



VCS JOINT PROJECT DESCRIPTION & MONITORING REPORT FORESTAL AZUL CARBON PROJECT



Document Prepared by UNIQUE land use

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Prepared By	UNIQUE land use and Forestal Azul
Contact	Forestal Azul S.A. Teniente Rivarola 832 and Florida, Fernando de la Mora Phone: +4976120853440 Email: andrea.braun@unique-forestinvestment.de

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1 PROJECT DETAILS

Joint Project Description & Monitoring Report: VCS Version 4.0

1.1 Summary Description of the Project

Forestal Azul S.A. is a company established in 2018 by a German investor (family office) in cooperation with the UNIQUE group. The aim of the company is to establish sustainable reforestation and forest restoration in Eastern Paraguay for the sequestration of carbon and the production of quality timber in a highly deforested landscape.

Forestal Azul purchased a property of 2,309 ha in the Department of San Pedro, Eastern Paraguay, in 2018. As most private estates in Eastern Paraguay, the property had undergone intense land use conversion in the past. When the company acquired the land, the property had been used for intense mechanized soy production and beef production on implanted pastures. Furthermore, the property maintained around 25 % of its surface covered with natural forest, which by then was highly degraded due to unregulated extraction of biomass and poles, hunting and fires. The condition of the natural forest was not good enough to initiate viable sustainable forest management. As so many other forest fragments in similar condition in the region, these forests are very vulnerable to forest fires. The risk is exacerbated by the lack of incentives for active forest protection and the changing climate that has been displaying longer droughts in recent years.

Forestal Azul seeks to establish sustainable forest land use systems adapted to the condition of the land, while at the same time financially viable and competitive. The land use system envisaged by the company is highly diversified and includes the restoration of degraded natural forests, the introduction of silvopastoral systems on implanted pastures, and fast growing eucalypt plantations on the areas used for mechanized soy production.

The company has introduced an innovative land use system aimed at restoring the degraded natural forest through intense enrichment planting. Thereby, exotic, fast growing timber species are introduced in strips within the degraded natural forest, and managed throughout one quality timber rotation together with the natural regeneration of the forest. After one quality timber rotation (estimated at 15 years), the exotic species are withdrawn from the system and harvested for timber production, leaving a recovered natural forest that by that time should be in a condition to be sustainably managed for the production of natural timber. In this sense, the exotic species ensure the financial viability of the system. Forestal Azul has acquired an exceptional license by the authorities for this system, which is the first of its kind in the country. The pilot project will be accompanied by the National University and the environmental and forestry authorities to evaluate whether this could be an option for the degraded natural forest patches distributed among private properties in the country.

In addition, Forestal Azul is introducing eucalypt plantations on areas previously used for mechanized soy and implanted pastures. On implanted pastures, plantations are combined with

cattle grazing to form silvopastoral systems. Both these systems will also be managed for the production of quality timber, in 10-13 years cycles, after which they will be harvested and replanted.

Overall, the company aims to establish 1,805 ha of these forest systems until 2021, with 1,159 ha of eucalypt plantations, 148 ha of silvopastoral systems, and 485 ha of enrichment planting in degraded natural forests. Thereof, 1,307 ha are integrated within the scope of this carbon project (first instance) and 992.5 ha are part of the first verification proposed (plantation years 2018 and 2019). In the future, the company might further expand its plantations in the region.

According to the Shareholder Agreement, the investment into Forestal Azul is secured for at least 15 years, with possibility for continuation. Even if an exit is realized, the longevity of the project is secured because re-planting occurs immediately after harvesting (evidenced in the Business Plan). The production cycle of the plantations is between 10 and 12 years, meaning by the time of sale to a potential buyer, plantations are between 1-5 years of age.

The project contributes to integrating the tree component into a productive landscape dominated by two commodities, soy and beef. Soy and beef are a cornerstone of Paraguay's economy, however the high dependency on these commodities has failed to bring about sustainable socio-economic development and resilience to climate change. Furthermore, quality timber production is highly relevant in a country that has turned from a net exporter to a net importer of wood and timber. Quality timber production offers several advantages compared to existing production models: It fosters long term investments and stewardship of the land, drives the local value addition and professionalization of the forest sector, provides more labor, and is better suited to restore degraded landscapes.

Forestal Azul has acquired FSC certification in 2018 (FSC® C141437). The company aims to bring about socio-economic value to the region. It is the main employment provider of its neighboring community, Paso Tuna, having provided formal jobs for around 40 to 70 FTEs in previous years in an environment where formal labour is scarce. Besides providing local labour, the company will initiate long term productive projects with smallholders to foster food security and better income streams through productive projects.

Forestal Azul is managed by an experienced team of UNIQUE, with a long-term mandate for the technical, environmental and social management.

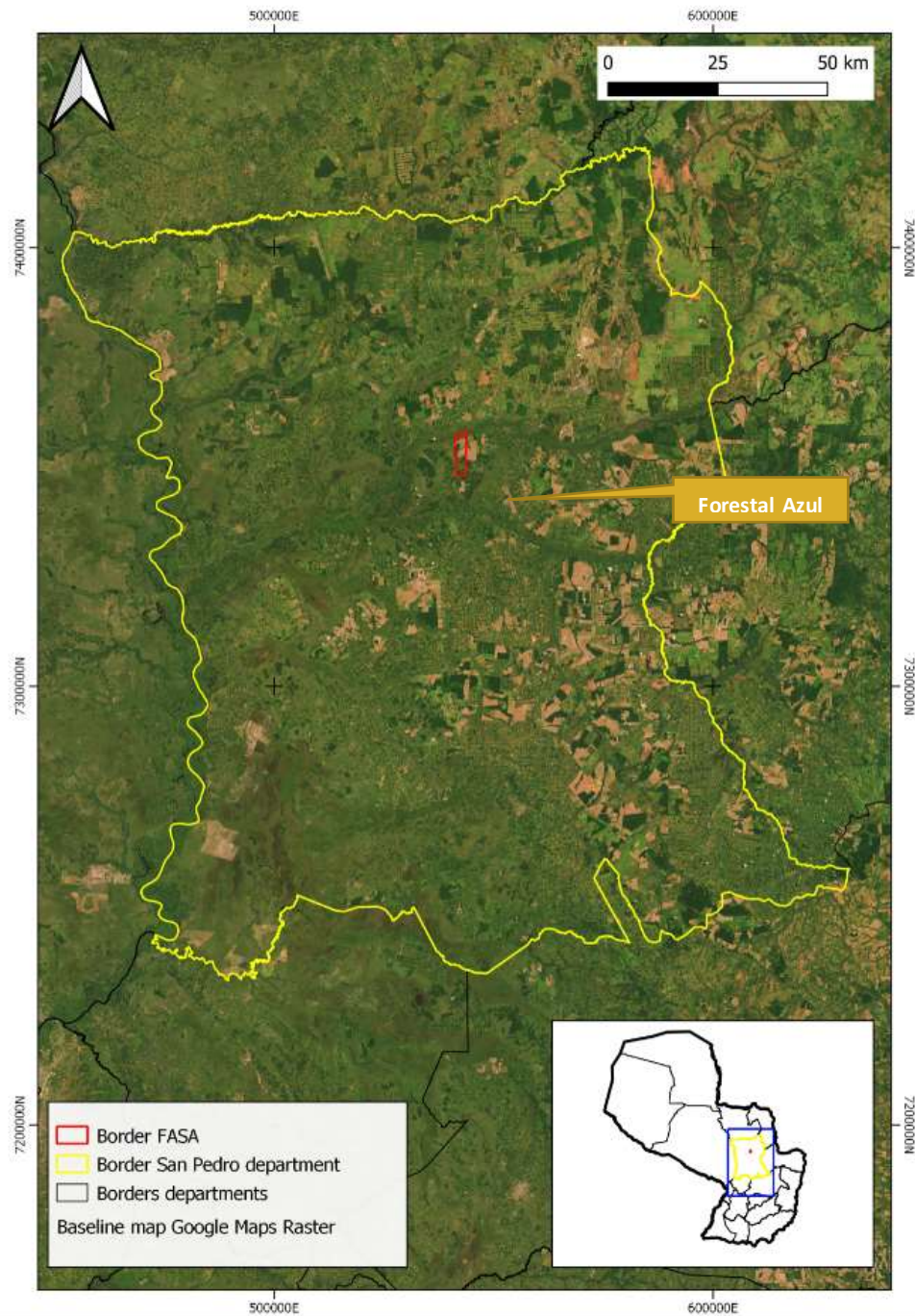


Figure 1. Location of the first project instance, 2020

The project will generate from its first activity instances removals of 284,957 t CO₂ over a crediting period of 20 years or 14,248 tCO₂ annually. Based on the non-permanence Risk Assessment of this project, 15 % buffer credits are to be deposited in the AFOLU pooled buffer account.

1.2 Sectoral Scope and Project Type

According to VCS Standard document version 4, chapter A1.1 (19.09.2019) the project activities fall under the eligible AFOLU project category of “Afforestation, Reforestation and Revegetation (ARR)”. The proposed project is a grouped project.

1.3 Project Eligibility

The proposed project activity supports the scope of the VCS program by initiating project activities that sequester carbon through afforestation of former agricultural and implanted pasture land, encompassing 731.5 ha and 575.5 ha of the first validation plantations, respectively.

The following eligibility criteria have to be met, to be accounted as AFOLU, ARR project under the VCS.

10 years no conversion of native ecosystems:

According to the VCS Standard (V4) Appendix 1.1., eligible AR areas must have been cleared of native ecosystems at least 10 years prior project establishment. Furthermore, according to chapter 3.2.4, activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program¹.

The project area consisted of agricultural fields, mostly mechanized soy, or implanted pasture, before tree planting took place.

A historical forest cover analysis of the area shows no conversion of forest in the last 10 years before project start. All areas which contain fragments of natural forests are either protected and not part of the project area subject to afforestation or managed as part of the enrichment planting model explained below.

To conclude, none of the proposed project afforestation areas has been or will be cleared of native vegetation/ecosystems for planting activities.

¹ https://verra.org/wp-content/uploads/2020/03/VCS-Standard-v4.0_Updated.pdf

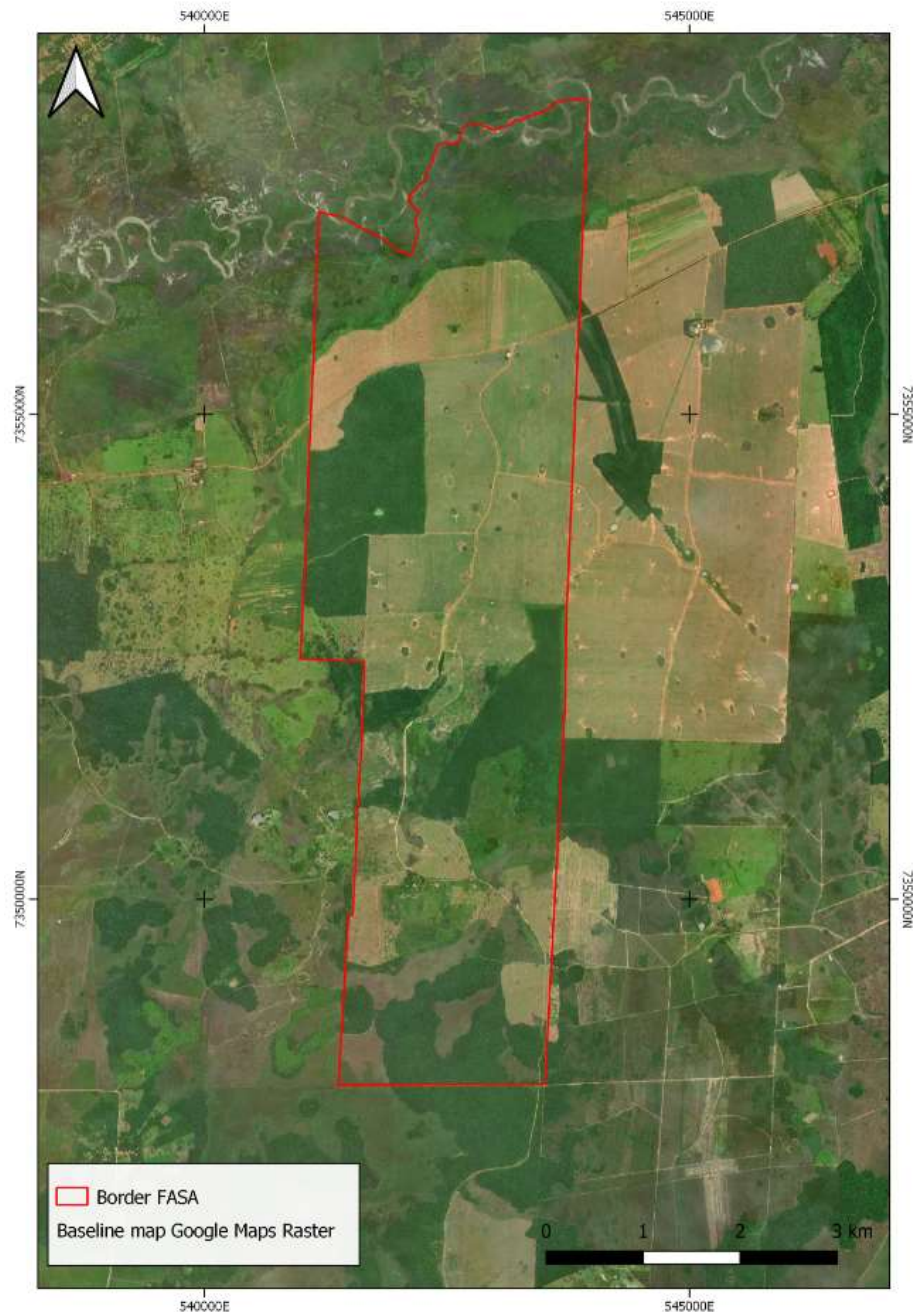


Figure 2: Forestal Azul Carbon Project area in December 2018, Google Earth

No Drainage

The VCS Standard Art 3.2.5 states: *“Activities that drain native ecosystems or degrade hydrological functions to generate GHG credits are not eligible under the VCS Program.”*²

² <https://verra.org/wp-content/uploads/2020/03/VCS-Standard-v>

Forestal Azul did conduct drainage in some of their areas and therefore they have been excluded from the area part of the first instance. In order to completely separate the areas affected by drainage, the following analysis was conducted.

The analysis for the area affected by the drainage was done using the following datasets as basis:

- The drainage lines/channels were digitalized
- A high resolution Digital Elevation Model created using Aerial imagery in the time just before the planting.

Where drainage lines were completely surrounding the forest compartment, all of the area is considered as “affected by drainage”. This refers to the compartments SPS 16-1, 16-2, 17-1 and 17-2

In all the other cases, drainage lines were either touching one border of the compartment or going through a part of the compartment. For these cases, the analysis used the configuration of the terrain, looking for “watershed” like characteristics. The area considered as “affected by drainage” in this case starts from the drainage line and extends outwards up to the point where a significant change in elevation is noticed on the Digital Elevation Model. The shapefiles with the drainage lines and the excluded part can be found as supporting documentation.

1.4 Project Design

Forestal Azul Carbon Project corresponds to the VCS scope 14 (Agriculture, Forestry and Other Land Use) under the Afforestation, Reforestation and Revegetation (ARR) AFOLU project category. The project is a grouped project and will register several different instances of project activities.

Eligibility Criteria

According to the Section 3.5.15 of the VCS Standard v.4, grouped projects shall include one or more sets of eligibility criteria for the inclusion of new project activity instances. The new instances will accomplish the applicability conditions of the methodology AR-ACM0003 Version 2.0, which is approved for use under the VCS Program. These conditions are described in the section 3.2 of this document to justify the inclusion of the first project instance areas.

Any new instance will meet the following criteria:

- 1) Meet the applicability conditions set out in the methodology applied to the project.
- 2) Use the technologies or measures specified in the project description and apply the technologies or measures in the same manner (See chapter 1.11).

- 3) Be subject to the baseline scenario determined in the project description for the specified project activity and geographic area.
- 4) Show the same characteristics with respect to additionality consistent with the initial instances for the specified project activity and geographic area.

The baseline scenario and the demonstration of additionality are determined for the entirety of the geographic project region where project activity instances are developed. The regional baseline scenario for all new project areas will be consistent with the baseline identified in section 3.4 where the tool “Combined tool to identify the baseline scenario and demonstrate additionality in ARR CDM project activities” has been applied. Similar barriers as presented in the analysis are relevant in any new instances in order to ensure their eligibility. The boundary of the project region of this grouped project was selected to represent similar land use systems and socio-economic conditions of Eastern Paraguay.

In addition, the internal project criteria for inclusion will be:

- 1) Areas that are biophysically suitable for the production of quality timber.
- 2) The sites should be on private properties with legal titles, and where the land is not being subject to long-lasting or unresolved disputes or conflicts over land use rights.
- 3) Sites where past transgressions of the environmental law by previous owners did not result in environmental liabilities that are difficult to resolve.
- 4) Natural forests or areas with High Conservation Values.

In addition and according to Section 3.5.16 of the VCS Standard v.4, grouped projects provide for the inclusion of new project activity instances subsequent to the initial validation of the project.

1.5 Project Proponent

Organization name	Forestal Azul S.A
Contact person	Andrea Braun
Title	Property manager
Address	Forestal Azul Teniente Rivarola 832 and Florida Fernando de la Mora Paraguay
Telephone	+4976120853440

Email	andrea.braun@unique-forestinvestment.de
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1.6 Other Entities Involved in the Project

Forestal Azul has a service provision contract with UNIQUE for the administrative, technical, and environmental and social management of the company and its operations. The operational management is conducted mainly by UNIQUE's Paraguayan subsidiary UNIQUE Wood Paraguay S.A., however monitoring, backstopping, reporting, and the development of the Forestal Azul Carbon Project is conducted by UNIQUE land use GmbH.

Organization name	UNIQUE Wood Paraguay
Role in the project	Project development and implementation
Contact person	Rafael Ortiz
Title	CEO
Address	UNIQUE Wood Paraguay S.A. Teniente Rivarola 832 and Florida Fernando de la Mora Paraguay
Telephone	+595 21 511 773
Email	rafael.ortiz@unique-wood.com

Organization name	UNIQUE land use GmbH
Role in the project	Project development support
Contact person	Matthias Seebauer
Title	Senior consultant

Address	UNIQUE Land Use GmbH Schnewlinstraße 10 79098 Freiburg Germany
Telephone	+4976120853428
Email	matthias.seebauer@unique-landuse.de

1.7 Ownership

Forestal Azul is a private limited company (Sociedad Anónima – S.A.) established under Paraguayan law by the public deed 10832811 dated 16.04.2018. The company is owned by Forestal Azul Holding (99 %) and UNIQUE Wood Paraguay (1 %). The majority shareholding of the Forestal Azul Holding lies with a German family office.

Forestal Azul purchased the property originally known as “Rodeo Guazu” in 2018. Property rights are registered through the public deed 10832806 dating 16.04.2018. The company is the rightful owner of the property rights and of carbon credits to be generated in this project. Property titles were subject to a legal due diligence before the purchase took place. In addition, neighboring community members were interviewed to rule out any claims on the land. No conflicts were identified.

Forestal Azul may expand its operations during the upcoming years (grouped project) through future property purchases or lease. In case land should be leased and incorporated into the project, the lease contract will include a chapter about carbon ownership of project activities.

1.8 Project Start Date

Starting date of the proposed ARR project activity: **01-06-2018**

The project start date is defined by the first month where soil preparation and plantation activities started. Additionally, registry of the land title in the name of Forestal Azul S.A in April 2018 is also provided as supporting documentation. First plantations were established in August 2018.

1.9 Project Crediting Period

Project start date	01.06.2018
Project end date	31.05.2038
Total Number of crediting years	20 years, renewable

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Project Year	Estimated GHG emission reductions or removals (tCO ₂ e)
06/2018 - 05/2019	1	330
06/2019 - 05/2020	2	7,337
06/2020 - 05/2021	3	27,540
06/2021 - 05/2022	4	54,511
06/2022 - 05/2023	5	80,018
06/2023 - 05/2024	6	61,645
06/2024 - 05/2025	7	23,523
06/2025 - 05/2026	8	2,867
06/2026 - 05/2027	9	2,266
06/2027 - 05/2028	10	2,266
06/2028 - 05/2029	11	2,266
06/2029 - 05/2030	12	2,266
06/2030 - 05/2031	13	2,266
06/2031 - 05/2032	14	2,266

Year	Project Year	Estimated GHG emission reductions or removals (tCO ₂ e)
06/2032 - 05/2033	15	2,266
06/2033 - 05/2034	16	2,266
06/2034 - 05/2035	17	2,266
06/2035 - 05/2036	18	2,266
06/2036 - 05/2037	19	2,266
06/2037 - 05/2038	20	2,266
Total estimated ERs		284,957
Total number of crediting years		20
Average annual ERs		14,248

1.11 Description of the Project Activity

From the total area, the first instance of the Carbon Project includes 1.159 ha of pure plantations and 148 of silvopastoral systems. Forestal Azul will expand the area to at least to 1,805 ha, including enrichment planting until 2021, however further expansion may occur in the future.

The project implementation/ plantation timeline of first instance plantations according to these different systems is presented in the Table below. The corresponding annual operational plan and the land use map for 2020 is presented in the Annex.

Table 1: Project land use and establishment plan of first instance plantations

Land use	Total área (ha)	Plantation establishment (ha)		
		2018	2019	2020
Pure Plantation – 1,000 trees/ha	625.5	184.5	354	87
Pure Plantation – 800 trees/ha	533.5	161	252	120.5
Silvopastoral Systems – 500 trees/ha	148	0	41	107

TOTAL	1,307	345.5	647	314.5
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Species selection for eucalypt plantations

Different species from the genera of eucalypts are selected, among them: *Eucalyptus grandis*, *E. urophylla*, and *Corymbia variegata*, as well as the hybrids *E. urograndis* (*urophylla* x *grandis*) and *E. grancam* (*grandis* x *camaldulensis*).

The main reason to select the non-native species indicated above is part of the necessity of the country to guarantee a sustainable timber source.

Currently, the country consumes between 12-15 million m³ per year, mostly for energetic purposes source unsustainably from remaining natural forest. Therefore, sustainable sources for timber production are needed to reduce the pressure on natural forests. The potentially negative impacts derived from these plantations are presented in chapter 2.3 Environmental Impact.

In Paraguay, there is very limited research and experience using native species for timber production purposes in an open field. At the moment, the state of the art regarding silvicultural knowledge and the lack of availability of controlled genetic material still limits investments in this regard. Nevertheless, Forestal Azul is participating in the establishment of trials with native species to generate silvicultural knowledge and proof of concept. In 2021, around 15 ha of mix systems have been established. On the best sites with fertile soils, *Eucalyptus grandis* and its hybrids are planted. This species is very productive, since it has a growth of 30 to 40 m³ per hectare per year. The species is suitable for the production of high value timber used for the manufacture of furniture, veneer and laminated wood. There is a high and growing national and international demand for the wood of *E. grandis*. *Eucalyptus grandis* x *camaldulensis* are employed on lower areas, as *E. camaldulensis* is more suited for more humid conditions.

The main advantages of eucalypts and other introduced species when compared to native species are related to high yields brought about by rapid growth rate (between 25 and 40 m³/ha/year) and shorter harvesting rotations (generally between 7 and 15 years). This makes them suitable for developing financially viable forestry projects. In the context of deforestation and forest degradation in Paraguay, they may also reduce the pressure on natural forests.

Eucalypt species have been employed successfully in Eastern Paraguay since the 1950s. To date, they have not shown an invasive behavior or limitations in terms of their productive or environmental suitability. With annual rainfall higher than 1,300 mm and a positive water household (precipitation > evapotranspiration), eucalypts have not been associated to water shortages.

In order to reduce the risk for pests and diseases, Forestal Azul is limiting the share of the area planted with one clone to 20 % of the total planted area. One of the challenges in the past has been the limited availability of genetic material, however in the last few years, professional

nurseries have developed and expanded. Forestal Azul cooperates with these nurseries to keep improving the knowledge on the available genetic material.

Species selection for enrichment of degraded natural forests

Enrichment planting has not been included as an active component for carbon sequestration for this project yet. It has been included as an optional component as “new instance” in case that a VERRA approved methodology will be in place that allows the enrichment planting techniques that allow e.g. the clearing of clearly defined areas in order to re-establish a healthy forest. I.e., with the methodologies currently available under VERRA, the innovative concept of enrichment planting that is approved by the host country cannot be introduced. Nevertheless, it is a fundamental component of Forestal Azul. Enrichment planting is a novel component with potentially high positive environmental/biodiversity impacts. The implementation is associated to significant financial risks. Any potential upside by the carbon component will strengthen the Company’s viability and reduce the financial risks of introducing new concepts to foster forest restoration through private investments.

