



**Verified Carbon
Standard**

AFFORESTATION OF DEGRADED GRASSLANDS IN CAAZAPÁ AND GUAIRÁ



Document Prepared by South Pole Carbon Asset Management Ltd

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PROJECT DETAILS

1.1 Summary Description of the Project

Miller Forest Investment AG (Miller) aims to establish sustainable forest plantations in eastern Paraguay. To achieve this, the company created a strategy to bring together more than 520 investors, guaranteeing the long-term investment required for the plantations and ensuring their permanence over time.

The *Afforestation of degraded grasslands in Caazapá and Guairá* project is in the Afforestation, Reforestation and Revegetation (ARR) category and aims to certify forest plantations managed by Felber Forestal S.A. (Felber) in the departments of Caazapá and Guairá, in Paraguay. In its first instance, the project consists of 2,716.71 ha established between 2016 and 2020 and 1,111.2 ha to be planted with the *Pinus ellioti*, *Pinus taeda*, *Eucalyptus urograndis* and *Eucalyptus urophila* species.

The current instance is located in the department of Caazapá (municipalities of Caazapá, Maciel, Doctor Moisés and Bertoni) and the department of Guairá (municipality of Ñumí). This region is characterized by its farming economic activities, mainly of extensive livestock for meat production. Before the start of the project, 100% of the area was dedicated to this activity, whose management resulted in high soil degradation, mainly due to the overload of livestock units per hectare, trampling and the use of burning cycles for pastures renovation.

The aim of the ARR project is to produce solid wood and energy (charcoal and chips) in order to meet the country's demand for forest products, hence reducing the pressure on natural forests. The project is expected to capture an average of 204,819 tCO_{2e} per year, reaching a total of 6,144,567 tCO_{2e} during the crediting period (2016-2045) as a result of the growth of forest biomass. Additionally, the project supports Paraguay's Sustainable Development Goals (SDG) since, compared to the livestock scenario, plantations contribute to creating direct and indirect jobs, dynamizing the economy, increasing tree cover and strengthening research.

1.2 Sectoral Scope and Project Type

The project is under the Sectoral Scope 14 "Agriculture, Forestry and other Land Use", in the Afforestation, Reforestation and Revegetation (ARR) category. It is a grouped project, whose expansion area is located in the departments of Caazapá and Guairá. The project has been implemented following the methodology requirements provided in sections 3 and 4 of the VCS Standard version 4.1 document.

1.3 Project Eligibility

The project activity is in the eligible category of Afforestation, Reforestation and Revegetation (ARR) of the AFOLU sector according to the “Appendix 1: Eligible AFOLU Project Categories”, thus complying with the following eligibility requirements:

- The project meets all the requirements of the VCS Program, including the six principles set out in section 2.2 of the VCS Standard v4.1 document.
- The activities carried out in the project are governed by current Paraguayan law (see section 1.4). The company constantly reviews the Paraguayan legislative system, in order to keep up to date with the country’s law.
- The methodology used in this document for the validation of the project and the verification of the first instance is approved by the VCS Program.
- The company plans to continue with the forestry activity for a minimum period of 30 years, thus ensuring constant carbon storage after harvest. In addition, the carbon loss occurred during the harvest is accounted for and included in the project’s emissions, according to the guidelines of the document “AFOLU Guidance: Example for Calculating the Long-Term Average Carbon Stock for ARR Projects with Harvesting”.
- The project does not affect native ecosystems, nor does it include activities that degrade hydrological functions. In other words, it has no impact on natural forests, does not cause drainage or involves the conversion of wetlands. Compliance with this item is described below:

No impact on native ecosystems analysis

The analysis was carried out for an area of 3,833.55 ha, of which 2,721 ha have been planted in the 2016-2020 period and 1,112.55 ha are expected to be planted in future. The methodological process consisted of 6 steps (Table 1), with the non-forest land representing the eligible area¹ and the remaining being defined as an ineligible area².

Table 1. Steps for the eligibility analysis

Step 1	Acquisition of Landsat 5 and 8 multispectral imaging
Step 2	Correction of atmospheric and radiometric Landsat 5 and 8 images
Step 3	Classification of land cover types: forest, non-forest and water
Step 4	Calculation of classification precision
Step 5	Final layer: forest, non-forest
Step 6	Eligibility analysis for the years to be covered by the project

¹ For this analysis, a forest is an area of more than 0.5 hectares with trees above 5 meters (m) and a canopy cover of more than 25% or with trees that can reach these thresholds in situ. It does not include lands with a predominant agricultural or urban use. The rest of the areas are considered non-forest (Forest definition for Paraguay: <https://cdm.unfccc.int/DNA/index.html>).

² The full description of the eligibility analysis is at: Gestión documental/eligibility analysis

For this analysis, medium-resolution multispectral images taken from Landsat 5 (years 2006, 2007, 2008, 2009, and 2010) and Landsat 8 (years 2016, 2017, 2018, 2019, and 2020) were used in order to visualize the forest and non-forest covers through a supervised classification.

