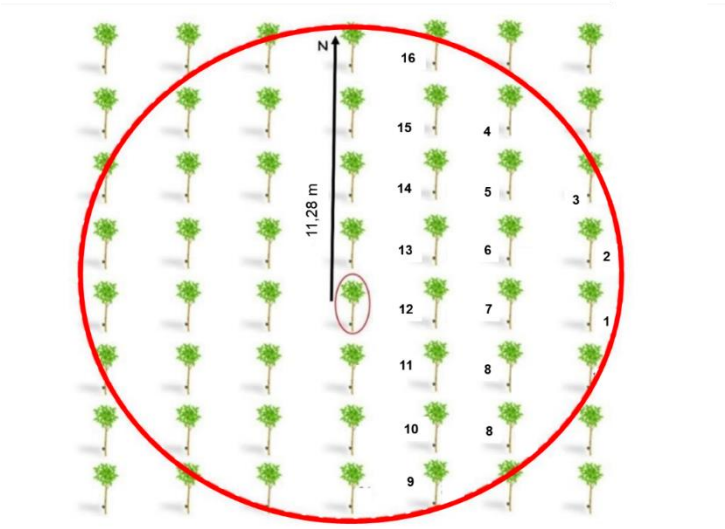


Figure 7. Parcel tree numbering.
Source: (CO2CERO SAS, 2023).

The height of the individuals must be measured in the first instance with specialized equipment. If you do not have the equipment, the height must be estimated visually by rounding the value to the nearest meter. The height measurement methodology must be explicit in the document and field forms. With the results generated by the field measurements, the carbon reserves (tons of CO_2e to date) are calculated in the carbon reservoirs included in the project, according to the methodology applied. These indirectly calculated sinks will be estimated using expansion factors as shown in section 1.1.3.

15.6.1 Data and parameters monitored

Below we can find the data and parameters subject to monitoring within the project.

Data/Parameter	Diameter at Chest Height (DHB).
Unit of measurement	Centimeters.
Description	Reflects tree growth and carbon storage.
Source of information	Field monitoring in the plantations stands linked to the project.
Applied values	Result of the monitoring plots measured in each of the plantations stands linked to the project.
Choosing data or measurement methods and procedures	The person in charge of monitoring this variable is the technical operator hired by the project owner. The frequency of measurement depends on the verification processes executed in the project. Finally, the accuracy of the measurements, methods, and measurement procedures are carried out following section 16.3 Site management and biomass growth monitoring, of BCR0001 V4.0.
Information purpose	Controlled, CO_2-related calculation of the removals generated by the project activity.
Quality control and assurance procedures	The procedures described in section 16 of the BCR0001 V4.0 methodology regarding the data verification process are carried out.
Monitoring frequency	Permanent. Measured every time the project is verified (triennial).
Comments	-

Data/Parameter	Total height (Ht).
Unit of measurement	Metre
Description	Reflects tree growth and carbon storage.
Source of information	Field monitoring in the plantations stands linked to the project.
Applied values	Result of the monitoring plots measured in each of the plantations stands linked to the project.
Choosing data or measurement methods and procedures	The person in charge of monitoring this variable is the technical operator hired by the project owner. The frequency of measurement depends on the verification processes executed in the project. Finally, the accuracy of the measurements, methods, and measurement procedures are carried out following section 16.3 Site management and biomass growth monitoring, of BCR0001 V4.0.
Information purpose	Controlled, CO_2-related calculation of the removals generated by the project activity.
Quality control and assurance	The procedures described in section 16 of the BCR0001 V4.0 methodology regarding the data verification process are carried out.
Monitoring frequency	Permanent. Measured every time the project is verified (triennial).

Comments	-

15.6.2 Monitoring crop management and growth

After completing the forest yield monitoring activities, the result is an estimation that provides information for quantifying the carbon stored in the plantations. It also offers an approximation of the behavior carbon stored over time. This activity seeks to guarantee the transparency of the information processed and allows a more accurate verification of the data taken in previous inventory phases.

In the subsections of Section 3, emphasis is placed on the measurement process and the importance of ensuring the authenticity of information to minimize the potential for overestimation or underestimation. The information obtained in this phase is recorded in predefined field formats that capture various variables related to the structure of evaluated individuals (such as height and diameter), along with species information, sowing year, and owner details.