For enrichment planting of natural forests, following exotic species are going to be introduced:

- *Melia azedarach*, or chinaberry (Eng.), *paraíso* (Esp.) (native of South and Southeast Asia), is a species known for high-quality furniture wood in South America, Asia and parts of Europe. It produces a rosy-colored wood that is comparable to the native *Cedrela fissilis*, which is highly sought-after. The species is found widely distributed in the tropics and sub-tropics. In Paraguay, it has been implanted in a variety of forestry and agroforestry systems since the 1980s with good results on well drained sites.
- *Hovenia edulis* (*dulcis*), or Japanese raisin tree (native to East Asia), is a deciduous shrub-like or small tree, growing up to 10 m. The tree is used as a food, medicine and source of wood. The fleshy, reddish branches of the inflorescences are edible, when the black fruits are ripened. The natural occurrence ranges from Japan, Korea and East China to the Himalayas up to altitudes of 2000 m, growing preferentially in a sunny position on moist sandy or loamy soils. Often cultivated for its fruit, grown as an ornamental, or planted as a pioneer species in reforestation projects, it has also been successfully grown in sub-tropical regions of South America, mainly Paraguay and southern Brazil.
- *Toona ciliata* is a forest species belonging to the *Meliáceas* family, native to Australia and distributed in several tropical regions. It was introduced with the purpose of replacing the Missionary Cedar (*Cedrela fissilis*), affected by the larva of *Hypsiphyla grandella*. In well drained sites located in the rolling hills of eastern Paraguay it has presented good results with no problems related to invasiveness or water. Its timber is of high value, and used in a variety of industries, such as construction, furniture, instruments, etc.
- *Gmelina arborea*, a fast-growing tree, which grows on different localities and prefers moist fertile conditions with 750–4500 mm rainfall. The tree attains moderate to large heights of up to 30 m. *Gmelina* wood is pale yellow to cream-colored or pinkish-buff when fresh, turning yellowish brown on exposure and is soft to moderately hard, light to moderately heavy, lustrous when fresh, usually straight to irregular or rarely wavy grained and medium course

textured. Gmelina timber is reasonably strong for its weight. It is used in constructions, furniture, carriages, sports, musical instruments and artificial limbs.

- Paulownia sp., or Kiri, native to East and Southeast Asia, is a broadleaved tree species known for its fast growth and light yet strong wood. The extraordinarily dimensionally stable wood is used for boat building, surfboards, furniture and instruments. Trees can grow to maturity in under 10 years (up to 4-5 m per year), making it one of the fastest growing hardwood species in the world. The fast growth in combination with its wood features makes the species also interesting as producer of biomass such as firewood and leaves for feedstock. Kiri only colonizes well on sterile and well-drained soils.

Silvicultural regimes

Before planting, the silvicultural regime is established based on estimated production tables. Production tables have initially been modeled based on figures of similar plantations and data of the Brazilian Corporation for Agricultural Research (EMBRAPA). Later on, they are calibrated based on annual inventories. The main features of the most widely applied regimes applied are presented in the tables below. In the following sub-sections, the basic characteristics of the different silvicultural regimes applied are presented.

Pure plantations

The areas previously used for agriculture are converted into forest plantations with the aim of high-quality timber production. Tree species employed belong to the eucalyptus family. Two different silvicultural regimes will run simultaneously:

- 12-year turnover for the optimization of the overall increment for high-quality timber.
- 10-year turnover for the optimization of the date of harvest, to smoothen the cashflow profile of the project.

The essential characteristics of both silvicultural regimes are illustrated in Table 2.

Table 2: The silvicultural regimes of pure high-quality timber plantations

Parameter	12-year turnover	10-year turnover
Planting density	1.000 trees / ha	800 trees / ha
Plant spacing	5 x 2 m	5 x 3 m
Used Tree Species	different Eucalyptus species	
Thinning	year 2, year 5 and year 8	year 2, year 4 and year 7
Pruning	year 1, year 2, year 3, year 4	
Harvest	year 12	year 10
Expected growth (MAI)	40 m ³ /ha/yr	38 m ³ /ha/yr

Silvopastoral systems

A silvopastoral production is set up on areas with sowed pasture (soils of the yield class III).

Silvopastoral production integrates two components in the same area: Management of cattle for beef production, and management of trees for wood and timber production. Trees are planted in spacings of two rows in between large alleyways that allow for grazing. To protect the young plants, cattle is only allowed into the area one year after trees are planted.

Cattle farming is limited to extensive pasturing for fattening (without breeding). The young cattle are bought with approximately 180 kg and fattened on the pasture to reach a weight of approx. 400 to 450 kg. Then they are sold to local traders or to slaughterhouses.

With the growth of the trees the shadow affects grass growth negatively. On average, during the whole forestry cycle, meat production amounts to approximately 60 % of a regular pure grassland system. Under open land conditions meat production of 200 kg/head/year is achieved with a stocking density of 1.5 head/ha. With silvopastoral production the average stocking density throughout the forestry production cycle may reach about 0.8 head/ha, and weight gain of about 100 kg/head/year.

Supplementary feeding is limited to 3 - 4 months in winter to avoid weight loss. The essential silvicultural regimes are presented below.

Table 5: Silvicultural and cattle farming measures of the silvopastoral systems (SPS)

Parameter	SPS with sowed grass	SPS in natural grasslands
Silviculture		
Planting density	714 trees / ha and 500 trees/ha	
Plant spacing	5 x 2 x 9 x 2 m	
Used tree species	different Eucalyptus species	
Thinning	year 2, year 5 and year 8	
Pruning	year 1, year 2, year 3, year 4	year 1, year 2, year 3
Harvest	year 12	
Estimated growth (MAI)	34 m ³ /ha/yr	25 m ³ /ha/yr

Enrichment planting of degraded forests

The remaining natural forests with a total area of 541 ha consist of three forest types.

- So-called *Bosques Altos* (translates: high forests): These forests falter on soils of the yield class II and III and reach heights from 30 to 35 m. On account of their potential yield they are converted into sustainably managed close-to-nature forests using intensive enrichment planting. This forest type covers 376 ha of the area of the Finca.
- So-called *Bosques altos a transición* (translates: high to transitional forests). These forests are less vigorous owing to their location. However most of them show good potential for production. These forests take up 165 ha. While some of these forests will be protected, those with potential for management may be managed in the future.



Figure 3: Aerial Photo of a degraded Timber Forest (Bosque Alto), taken in October 2017

In the last decades the natural forests on the finca have been used intensively and with little care to their condition. What stayed behind are forests which are strongly degraded in

composition and structure: Basal area (currently 8 m²/ha) and stem wood volume (currently 48 m³/ha) reached only one third of their potential when healthy and/or in well preserved condition.

Basis for decision to conduct enrichment planting

By the end of 2017 an inventory was conducted in the natural forests of the finca, showing these are in a highly degraded state due to recurrent exploitation over the past decades. The average results of the forest inventory are presented in the Table below and analyzed according to Grulke (2001). The main observations in this regard are summarized below:

- The natural regeneration of commercial species with a DBH > 10 cm is 212 individuals/ha, while the natural regeneration considering individuals with 2 m in height and DBH < 10 cm only reaches 132 individuals/ha. According to Grulke (2005), a forest can be considered highly degraded when the future number of trees is less than 200 trees/ha or if natural regeneration is less than 200 individuals/ha.
- The basal area of trees with DBH > 10 cm reaches 7.6 m²/ha. This value is considered too low for sustainable management, which requires a minimum basal area of 14 m²/ha.
- The standing volume of trees with DBH > 10 cm reaches 48.1 m³/ha, below the minimum values for management. As a reference, for a moderately altered forest, an average stand volume of 150 m³/ha or more is considered normal.

Table 8: Parameters and benchmarks to define the level of degradation of natural forests in eastern Paraguay according to Grulke, 2001, compared to the results of the baseline inventory conducted in the natural forests on Forestal Azul

Parameter	Unit	Level of Degradation		
		Light	Intermediate	Strong
N° of species	N°/ha	>65	60-64	32-59 Result: 53
N° of trees with DBH > 10 cm	N°/ha	>460	370-459	300-369 Result: 212
N° of regenerating mature commercial trees/ha	N°/ha	>30	20-29	10-19 Result: 6
N° of naturally regenerated commercial trees (DBH < 10 cm)	N°/ha	>1.400	1.000-1.399	500-999 Result: 132
Basal area (m ² /ha)	m ² /ha	>32	25-31	14-24 Result: 7,6
Stand Volume of trees with DBH > 10 cm	m ³ /ha	>200	150-199	60-149 Result: 48
Stand Volume of trees with DBH > 40 cm	m ³ /ha	>30	20-29	10-19 Result: 14,5

Source: Markus Grulke, 2001.

According to the results described, the natural forests on Forestal Azul are located in the lower left quadrant of the matrix presented in Figure 4.

Due to the level of degradation, the forest cannot be rehabilitated by only promoting the natural regeneration of high value commercial species. Therefore, it is considered appropriate to subject it to an intensive enrichment regime in order to restore/rehabilitate the forest and reintegrate it into a sustainable system of production and value creation. The system will be implemented in the form of rows of enrichment plantations with fast-growing exotic tree species of the mahogany family. This will require the clearing of rows of about 20 to 30 m width, in which implanted trees will be managed just like a pure plantation.

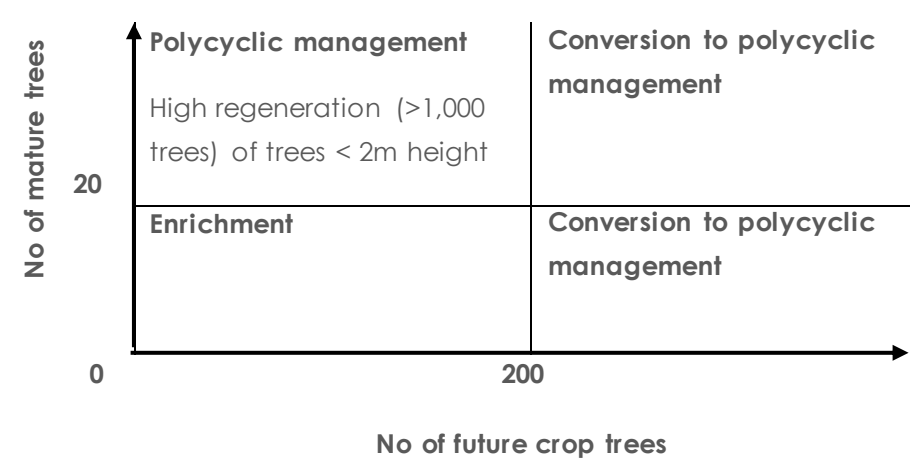


Figure 4: Decision making matrix for the sustainable management of forests in eastern Paraguay

When clearing, natural regeneration of future crop trees and commercial tree species will be spared. Note that, in Paraguay, naturally occurring future crop trees usually coincide with endangered species, due to their over-exploitation in the past, and their low appearance in higher diameter classes.

While managing the planted trees, natural regeneration in both the cleared rows and the natural remaining forests in between the rows will be fostered and managed. The process is illustrated in the figure below.

Opening of 20 m aisles and introduction of selected high-value exotic species in a density of 500 trees/ha	Management of introduced species in a rotation of about 15 years and management of natural regeneration	Regeneration of the natural forest that is managed in a polycyclic system after the harvest of exotic species
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Figure 5: Intensive enrichment planting process

These fast-growing, non-native tree species secure the economic feasibility of the natural forest rehabilitation. After one generation, the fast-growing planted trees are harvested and completely removed from the system.

This is economically an interesting option because the degradation processes of the past decades have only impacted the growing stock, but not the ground (neither nutrient abstraction nor soil compaction by agricultural use).

The advantages of this system are:

- 1) Reactivation of a natural ecosystem that is currently not productive and therefore in danger of disappearing.
- 2) Halting of degradation of the soil and as a result promising increments.
- 3) Interesting income will be maintained after 12 to 15 years, which ensures the economic sustainability of the forest management.
- 4) After the rotation of the enriching species, there is a recovered and diverse native forest left that can be managed sustainably.
- 5) Because of the previous use there is a minimum of infrastructure established.
- 6) There is no conflict with agricultural production since it is located on forest land.

Table 9: The silvicultural regime of intensive enrichment planting

Parameter	Silvicultural implementation
Site preparation	Opening of 20 m wide aisles in between of 20 m wide alleys of forest
Plant spacing in the aisles	5 x 2 m (equals 500 trees/ha)
Used tree species	Paraiso (<i>Melia azederach</i>), Hovenia (<i>Hovenia dulcis</i>), Toona (<i>Toona ciliata</i>), Gmelina (<i>Gmelina</i> sp.), Kiri (<i>Paulownia</i> sp.)
Thinning	year 2, year 5 and year 8
Pruning	year 1 (2x), year 2 (2x), year 3, year 4
Final harvest	year 10-15 (mean 12 years)
Estimated growth (MAI)	17 m³/ha/yr (of which 11 m³/ha/a stem wood)

Forest operations

Table 3. Schedule example of forest operations

Activity/years	Plantation age											
	1	2	3	4	5	6	7	8	9	10	11	12
Weeding	X	X	X									
Pruning	X	X	X									
Thinning		X		X			X					
Harvest										X		

Forest planning

Plantations are divided into compartments (called “bloques”) with surfaces between 20 and 50 ha. These are the smallest spatial units used for forest planning and monitoring. One compartment is homogeneous in terms of its silvicultural regime, species used, and operations conducted. These compartments are also the basic unit used for forest monitoring.

Soil preparation

The site is cleared mechanically before planting activities are conducted. Tree stumps that remained from previous clearances years ago are removed, and shrubs are felled. The organic material is distributed over the plantation area with a motor scooter.

Soil practices applied include plowing, harrowing, deep plowing and manual drilling. Furthermore, on around 20 % of the area, lime is applied to prevent soil acidification, often accompanied by pre-emergent herbicide.

Planting

Initially, all areas which will be reforested are demarcated. During planting, the highest priority is to ensure good growth and seedling survival. Therefore, the plant rooting is facilitated by planting the seedlings in wide spacings and in a single pit. Sometimes, platforms have to be constructed to ensure a uniform ground, or stones and other objects have to be removed before planting. Compaction is avoided after planting, to ensure good root establishment.

The best planting period is between March/April to September/October, based on previous experiences, since planting during hot or dry conditions increases seedling mortality. However, in exceptional cases planting is conducted in dry periods using gel and irrigation.

In case tree mortality reaches more than 15-20%, replanting is conducted during the first six month after planting. In order to reach the yield target, a survival rate of 85-90% is required. This is usually determined latest one year after planting.

Maintenance

Maintenance activities include all operations necessary to protect trees from regular threats. This includes protection from leaf-cutting ants, weeds, fire, and pests and diseases. Regular maintenance includes:

- The protection against weeds, particularly during the first year, as high weeds compete with young trees. Weed control includes regular mechanical control, using hoe or machete, or chemical control employing glyphosate. Normally, chemical control is only employed during year 1, with up to 3 applications of about 2 l/ha throughout the year.
- Control of leaf cutting ants: Leaf cutting ants are the most important threat to forest plantations in the Cono Sur region. They can significantly affect tree development, and easily cause the death of young trees. Leaf cutting ants are controlled chemically with pesticides based on the active ingredient Fipronil. Pesticides are applied on low doses specifically dosed according to the ant species and nest sizes. Application is conducted with baits that are more environmentally friendly compared liquid spray and less hazardous to human health.
- Firebreaks are installed and maintained around established compartments to protect plantations against the advancement of fires. During the dry season, efforts for vigilance and fire control increase.

Pruning

Pruning is conducted to ensure the production of clean timber free of knots. Pruning is planned to reach up to a height of 10 m, in around 4 to 5 pruning interventions, mostly during the first three to four years.

Thinning and harvesting

Thinning is performed to minimize intraspecific competition and promote diameter growth of the best trees. The best-performing trees are selected to remain, while poor performing trees are harvested.

Thinnings are conducted at a plantation age of 2 (1st thinning), 4-6 years (2nd thinning), and 7-9 years (3rd thinning). Approximately 35% - 43% of the standing volume is harvested during thinning, leaving a target final density of 200 trees/ha for the final cut. The final harvest is conducted at age 10-13, depending on the planting design, tree development and competition.

First thinning is conducted largely manually, whereas from second thinning onwards, semi-mechanized harvesting methods are employed, using harvesters and/or skidders.

Forest operations for enrichment planting

Opening of strips

A compass is used to mark the center of a strip. A 1.5-m cut is made at this point, and on each side 10 m are opened with a machete, making a total width of 20 m. This corresponds to cleaning lianas and large weeds.

Tree marking

Then, potential commercial trees that should be managed are marked:

- Future trees: trees of commercial interest with a diameter of less than 10 cm and a height of at least 2 m.
- Commercial/seedling trees: healthy trees of commercial species with a diameter greater than 10 cm and between 3 and 5 m in height.

Felling, cropping and clearing

The unmarked trees are felled. The aim is to have a single directed felling cut whenever possible, but given the severely degraded state, often the trees are very crooked or their movement is limited by the lianas.

Trunks with a remaining value for certain production, normally firewood or coal, are pre-cropped on-site and removed.

Planting

A mechanical clearing with a machete or chainsaw is carried out in the plantation line and like that a grid is formed at the established density of the plantation. In this case 5 x 2 m (in the future perhaps 2.5 m x 5 m). Then, with a pointed shovel plant holes of about 30 cm depth and a radius of about 20 cm are dug. Each plantation line corresponds to a species, and at least 2 species are used per strip.

Maintenance of enrichment plantation

As with the eucalypt plantations, ant and weed control is conducted regularly, particularly during the first 2 years, using Fipronil and Glyphosate, respectively.

Formative pruning

Formative pruning is carried out when the planted trees reach 2 m in height, depending on the species. For Paraiso, this is estimated at about 6 months. At the same time, the management of natural regeneration can start (see next).

Management of future trees and regeneration

The management of regeneration and future trees that were selected is initiated before felling. For the management of the regeneration, the best shoot is selected.

Pruning and thinning

Pruning and thinning regimes must be adjusted for each species according to their development.

Infrastructure

As the property was already used for productive purposes before plantations are established, plantations are easily accessible. They can be reached by main roads accessible year-round by truck. The average density of these roads is of 10 m / ha.

Due to climatic conditions (rains, winds) or the irregular use of some roads (growth of vegetation), maintenance of roads, extraction routes and firebreaks is carried out every two to three months. Not frequented side-roads are often used as firebreaks, and therefore, their maintenance is critical.

Conservation

The property exhibits fragments of natural ecosystems that are protected by Forestal Azul. All natural forests not enriched will be strictly protected, including patches of transitional forests (about 150 ha). In addition, an area of around 100 ha of lowlands are strictly protected.

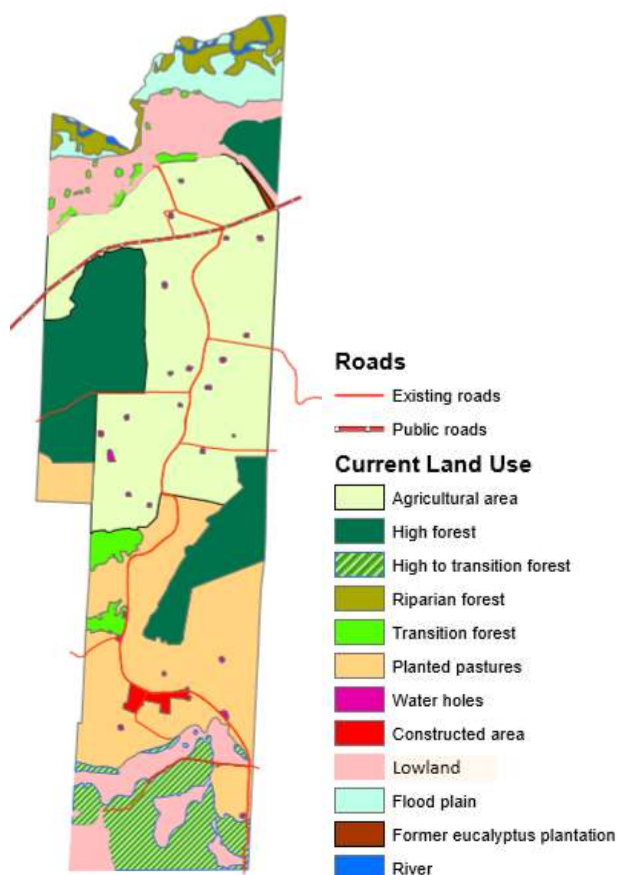


Figure 6: Ecosystems in Forestal Azul

The project introduces the following safeguards to avoid impacts on protection sites:

- i) Plantations are only established on demarcated sites, monitored through geospatial data;
- ii) Hunting, uncontrolled logging, and the uncontrolled use of fire are forbidden and monitored;
- iii) Pesticides are used only when needed, and their management and use is controlled;
- iv) Roads and infrastructure is mostly existent or established on already modified areas; and,
- v) Road construction and maintenance, as well as plantations establishment, is conducted according to best practices to avoid erosion. Conservation sites established by the company are compatible with the requirements by law. The law prohibits any forest conversion, requires the maintenance of at least 25 % of natural forest cover compared to 1986, and buffer zones according to the specifications of the Decree 9824 from 2012 (see Table 5). The project holds a valid environmental license granted by the Ministry of Environment.

Jurisdiction of JNR

Paraguay is a partner country of the FCPF and runs under the REDD+ readiness program. However, the Forestal Azul Carbon Project is not part of a JNR program of the VCS or the state of Paraguay.

1.12 Project Location

Forestal Azul is a large landholding (hereinafter referred to as Estancia or Finca) with an area of 2,309 ha (Estancia Rodeo Guazú). It is located in the eastern region of Paraguay, in the district of San Pedro, approximately 250 km north from the capital Asunción and 20 km south from Santa Rosa del Aguairay. The property is easily accessible through the paved road Ruta 3, followed by a dirt road on the last 7.5 km. It is surrounded by other large landholdings mainly dedicated to cattle grazing, soy, maize, and forestry. In the north, the River Aguairay Guazú establishes itself as a natural border to the property.



Figure 7: Geographical location of the Estancia Rodeo Guazú

The FMU Forestal Azul currently encompasses a target net production area of around 1,805 ha, already including first instance plantations. For further expansion, other properties in the vicinity will be considered. Since these areas have not yet been identified, the outer project boundary is the entire Department of San Pedro. The plantations of the first project instances are located between $24^{\circ}37'54.00S$ - $24^{\circ}43'31.00S$ and $56^{\circ}20'06.00W$ - $56^{\circ}14'25.00W$.

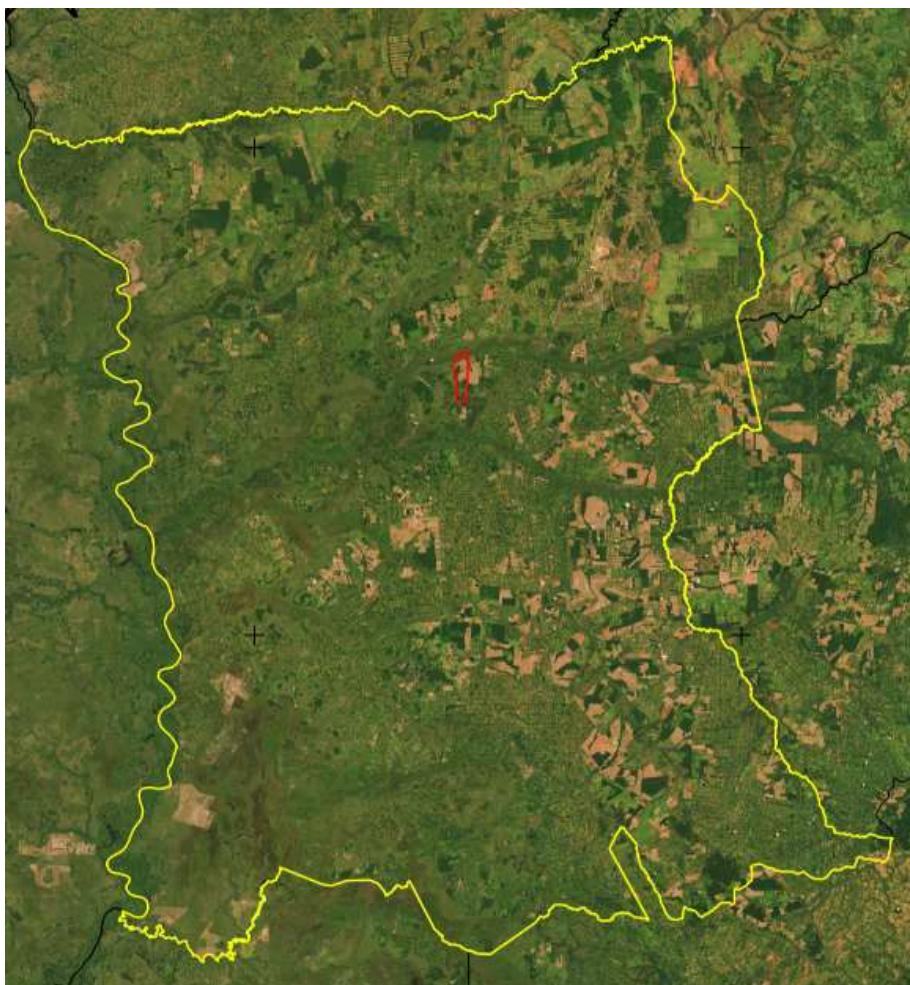


Figure 8: Outer boundary of Forestal Azul Carbon Project (Department of San Pedro), inside Forestal Azul first instance.