Of the total area analyzed, 3,827.91 ha are eligible (99.85%), of which 2,716.7 ha have been already planted and 1,111.2 ha are planned to be planted. Table 2 shows the results of the eligibility analysis performed in the first instance.

Table 2. Results of the eligibility analysis

Period	Eligible (ha)	Non-eligible (ha)	Eligible area (%)	Non-eligible area (%)
2006- 2016	1,233.76	1.35	32.18%	0.04%
2007- 2017	587.03	0.06	15.31%	0.00%
2008- 2018	519.95	2.46	13.56%	0.06%
2009- 2019	185.84	0.41	4.85%	0.01%
2010- 2020	1,301.33	1.35	33.95%	0.04%
Total	3,827.91	5.64	99.85%	0.15%

1.4 Project Design

The project aims to establish multiple-purposed (mainly for timber and energy production) commercial forest plantations whose carbon sequestration increases in reference to the baseline scenario. The project design is based on the requirements and guidelines for ARR projects. As it is a grouped project, the new instances will be verified according to the applicable guidelines.

Eligibility Criteria

The new instances must be included in the monitoring report and contain sufficient information (technical and geographic) in compliance with the eligibility criteria of the VCS standard as they will be presented in the next verification after their establishment. New instances must demonstrate compliance with the following criteria:

- Being part of the expansion area that was initially delimited.
- Their activities must be under the control of the project participants.
- Meeting all the applicability conditions listed in section 1.3 and described in the methodology.
- Having a Forest Management Plan, being registered in the National Forestry Institute (INFONA) and complying with the Environmental Management Plans and other requirements described in section 1.14.
- Being subject to the baseline scenario determined as per project description.
- Demonstrating the income additionality from carbon credits sales.

- Proving the ownership of each project instance from the beginning, either through purchase or leasing contracts with the land owners.
- Having a start date equal to or later than the start date of the grouped project.

1.5 Project Proponent

Organization name	Miller Forest Investment AG
Contact person	Mr. Josef Miller
Title	CEO, Miller Forest Investment AG
Address	88281 Schlier, Germany
Telephone	+49 7529 971 395
Email	jom@miller-ag.de

1.6 Other Entities Involved in the Project

Organization name	Felber Forestal S.A.
Role in the project	Establishment, management and use of forest plantations
Contact person	Mr. Carsten Felber
Title	President, Felber Forestal
Address	Estancia Curuzu – Maciel, Caazapá, Paraguay
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Email	carsten.felber@felber-forestal.com

Organization name	South Pole Carbon Asset Management Ltd.
Role in the project	Advice on the certification of the ARR project according to the VCS guidelines
Contact person	Mr. Christian Dannecker
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1.7 Ownership

Miller Forest Investment AG is a company that groups small to medium investors who can participate in the ARR project by evidencing the purchase or lease of forest land in Paraguay. Therefore, the project ensures land tenure rights in accordance with the agreements in place or the modality adopted by direct investors, as described in Figure 1³.

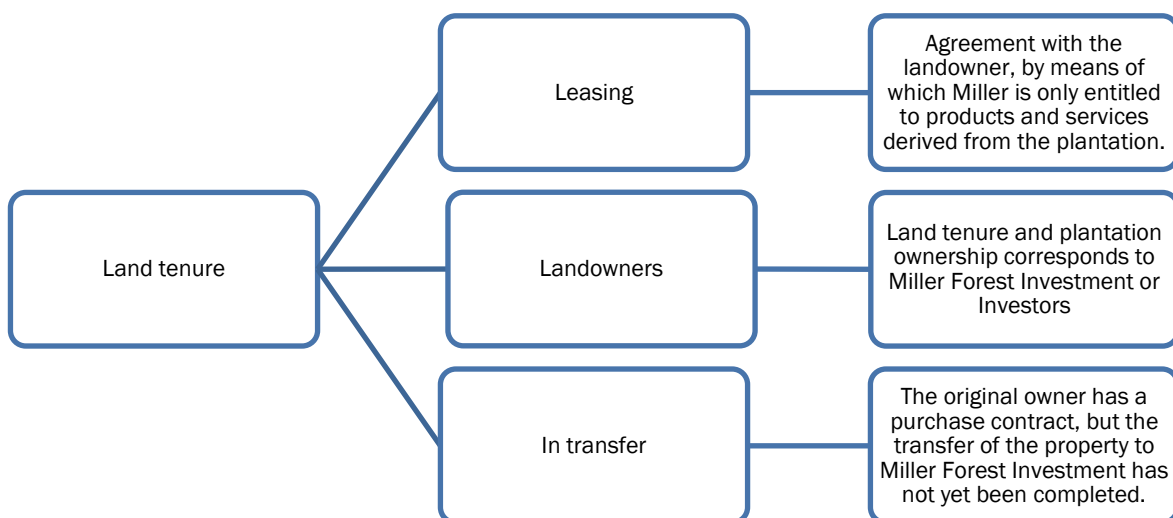


Figure 1. Land tenure scheme in the Afforestation of degraded grasslands in Caazapá y Guairá project.