The verified growth period is between the most recent verification and the previous one. Within each verification period, the removals of this certification are distributed linearly. Within each verification period, the carbon removals are evenly distributed over time. The results of each monitoring phase and the subsequent verification are presented in folder *13_Monitoring report*.

15.7 Monitoring of the evaluation of the socio-economic and environmental aspects

An evaluation of environmental and socio-economic aspects is conducted for the project, aiming to understand the impacts generated by the activities to be carried out (see *13_Monitoring report\04_NNH\01_Enviromental aspect & 02_Socioeconomic aspect*); likewise, in the 7 Risk management section, the potential environmental, social, and financial risks are presented along with their respective monitoring indicators and variables that arise during its execution.

15.8 Assigment of roles and responsibilities for monitoring and reporting of relevant variables for GHG removal calculations

The technical operator contracted by CO2CERO S.A.S. (Project Holder) will be responsible for monitoring the established variables. The reporting of measurements will be done periodically to collect information in a timely manner and make the corresponding estimations.

The responsibilities of the technical operator include:

- Gathering accurate and relevant data of measurable parameters.
- Monitoring tree growth through periodic measurements of individuals using sampling techniques to obtain the data presented in this same chapter.
- Maintaining detailed records of activities and operations carried out in the Project's plantations.
- Preparing technical reports summarizing the collected information and monitoring results. Additionally, sending the databases with all field-measured data.
- Reviewing the recorded values for each variable in different plots to control the quality of in-situ data; adapted from (Ecologic S.A.S., 2022).
- Complying with applicable regulations and standards related to the Project, following safety norms and sustainable forest management guidelines.

CO2CERO S.A.S., as the project holder, must ensure that the monitoring information is provided within established timeframes and in an appropriate manner. Therefore, a review and control process are conducted on what the technical operator responsible for monitoring delivers.

15.9 Monitoring the evaluation of the project´s contribution to the Sustainable Development Goals (SDGs)

For each goal, its respective evaluation is carried out by implementing the BCR TOOL (refer to *13_Monitoring report\03_SDG\BCR TOOL SDG_Alcaravan_V4.xlsm*), in which the Project selects the indicators controllable by the Project, their annual results, and the final result, confirming compliance with the worked indicator. Likewise, within Chapter 11 Sustainable Development Objectives (SDG), a brief description of the actions and activities carried out by the project is presented, working together with the participants and prioritizing collective well-being and local development.

16 Information management

Proyecto Forestal Alcaraván Orinoquía manages its information under the guidelines established by the project developer and its corresponding information management and data management processes. In the *16_Information management* folder, the procedures for information management in Forest Carbon Projects are presented.

For each of the products and deliverables generated for this initiative, a quality review process has been provided, which depends on the sources that provide the information. The process depends on the sources of information, and the data generator filters their records to provide relevant information for the project's needs. When project participants

receive municipal administrative information, it undergoes a quality review by the project developer. The developer verifies the accuracy, transparency, and quality of the information, which is then integrated into the project document, monitoring report, and other relevant components.

Finally, the products that are to be awarded to the validation and verification body will be supervised by the project developer and the other project partners if required. Their contents will be evaluated against the certification program and methodological rubrics to minimize uncertainty and ensure alignment and consistency with the established standards.

The information processed and produced for the projection and quantification of GHG removals in both the Ex-Ante and Ex-Post scenario, has been managed within a level of uncertainty corresponding to ISO 14064-2, 14064-3 and 14065: 2020 standards, equivalent to 95% or higher. Moreover, the materiality threshold considered in the different calculations is set at 5%, as specified in the certification program. This indicates that currently Proyecto Forestal Alcaraván Orinoquía currently maintains an error margin of less than 10%, after evaluating the data collected from the forest inventory.

17 References

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18 References and document history

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Version	**Date**	**Responsible**	**Change**
1	02/11/2022	Andrés Silva	Initial Version (V1)
2	17/02/2023	Andrés Silva	Version two (V2)
3	10/03/2023	Andrés Silva	Version three (V3)
4	24/04/2023	Andrés Silva	Version four (V4)
5	05/06/2023	Andrés Silva	Version five (V5)
6	05/07/2023	Angie Castillo	Version six (V6)
7	14/08/2023	Angie Castillo	Version seven (V7)
8	13/12/2023	Angie Castillo	Version eight (V8): BCR standard and methodology BCR0001 update