Project GIS maps are available as supporting documentation.

1.13 Conditions Prior to Project Initiation

The subchapters below provide a general description of the baseline condition of the region defined as the outer boundary according to section 1.12 above.

Climate

Eastern Paraguay exhibits a sub-tropical climate, with annual average temperature and rainfall of around 23°C and 1,300 mm (see Figure below).

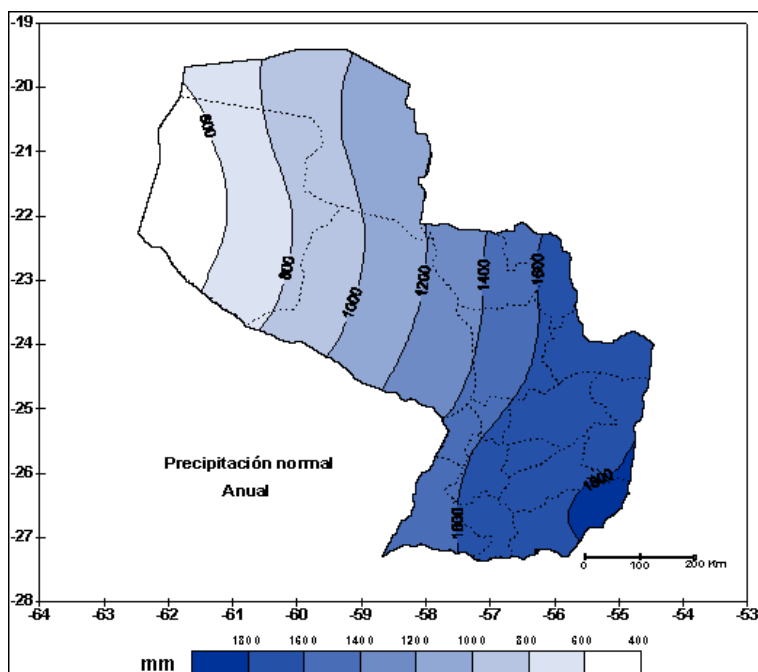


Figure 9: Precipitation gradient in Paraguay³

The climate of Eastern Paraguay can be described as subtropical. The city of San Estanislao exhibits approximately 1,500 mm of annual rainfall. Average temperatures range between 25 °C during the summer month of December/January and 17 °C during the winter month in June/July.

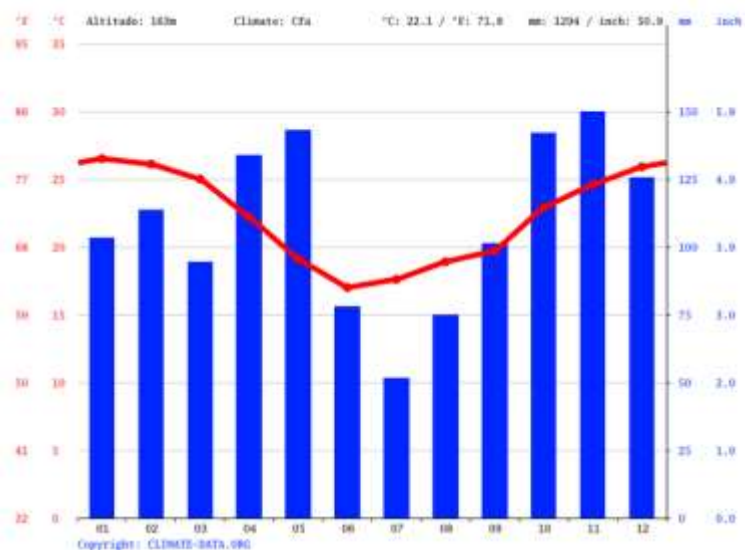


Figure 10. Climate data San Estanislao, San Pedro Department

³ Source: www.camposparaguay.com.py

The region exhibits its dry season in winter, with peaks between June and September, in which average monthly precipitation is approximately 40-50 mm. The risk of fire is highest during these months.

Topography and soil

Eastern Paraguay exhibits rolling hills, alternating between higher areas, lowlands and sandy soils on slopes. In general, the region is relatively flat, with gentle slopes towards water courses. While soil and climatic conditions are suitable for forestry, large varieties in suitability are common in most properties, with a share of low suitability on lowlands prone to floods.

The soils most suitable for plantations are located on higher, well drained areas that were formerly used for agriculture, mainly soy and maize, sugarcane, or implanted pastures. These soils belong to the sub-group “Arenic Rhodic Kandiudult”. They present some limitations in terms of erosion, due to superficial sandy layers, acidity and fertility. However, they are well suited for plantation forestry given appropriate correction measures are implemented.

On transition areas between lowlands and higher areas, where limitations for forestry are a bit stronger, the soils belonging to the sub-group “Psamment Rhodic Kandiudult” are common, which, under certain conditions, can be used for reforestation. The current land use on Azul is presented in chapter 3.4. in detail.

Hydrology

It is a flat region with a heterogeneous set of wetlands such as lagoons, estuaries and wetlands that are subject to the influence of the floods of the Paraná, Pilcomayo and Paraguay rivers and their tributaries. Nevertheless, target production areas avoid areas associated to water bodies, subject to flooding.

Socioeconomic situation

Eastern Paraguay concentrates 97% of the country’s population, with 6.9 million inhabitants in 2019, and extends over 160 000 km.

The country was exhibiting rapid economic growth between 2003 and 2018, and poverty decreased significantly, with a poverty rate of 24% in 2019. However, social progress deaccelerated from 2013 onwards, and inequality remains high in rural areas, with a large gap between the high-tech agroindustry and the “campesinos”, often living in regions with weak social structures and state presence. This has fueled long-lasting, unresolved social conflicts related to access to land, drug production and trafficking, particularly in the northern part of Eastern Paraguay.

The agro-exporting model has made the country dependent on the international commodity prices of only two products (soy and beef). In the context of an absent state in many rural areas, this model has failed to create local sustainable socio-economic value, leading to the rural exodus

of smallholders and traditional farmers. 2019 and 2020 have been years of economic crisis, affecting the rural poor disproportionately.

Vegetation and ecosystems

The Forestal Azul Carbon Project is officially located in a transition region between two ecoregions, the "Chaco Húmedo" (mosaic forests and savannas on sedimentary soils, originating from rivers), and the "Atlantic Forests" (subtropical broadleaf forest). Usually, lowlands associated to watercourses feature Chaco-like characteristics, while high areas with deeper soils belong to the Atlantic Forest ecoregion.

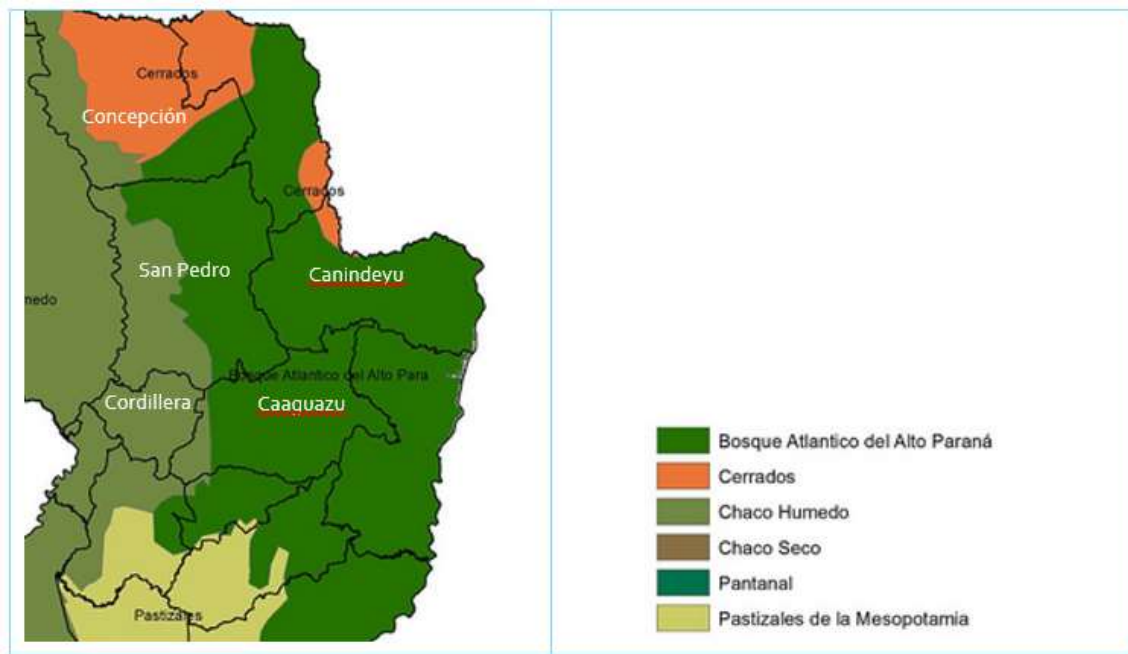


Figure 11. Ecoregions of Eastern Paraguay according to Dinerstein et al. (2017)

The Forestal Azul Carbon Project targets higher areas, which usually belong to the Atlantic Forest. This ecoregion features a deforested and degraded landscape, classified as critically endangered⁴ (Dinerstein et al., 2017). Deforestation has been rampant in the region in the last 50 years (see Figure 12). The subtropical Atlantic Forest which once dominated the landscape has been replaced by implanted pastures and mechanized grain production, leaving only 10-15 % of the original forest cover (2 M ha) distributed in highly fragmented and mostly degraded patches.

⁴ <https://academic.oup.com/bioscience/article/67/6/534/3102935>

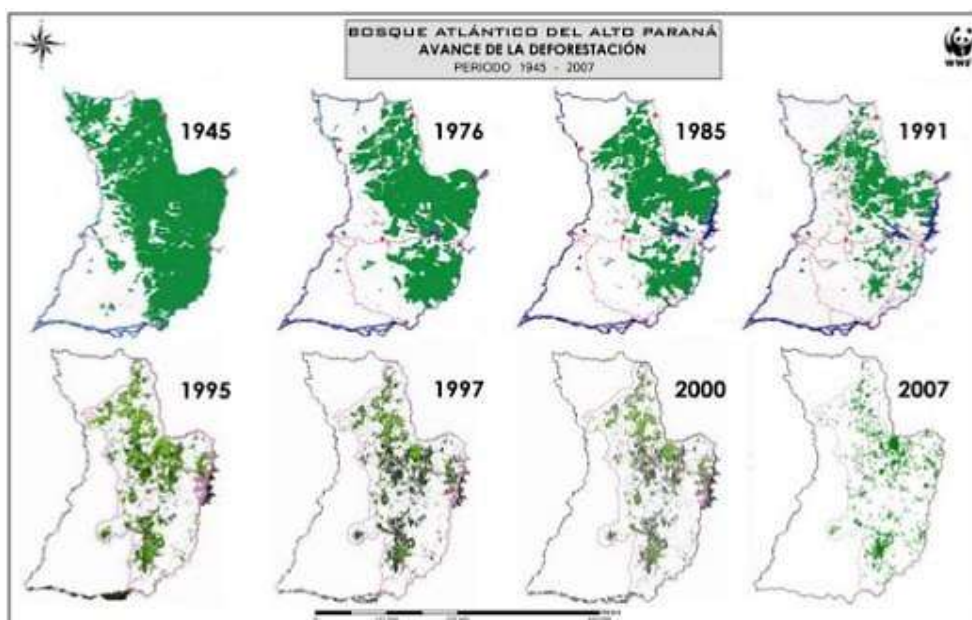


Figure 12. Deforestation development in Eastern Paraguay

Large scale forest conversion has particularly been targeted at the most fertile soils for agriculture, found eastwards of the region, towards the Brazilian border, where grain production is concentrated in large landholdings that employ high level of technology. The most important land uses in the region are beef production (grazing on implanted and natural pastures) and grain production, with around 8 million cattle and 3 million ha of soy (see Figure 13).

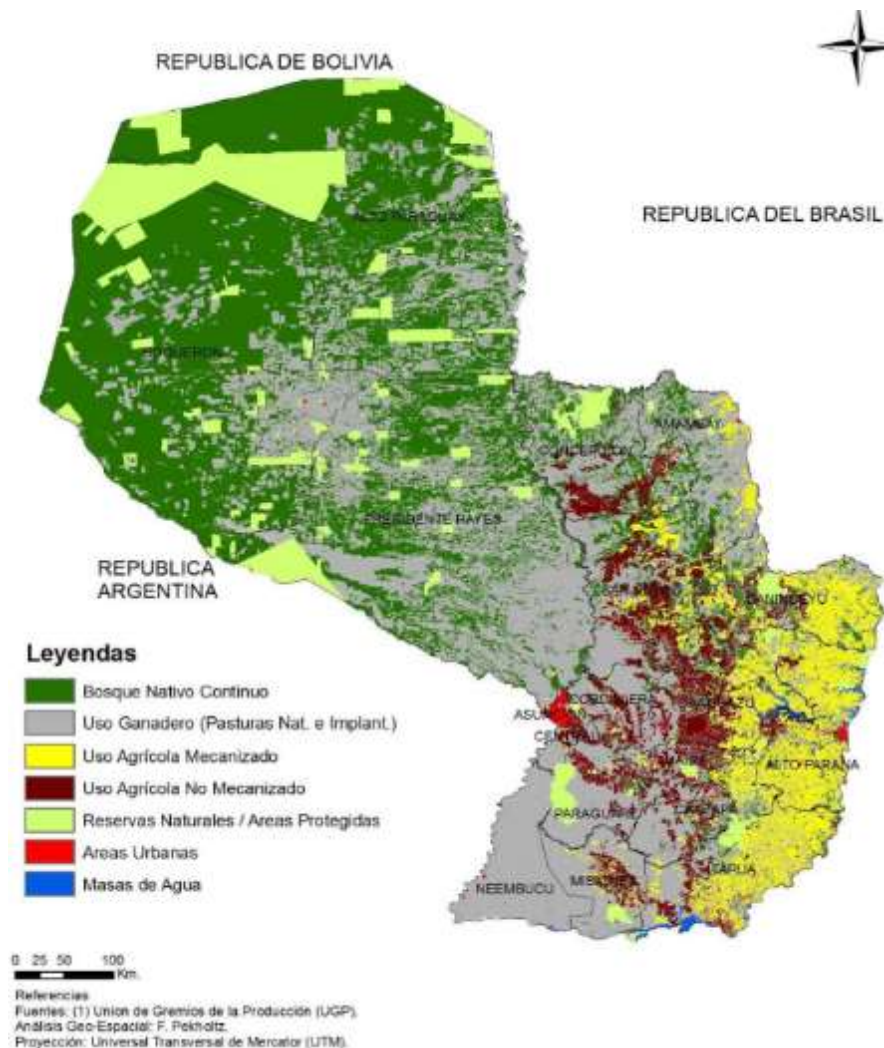


Figure 13. Land use of Paraguay (2009)

The land use on Forestal Azul encountered previous to project initiation corresponds to the most common land uses found in the region: mechanized soy on 731.5 ha and implanted pastures on 575.5 ha (see Figure 14). Mechanized soy is a high input land use model, where genetically modified seeds are sourced from large agro industrial companies (mostly Monsanto) and employed together with a technological package. The whole area is mechanized, and subject to two harvests in one year: Soy in Summer (January/February) and corn in Spring (September).

Cattle, on the other hand, is quite extensive. On Forestal Azul, much of the implanted pasture was in a compacted/degraded state when bought by the company. The owner was leasing his pasture for cattle production, which was used for grazing. Usually, cattle is bought with 9 months of age and around 90 kg/animal and sold after 1.5 to 2 years of fattening, with around 450 kg/animal. Fattening is conducted through grazing, sometimes with some supplementary feeding conducted in winter to avoid weight loss. Besides veterinary inputs and supplements, the inputs used on the grass are low, sometimes using broadleaf herbicides and ant or termite control.

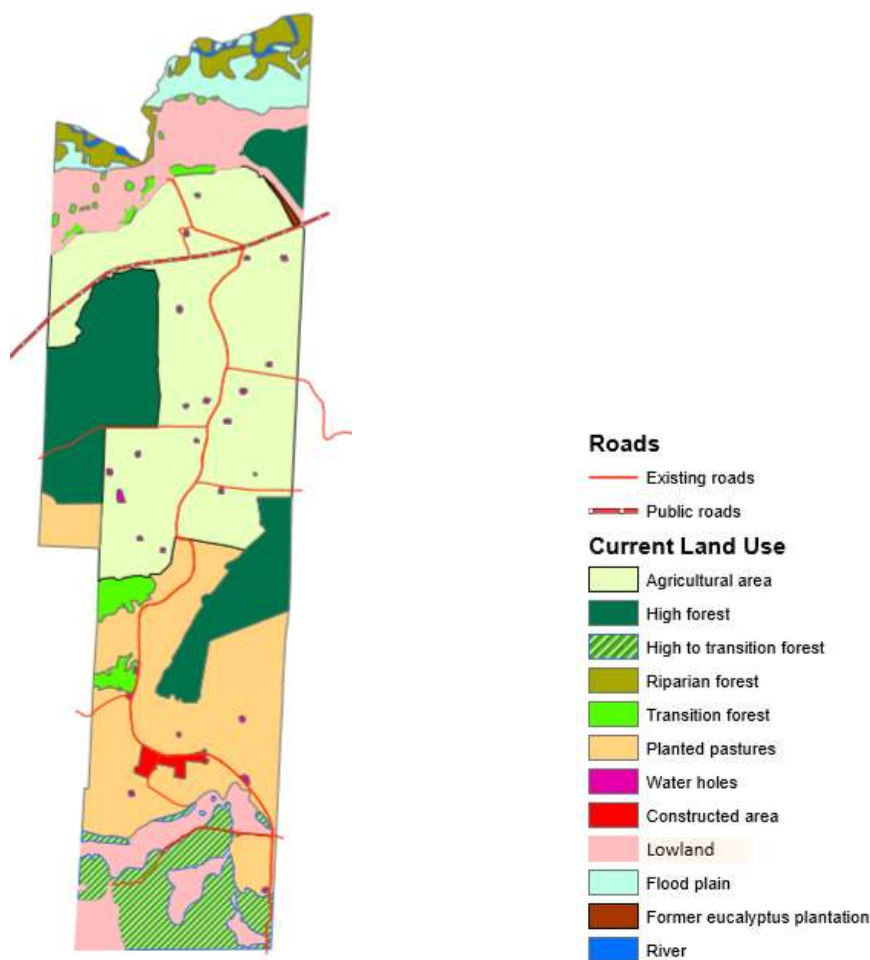


Figure 14. Land use on Forestal Azul before project initiation (2018)

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The ARR project activity is in compliance with all applicable legal and regulatory requirements, which are implemented and scrutinized. A list of the main laws concerned can be found below (Table 4).

The legal and institutional framework of Paraguay is composed by a series of laws and regulations that govern the Azul Carbon Project. Among the most important is the Forestry Law 422/73, which declares the use and rational management of the country's forests and forest lands as public interest.

For the lawful operation of the project, the activities need to get approval and/or registration by the applicable regulatory agencies as follows:

- The National Forest Institute (INFONA), created by Law N° 3464/08, is the institution responsible for the forest sector. INFONA provides permits for the transport and commercialization of timber, approves forest management plans, and registers plantations.
- The Environmental Ministry (MADES) implements and monitors environmental regulations. MADES is responsible for regulating private projects under the Environmental Impact Assessment Law (Law N° 294/93). Rural properties larger than 20 ha are subject to the assessment of environmental impacts and the environmental licensing process (Decree N° 453/2013).

The most important environmental regulations that apply to the project are presented as follows:

- All rural estates in Paraguay covering a surface larger than 20 ha are obliged to maintain 25 % of original forest cover (Law N° 422/1973 and Decree N° 18,831/1986).
- Buffer zones of streams and rivers shall be protected. The exact width depends upon the size of the water body and is regulated by Law N° 4,241/10 and Decree N° 9,824/12.
- Conversion of natural forests to other land uses is not allowed since 2004 (Law N° 2,524/2004 and subsequently N° 3,139/ 2006, N° 3,663/2008, N° 5,045/2013, and N° 6,256/2018).
- Crimes against the environmental law are penalized Law N° 716/96.

In addition, labor relations are governed by Law N° 17,071/1943, N° 1,860/1950 and N° 375/1956. The most important provisions are summarized below:

- The Law N° 213/93 establishes the latest provisions on minimum wage, vacations and other benefits that shall be observed when engaging labor in Paraguay.
- Workers must be registered in the national social security system (IPS), which provides health insurance and retirement pension fund. Costs are split between the employer and the employee, contributing with 16 % and 9 % of the salary, respectively.

Table 4. Main laws relevant for the Forestal Azul Carbon Project in Paraguay

Aspect	Main laws	Description
Main environmental laws	▪ Environmental Impact Assessment Law N° 294/1993 Decrees N° 453/2013 and 954/13 introduce relevant changes to this law. ▪ Crimes against the environment are defined by Law 716/96	The most important requirement for private property owners is the need for an environmental license, subject to an Environmental Impact Assessment. Rural estates larger than 20 ha are subject to the environmental licensing process. The law defines environmental crimes and the sanctions applicable.
Forest and land use laws	▪ Forest law Law N° 422/1973 and decree N° 18.831/1986. ▪ Moratorium on land use change of natural forests in Eastern Paraguay Law N° 2524/2004, followed by Laws N° 3139/ 2006, 3663/2008, 5.045/2013, N° <u>5.266/18</u> and N° 6676/2020.	▪ In Eastern Paraguay, conversion of forest land is forbidden. ▪ All rural estates with a surface > 20 ha need to maintain 25 % of the forest cover existing in 1986. ▪ The law also establishes minimum buffer areas along streams and rivers, and restrictions on steep areas.

Aspect	Main laws	Description
	▪ Water resources and buffer areas Law N° 3239/07, N° 4241/10 and Decree N° 9824/12 ▪ Protected Areas N° 352/1994 and Resolution N° 200/2001 ▪ Wildlife is protected by Law 96/92 ▪ Environmental services by Law 3001/06	▪ Forestry activities involving exotic species is not allowed in protected areas. ▪ Plantations are subject to registration before INFONA for the legal commercialization of timber. ▪ Uncontrolled hunting is forbidden.
Main laws related to labour	▪ Labour Code, Law 213/93, modified and partially updated by Law 496/95, and the Labour Procedural Code, Law 742/61. ▪ All fundamental ILO conventions were ratified by Paraguay.	▪ The law establishes minimum wage, obligatory social security provisions, benefits, freedom of association.
Main laws related to indigenous peoples	▪ Paraguay is a signatory to the core international human rights treaties, including the ILO Indigenous and Tribal Peoples Convention, 1989 (No. 169). ▪ Art. 64 of the Constitution	▪ Paraguay recognizes the right of indigenous communities to communal ownership of their lands.

1.15 Participation under Other GHG Programs

Projects Registered (or seeking registration) under Other GHG Program(s)

The project has not been registered or seeking registration under any other GHG program.

Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG program.

1.15.1 Other Forms of Credit

Emissions Trading Programs and Other Binding Limits

1.15.2

GHG removals generated by this project will not be used for compliance with binding limits to GHG emissions since such limits are not enforced in Paraguay. There are no emissions trading programs in place in the country.

Other Forms of Environmental Credit

1.16.1

The grouped project is not being used to create other environmental credits.

1.17 Additional Information Relevant to the Project

Leakage Management

1.16.2

The Forestal Azul Carbon Project aims to increase the carbon stock of former agricultural land and implanted pastures through afforestation. Leakage would only occur if pre-project activities by previous owners would be shifted somewhere else in detriment of natural forests and/or ecosystems. The risk of leakage is low, as deforestation is not allowed in the region, and the previous owner did not move to an area regarded as an agricultural frontier.

Commercially Sensitive Information

None.

Sustainable Development

The project contributes to the national forest sector by providing proof of concept and implementation of models aligned to political goals, such as the national plan of reforestation (Decree N° 10,147 of 2012), governmental efforts to formalize the biomass sector (Decree N° 4056/2015), and the contribution to the National Determined Contributions of the country, where afforestation is highlighted as a prominent measure.

On the other hand, the Forestal Azul Carbon Project will be one of the first to introduce the carbon component, which will bring about proof of concept and more experience in the region. The project managers will inform the national authorities of the Project, to avoid any possible double accounting in the future, and contribute to any governmental efforts in this regard.

Further Information

Additional information is provided in the Appendix and in the relevant sections.

2 SAFEGUARDS

2.1 No Net Harm

Summary of environmental impact

- The project seeks to recover degraded natural forests, with potential impact for the whole country in terms of introducing and providing proof of concept for a viable natural forest restoration model. Otherwise, these forests are subject to continuous degradation. While the Government has been introducing other mechanisms to foster forest protection (through Payments for Environmental Services, for example), these are not yet making a difference as they are not effectively working on a large scale.
- The project targets areas already heavily modified (used for beef production or mechanized agriculture) for eucalypt planting. These areas have been deforested decades ago. Tree planting on these sites reduces erosion, contributes to an improved water household,

sequesters carbon and in some cases, provides better condition for the connection of natural forests (natural corridors for biodiversity).

- Forestal Azul holds a valid environmental license. While the environmental license is not subject to exhaustive monitoring by authorities, it is a good tool to ensure compliance to the most important environmental regulation (such as non-deforestation, maintenance of the minimum natural forest reserve, and buffer zones), which is evaluated by the Environmental Ministry through satellite imagery at a frequency of about 2 years.
- The plantations require input such as lime, fertilizer, and pesticides for ant and weed control (Glyphosate and Fipronil). These are common products in Paraguay, already used before the activity on these sites. The input use of the plantations is much lower when compared to agriculture, and roughly the same or slightly higher when compared to beef production.
- To date, all commercial forest plantations are still dependent to a certain degree on using herbicides. Weed control is particularly important in the first year of plantation establishment to ensure the survival of the trees. During this time, weed grows faster than implanted trees leading to strong competition and death of trees if left uncontrolled.

There are several ways of controlling weeds. In Forestal Azul, chemical pesticide control with Glyphosate is used in combination with manual control and animals that control weeds in Silvopastoral systems.

Around 4-10 liters / ha are employed for a whole forestry cycle (12 years), usually all in the first two years (2-3 applications per year). After year 3, herbicides are discontinued or used very punctually. It should be noted that forest plantations are replacing previous uses where glyphosate use is more intense. In the first instance, 56 % of plantations are established on areas previously used for intensive agriculture that require around 15 l/ha/year (in total over 12 years 180 l/ha) and 44 % replacing traditional cattle systems where the use of herbicides is roughly the same as in forestry when considering the whole forestry cycle. Therefore, overall, the net environmental impact of forest plantations is strongly positive, reducing the use of Glyphosate significantly.

Regarding risk mitigation, all pesticides are managed according to best practice, and they are used specifically and following health and safety standards and environmental mitigation measures. This is also controlled during annual FSC audits.

Summary of socio-economic impact

- Forestal Azul holds a legal title that is not subject to claims from third parties. During the due diligence conducted in 2018, conflicts between the former property owners and local communities were not identified.
- Neighboring community members do not depend on the resources on production sites, meaning forest production does not restrict local people's access or use of resources of critical importance to their livelihoods, or negatively affect ecosystem services. Mostly, community members have small plots for cultivation and animal husbandry, or work in neighboring properties.

- Compared to previous land uses, the plantations provide benefits to local people, by providing local jobs. Plantations forestry provides around 25 Full Time Equivalents per 1,000 ha compared to 2-3 Full Time Equivalents on traditional cattle ranches. This number is even higher for the degraded natural forest restoration, as it requires high input of manual labour. Between 2018-2020, Forestal Azul maintained between 30 and 80 employees, most of the coming from the neighboring community Paso Tuna.
- All labour complies with social security and the labour code. This is a net positive impact in an environment where 80 % of labour is informal.
- Forestal Azul seeks to introduce productive projects with neighboring community members starting in 2021. The plan is to establish eucalypt plantations on smallholder land (target is to work with around 10 to 15 producers and potentially expand in the future), with the provision of inputs and technical assistance by the company. Income is then shared after thinning and harvesting.

General safeguards

- The project is FSC certified and subject to annual third party verification since 2018 (FSC® C141437).

2.2 Local Stakeholder Consultation

Engagement with local communities and sub-contracted personnel

The plantation is surrounded by other medium and large properties dedicated to cattle and agriculture. The closest communities are Paso Tuna and Costa Pucú, located at around 7 km westwards and eastwards, respectively. Paso Tuna is regarded as the most vulnerable community, as it is further away from the paved road (around 12 km). It consists of approx. 60 families dedicated to subsistence agriculture and animal husbandry. The public dirt road that connects the community with the paved road crosses Forestal Azul.

Interviews with community members were conducted during due diligence and later during meetings and a quick participatory rural appraisal with the goal of i) Establishing relationships with communities; ii) Understanding if there were any conflicts over land and/or resources; and, iii) Evaluating the level of vulnerability and identifying possible projects to be conducted with community members. Also, personnel is recruited from neighboring communities ever since the project initiated.

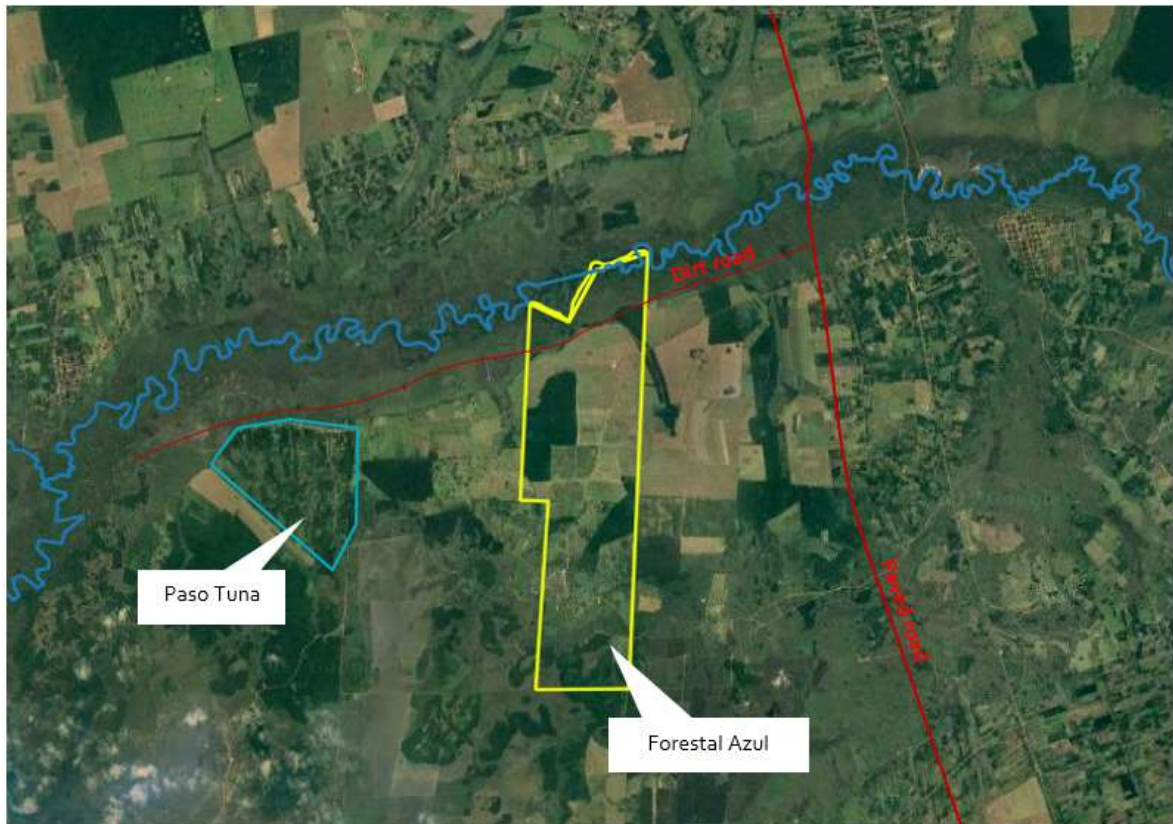


Figure 15: Image of Forestal Azul's surroundings

The local stakeholder engagement strategy followed by Forestal Azul involved:

- Collection of basic baseline information of the community (location, number of families and main livelihood, land tenure and available infrastructure) and identification of key community representatives and local organizations.
- Inception meeting with the community to introduce the project and the team, its expected impacts, and the communication and grievance mechanism.
- Introduction of a Community Liaison Officer (CLO) to manage the Communication and Grievance Mechanism. The CLO acts as the main contact person between community members, field workers and the company.
- Introduction of the social monitoring system, which among health and safety aspects also includes the monthly assessment of labour relations, to ensure sub-contracted personnel is employed according to the conditions of the national labour code, and an annual or bi-annual assessment of job-satisfaction among sub-contracted personnel. Please note that labour laws and regulations covering works rights in Paraguay are regularly updated and compliance controlled.
- Punctual support on demand, for instance annual donations to schools or maintenance of public roads.

Third-party stakeholder consultations

Stakeholder consultation is conducted every year by independent FSC auditors during annual audits. The scale and scope of these consultations varies. Usually, it includes at least interviews with sub-contracted workers, contractors, and community members.

During so-called principle audits (first audit and then every 5 years), a more exhaustive consultation phase is conducted, during which the certification agency consults national, regional, and local stakeholders about the project. This includes environmental and forest authorities, NGOs and experts, local community members and associations, contractors, and workers. The management team keeps a complete list of stakeholders.

For the validation audit, stakeholders such as the project investors, project managers, and workers have been informed verbally about the carbon project, and during the validation audit, some of these stakeholders were interviewed by the auditors. In general, project stakeholders are used to audit processes due to the FSC audit.

Stakeholder consultation when assessing High Conservation Values (HCV)

Forestal Azul has conducted public consultations for the identification of High Conservation Values (No High Conservation Values were found). National stakeholders were consulted for the validation of the assessment results, including civil society representatives and national authorities.

Public disclosure

A public summary of the management plan and monitoring results is disclosed for the public on an annual basis, according to FSC principles: https://www.unique-wood.com/wp-content/uploads/2020/07/2019-2020-Forestal-Azul_Resumen-del-Plan-de-Manejo.pdf

Results

Stakeholder consultation revealed that:

- Overall, neighboring communities are in favour of the project, particularly when it implies in significant job creation.
- The project has maintained and built up a number of local service providers, which is viewed as positive by community members. In the first years the project has been the main employer in the region, providing 70-80 permanent jobs. Throughout 2021, an average of 83 Full Time Equivalents were working in Forestal Azul.
- No critical comments have been collected in any of the stakeholder consultation conducted in the framework of FSC certification.

- In December 2021, the annual job satisfaction interview was applied to 27 workers. Job satisfaction is very high. Evaluation scores applied are between 1 and 5, 1 being “Unacceptable” and 5 “Very good”. All scores are above 4.
- Two grievances by staff were collected and addressed in 2021.
-

Please note the latest grievances are always published in the public summary of the management plan.

2.3 Environmental Impact

Procedures to mitigate potential environmental and social impacts of the project are in place. A summary of the potential impacts and implemented mitigation measures is presented in the Tables below. This is documented and can be verified through Forestal Azul’s records, the Management Plan, and other project documentation. The management system implemented to identify and manage the ES risks of the project will be maintained by Forestal Azul.

Table 5: Environmental impact and mitigation measures implemented

Environmental impacts	Mitigation measures
Deforestation and/or further degradation of the natural forest through the intense clearing of 20-m strips for enrichment The restoration system requires intense intervention in the natural forest, which requires the clearing of vegetation (oftentimes bushland and high grasses).	The enrichment system aims at the long-term restoration of the forest. Specifically, the following measures are implemented for this purpose: ▪ The opening of strips in the enrichment area is done in a controlled manner. The aim is to minimize the circulation of machinery. ▪ Trees and their natural regeneration (some of these species are in danger of extinction) are marked and subsequently integrated into forest management as far as possible. If it is not possible to avoid damage, the trees are cut in such a way as to encourage the management of regrowth. ▪ Natural regeneration in and between strips is managed together with the exotic trees. ▪ After a rotation, the exotic trees are removed from the system, leaving a forest restored for sustainable management.
Habitat destruction and conversion though plantations Plantations could have negative impacts on local ecosystem and biodiversity if they are established on natural ecosystems.	▪ Plantations are established on areas previously used for implanted pastures (beef production) or mechanized agriculture. ▪ Under no circumstances does forest conversion take place for the establishment of plantations. A historical land use assessment is conducted before planting. ▪ A condition for land lease is the existence of a valid environmental license by the owner. ▪ A baseline biodiversity study was conducted documenting the state of the site before planting.
Impacts of eucalypts on water availability Eucalypts are characterized by high water consumption. Such behavior may cause water scarcity in dry environments.	▪ The project region, exhibits annual precipitation > 1,300 mm. Also, the region is natural forest area, highly fragmented and degraded, meaning the plantations may contribute in improving the water household (increased water retention in the soil compared to agriculture, etc.). ▪ Eucalypts are not planted in areas important for water recharge (in lowlands subject to flooding). ▪ Buffer zones of rivers and streams are protected.
Invasive behavior of exotic species In some areas, eucalypts have been described as having an invasive behavior. However, this	▪ Exotic trees are planted only in demarcated areas. ▪ Genetic eucalypt material planted mostly encompasses clones (not seeds), with limited capacity to produce seeds and spread.

Environmental impacts	Mitigation measures
has not been observed in Paraguay until now.	▪ An invasive behavior of eucalypts has not been observed in the project to date.
Soil erosion The FMU is located on terrain that is either flat or shows soft declinations. Only Cerro Verde has parts steeper than 15°. Due to the absence of steep terrain, the risk of erosion is low. However, forestry activities may still potentially cause erosion, during the installation and use of roads and, particularly, during harvesting.	▪ Roads are built respecting good practices to facilitate proper drainage and prevent erosion. ▪ In areas dedicated to plantations with fragile soils, contour lines, ridges or other measures are implemented to control surface runoff to counteract erosion. ▪ Thinning and harvesting are carried out in a controlled manner, with heavy machinery circulating only on the roads and tracks of the extraction of signs.
Pesticides and inputs Plantations require the application of chemical inputs, such as calk for soil acidity, fertilizer, herbicides (glyphosate) and Fipronil for ant control. Such inputs, when used without care, can affect non-target organisms and affect human health negatively.	▪ Inputs are quantified and applied only when needed, following specific dosage and recommendations of the producer. ▪ Pesticides and other chemical inputs are stored in deposits with impermeable floors, ventilation and fire-extinctors. ▪ The products are only received if they are in their original containers, are still valid, and accompanied by the security sheet. ▪ Packaging of potentially toxic waste is disposed according to national regulations and recycled by an accredited company.
Fuels and oils The machinery used in the finca requires oils and fuels. If not well maintained, these may leak into the soil or waterways.	▪ Machinery used is well maintained. ▪ Fuels and oils are organized, stored and labelled appropriately. ▪ Fuel and oil exchange are conducted on impermeable platforms.
Illegal activities Hunting, fishing and the uncontrolled extraction of timber and plants may in the finca by company workers or external people may further contribute to the degradation of ecosystems.	▪ Permanent presence of company staff in the FMU ensures the control of activities in the area. ▪ Hunting, fishing and uncontrolled logging of natural timber species is strictly forbidden. ▪ Appropriate signs are installed, and workers are continuously instructed about prohibited activities.
Forest fires Eucalyptus plantations are susceptible to fire, which can have	▪ During the dry season, permanent vigilance is conducted.

Environmental impacts	Mitigation measures
devastating environmental consequences	▪ Staff are continuously trained in fire prevention and firefighting. ▪ Firebreaks are installed, the fuel on site is maintained low, particularly during the dry season. ▪ Appropriate fire prevention and firefighting tools are available at each site, as well as the protective equipment for firefighting. ▪ Cooperation with neighbors is in place in all units for vigilance and combat.

2.4 Public Comments

During the public comment period (12/07/2021 – 11/08/2021), no comments were received regarding the Forestal Azul Carbon Project.

2.5 AFOLU-Specific Safeguards

AFOLU-Specific Safeguards are addressed as follows:

- Local stakeholder identification process and a description of results.

As described in section 2.2 above, stakeholder identification and consultation processes are in place. Stakeholder engagement includes environmental and forest authorities, NGOs and experts, local community members and associations, contractors, and workers. The management team keeps a complete list of stakeholders per FMU.

- Risks to local stakeholders due to project implementation and how the project will mitigate such risks.

These risks and mitigation measures are identified and described in Table 10 below.

- Risks to local stakeholder resources due to project implementation and how the project will mitigate such risks, including the plans to ensure the project will not impact local stakeholder's property rights without the free, prior and informed consent.

These risks and mitigation measures are identified and described in Table 10 below.

- Processes to ensure ongoing communication and consultation with local stakeholders, including a grievance redress procedure to resolve any conflicts which may arise between the project proponent and local stakeholders.

A grievance mechanism is in place and publicly available in the Annex of the annually updated public summary of the forest management plan⁵.

⁵ https://www.unique-wood.com/wp-content/uploads/2021/07/2020-2021-PAYCO_-Plantaciones_Resumen-Publico-PMF.pdf

Table 6: Social impact and mitigation measures implemented

Risk	Affected stakeholders	Mitigation measures
Displacement/livelihoods /access to ecosystem services	Local community members	▪ The project is taking place on private properties. ▪ The legality of the title was assessed, and no disputes identified. ▪ Initial consultation with local communities and the grievance mechanism are used to rule out or act upon disputes and/or conflicts. No conflicts about land use or access have been raised to date.
Risks of accidents / Health and safety Forestry is characterized by dangerous work, particularly when harvesting. Other jobs, such as the application of pesticides and chemical products, also bear risk for human health.	Field workers	▪ Constant on-the-job trainings and trainings for specific dangerous work are implemented (e.g.: chainsaw operation). ▪ Procedures for the correct use, storage and application of pesticides and chemical products. ▪ Provision of security equipment adequate for the different types of work. ▪ Trainings in emergency preparedness, first aid and health and safety. ▪ Provision and monitoring of first aid kits. ▪ Installation of warning signs in dangerous places. ▪ Provision of appropriate food and accommodation for workers. ▪ Annual consultations with workers on job satisfaction.
Non-observation of minimum labor benefits (wage, social security, etc.). In rural Paraguay, labor is usually informal. Therefore, benefits such as social security are not observed.	Sub-contracted workers	▪ Monitoring of minimum working standards among contractors and sub-contracted personnel. Any deviation of minimum standards is corrected immediately.
Dust and noise /accidents on the road	All workers and neighboring	▪ Speeding signs are introduced along internal roads.

Risk	Affected stakeholders	Mitigation measures
Transport of wood products and inputs in and out of the FMU could increase traffic and increase dangers to the communities located on the access road. Workers circulating in motorbikes could also be at risk by increased traffic and dust.	community members	▪ The use of helmets is required and monitored when using motorbikes. ▪ Instruct drivers in safe driving, particularly on the community access road. ▪ Grievance mechanism
Reputational risks / political risks Eucalypts have been criticized by environmental groups in Paraguay, as well as large landholdings.	The company	▪ Engaging environmental and social actors in management decisions ▪ Implementing best practices ▪ Grievance mechanism ▪ FSC certification

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Approved CDM methodology: AR-ACM0003 “AR Large scale - Afforestation and reforestation of lands except wetlands”, version 2

These CDM methodological tools will be used in accordance with the methodology:

- “Combined tool to identify the baseline scenario and demonstrate additionality”, version 7
- “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, version 4.2
- “Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity”, version 4.0
- “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, version 01.1.0
- Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities, version 1.0

- Tool Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity, version 2.0

3.2 Applicability of Methodology

Applicability conditions of the methodology AR-ACM0003: Afforestation and reforestation of lands except wetlands (Version 2) are:

(a) The land subject to the project activity does not fall in wetland category

Forestal Azul plantations are established on former agricultural and pasture lands. Wetlands, degraded forests and other sites are protected.

According to the soil classification of the IPCC, all gleysols are considered wetland soils and therefore the respective areas are treated commonly as wetlands.

According to Forestal Azul internal SOP's, no plantations are established on wetlands. Soil analysis of the plantations, which were conducted by independent consultants, confirm this procedure. The most represented soil types is the mineral soil Cambic Arenolos. The characteristics of this type of soil is shown in the Table below.

The total area of the property shows areas classified as wetlands, however these are located on protected sites. The plantations are established only on former agriculture or pasture land. Furthermore, soil analysis results are available upon request.

Table 7. Sample data of a Cambic Arenosol soil type, data HWSD

Parameter	Value
Dominant soil group	Cambic Arenosol
Topsoil texture	Coarse
Drainage class	Somewhat excessive
Topsoil sand fraction (%)	83
Topsoil silt fraction (%)	10
Topsoil clay fraction (%)	7
USDA Texture classification	loamy Sand
Reference Bulk density (kg/dm ³)	1.64
Topsoil gravel content (%)	0
Topsoil organic carbon (% weight)	0,43
Topsoil pH	7.9
Topsoil CEC (cmol/kg)	22

(b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary:

(i) Land containing organic soils;

(ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to the methodology.

Soil disturbance in the project only happens during soil preparation before plantation. This activity is conducted only in the lines where trees will be planted, with a width of maximum 50 cm and up to 50 cm depth. The maximum density of plantations uses a spacing of 5 x 2 m, with a separation of 5 meters between lines and 2 m between trees for pure plantations. In the case of silvopastoral systems, trees are established in double rows of 5 x 2 m like pure plantations, and then separated by a wider alleyway in between of 9 m. In the worst-case scenario using the spacing of 5 x 2 m, soil disturbance affects 10 % of the area considering:

- A line of trees every 5 m results in 20 lines/ha

20 lines * 0,5 m of width * 100 m of length/ha = 1,000 m² of soil disturbance/ha

Applicability conditions of the tool: “Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities” (Version 01.0.0)

This tool has no internal applicability conditions

Applicability conditions of the tool 0002: “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities:

- a) Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law even if the law is not enforced. – The project complies with all laws and regulations of the country of Paraguay as state in the chapter 2.1.

- b) This tool is not applicable to small – scale afforestation and reforestation project activities – The project is not considered small scale afforestation. The tool used is the AR-ACM0003 A/R Large scale afforestation and reforestation of lands except wetlands.

Applicability conditions of the tool: “Calculation of the number of sample plots for measurements within A/R CDM project activities” (Version 2.1.0)

This tool has no internal applicability conditions

Applicability conditions of the tool: “Tool for estimation of change in soil organic carbon stocks

Due to the implementation of A/R CDM project activities”, version 01.1.0

- a) The areas of land (i) do neither fall into the wetland category, nor (ii) contain organic soils as defined in “Annex A: glossary” of the IPCC GPG LULUCF 2003, as shown above.

Please refer to a) under the applicability conditions of AR-ACM0003

- b) The A/R CDM project activity meets the listed conditions. (i) Litter remains on site as there is no incentive to remove litter from the plots. (ii) Also, soil disturbance associated with the A/R activity only occurs for planting.

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Aboveground and Belowground Biomass	CO2	Yes	This is the major carbon pool subjected to project activity.
	Dead wood and litter	CO2	Yes	For conservative reasons dead wood is included using the default factor presented in the Tool ‘Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities’
	Soil Carbon	CO2	Yes	Carbon stock in these pools may increase due to implementation of the project activity.
Project	Aboveground and Belowground Biomass	CO2	Yes	This is the major carbon pool subjected to project activity.
	Soil Carbon	CO2	Yes	Carbon stock in these pools may increase due to implementation of the project activity.

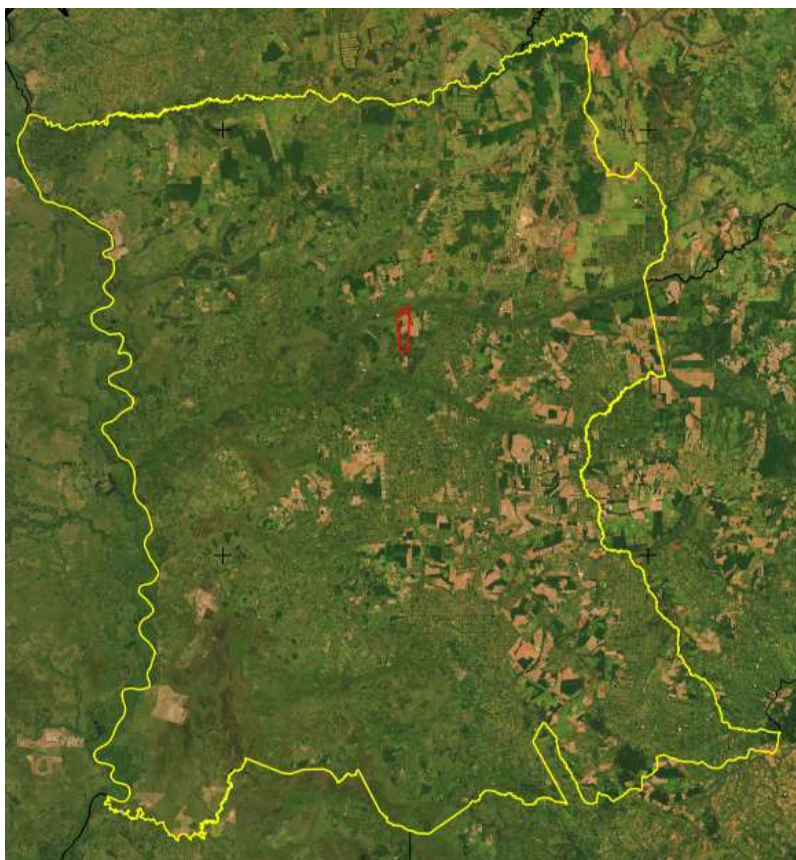


Figure 16: Forestal Azul Outer Boundary (yellow) and First Instances (red)

3.4 Baseline Scenario

The baseline scenario was defined by using the “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities”, version 01. Since only one stratum was identified for the baseline scenario, the procedure is only applied once. Following is a description of the application of this tool.

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

Forestal Azul started its afforestation project in April 2018 with the first planting activities in June 2018. This is before the registration date and after 31 December 1999. The analysis of satellite images shown in the eligibility chapter illustrates that afforestation process did not start within project boundaries until 2018.

The investors are interested in implementing sustainable and diversified land use projects, as demonstrated by the intent in the shareholder agreement and the fact that the project has acquired FSC certification already in 2018. Carbon credits have been considered an important addition to the project particularly after experiencing the difficulty of implementing “first of its kind” models. The carbon component would diminish the risk associated to this sort of project and motivate further expansion of sustainable practices by investors.

Step 1. Identification of alternative land use scenario to the proposed ARR project activity

In Eastern Paraguay, the dominant land uses are mechanized soy production and cattle. These have expanded into areas traditionally occupied by family farmers, given through rental contracts or sales by family farmers, mainly in the departments of Caaguazú, San Pedro, and Caazapa (World Bank⁶ 2015).

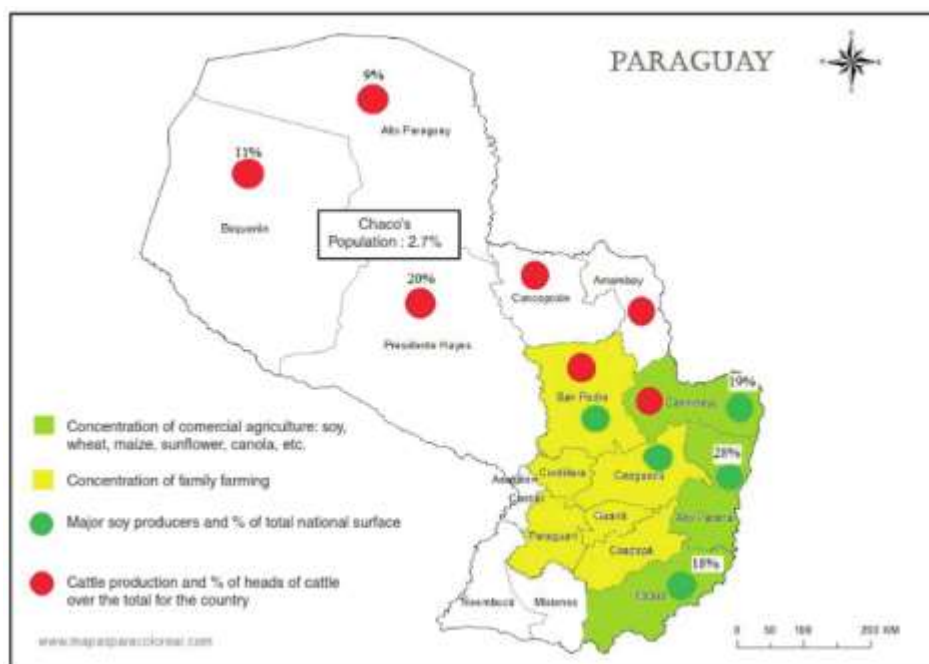


Figure 17. Spatial Distribution of the Main Agriculture Activities (Arce et al. 2015)

- Sub-step 1a. The following realistic and credible alternatives to the proposed project activity are identified:

1. Continuation of pre-project land use (cattle and soy/ maize production)

The pre-project land use in Forestal Azul is agriculture (732 ha in the first instance) and beef production on implanted pastures (573.5 ha in the first instance). The best soils are located on higher areas. They are used for grain crops, specifically soy and maize. This is in line with the dominating land uses and trends in San Pedro in the past years and decades (San Pedro soy and maize production represents 9.4% and 15% of the total national production areas in 2012).

⁶ <http://documents1.worldbank.org/curated/en/556311467986343378/pdf/93943-REVISED-Box393201B-PUBLIC-53889TA-No-3-Paraguay-Ag-Sector-Risk-Assessment-WEB-26-06-2015-jtc.pdf>

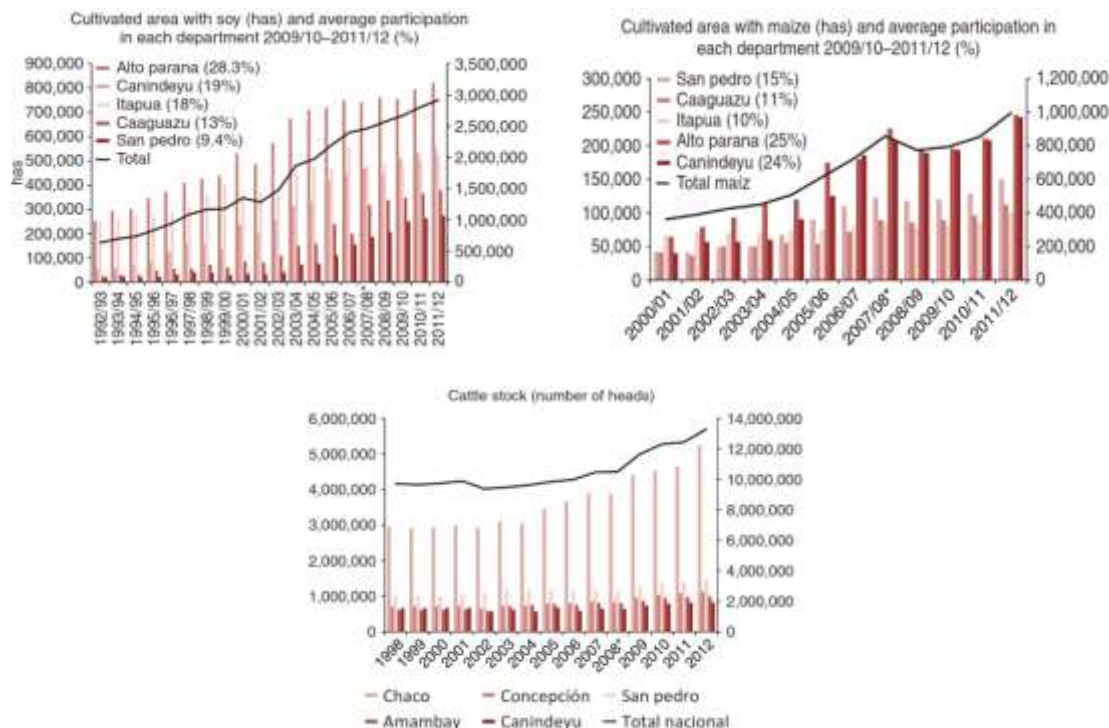


Figure 18. Cultivated areas of soy (upper left), maize (upper right) and cattle stock in departments of Paraguay and their national shares (Arce et al. 2015)

2. Forestation of the land within the project boundary without being registered as the A/R CDM project activity

Overall, landowners are weary of establishing forest plantations, particularly due to its long term horizon. Most landowners are either traditional cattle ranchers that strongly identify with cattle production, or belong to the newer generation agroindustry, that establishes soy production that is heavily input-based and mechanized. Based on current estimations, there are about 100,000 ha of forest plantations in Paraguay, whereas around 400,000 ha of plantations would be needed to provide the sustainable supply of the country's need in terms of fuelwood and timber. Therefore, there is a need of incentives to foster long term plantations.

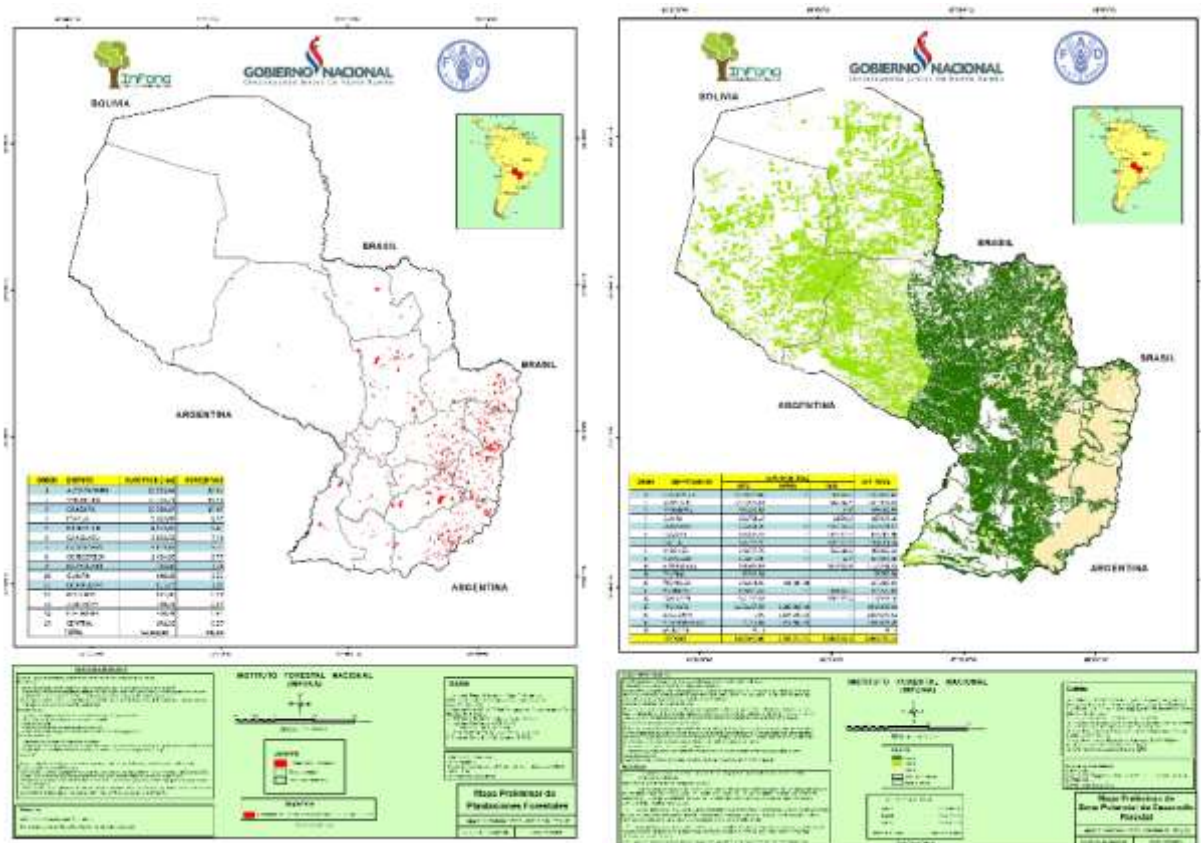


Figure 19. Left: Locations of commercial plantations in Paraguay (INFONA Maps Project TCP PAR 3304) - Caazapá, San Pedro and Alto Paraná departments concentrate almost 60% of plantations (31,000 hectares); Right: Areas for potential forestry development (INFONA Maps Project TCP PAR 3304) - High potential areas (less than 100 km from ports or industries) add up to 9,000,000 hectares, mainly in central Paraguay.

3. Other alternatives

No other possible alternative scenarios have been identified.

- **Sub-step 1b. Consistency with enforced mandatory applicable laws and regulations.**

In principle, all land use alternatives identified above comply with all mandatory regulations in the country (see applicable Laws and regulations in Section 1.14).

It should be noticed that mechanized soy production and beef production have often been implemented without complying to the national environmental law in the past (see sub-section below). In addition, the lack of the enforcement of the labour code in rural Paraguay is systematic,

with around 80 % of rural labour working informally⁷. This is common among all sizes of rural establishments.

The Forestal Azul Carbon Project complies with all relevant Paraguayan laws and regulations, which is an aspect regularly verified by third party audits conducted within the scope of the projects FSC certification (FSC® C141437). The intensive enrichment planting model as implemented by Forestal Azul is not contemplated within the current regulations. However, Forestal Azul was granted an environmental license from the Environmental Ministry. The project has been embedded in the framework of a research cooperation with the National University of Asunción and the National Forest Service, who will accompany the pilot project. The documentation can be verified at the Company office.

Weak environmental law enforcement in the country

In the 20th Century, Eastern Paraguay was been severely deforested by uncontrolled conversion from natural forests to crop- and pasture land. Deforestation rates in the Eastern region between 1973 and 1989 were estimated at 175,000 ha/ year, and between 1989 and 2000 at 123,000 ha per year (Huang et al. 2007, 2009). Total forest loss reached approx. 4,460,595 ha between 2001 and 2014 (Global Forest Watch, 2016) while the tree cover gain for the whole country from 2001 to 2012 amounted only 51,023 ha (ibidem).

In 1973, the forestry law N° 422/73 declared in the public interest to protect forests to control soil erosion and protect water basins. Yet illegal exploitation and conversion continued in line with the rapid expansion of large scale agriculture. The introduction of the Decree N° 18,831 in 1986 obliges forest property owners to maintain 25 % of natural forest cover on properties larger than 20 ha. The enforcement of this law has been weak in the first two decades after its implementation, but improved after the creation of the Environmental Ministry and the introduction of the environmental licensing process in the 90s. This Decree remains, to date, the single most important instrument through which some forest cover was secured on private properties. This is particularly relevant in Paraguay, where all forests outside of protected areas are distributed in private properties.

In 2004, Paraguay had the highest deforestation rate in America when the Government passed a moratorium on forest conversion in Eastern Paraguay (Law N° 2524/2004 and subsequent extensions), also known as the “zero deforestation law”.

⁷http://www.ilo.org/wcmsp5/groups/public/---americas/---ro-lima/documents/publication/wcms_245620.pdf

than 25%) by those owners who have environmental liabilities (a debt with respect to such reserves), applying referential market prices and in a free payment arrangement between owners. So far, the impact of this law has been moderate, as it is failing to create the environment for a functioning market (Clark, 2005¹⁰).

Step 2. Barrier analysis

• Sub-step 2a. List of barriers

Following is a list of barriers applicable in the following sub-step 2b, for the land-use alternatives identified above:

- Investment barriers
 - Financial risk related to long term uncertainties in a context of an emerging market and a lack of similar experience related in general to forestry, and specifically to the restoration of heavily degraded forests.
 - High hurdles to invest in forestry due to high initial investment and long payback period compared to common land uses, mainly grain and beef production.
- Barriers related to the timber and wood market
 - Non-leveled playing field due to the competition with the highly informal woodfuel market (low prices for woodfuel), and under-developed market for quality timber. Possibilities of price risks due to the fluctuations in the prices of products over the project period in the absence of efficient markets and insurance mechanisms.
- Barriers due to local ecological conditions, inter alia:
 - Changing climatic patterns and increase of extreme weather events
 - Incidence of pests and diseases
- Barriers related to local tradition, inter alia:
 - Traditional equipment and technology of the forest industry, based on natural forest species that were depleted
 - Lack of capacity to predict systems productivity (e.g. lack of long-term forestry experience, first ground proof of growth models)
 - Local culture still opts for the most traditional/common land uses
 - Absence of professional service providers
 - The land use scenario is the “first of its kind”: No activity of this type is currently operational in the host country or region
- **Sub-step 2b. Elimination of scenarios prevented by barriers**

¹⁰ <http://parquesnacionalesdelparaguay.blogspot.com/2014/11/salvando-el-bosque-atlantico-en-paraguay.html>

Alternative 1

It is not prevented by any barrier. It is the current land use, and the one that has been practiced for more than 20 years with increasing trends.

Alternative 2

The alternative 2 “Forestation of the land within the project boundary without being registered as the A/R CDM project activity” is an activity that faces several risks and barriers preventing implementation.

Given the rate of deforestation in the country, wood shortages in the domestic market and Paraguay’s geographical conditions, one could expect forest plantations to be a major form of land use in the country (Szulecka et al. 2017). Unlike its neighbors, Brazil and Argentina, Paraguay’s tree planting efforts are slowly implemented. The government’s current national reforestation plan, Plan Nacional de Reforestación, approved by Decree N° 10,147 of 2012, aims to establish 450,000 ha of new forest plantation by 2037, of which ca. 1/3 for wood fuel and 2/3 for industrial roundwood. While there seems to be a strong rational push for both productive and protective reasons, limited activity has taken place (ibidem). This has several reasons, such as financial constraints, cultural factors, and technical capacity. Unlike other countries in the region, Paraguay has failed to put in place functioning support and subsidy programs to foster reforestation.

The Forestal Azul Carbon Project is the first project of its kind with a diversified land use model (featuring forest plantations, silvopastoral systems, cattle, and natural forest restoration). The company is piloting a forest restoration model to recover heavily degraded natural forests, on a national level. It is also one of few in the region to establish forest plantations for the production of quality timber. Only two other companies in the San Pedro Department produce quality timber, the most noticeable and largest one being established by the agricultural company PAYCO.

The project contributes to national goals and sustainability as follows:

- the ground-proofing of a model of forest restoration that could potentially be scaled up and have an impact to recover thousands of hectares of degraded forests on private land. The Government, through Law 3001/2006 is seeking to motivate forest conservation through PES schemes, however its uptake is slow. To date, there is no proven sustainable business model to recover degraded forests on a large scale.
- proof of concept and implementation of models aligned to political goals, such as the national plan of reforestation (Decree N° 10,147 of 2012), governmental efforts to formalize the biomass sector (Decree N° 4056/2015), and the contribution to the National Determined Contributions of the country, where afforestation is highlighted as a prominent measure.
- the local production of sustainable timber and wood, in the context of a market gap of sustainable timber. According to a market study conducted by the Fund, there is a sustainable production gap of around 11-12 m³ per year (mainly fuelwood), which translates

into a need of 360-400,000 ha of plantations (in line with the Governmental reforestation plan).

- the introduction of best practices for quality timber production and increased value addition, fostering national professionalization and industrialization. In terms of the environment, quality timber production is more compatible with sustainable forestry than other products, as it needs long rotations. Quality timber production, besides carbon or environmental services, is the only product that has the potential to generate revenues streams for the forest restoration model, allowing for forest recovery in the first place. Other benefits include an increased stewardship of the land due to long-term interest.
- the production of sustainable biomass reducing pressure on natural forests.
- the introduction of best practices and standards in a highly informal context.
- Longer rotations bring about a higher value addition. Increasing the area of these forest models for quality timber is expected to contribute to the forest sector, in two ways:
 - a. The increasing supply from plantations with improved quality is expected to drive the wood processing industry modernization; and,
 - b. The need for more silvicultural interventions for quality timber requires specialized labour, which will bring about positive impacts in terms of employment and the development of professional service providers.

Nevertheless, given it is a long-term investment, the project faces uncertainties that translate into the barriers as briefly presented in the previous sub-section. Specifically, these are:

- Investment barriers related to the long investment horizon
- Barriers related to local tradition, particularly considering the “first of its kind” character
- Barriers due to ecological conditions: Natural and sanitary risks
- Barriers related to an underdeveloped quality timber market and an informal biomass market

Each of these barriers is detailed in the sub-sections below.

Investment barriers related to the long investment horizon

The lack of access to appropriate funding for forestry are the reasons most commonly cited for the slow progress with reforestation. Besides high investments needed, the cashflow profile of forestry projects, where initial investments are high, and returns are only harnessed after many years, is discouraging for landowners.

The Paraguayan Government has been fostering forest plantations in the country since the 1990s. The first incentive scheme developed by the Paraguayan Government was introduced through the forestry law 422 in the 70s, which failed due to a poor technical design, budgetary constraints, and mismanagement (FAO, 2006). Then, in the 90s, the Afforestation and Reforestation Law (Nº 536/95) should have represented a turning point in the development of

forest plantation. The incentive scheme subsidized 75 % of payments for plantation establishment and maintenance costs in the first three years. In addition, plantation forests receive a 50% property tax exemption. Initially after the promulgation of this law, from 1995 till 2004, about 34,000 ha of plantations were established (Szulecka et al. 2017). However, due to many project planning mistakes, poor management, lack of institutional capacity and lack of dedicated funds, the subsidy law quickly became un-operational (Szulecka et al. 2017). According to FAO¹¹ (2006), the implementation of this law was discontinued after a few years due to budgetary constraints, with the State owing about USD 6 million of subsidies to producers.

Most commercial credit lines have not been appropriate to fund forestry projects. Only in 2019 the Government introduced an attractive credit line to fund forestry projects through the National Development Bank (Banco Nacional de Fomento). This was aimed to spur investments into sustainable biomass production through forest plantations, to halt forest degradation driven by informal sourcing of biomass. This mechanism has been hardly uptaken by the sector to date.

Forestal Azul could overcome this limitation through equity investments and loans. Nevertheless, the long-term nature of the project and its unique features compared to other projects in the region increase its financial risk, as explained in the following sub-chapters.

Barriers related to local tradition, particularly considering the “first of its kind” character

Forestal Azul is the only company in the country implementing a forest restoration model for heavily degraded natural forests (intensive enrichment planting). Also, Forestal Azul is among only three companies in the region producing quality timber. Only PAYCO, a large agricultural company, and Forestal Apepu, a smaller company established in 2019, have been introducing quality timber plantations in the project region. Other plantations in the San Pedro Department are established for biomass production, with little value added, high densities, and no silvicultural complexity.

Despite the many benefits of the models implemented by Forestal Azul, the lack of local tradition, professional service providers, and experience hampers their implementation. The lack of experience with enrichment planting (the restoration of heavily degraded forests) has already had negative financial impacts on the whole project for the following reasons:

- i) It took a long time to acquire the licenses for this model, delaying operations;
- ii) The lack of standardized operational procedures and professional service providers has caused significant inefficiencies in operations, and;

¹¹ FAO (2006). Tendencias y perspectivas del sector forestal en América Latina y el Caribe.

- iii) The whole model required more work than expected, driven by the fact that manual labour in a heavily degraded forests is strenuous and slow (high weeds, low visibility, slow progress in general).

For all the reasons above, unitary costs per hectare were almost double compared to initial expectations. This can be shown by the Company's Business Plan and evaluations conducted between 2018 and 2020.

Barriers related to an underdeveloped quality timber market and an informal biomass market

The project faces significant market risks. The market for quality timber shows potential, particularly for veneer. Sawmills, on the other hand, work with old technology due to their historical dependence on natural forests. The biomass market exhibits low prices, leading to marginal profits that in some cases do not cover the costs for sustainable production.

The share of biomass in the country's energy production is as high as 46 %, of which over 70% is informally sourced from natural forests. The informality of the biomass value chain slows down any efforts of reforestation. Since 2015, Paraguay is introducing efforts to formalize the biomass value chain, through a certification scheme that should allow the traceability of biomass and formalize the value chain until 2030. To date, however, this still work in progress, with the market still being flooded with biomass coming from unsustainable sources.

Barriers due to ecological conditions: Natural and sanitary risks

According to several climate models, precipitation regimes in the region are not expected to change considerably, and therefore, forest investments are considered attractive. Nevertheless, rain distribution has become more uneven in recent years, leading to extended dry periods on the one hand, and increased flooding events on the other. This is considered a risk in forestry, albeit it is also a risk across all land use investments.

In Forestal Azul, the loss of plantations and carbon stocks due to fire or flood is highly unlikely, as planting sites are well selected and fire protection measures are implemented rigorously. But the changing weather may have other implications, such as the decreasing productivity of the plantations, and the incidence of unknown pests and diseases which affect timber quality in unknown ways.

In other similar forest investments in the region, plantations have been affected by the gall wasp *Lectocybe invasa*, the beetle *Costalimaita ferruginea*, and a fungal disease caused by the canker *Teratosphaeria zuluensis*, also known as *Coniothyrium zuluensis*.

Conclusions of the barrier assessment

As shown throughout this Chapter, the forest project faces risks that are related to its “first of its kind” character and long term investment horizon. The carbon finance component would reduce these risks by diversifying the product portfolio, introducing an early income stream, and allow for greater flexibility in terms of benefit sharing arrangements. It would also set a precedent to motivate further innovative investments into sustainable forestry, aiming at forest restoration.

- **Sub-step 2c. List of scenarios that are not prevented by any barrier**

Application of the decision tree of sub-step 2c (considering the outcome of sub-step 2b) leads to the following conclusions:

Continuation of pre-project activity has been identified as the most plausible scenario in the absence of the proposed project activity. The pre project activity will continue as it has been shown for the last 20 years.

3.5 Additionality

Additionality has been demonstrated through application of Steps 0 to 2 above and through Common Practice Analysis in Step 4 (in this section below) which results in only one land use scenario and according to the “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities” it is the baseline scenario.

Step 4. Common practice analyses

Based on current estimations, there are about 80,000 to 100,000 ha in Paraguay (of which 75 % for woodfuel production), whereas between 360,000 and 400,000 ha are needed to close the sustainable supply gap of ca. 11-12 million m³ per year. This gap can be characterized as follows:

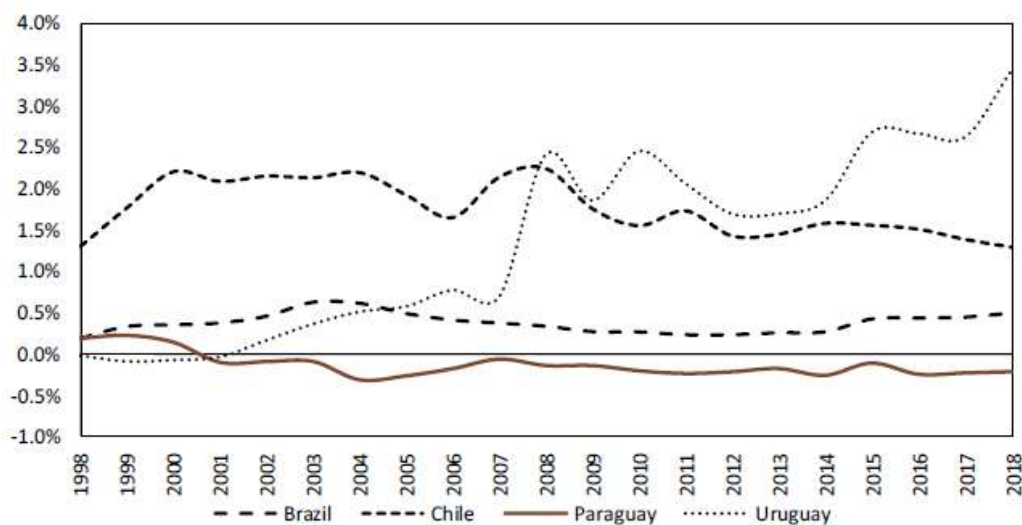
- **Biomass and energy:** Natural forests are still the main source of wood fuel for Paraguay’s energy matrix, with over 10 million m³ per year extracted unsustainably (deforestation and forest degradation) or provided from conversion of natural forests (mainly in Western Paraguay). 46 % of Paraguay’s energy consumption is based on wood fuel (fuelwood and charcoal) (GIZ, 2013).
- **Sawn timber, veneer & plywood:** The role of natural forests in sawlog and veneer log supply has been steadily decreasing due to high historic deforestation and forest degradation as well as improving regulation; for example, roundwood intake of veneer/plywood industry now ca. 80% from plantations. While the veneer and plywood industry are modernizing, sawmills (mostly SMEs supplied from smallholder plantations) use outdated technology and still rely mainly on natural forest logs. They operate at below 50% capacity utilization.

While countries with significant investment in plantation forestry such as Brazil, Chile and Uruguay established or maintained significant forest product trade surpluses over the last two decades, Paraguay turned into a net forest product importer in 2001.

Foreign investors continue to be discouraged by bureaucracy and corruption, biased or inconsistent enforcement of laws and a general lack of infrastructure. At the same time timber demand for industrial use keeps growing while the offer decreases with a bigger gap since 2013. FAO calculated that to fulfill demand of installed industries by 2020, planting should average 10.000 hectares/ year¹².

Table 8. Summary of timber plantation development in Paraguay (FAO 2004, 2006; FRA 2015c; INFONA 2011, 2013; Gonzales 2004, in Szulecka et al. 2017)

Time	Driving Paradigm	Relevant developments of Paraguay's timber plantations
1940s	National	First documented tree plantation efforts for energy purposes
1955–1966	National	National Agricultural Institute starts producing seedlings and exotic trial plots
1970s/80s	National	National plan under the Law n. 422/73; 10,025 ha of new plantations
1980s – on	Social, Global political	Agreements establishing a forestry extension program between the governmental forestry and development agencies (Swiss Technical Mission, Peace Corps, GTZ, European Union, Japan, others)
1991 – 1994	National, Corporate, Social	Reforestation for energy purposes; 1,763 ha of new plantations
1992 – 1993	Corporate, Social	Compensation regime (Decree n. 14047); 1,227 ha of new plantations
1995	Corporate	Plantation Promotion Law n. 536/95
1997 – 1998	National	Model forests; 115 ha of new plantations
1996 – 2004	Corporate	Plantations under the Law n. 536/95; 14,023 ha of new plantations
2006	Corporate	Investment and export network to promote forest products and timber plantations (REDDEX)
2010 – on	Corporate	Creation of first credit funds for timber plantations from different institutions (Fondo Ganadero, Agencia Financiera de Desarrollo)
2010 – 2013	Corporate, Social, Corporate-modified, Global-political	Plantation area added under monitoring of INFONA; 31,996 ha
2013	All	Total plantation area 81,125 ha (0.2% of the country's territory)



Source: FAO and IMF

Figure 21. Paraguay's forest production trade balance

According to Szulecka et al. (2017), Law N° 536 of 1995 had a visible impact on the plantation sector in Paraguay, as the country saw new projects of afforestation and reforestation that were implemented rapidly afterwards. The law encouraged especially medium and bigger private corporate plantation investments. In particular, three large plantation estates can be seen as

¹² <https://www.gatewaytosouthamerica-newsblog.com/forestry-development-in-paraguay/>

important industrial projects linked to this law. It encouraged the Shell Group to invest in *Eucalyptus grandis* and *Eucalyptus urophylla* plantations in Alto Parana and Caazapá. Some 7,000 ha of plantations were later taken over by the Argentine company POMERA Maderas, which has developed the plantation until the present, combining tree planting with their own research on eucalyptus clones. Another example is the reforestation project of Copetrol that was launched in 1997. The company possesses the largest plantation area in the country, 13,000 ha (Copetrol, 2015). The third large company organizing commercial timber plantation is Ganadera Vista Alegre (VASA) with 3,500 ha eucalyptus and teak in the San Pedro department (Szulecka et al. 2017). More recently, several other players entered the market, such as Silvipar, PAYCO, and Felber.

Plantations established under the corporate paradigm are monocultures of exotic species. Trees are mostly planted for biomass, whereas only about 25,000 ha are established for quality timber, with the PAYCO plantations and POMERA being the largest producers.

When considering overall profit, plantations can compete with soy production in areas that present certain limitations for mechanized agriculture. This is the case in San Pedro, where some of the soils present superficial sandy layers incompatible with agriculture due to their low capacity of water storage. On the other hand, plantations have shown to be more lucrative than beef production. Nevertheless, the cashflow profile is discouraging for landowners, particularly the long time horizon for plantation investments combined with high initial costs. In spite of the good biological growth conditions for timber production and availability of appropriate large areas, plantations cannot compete soy and cattle breeding which are the country's principal commodities in terms of quick payback of invested money.

Soybean cultivation is a clearly defined business model, where 75% of the production goes for export (BID, 2010). Soybean and beef producers are organized into business association and chambers of commerce, and certainly have more government support (Szulecka et al. 2017). This is also underpinned by cultural factors. Many of the most traditional landowners are cattle ranchers. They own large properties inherited by the family, and are not interested in innovation.

While large-scale corporate plantations are still a rarity in Paraguay, scientific and political discourses previously remaining outside the domain of forestry have begun to influence the global forestry regime. Among these different discourses, climate change mitigation and the emergence of "carbon forestry" are the most publicized, although they still display marginal impact on plantations on the ground. Paraguay belongs to the very few states where the Clean Development Mechanism (CDM) "carbon forestry" plantation has been successfully established and under- went the complicated validation procedures. The CDM plantation was organized in the Paraguari department by the Japan International Research Center for Agricultural Sciences (JIRCAS) with the cooperation of INFONA (Szulecka et al. 2017). Despite its small scale (215 ha of eucalyptus and *Grevillea robusta*) it nevertheless constitutes an important development in bridging the global climate change debate with local action (CDM, 2009).

The project is considered an innovative project as the production of quality timber is foreseen as well as in parts enhancement plantings of highly degraded forests which has never taken place in the host country. Therefore, the project is not considered a common practice.

3.6 Methodology Deviations

No deviations.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

According to the methodology AR-ACM0003 “Afforestation and reforestation of lands except wetlands” (Version 02.0) baseline net GHG removals by sinks are calculated using Equation 1 of the methodology. It is expected that soil carbon stocks will not show a permanent net increase:

$$\Delta C_{BSL,t} = \Delta C_{TREE_BSL,t} + \Delta C_{SHRUB_BSL,t} + \Delta C_{DW_BSL,t} + \Delta C_{LI_BSL,t}$$

Where:

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sink in year t; t CO2-e

$\Delta C_{TREE_BSL,t}$ = Change in carbon stock in baseline tree biomass within the project boundary in year t

$\Delta C_{SHRUB_BSL,t}$ = Change in carbon stock in baseline shrub biomass within the project boundary, in year t

$\Delta C_{DW_BSL,t}$ = Change in carbon stock in baseline dead wood biomass within the project boundary, in year t

$\Delta C_{LI_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary, in year t

Two baseline strata are distinguished based on the land use and canopy cover: agricultural and pasture areas. To increase the detail of the pasture areas analysis, the pasture was divided into open pasture, dense bush (3 ha) and open bush (101 ha). This was done to account for areas where bushland colonized pasture, resulting in increased biomass compared to open pasture.

According to the methodology, the baseline emissions and removals are calculated using the AR-Tool 14

A/R Methodological tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (Version 04.2) as well as AR-Tool 12 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” (Version 03.1).

In order to estimate baseline stocks and stock change of trees and shrubs a canopy cover assessment was conducted to determine the baseline coverage of trees and shrubs according to 6.3 of the AR-Tool 14.

This was done using the “Open Foris Collect” and “Collect Earth” software to do a simple canopy cover ticking.

For this different sub-steps applied:

1. Random sample points were identified among the stratified areas using QGIS (v. 3.10). In total 30 points were assessed.
2. A survey was designed using Open Foris Collect (version 3.26.12). This survey created a sample design covering the identified random samples with a 0.5 ha cluster, encompassing a 5x5 sub-point grid. Each of the points could be ticked with the following covers: “Tree”, “Shrub”, “Grass” and “other”.
3. Both, the survey and the QGIS grid were imported to “Collect Earth” (v. 1.10.18), which uses Google earth and the Google earth engine. Satellite imagery of 2 dates, shortly before project beginning were used: 12.6.2016 & 15.7.2017. Since the project started in 2018 the baseline land use was ensured (avoidance of images from after the project start date with possible project activities visible).
4. A special case applied for clusters, which were located on or even exceeding the project boundary. In this case all respective subplots, which were located within project boundaries were pushed to the opponent side of the cluster, where project land tenure or the stratum was given (Figure 22).

:

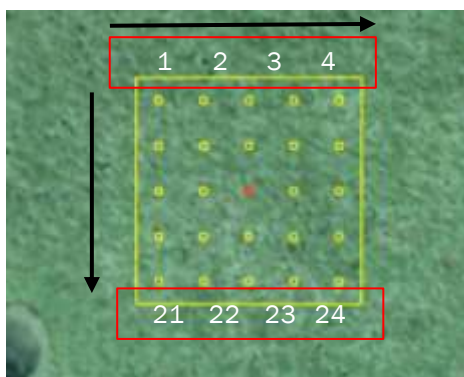


Figure 22. Plot layout using Collect Earth in Google Earth, each subplot receives a unique ID, starting in the left upper corner



Figure 23. Procedure for sampling along stratum/tenure boundaries, indicated by the red line

Table 9. Baseline stratums in Forestal Azul First Instance project

Coverage (%)	Baseline Stratum			
	Agriculture	Pasture	Bushland Open	Bushland Dense
Tree	0%	2,1%	0%	0%
Shrub	0%	4,5%	19.5%	44.3%
Grass	100%	93,3%	80.5%	55.7%
Unknown	0%	0%	0%	0%

Therefore, the canopy cover assessment has the following implications on the assessment of the baseline tree and shrub stocks and stock changes:

Baseline shrub carbon stock

The baseline carbon stock is estimated using the forest definition of Paraguay, which is defined as 25% tree coverage, 0.5 ha and 5m of minimum tree height. According to AR-Tool 14, chapter 11 the shrub carbon stock is accounted as 0 t C/ha, since shrub coverage is <5% (20% of 25%).

Baseline tree carbon stock for agriculture and pasture

The pre-existing tree C stock is calculated using the formulas 20 and 21 from the AR-Tool14:

$$C_{TREE_BSL} = \sum_{i=1}^M C_{TREE_BSL,i}$$

$$C_{TREE_BSL,i} = \frac{44}{12} \times CF_{TREE} \times b_{FOREST} \times (1 + R_{TREE}) \times CC_{TREE_BSL,i} \times A_i$$

Where:

C_{TREE_BSL} = Carbon stock in pre-project tree biomass; t CO₂e

$C_{TREE_BSL,i}$	= Carbon stock in pre-project tree biomass in stratum i; t CO ₂ e
CF_{TREE}	= Carbon fraction of tree biomass; t C (t dm),
b_{Forest}	= Mean above-ground biomass in forest in the region or country, t dm ha,
R_{TREE}	= Root-shoot ratio for trees in the baseline, dimensionless
$CC_{TREE_BSL,i}$	= Crown cover of trees in baseline stratum i
A_i	= Area of baseline stratum i, delineated on the basis of tree crown cover at the start of the A/R CDM project activity; ha

Parameter	Value	Unit	Source
CF_{TREE}	0.47	dimensionless	AR-Tool 14
R_{TREE}	0.25	dimensionless	AR-Tool 14
$CC_{TREE_BSL,PASTURE}$	1.3%	%	Canopy cover assessment
b_{Forest}	80	t dm/ha	de Sy et al (2015), tropical moist deciduous forest

Baseline tree and shrub carbon stock change

The shrub carbon stock change is estimated to be 0, since the baseline shrub stock is accounted as 0 as well.

According to section 5 of the Tool, changes in carbon stocks in trees in the baseline are accounted as zero, as the following conditions are met: Based on the evidence and documentation presented above under 1.13 and 3.4 the project lands were under continuous pasture and agricultural management for decades with continuous degradation and forest deforestation prevailing in the region.

Paraguay and the project region suffers from severe environmental degradation. Paraguay's deforestation rate was until recently one of the highest in Latin America. Deforestation, combined with further unsustainable land management practices including implanted pastures and monocultivation of crops like soybeans and sugarcane, further exacerbate soil erosion, loss of soil fertility and decreased quantity and quality of water resources.

The low level of pre-existing trees assessed in the project area is included in the project as carbon stocks, however, no change is assumed since these trees have all reached maturity. In addition, the trees will be left on site and are not part of the carbon monitoring system.

Baseline dead wood and litter carbon stock

The dead wood carbon stock is calculated using conservative default factor method of equation 9 in the AR-Tool 12.

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

Where:

$C_{DW,i,t}$ = Carbon stock in dead wood in stratum i at a given point of time in year t; t CO2e

$C_{TREE,i,t}$ = Carbon stock in trees biomass in stratum i at a point of time in year t; t CO2e

DF_{DW} = Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass

The litter carbon stock is calculated using conservative default factor method of equation 15 in the AR-Tool12.

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

Where:

$C_{LI,i,t}$ = Carbon stock in dead wood in stratum i at a given point of time in year t; t CO2e

$C_{TREE,i,t}$ = Carbon stock in trees biomass in stratum i at a point of time in year t; t CO2e

DF_{LI} = Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass

Parameter	Value	Unit	Source
Carbon stock in dead wood, default factor	1	%	AR-Tool 12, Table 5, Mean project area precipitation: 1300 mm/yr.
Carbon stock in litter, default factor	1	%	AR-Tool 12, Table 6, Mean project area precipitation: 1300 mm/yr.

As result, the baseline carbon estimation is summarized below:

Table 10. Baseline emissions

Year	Project year	Annual planted area (ha)	$C_{TREE_{BSL}}$ (t CO2e)	$C_{DW,i,t}$ and $C_{LI,i,t}$ trees (t CO2e)	Total Baseline emission (t CO2e)
2018	1	346	853	10	863
2019	2	647	1,452	17	1.468
2020	3	315	749	9	758
Total	-	1.307	3,054	35	3,089

4.2 Project Emissions

The ex-ante actual net GHG removals by sinks are estimated using the equation 2 described in section 5.5 of the methodology AR-ACM0003 (Version 02.0):

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

Where:

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year t; t CO2-e

$\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; t CO2-e

$GHG_{E,t}$ = Increase in non-CO2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t, as estimated in the tool “Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity”; t CO2-e

Further:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t} + \Delta SOC_{AL,t}$$

$\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; t CO2-e

$\Delta C_{TREE_PROJ,t}$ = Change in carbon stock in tree biomass in project in year t; t CO2-e

$\Delta C_{SHRUB_PROJ,t}$ = Change in carbon stock in shrub biomass in project in year t; t CO2-e

No shrub biomass will be accounted in this project

$\Delta C_{DW_PROJ,t}$ = Change in carbon stock in dead wood in project in year t; t CO2-e

No dead wood biomass will be accounted in this project

$\Delta C_{LI_PROJ,t}$ = Change in carbon stock in litter in project in year t; t CO2-e

No litter biomass will be accounted in this project

$\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in project, in year t; t CO2-e

The change in carbon stock in tree biomass in this grouped project is estimated using the A/R methodological tool “estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (Version 04.2). Based on the tool the stock difference method is applied and the ex-ante tree biomass is estimated using the method of “Estimation by modelling of tree growth and stand development, presented in section 8 of the tool. The ex-ante

estimation of carbon stock changes is based on an average growth assumption (MAI) for the entire project area according to its planting strata.

The ex-ante growth model was developed based on the assumptions presented below and is available as supporting documentation.

For the diameter growth of Eucalyptus, company internal assumptions were used for the Ex-ante estimation. Different planting strata follow different growth increment assumptions depicted in Table 11.

Table 11. Mean annual increment according to planting schemes

Planting scheme	MAI	Unit
1000 trees/ha	≈ 40	m ³ /ha yr.
800 trees/ha	≈ 38	m ³ /ha yr.
500 trees/ha	≈ 31	m ³ /ha yr.

The root-to-shoot ratio is a mean of published ratios of *E. camaldulensis* and *E. globulus* in Barton and Montagu (2006)¹³ and Fabiao et al. (1995)¹⁴ and is estimated to be 0.37.

Even though the plantations have different stem densities and are stratified according to this, the major silvicultural measures are across all strata the same. The entire rotation cycle is 12-13 years, while thinning operations or natural mortality reduce the stem density (Table 12). Default carbon fraction: 0.47 as per AR Methodology. Wood density is estimated to be 540 g/cm³, based on average wood densities of three *Eucalyptus grandis* and *E. urophylla* published in the global wood density database (Zanne et al., 2009). The biomass expansion factor is used from IPCC Good practice guidance for LULUCF for temperate broadleaf trees (lower confidence interval): 1.15, since table 3A 1.10 mentions no sub-tropical climate (IPCC, 2003).

Table 12. Stem density of strata in different years, thinning operations in years 2, 5 and 8

Year	1000 trees/ha	800 trees/ha	714 trees/ha	500 trees/ha
1	1,000	800	714	500
2	850	680	600	450
3	850	680	600	450
4	550	450	450	400
5	550	450	450	400
6	550	450	450	400

¹³ Barton, C. V. M. and Montagu, K.D. (2006) Effect of spacing and water availability on root:shoot ratio in *Eucalyptus camaldulensis*, Forest Ecology and Management 221 (2006) 52–62

¹⁴ Fabiao, A. Madeira, M. Steen, E. Kätterer, T. Ribeiro, C. and Araujo C. (1995): Development of root biomass in an *Eucalyptus globulus* plantation under different water and nutrient regimes, Plant and Soil 168 – 169: 215-223

Year	1000 trees/ha	800 trees/ha	714 trees/ha	500 trees/ha
7	350	300	300	300
8	350	300	300	300
9	350	300	300	300
10	200	200	200	150
11	200	200	200	150
12	200	200	200	150

Table 13. Biomass model for Eucalyptus – 1000 trees/ha

Project year	Stock (m³/ha)	Total ABG (tCO2e)	Total BGB (tCO2/ha)	Total Biomass (tCO2/ha)
1	1.9	2.1	0.8	2.9
2	24.8	20.4	7.6	28.0
3	47.2	52.5	19.6	72.1
4	103.2	114.7	42.7	157.4
5	227.7	185.6	69.2	254.8
6	157.9	175.4	65.4	240.8
7	215.6	239.5	89.3	328.8
8	387.9	301.8	112.5	414.2
9	195.8	217.6	81.1	298.7
10	232.3	258.1	96.2	354.3
11	265.1	294.6	109.8	404.4
12	292.5	-	-	-
13	1.9	2.1	0.8	2.9
14	24.8	20.4	7.6	28.0
15	47.2	52.5	19.6	72.1
16	103.2	114.7	42.7	157.4
17	227.7	185.6	69.2	254.8
18	157.9	175.4	65.4	240.8
19	215.6	239.5	89.3	328.8
20	387.9	301.8	112.5	414.2
21	195.8	217.6	81.1	298.7
22	232.3	258.1	96.2	354.3
23	265.1	294.6	109.8	404.4
24	292.5	-	-	-
Long-Term Average		155.2	57.8	213.0

Table 14. Biomass model for Eucalyptus – 800 trees/ha

Year	Stock (m³/ha)	Total ABG (tCO2e)	Total BGB (tCO2/ha)	Total Biomass (tCO2/ha)
1	1.5	1.7	0.6	2.3
2	19.6	16.3	6.1	22.4
3	37.4	41.5	15.5	57.0
4	82.3	91.4	34.1	125.5
5	178.2	148.5	55.4	203.9
6	132.7	147.5	55.0	202.5
7	181.6	201.8	75.2	277.0
8	305.4	254.5	94.9	349.4
9	192.9	214.3	79.9	294.2
10	229.0	254.4	94.8	349.3
11	261.5	290.6	108.3	398.9
12	288.6	-	-	-
13	1.5	1.7	0.6	2.3
14	19.6	16.3	6.1	22.4
15	37.4	41.5	15.5	57.0
16	82.3	91.4	34.1	125.5
17	178.2	148.5	55.4	203.9
18	132.7	147.5	55.0	202.5
19	181.6	201.8	75.2	277.0
20	305.4	254.5	94.9	349.4
21	192.9	214.3	79.9	294.2
22	229.0	254.4	94.8	349.3
23	261.5	290.6	108.3	398.9
24	288.6	-	-	-
Long-Term Average		138.6	51.6	190.2

Table 15. Biomass model for Eucalyptus – 714 trees/ha

Year	Stock (m³/ha)	Total ABG (tCO2e)	Total BGB (tCO2/ha)	Total Biomass (tCO2/ha)
1	1	1,5	0,6	2,1
2	16	18,0	5,4	19,7
3	37	41,5	15,5	57,0
4	82	91,4	34,1	125,5
5	178	198,1	55,4	203,9
6	133	147,5	55,0	202,5
7	182	201,8	75,2	277,0
8	305	339,4	94,9	349,4
9	193	214,3	79,9	294,2
10	229	254,4	94,8	349,3
11	261	290,6	108,3	398,9
12	289	320,7	0,0	0,0
13	1	1,5	0,6	2,1
14	16	18,0	5,4	19,7
15	37	41,5	15,5	57,0
16	82	91,4	34,1	125,5
17	178	198,1	55,4	203,9
18	133	147,5	55,0	202,5
19	182	201,8	75,2	277,0
20	305	339,4	94,9	349,4
21	193	214,3	79,9	294,2
22	229	254,4	94,8	349,3
23	261	290,6	108,3	398,9
24	289	320,7	0,0	0,0
Long-Term Average		138.6	51.6	190.0

Table 16. Biomass model for Eucalyptus – 500 trees/ha

Year	Stock (m ³ /ha)	Total ABG (tCO ₂ e)	Total BGB (tCO ₂ /ha)	Total Biomass (tCO ₂ /ha)
1	1	1.1	0.4	1.6
2	12	10.8	4.0	14.8
3	29	32.3	12.0	44.3
4	64	71.1	26.5	97.6
5	89	99.0	36.9	135.9
6	133	147.5	55.0	202.5
7	182	201.8	75.2	277.0
8	305	254.5	94.9	349.4
9	193	214.3	79.9	294.2
10	229	254.4	94.8	349.3
11	261	290.6	108.3	398.9
12	289	0.0	0.0	0.0
13	1	1.1	0.4	1.6
14	12	10.8	4.0	14.8
15	29	32.3	12.0	44.3
16	64	71.1	26.5	97.6
17	89	99.0	36.9	135.9
18	133	147.5	55.0	202.5
19	182	201.8	75.2	277.0
20	305	254.5	94.9	349.4
21	193	214.3	79.9	294.2
22	229	254.4	94.8	349.3
23	261	290.6	108.3	398.9
24	289	0.0	0.0	0.0
Long-Term Average		131.5	49	180.5

Table 17. Annual estimation of tree biomass GHG removals by sinks in the project scenario for the first project instances (4,401 ha).

Project year	Accumulated tree biomass GHG removals by sinks, tCO ₂ e	Annual estimation of tree biomass GHG removals by sinks; tCO ₂ e
1	610	610
2	7,731	7,120
3	33,769	26,038
4	86,061	52,292
5	163,916	77,855
6	223,482	59,566
7	244,873	21,391
8	245,630	757
9	245,630	-
10	245,630	-
11	245,630	-
12	245,630	-
13	245,630	-
14	245,630	-
15	245,630	-
16	245,630	-
17	245,630	-
18	245,630	-
19	245,630	-
20	245,630	-
Total		245,630

Estimation of the changes in carbon stocks in dead wood: $\Delta C_{DW_PROJ,t}$

As the plantations will be fully managed, no deadwood will occur. Therefore, this carbon stock will be accounted as zero for the ex-ante and ex-post estimations.

Estimation of the changes in carbon stocks in soil organic carbon (SOC): $\Delta SOC_{PROJ,t}$

Changes in carbon stocks in the SOC pool is calculated as indicated in the “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities” (version 01.1.0):

$$\Delta SOC_{PROJ,t} = \frac{44}{12} * \sum_{t=1}^t A_{PLANT,t} * dSOC_t * 1year$$

Where:

$\Delta SOC_{PROJ,t}$ = Change in SOC stock within the project boundary, in year t; t CO2-e

$A_{PLANT,t}$ = Area planted in year t, ha

$dSOC_t$ = The rate of change in SOC stocks within the project boundary, in year t, tCha-1yr-1.

The approved IPCC spreadsheet to facilitate the calculation of changes in soil organic carbon stocks was used for calculating a one-hectare based model which is up-scaled for the planting area according baseline land use. The factors applied are 0.07 t C/ha yr. for all areas formerly being pasture and 0.8 t C/ha yr. for all areas formerly being agriculture. The following Table 18 shows the aggregated SOC changes.

Table 18. Aggregated SOC Changes

Project year	Planting 2018	Planting 2019	Planting 2020	Annual SOC (tC/yr.)	Cumulative SOC (tC)
1	159	-	-	159	159
2	159	303	-	462	621
3	159	303	164	625	1,246
4	159	303	164	625	1,872
5	159	303	164	625	2,497
6	159	303	164	625	3,123
7	159	303	164	625	3,748
8	159	303	164	625	4,374
9	159	303	164	625	4,999
10	159	303	164	625	5,625
11	159	303	164	625	6,250
12	159	303	164	625	6,876
13	159	303	164	625	7,501
14	159	303	164	625	8,127
15	159	303	164	625	8,752
16	159	303	164	625	9,378
17	159	303	164	625	10,003
18	159	303	164	625	10,628
19	159	303	164	625	11,254
20	159	303	164	625	11,879

These SOC stock changes result in removals by sink as follows:

Table 19. Total SOC removals in the project

Project year	Annual SOC GHG removals by sinks; tCO2-e	Cumulative SOC GHG removals by sinks; tCO2-e
1	583	583
2	1,683	2,265
3	2,255	4,521
4	2,255	6,776
5	2,255	9,032
6	2,255	11,287
7	2,255	13,543
8	2,255	15,798
9	2,255	18,054
10	2,255	20,309
11	2,255	22,565
12	2,255	24,820
13	2,255	27,075
14	2,255	29,331
15	2,255	31,586
16	2,255	33,842
17	2,255	36,097
18	2,255	38,353
19	2,255	40,608
20	2,255	42,864
Total		42,864

4.3 Leakage

According to the methodology AR-AM0003 (Version 02.0), the leakage emission has to be assessed with the tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” (Version 02).

$$LK_t = LK_{AGRIC,t}$$

Where:

LK_t = GHG emissions due to leakage, in year t; t CO₂-e

$LK_{AGRIC,t}$ = leakage due to the displacement of agricultural activities in year t

This tool evaluates the displacement of crop cultivation and grazing activities. Section 6 of this tool indicates that leakage emissions can be considered insignificant if they meet the following requirements:

- (a) Animals are displaced to existing grazing land and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;
- (b) Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;
- (c) Animals are displaced to cropland that has been abandoned within the last five years;
- (d) Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;
- (e) Animals are displaced to zero-grazing system

The Forestal Azul Carbon Project aims to increase the carbon stock of former agricultural land and implanted pastures through afforestation.

The risk of leakage is low, since the project works with traditional landowners settled in Eastern Paraguay. As a known fact, previous owners have not shifted pre-project activities to any other region where deforestation/forest conversion is allowed. Any forest conversion in Eastern Paraguay is forbidden, and while law enforcement is weak, blatant deforestation has become unusual (partially due to the lack of large forest areas and partially due to social control). Deforestation in the project region does not usually happen as clear cutting anymore, but rather as long-term and continuous degradation of forests (see chapter 3.4). The shifting of cattle by the previous owners corresponds to Section 6 requirements a of the methodology /explained above), whereby cattle was shifted to existing grazing land without exceeding the carrying capacity. In addition, the Company introduces cattle on part of the plantations, leasing the areas between plantations to the neighbour for cattle grazing. Thereby the neighboring cattle rancher does not need to find additional area or buy additional fodder for his cattle in winter, when fodder is low. This can be considered a buffer on any potential leakage activity.

Therefore leakage emission attributable to the displacement of grazing activities under the project are considered insignificant and hence accounted as zero. However, potential displacement will be monitored throughout the project lifetime

4.4 Estimated Net GHG Emission Reductions and Removals

The ex-ante net anthropogenic GHG emission reductions and removals are calculated using equation 5 of the methodology AR-AM0003:

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

Where:

$\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks, in year t; t CO2-e

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks, in year t; t CO2-e

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks, in year t; t CO2-e

LK_t = GHG emissions due to leakage, in year t; t CO2-e

The results for the first project activity instance are shown below.

Table 20. Total ex-ante net anthropogenic GHG emission reductions and removals in the project shown for the first activity instances

Project year	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	VCS buffer credits (15% risk buffer) (tCO2e)	Estimated net GHG emission removals (tCO2e)
1	863	1,193	-	50	281
2	1,468	8,806	-	1,101	6,236
3	758	28,298	-	4,131	23,409
4	-	54,511	-	8,177	46,335
5	-	80,018	-	12,003	68,015
6	-	61,645	-	9,247	52,398
7	-	23,523	-	3,528	19,994
8	-	2,867	-	430	2,437
9	-	2,266	-	340	1,926
10	-	2,266	-	340	1,926
11	-	2,266	-	340	1,926
12	-	2,266	-	340	1,926
13	-	2,266	-	340	1,926
14	-	2,266	-	340	1,926

Project year	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	VCS buffer credits (15% risk buffer) (tCO2e)	Estimated net GHG emission removals (tCO2e)
15	-	2,266	-	340	1,926
16	-	2,266	-	340	1,926
17	-	2,266	-	340	1,926
18	-	2,266	-	340	1,926
19	-	2,266	-	340	1,926
20	-	2,266	-	340	1,926
Total	3,089	288,047	-	42,744	242,214

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	MAI
Data unit	m ³ /ha/yr
Description	Mean Annual Increment
Source of data	Estimated growth tables
Value applied:	35
Justification of choice of data or description of measurement methods and procedures applied	The value applied is a conservative average of all plantations. Growth estimations are based on inventory data, locally available information on growth performance and the eucalyptus growth simulator of EMBRAPA.
Purpose of Data	Determination of Ex-Ante volume growth of the plantations
Comments	-

Data / Parameter	CF _{TREE}
Data unit	t C(t.d.m.) ⁻¹
Description	Carbon fraction of tree biomass
Source of data	Default value
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" IPCC default value of 0.47 is used

Purpose of Data	Determination of baseline emissions/removals and project emission/ removals
Comments	-

Data / Parameter	R_{TREE_BSL}
Data unit	dimensionless
Description	Root : Shoot ratio of trees
Source of data	Default value
Value applied:	0.25
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" IPCC default value of 0.25 is used
Purpose of Data	Determination of baseline emission/removals
Comments	-

Data / Parameter	b_{Forest}
Data unit	t d.m. ha ⁻¹
Description	Total Aboveground biomass of trees in the country, where the AR CDM project activity is located
Source of data	Value for tropical moist deciduous forest in Paraguay, de Sy et al. (2015) ¹⁵
Value applied:	80

¹⁵ De Sy, V., Herold, M., Achard, F., Beuchle, R., Clevers, J. G. P. W., Lindquist, E., & Verchot, L. (2015). Land use patterns and related carbon losses following deforestation in South America. Environmental Research Letters, 10(12), 124004.

Justification of choice of data or description of measurement methods and procedures applied	Scientific study
Purpose of Data	Calculation of baseline emission removals
Comments	-

Data / Parameter	ΔC_{DW_BSL}
Data unit	percent
Description	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass
Source of data	Default factor
Value applied:	1%
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool " Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities ", the project mean annual precipitation is 1300 mm/yr.
Purpose of Data	Calculation of baseline emission removals
Comments	-

Data / Parameter	ΔC_{LI_BSL}
Data unit	percent
Description	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass
Source of data	Default factor
Value applied:	1%

Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool " Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities ", the project mean annual precipitation is 1,300 mm/yr.
Purpose of Data	Calculation of baseline emission removals
Comments	-

Data / Parameter	BEF
Data unit	dimensionless
Description	Biomass expansion factor, expressing the additional biomass of a tree when only stem volume is known.
Source of data	Default factor
Value applied:	1.15
Justification of choice of data or description of measurement methods and procedures applied	According to IPCC Good Practice Guidance for LULUCF – Table 3A.1.10, Broadleaf Temperate forest since no sub-tropical values are available, lower confidence interval
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	$R_{TREE, project}$
Data unit	dimensionless
Description	Mean of Root : Shoot ratio used from the AR CDM Methodological Tool AR-TOOL 14
Source of data	Average

Value applied:	$R_j = \frac{e^{(-1.085+0.9256 \times \ln b)}}{b}$
Justification of choice of data or description of measurement methods and procedures applied	AR CDM Tool Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (Version 04.2)
Purpose of Data	Calculation of ex-ante and ex-post project emission removals
Comments	-

Data / Parameter	Wood density
Data unit	t/m ³
Description	Weight to volume relation of <i>Eucalyptus grandis</i> and <i>E. urophylla</i>
Source of data	Zanne et al. (2009)
Value applied:	0,54
Justification of choice of data or description of measurement methods and procedures applied	According to Zanne et al. (2009) ¹⁶ a mean of all available wood densities of <i>E. grandis</i> and <i>E. urophylla</i> was calculated.
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	SOC _{REF,i}
Data unit	t C ha ⁻¹
Description	Reference SOC stock corresponding to the reference condition in native lands

¹⁶ Zanne, A.E., Lopez-Gonzalez, G.*, Coomes, D.A., Ilic, J., Jansen, S., Lewis, S.L., Miller, R.B., Swenson, N.G., Wiemann, M.C., and Chave, J. 2009. Global wood density database. Dryad. Identifier: <http://hdl.handle.net/10255/dryad.235>.

Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	47
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" a default value of 47 for tropical moist climate regions and soils with low activity clay (LAC).
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	$f_{LU, i}$
Data unit	dimensionless
Description	Relative stock change factor for baseline land-use in stratum I of the areas of land
Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	Agriculture: 0.48 Pasture/Grassland: 1.0
Justification of choice of data or description of measurement methods and procedures applied	Table 4 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" gives 0.48 as a relative stock change factor for long term cultivation in a tropical moist region and 1.0 for grasslands.
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	$f_{MG,i}$
Data unit	dimensionless
Description	Relative stock change factor for baseline management regime in stratum I of the areas of land
Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	Full tillage/Agriculture: 1
Justification of choice of data or description of measurement methods and procedures applied	Moderately degraded/Pasture: 0.97
Purpose of Data	Table 4 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" gives a default value of 1 for full tillage in agriculture and Table 6 0.97 for tropical moderately degraded grasslands
Comments	Calculation of project emission removals

Data / Parameter	$f_{IN,i}$
Data unit	dimensionless
Description	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum I of the areas of land.
Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	Medium/cropland: 1 Medium/grasslands: 1
Justification of choice of data or description of	According the Table 5 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation

measurement methods and procedures applied	of A/R CDM project activities” an input factor of 1 is used when medium manure input is applied, while table 6 shows an input factor of 1 for medium manure inputs in grasslands.
Purpose of Data	Calculation of project emission removals
Comments	-

5.2 Data and Parameters Monitored

Data / Parameter	FF
Data unit	-
Description	Form Factor for volume
Source of data	Empiric measurement
Description of measurement methods and procedures applied	Diameter and height were measured in 41 trees in different stem lengths to determine the tree volume according to sectional diameter method 10.b of the methodology AR Tool 18. Also, the R2 factor is 0.98, above the minimum established of 0.85.
Frequency of monitoring/recording	In 2019, 41 trees were measured and statistically analyzed to ensure the requirements of the AR tool 18.
Value applied:	0.4
Monitoring equipment	Diameter tape
QA/QC procedures applied	The team was trained for the activity and the results were proofed by the technical expert.
Purpose of data	Calculation of volume
Calculation method	Excel
Comments	-

Data / Parameter	Ai
Data unit	Ha
Description	Area of tree biomass stratum i
Source of data	GIS or/and GPS
Description of measurement methods and procedures applied	Areas in project area will be tracked in the field using the GPS. Each plot which will be subject to planting is tracked - a standard procedure of the baseline and monitoring inventory
Frequency of monitoring/recording	Before the start of the project (planting) and adjusted thereafter every y since yearly with satellite imagery
Value applied:	See project database
Monitoring equipment	GPS (Garmin), GPS Smartphones, QGIS software
QA/QC procedures applied	Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible; all field team members are trained in GPS/GIS application
Purpose of data	Calculation of project emissions
Calculation method	GIS tool
Comments	-

Data / Parameter	wi
Data unit	Dimensionless
Description	Relative weight of the area of stratum I, the area of the stratum i divided by the project area.
Source of data	Calculated
Description of measurement methods and procedures applied	N/A

Frequency of monitoring/recording	Calculated for each monitoring event, at least every five years												
Value applied:	For ex ante situation the following values are estimated from the first project instance: <table border="1"> <tr> <th>Stratum (Year_Density)</th><th>Wi</th></tr> <tr> <td>2018_714</td><td>0.16</td></tr> <tr> <td>2018_1000</td><td>0.19</td></tr> <tr> <td>2019_500</td><td>0.04</td></tr> <tr> <td>2019_714</td><td>0.25</td></tr> <tr> <td>2019_1000</td><td>0.36</td></tr> </table>	Stratum (Year_Density)	Wi	2018_714	0.16	2018_1000	0.19	2019_500	0.04	2019_714	0.25	2019_1000	0.36
Stratum (Year_Density)	Wi												
2018_714	0.16												
2018_1000	0.19												
2019_500	0.04												
2019_714	0.25												
2019_1000	0.36												
Monitoring equipment	N/A												
QA/QC procedures applied	N/A												
Purpose of data	Calculation of project emissions/removals												
Calculation method	Area of the stratum i divided by the project area												
Comments	-												

Data / Parameter	s_i
Data unit	t d.m. (or t d.m. ha ⁻¹)
Description	Estimated standard deviation of biomass stock in stratum i
Source of data	Project based monitoring system
Description of measurement methods and procedures applied	N/A
Frequency of monitoring/recording	s_i is calculated for each monitoring event, at least every five years
Value applied:	For ex ante situation the following values are estimated from the first project instance:

	Stratum (Year_Density)	Si
	2018_714	11.57
	2018_1000	10.97
	2019_500	1.13
	2019_714	5.93
	2019_1000	2.75
Monitoring equipment	N/A	
QA/QC procedures applied	N/A	
Purpose of data	Calculation of uncertainty of project emissions/removals	
Calculation method	Excel or tool available to calculate standard deviation	
Comments	-	

Data / Parameter	n_i	
Data unit	Dimensionless	
Description	Number of sample plots in stratum i	
Source of data	Calculated	
Description of measurement methods and procedures applied	N/A	
Frequency of monitoring/recording	n_i is calculated for each monitoring event, at least every five years	
Value applied:	For ex ante situation the following values are estimated from the first project instance:	
	Stratum (Year_Density)	n_i
	2018_714	24
	2018_1000	23
	2019_500	12
	2019_714	37

	2019_1000	42
Monitoring equipment	N/A	
QA/QC procedures applied	N/A	
Purpose of data	Calculation of project emissions/removals	
Calculation method	The calculation method is described in the Chapter 5.3	
Comments	-	

Data / Parameter	$A_{p,i}$
Data unit	Ha
Description	Size of a sample plot in stratum i
Source of data	Field measurement
Description of measurement methods and procedures applied	After calculating the No of sample plots required to achieve the desired precision level (90/10) a stratified random selection is carried out.
Frequency of monitoring/recording	Yearly
Value applied:	200 and 250m ²
Monitoring equipment	N/A
QA/QC procedures applied	Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible; all field team members are trained in GPS/GIS application
Purpose of data	Calculation of project emission removals

Calculation method	It is calculated based on the area needed to include 20 trees in the Permanent Sample Plot, varying strictly by tree planting density
Comments	-

Data / Parameter	DBH
Data unit	cm
Description	The diameter at breast height (1.3 m from the ground)
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures applied	The circumference or DBH of the tree at 1.3 m will be measured in the field for each 20 tree presented in the Permanent Sample Plot.
Frequency of monitoring/recording	Every year after the first year of plantation
Value applied:	n.a. (see Excel base carbon accounting sheet)
Monitoring equipment	Diameter tapes
QA/QC procedures applied	Training of inventory team is fundamental to ensure the quality of the data. Analysis to avoid typos or mistakes comparing with past years are conducted after the measurements and re-measurements might be required.
Purpose of data	Estimation of ex-post project emissions/removals
Calculation method	N/A
Comments	-

Data / Parameter	H
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Data unit	m
Description	Height of tree planted
Source of data	Field measurements in sample plots. For ex ante estimations, H values are derived from growth tables used in the project
Description of measurement methods and procedures applied	Height of the tree is measured using a vertex IV
Frequency of monitoring/recording	Every year after the first year of plantation
Value applied:	N/A (see Excel base carbon accounting sheet)
Monitoring equipment	Vertex IV
QA/QC procedures applied	To ensure that measurements have been taken correctly, it is important to calibrate the Vertex IV at least once every day, even twice when the temperatures are very high.
Purpose of data	Estimation of ex-post project emissions/removals
Calculation method	At the end of the field work independently 10-20% of the plots will be checked. Field data collected at this stage will be compared with the original data. Any errors found will be corrected and recorded.
Comments	Calculation of project emission removals

Data / Parameter	T
Data unit	Year
Description	Time period elapsed between two successive estimations of carbon stock in a carbon pool
Source of data	Recorded time

Description of measurement methods and procedures applied	N/A
Frequency of monitoring/recording	N/A
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	N/A
Purpose of data	Calculation of project emission removals
Calculation method	N/A
Comments	If the two successive estimations of carbon stock in a carbon pool are carried out at different points of time in year t2 and t1, (e.g. in the month of April in year t1 and in the month of December in year t2), then a fractional value will be assigned to T

5.3 Monitoring Plan

Monitoring system structure

Forestal Azul has a technical team that manages and monitors the plantations. The monitoring system uses standard procedures in order to obtain verifiable and reliable information on the growth of the plantations, thus allowing the accounting of the sequestered carbon.

The complete monitoring system of the project includes different aspects. On the one hand, a monitoring system is used to record operations, inputs used and associated costs, using Excel tools for different analyses. In addition, yearly inventories are conducted to assess the development of the plantations. A GIS project is also continuously updated with reliable information of location, project boundaries, plots, infrastructures, etc.

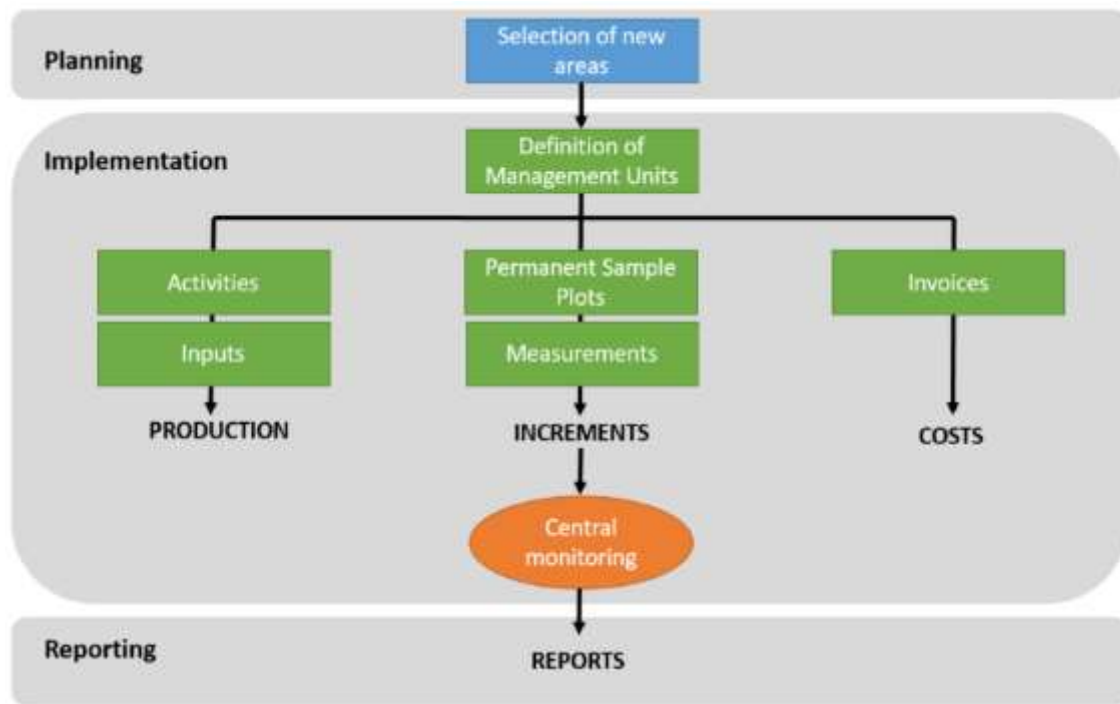


Figure 24: Overview of the production monitoring system of the project

Forest growth monitoring is based on field measurements once a year, starting after plantations turn 1-year of age. During inventories, the development of planted trees is evaluated, including aspects such as forest health and the quality of pruning. The objective of the measurements is to be able to monitor the growth of the trees and the progression of the value of the assets.

Inventories are conducted during the last few months of each year. The analysis of the inventory data feeds into the decision-making for the upcoming year. This allows to report reliably to investors and to plan silvicultural interventions, leading to adaptive management. The data is used to choose the genetic material to be planted in new sites according to their behavior, and adjust the schedules of pruning and harvesting.

Geographical delimitation of project boundaries

The area of the project has been delimited using satellite imagery. The plantations are divided into compartments, the smallest monitoring unit with an average surface of around 50 ha. Each compartment is tracked and recorded as polygon and sent to the GIS department. The GPS track in the first approach, and later, the overall plantation boundaries, are continuously re-assessed and updated with GIS and satellite imagery.

Stratification and update of effective areas

Stratification was primarily conducted based solely on soil analysis conducted before planting. The classification refers to differences expected in the Mean Annual Increment (MAI) and is therefore a sensitive step for overall growth calculation. However, soil analysis does not always

cover all the eventualities in the terrain (eg. Depth). This first classification is re-evaluated on a yearly basis based on the growth differences of the same species. When significant differences are identified, the classification might be readapted.

Each compartment shares a common stratum (same age, species and ideally soil quality and growth). This is the smallest unit used for all silvicultural measures.

Sampling design, plot selection and location

For the monitoring of plantation growth and the estimation of future yields, annual forest inventories are conducted in Permanent Sample Plots (PSPs) installed randomly in all production sites. The data obtained is fundamental to assess survival rates, forest health, to calibrate growth and yield tables, and finally, to predict the mean annual increment (MAI) and the sequestered carbon of the plantations.

The PSPs consist of 20 planted trees (regardless of whether they survived or not) and are established randomly. According to internal procedures, the minimum density is 1 PSP every 10 ha, corresponding to a minimum sampling size of 0.2 % in terms of area. However, to date, the real average is 1 PSP every 6 ha, corresponding to 0.3% of the planted area.

Table 21. PSP size depending on planting density

Spacing	Plot size (m ²)
9 x 2.5	250
5 X 2	200

Trees in PSPs are numbered as shown in Figure 25 and their coordinates are recorded. Measurements are performed every year between November and December. The first measurement takes place at least one year after planting (e.g. if one compartment is planted in June or October 2019 the first measurement takes place between November and December 2020).

Data Collection

Following data is measured: Vitality of the tree, tree height, diameter at breast height (DBH), manifestation of diseases or damages, quality of silvicultural treatments applied, and additional observations if any. Data collection is conducted using an application developed by UNIQUE.

The company has SOPs for the measurement of PSPs and data collection. The most important Sections of the SOPs have been translated from Spanish to English and are presented in the Annex.

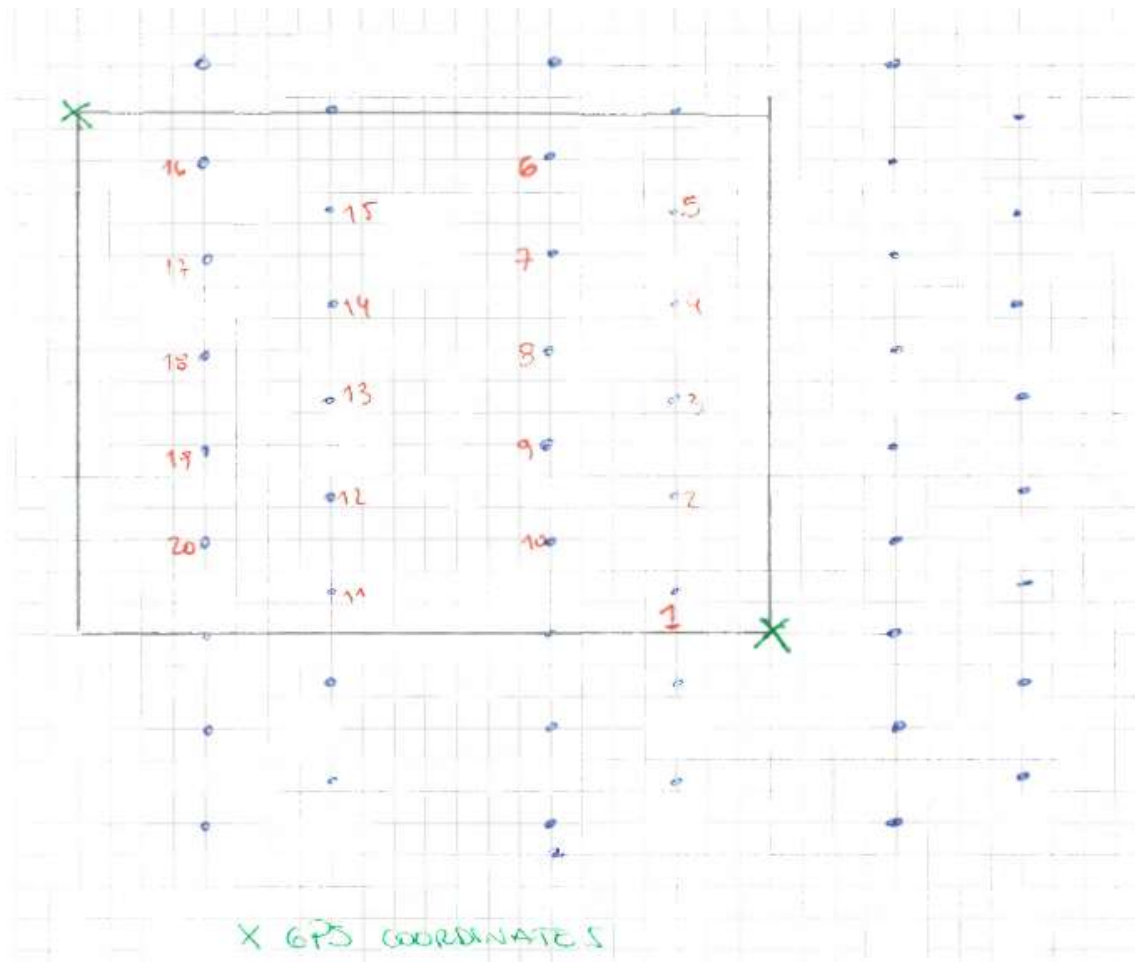


Figure 25. Design of a permanent sample plot

Data analysis

The analysis of the inventory data is done with the simple average of the trees in the plot and interpolation to area occupied by the trees measured. These values are then averaged at the compartment (block) level. To calculate the total volume per compartment and property, values are multiplied by the reported area of the compartment. In this way, following parameters are calculated at compartment (block) level:

- Minimum, average and maximum DAP
- Minimum, average and maximum height
- Density of living trees *
- Active stand density *
- Basal area *
- Volume *
- Average affection by wasp, fungus and cattle damage

*These values are calculated per hectare and require the area of the plot for interpolation. The area of the plot depends on the planting density and were presented in Table 21.

Calibration of growth and yield tables

Production tables used to estimate growth and yield are based on inventory data, locally available information on growth performance and the eucalyptus growth simulator of EMBRAPA (Brazilian Agricultural Research Corporation; Empresa Brasileira de Pesquisa Agropecuária). Tables used are separated by silvicultural system and the expected MAI. In Paraguay, there are no production tables available based on long standing scientific research, and therefore, tables may be subject to variations while they are calibrated. A MAI variation of 5-10 % from one year to the other is considered acceptable and within the normal ranges of biological production. Within time, the reliability of these production tables is expected to increase.

Currently, for the quality timber production there are 4 basic growth tables to reflect the differences in silvicultural regime, and to separate standard quality sites from marginal sites. The growth tables for standard quality sites foresee thinnings at the age of 2, 5 and 8, and the final cut in year 12 for both silvicultural regimes. Whenever the site conditions are below standard and the plantations are underperforming, growth tables for marginal sites were applied, where the final cut is estimated at year 15. According to the measured plantation development, standard quality and marginal sites are subdivided into site classes (MAI classes) in function of the development of tree height over plantation age.

Procedures for internal auditing and QA/QC

Monitoring requires provisions for quality assurance (QA) and quality control (QC) to be implemented via a QA/QC plan. The main parts of this QA/QC are:

- Collecting reliable field measurements
- Verifying methods used to collect field data
- Procedures to ensure reliable field measurements
- Data maintenance and archiving

Collecting reliable field measurement data

Collecting reliable field measurement data is an important step in the quality assurance plan. Those responsible for the measurement work are properly trained in all aspects of the field data collection as well as the different instruments to use during the activity. The local forest manager responsible is well trained to use the instruments and conduct the inventories. The FMU manager conducts yearly on-the-job trainings with the workers supporting the activity, ensuring new workers are properly trained.

Verifying methods used to collect field data

The data collection app is calibrated annually and verified by the monitoring responsible. Also, its correct use is described by the SOPs, and updated whenever necessary by the monitoring responsible.

Verifying data entry and analysis techniques

Analysis is conducted by the forest production responsible, and then verified by the high level manager. Final data is also underlying the analysis of the Biological Asset Value, which is under great scrutiny by investors. Annually, growth and monitoring results are reported on specifically.

Procedures to ensure reliable field measurements

Before conducting the analysis of the data, quality control of the obtained data is conducted by the monitoring responsible. Unexpected results or high deviations between trees in the PSPs are evaluated, and PSPs are re-measured when necessary. Also, and a comparison with previous years is conducted to ensure consistency of the data throughout the project lifetime.

To ensure correct and reliable data regarding carbon sequestration, every verification year a re-measurement of 5% of all plots will be conducted 1 to 4 months after the first measurement has been completed.

Data maintenance and archiving

Because of the relatively long-term nature of these project activities, data archiving (maintenance and storage) are an important component of the work. All data are automatically updated in a cloud facilitated by the project manager (UNIQUE), to which the technical staff of the project and monitoring team has access too. Occasionally, access is given to third-parties, such as auditors.

Copies of all raw data, reports of analysis and supporting spreadsheets will be stored in a dedicated long-term electronic archive for at least 2 years following the end of the last crediting period.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

The achieved GHG emission reductions presented in this chapter refer to the first monitoring period of this project **m1** from 01.06.2018 until 31.12.2020.

The total area included in m1 from the first project instances is 1305.5 ha. Of this area, 316 ha was planted in 2020 which is included in this m1 following the 'no biomass increase approach' of the Methodology, since the seedlings had not reached the dimensions eligible for the annual inventory and measurement of DBH. Therefore, the inventory was only implemented on 992.5 ha. SOC is accounted for all areas of the first instances. After an evaluation of the uncertainty, the stratification was separated by year and tree density.

6.1 Data and Parameters Monitored

Data / Parameter	A_i		
Data unit	Ha		
Description	Area of tree biomass stratum i		
Value applied:	Stratum (Year_Density)	Plantation density	Area
	2018_714	714	161
	2018_1000	1000	184.5
	2019_500	500	41
	2019_714	714	252
	2019_1000	1000	354
	2020_	n.a	314.5 (zero biomass increase)
Comments	Areas are yearly updated using satellite imagery		

Data / Parameter	$A_{p,i}$
Data unit	Ha
Description	Size of a sample plot in stratum i . This varies depending on the plantation density. Permanent Sample Plots always measure 20 trees.

Value applied:	Type of Plantation	Area (m ²)
	500 trees/ha (5x2.5x2m)	400
	714 trees/ha (5x2.5m)	280
	1.000 trees/ha (5x2m)	200
Comments	-	

Data / Parameter	DBH
Data unit	cm
Description	The diameter at breast height (1.3 m from the ground)
Value applied:	See Excel File “Forestal Azul Inventory Database”
Comments	-

Data / Parameter	W_i	
Data unit	Dimensionless	
Description	Relative weight of the area of stratum I, the area of the stratum I divided by the project area (without the zero biomass increase area)	
Value applied:	Stratum (Year_Density)	Wi
	2018_714	0.16
	2018_1000	0.19
	2019_500	0.04
	2019_714	0.25
	2019_1000	0.36
Comments	-	

Data / Parameter	S_i
Data unit	t.d.m. (or t dm.m. ha ⁻¹)

Description	Estimated standard deviation of biomass stock in stratum i ((without the zero biomass increase area)	
Value applied:	Stratum (Year_Density)	Si
	2018_ 714	11.57
	2018_ 1000	10.97
	2019_ 500	1.13
	2019_ 714	5.93
	2019_ 1000	2.75
Comments	-	

Data / Parameter	n_i	
Data unit	Dimensionless	
Description	Number of sample plots in stratum i (without the zero biomass increase area)	
Value applied:	Stratum (Year_Density)	n_i
	2018_ 714	24
	2018_ 1000	23
	2019_ 500	12
	2019_ 714	37
	2019_ 1000	42
Comments	-	

Data / Parameter	H	
Data unit	m	
Description	Height of tree planted	
Value applied:	See Excel “Forestal Azul Inventory Database”	
Comments	-	

Data / Parameter	T	
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Data unit	Year
Description	Time period elapsed between two successive estimation of carbon stock in a carbon pool
Value applied:	2 years
Comments	-

6.2 Baseline Emissions

Baseline emissions for this monitoring period m1 was calculated following the approach demonstrated in section 4.1. The table below displays the baseline carbon stocks for the pre-existing trees for the planting year 2019 that are subject to this monitoring period. Plantations with a density of 1,000 trees/ha had agriculture as a baseline and therefore it is accounted as zero.

Table 22. Baseline biomass for this monitoring period

Stratum	Areas planted / restored per year (ha)	C _{TREE_BSL} Pre-existing biomass of trees (tCO ₂ -e)	C _{CW_BSL} Dead wood pre-existing trees (tCO ₂ -e)	C _{SHRUB_BSL} Pre-existing shrub biomass (tCO ₂ -e)	C _{BSL_TOTAL} Total Biomass baseline (tCO ₂ -e)
2018_714	161	863	10	0	872
2018_1000	184,5	0	0	0	0
2019_500	41	266	4	0	269
2019_714	252	1,204	13	0	1,217
2019_1000	354	0	0	0	0

6.3 Project Emissions

The actual net GHG removals by sinks have been calculated using equation 2 of the methodology (AR-ACM0003: Afforestation and reforestation of lands except wetlands. Version 02.0) as described below.

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

Where:

$\Delta C_{ACTUAL,t}$	= Annual actual net greenhouse gas removals by sinks at time t ; $t \text{ CO}_2\text{-e yr}^{-1}$
$\Delta C_{P,t}$	= Change in carbon stocks in project, occurring in the selected carbon pools, at time t ; $t \text{ CO}_2\text{-e yr}^{-1}$
$GHG_{E,t}$	= Increase of non- CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t , $t \text{ CO}_2\text{-e}$

Change in the carbon stocks in project have been calculated using equation 3 of the methodology, however shrub biomass is not considered in this project:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SOC_PROJ,t}$$

Where:

$\Delta C_{P,t}$	= Change in carbon stocks in project, occurring in the selected carbon pools, at time t ; $t \text{ CO}_2\text{-e yr}^{-1}$
$\Delta C_{TREE_PROJ,t}$	= Change in carbon stock in tree biomass in project in year t , as estimated in AR-TOOL14; $t \text{ CO}_2\text{-e yr}^{-1}$
$\Delta C_{SOC_PROJ,t}$	= Change in carbon stock in the soil organic carbon (SOC) pool within the project boundary, as estimated in AR-AM0014, in year t ; $t \text{ CO}_2\text{-e yr}^{-1}$

Estimation of carbon stock changes in trees and shrubs

Carbon stock changes of trees and shrubs are estimated applying the AR-Tool 'A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities' (Version 04.1).

Estimation of carbon stock change in trees

The following sections and equations of the tool are applied:

Chapter 8: Estimating carbon stock in trees at a point of time

8.1. Estimation by measurement of sample plots

8.1.1. Stratified random sampling

Tree biomass estimated based on equation 6 and 8 of Appendix 1 of the tool

Mean carbon stock in trees within the tree biomass estimation strata and the associated uncertainty are estimated by applying equations 12-15 of the tool

The following equations of the methodology have been applied:

$$C_{TREE,t} = \frac{44}{12} * CF_{TREE} * B_{TREE,t}$$

$$B_{TREE,t} = b_{TREE,t} * A$$

$$b_{TREE,t} = \sum_{i=1}^M w_i * b_{TREE,t,i}$$

Where:

$C_{TREE,t}$ = Carbon stock in tree biomass within the project boundary at a point in time in year t ; t CO₂-e.

CF_{TREE} = Carbon fraction of tree biomass; t C (t d.m.)⁻¹.

$B_{TREE,t}$ = Total tree biomass within the project boundary at a given point in time in year t ; t d.m.

$b_{TREE,t}$ = Mean tree biomass per hectare within the project boundary at a given point in time in year t ; t d.m. ha⁻¹

A = Project area; ha

w_i = Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata (A_i/A), dimensionless

$b_{TREE,t,i}$ = Mean tree biomass per hectare in stratum i at a given point in time in year t ; t d.m. ha⁻¹

Determination of tree biomass $b_{TREE,t,j}$

Tree biomass estimation follows the guidance for measurement of variable plots given in Appendix 1 of the Tool, equations 6 and 8.

The following table summarizes the values applied for equation 8 (of Appendix 1 of the Tool):

Table 23. Values applied to calculate tree biomass

Equation value	Description	Value applied	Source
$V_{TREE,j} (BA_{p,i})$	Stem volume per hectare of trees of species j in sample plot p of stratum i estimated by using the basal area of the plot as entry data into a volume table or volume equation; $m^3 ha^{-1}$	See Excel inventory data 2019	Published and project volume tables
D_j	Density (over-bark) of tree species j ; $t d.m. m^{-3}$	0,54	Zanne et al (2009) ¹⁷
$BEF_{2,j}$	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j ; dimensionless	1.15	IPCC value, Table 3A.1.10, Broadleaf Temp
R_j	Root-shoot ratio for tree species j ; dimensionless	Default equation of AR-TOOL 14	AR-TOOL 14

The calculation of the tree biomass was done in Excel. The file '2021-02-08 Forestal Azul Carbon Inventory M1' is available as supporting documentation.

Table 24. Summary calculation B_{TREE} and C_{TREE}

Stratum	Area (ha)	w_i	$b_{TREE,t}$ $t d.m.$ ha^{-1}	$B_{TREE,t}$ $t d.m.$	$C_{TREE,t}$ $t CO_2-e$
2018_714	161	0.16			

¹⁷ <https://datadryad.org/stash/dataset/doi:10.5061/dryad.234>

2018_1000	184,5	0.19	16.1	15,962	27,508
2019_500	41	0.04			
2019_714	252	0.25			
2019_1000	354	0.36			
Total	993	1			

Calculation of uncertainty following the guidance of Appendix 2 of the A/R Methodological Tool

Table 25. Calculation of uncertainty

Stratum	S_i t.d.m. ha ⁻¹	n_i	U_c %	$U_{c\text{ mean}}$ (t CO ₂ -e)	u_c Discount (t CO ₂ -e)
2018_714	12	24	6.6	1,817,8	0
2018_1000	11	23			
2019_500	1	12			
2019_714	6	37			
2019_1000	3	42			
Total	13	138			

Based on the Tool no discount of C_{TREE} is necessary as $u_c < 10\%$

The LTA was updated using the latest production tables of the project. Annually, the PP conducts forest inventories and about every 2 years, the results of these inventories are used to calibrate the timber production tables that underpin all project planning documentation (Business Plan, cashflow, etc.). This calibration serves to adjust the expected tree growth curve and future increment expectations. The update of the LTA is conducted based on the same tables.

The latest production tables of the Forestal Azul project have been developed in 2021. The resulting updated LTA to date (Ex-Post LTA) is shown per stratum in the Table below, in comparison

to the Ex-Ante LTA and to the actual standing biomass per ha according to the inventory conducted in 2020 (Average b Tree).

The results show that:

- The LTA Ex-Post is similar to the LTA Ex-Ante, with a slight increase in the Strata of 714 trees/ha and a significant decrease in the strata of 500 trees/ha.
- The increase is related to the fact that tree growth dynamic has been adjusted to what has been observed by the PP across all its plantations in Paraguay – that tree growth is more accelerated in the first few years after planting, compared to later in development, contrary to what was initially assumed (a more linear growth dynamic). While overall biomass increment did not increase in these Tables compared to the previous ones, this growth dynamic leads to a slightly higher average growth and results in a higher LTA.
- The new LTA of the stratum of 500 trees/ha is significantly lower, according to lower growth expectation as initially assumed.
- Last but not least, changes in the stratum of 1,000 trees/ha were not significant, leading in basically no change in the LTA of this stratum.

LTA has still not been reached: comparing the different strata current LTA with the LTA ex-ante and LTA ex-post, none of the strata has reached the value by the end of this first verification. See table below:

Table 26. LTA ComparisonStratum	Average bTREE (tCO ₂ e) in 2020	LTA Ex-Ante (tCO ₂ e)	LTA Ex-Post (tCO ₂ e)	Difference to reach LTA Ex-Ante (tCO ₂ e)	Difference to reach LTA Ex-Post (tCO ₂ e)
2018_714	33,8	190,2	202,4	156,4	168,6
2018_1000	63,5	213,0	213,0	149,5	149,5
2019_500	3,7	180,5	137,8	176,8	134,1
2019_714	11,5	190,2	202,4	178,7	190,8
2019_1000	20,6	213,0	213,0	192,4	192,4

Estimation of changes in soil organic carbon stocks

For ex-post estimation of the SOC changes under the project scenario for this monitoring period, the default method of the A/R Methodological tool 'Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities' (Version 01.1.0) is applied. The application and justification of the tool is outlined in section 4.2.

The rate of change in SOC stock in the project scenario until the steady state in SOC content is reached (assumed in 20 years from the time of the initial site preparation) is calculated as 0,61 tC/ ha/ yr which represents the weighted average value over all baseline strata.

For this monitoring period, soil carbon only includes the months of 2019 since planting period.

Table 27. Calculation of SOC change for this monitoring period

Year	SOC area (ha)	Cumulative SOC area (ha)	Total ΔSOC strata 1-4 (t CO ₂ -e)
2018	346	346	517
2019	647	993	1,855
2020	0	993	2,547
Total			4,920

Change in carbon stocks of trees

According to the tool AR-TOOL14 A/R Methodological tool 'Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities' (Version 04.1) at the first verification $C_{TREE, t2}$ is set equal to the carbon stock in the first verification. Based on this, the following table shows the change in carbon stock during the period between two points of time $t1$ (pre-existing baseline tree biomass) and $t2$. The Excel sheet '2020-11-15 Forestal Azul Carbon Inventory M1' details the full calculation of emission reductions for this monitoring period and is available upon request.

Table 28. Change in carbon stocks during the period between two points of time $t1$ (pre-existing tree and shrub biomass) and $t2$

Year of inclusion of	Area strata included	$C_{TREE, t1} = C_{TREE_BSL, t1}$	$C_{DW_BSL, t1}$	$C_{SHRUB_BSL, t1}$ (t CO ₂ -e)	$C_{TREE_PROJ_DISCOUNT, t2}$	$C_{DW_PROJ, t2}$	$\Delta C_{TREE+DW_PROJ, (t2-t1)}$
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project areas	in year t (ha)						
2018	346	863	10	0	6,211	0	5,339
2019	647	1,469	17	0	10,648	0	9,162
2020	0	0	0	0	10,648	0	10,648
Total	993	2,332	26	0	27,508	0	25,150

Actual net greenhouse gas removals by sinks

Table 29. Actual net greenhouse gas removals by sinks for the different years of the monitoring period

Year	Project implementation (cum. months)	Cumulative tree net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual tree net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual SOC net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual total net GHG removals by sinks, in year t; (t CO ₂ -e)
2018	7	6,211	6,211	517	6,729
2019	19	16,860	10,648	1,855	12,504
2020	31	27,508	10,648	2,547	13,196
Total	31	27,508	27,508	4,920	32,428

6.4 Leakage

Leakage is in compliance with Section 6 of the A/R Tool as no displacement of cattle took place for planting. Therefore, it is accounted as zero.

Table 30. GHG emissions due to leakage, in year t

Year	Leakage (t CO ₂ -e)
2018	0
2019	0
2020	0

Total	0
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6.5 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)	Buffer pool allocation	VCUs eligible for Issuance
2018	872	6,729	-	5,856	878	4,978
2019	1,486	12,504	-	11,018	1,653	9,365
2020	-	13,196		13,196	1,979	11,216
Total	2,358	32,428	-	30,070	4,510	25,559

The total GHG emission reductions of the first project instances for the 1st monitoring period 01.06.2018 until 31.12.2020 are 30.070 tCO₂e. The non-permanence risk rating is 15% (as determined in the AFOLU non-permanence risk report attached as a separate document). Therefore, the total number of buffer credits that need to be deposited into the AFOLU pooled buffer account is 4.510 tCO₂e. The number of GHG credits eligible to be issued as VCUs for the first project instances of this monitoring period is 25.559 tCO₂e.