Below, the land tenure modality of the first instance areas to be verified are detailed⁴.

Table 3. Ownership rights

Land tenure type	Area (ha)	Area (%)
Leasing	1,430.99	59
Legal ownership	616.57	25.4
Purchase transfer	376.9	15.5
Total	2,424.5	100

³ Miller's rights over the carbon credits are proved by making sure that project owners are classified in these modalities.

⁴ For more details on land tenure rights, please go to: Gestión documental/land tenure/ land tenure supports.

1.8 Project Start Date

In accordance with the rules of the VSC Standard v4.1 document, the project start date is when the activities that lead to the GHG emission removals are implemented. Consequently, the start date is January 13, 2016, when the project plantations were established in lot P3-18, Pozo Azul⁵.

1.9 Project Crediting Period

The project crediting period is 30 years, starting from January 13, 2016 and ending on January 12, 2045.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2016	-
2017	68,703
2018	117,209
2019	137,541
2020	169,047
2021	185,984
2022	246,791
2023	229,647
2024	209,196

⁵ The start date supporting documents are available at: Gestión documental/start date.

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2025	229,701
2026	251,859
2027	260,953
2028	241,997
2029	204,151
2030	225,343
2031	191,981
2032	204,045
2033	233,726
2034	225,933
2035	232,845
2036	255,902
2037	229,647
2038	211,552
2039	230,999
2040	250,039
2041	241,219
2042	183,377
2043	250,506

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2044	232,692
2045	191,984
Total estimated ERs	6,144,569
Total number of crediting years	30
Average annual ERs	204,819

1.11 Description of the Project Activity

Organization chart

The partnership between Miller and Felber is part of the Paraguayan forest industry and their operation is mainly focused in the departments of Caazapá and Guairá. Within this association, the Miller Forestry Investment company is in charge of finding investors, executing agreements and having constant communication with investors. Their forestry activities, from planting to trading the final product, are outsourced to specialized companies, which will be selected and supervised by Felber Forestal S.A., the entity in charge of implementing and managing the forest plantations (Figure 2).



Figure 2. Project stages and accountable entities

Within Felber, the responsibilities for the plantations are distributed according to the organization chart presented in Figure 3⁶. Additionally, the project receives advice services from the company Red Forestal regarding the monitoring of the plantation growth through forest inventories; and from Swiss Carbon Value Ltd. (South Pole), which supports the certification and commercialization of carbon credits.

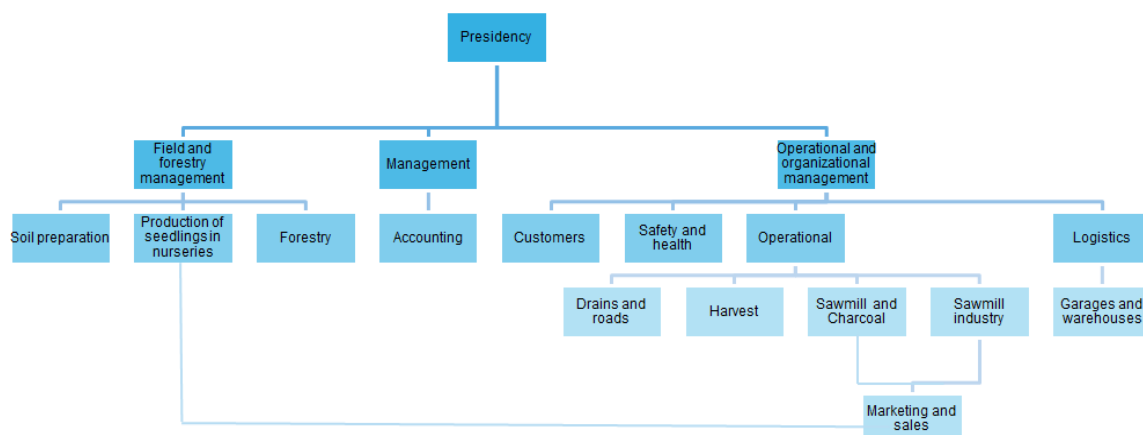


Figure 3. Roles assigned in Felber Forestal S.A.

Reforestation with commercial species

The project's first instance area that has been planted is 2,716.7 ha, which is distributed in six properties and 248 lots dedicated to the production of raw materials (solid wood and energy) in order to meet the forest demand of the country and reduce the pressure on natural forests.

At the present the project is not located within a jurisdiction covered by a REDD+ program, since the institutions do not have projects implemented in the project area⁷.

The project plantations have different forestry practices according to their final destination⁸ as follows:

- Plantations of eucalyptus and pine hybrids with 12-year cycles in order to produce solid pulpwood to meet the sawmills demand.
- Wood for energy use (biomass), that is, to obtain firewood and charcoal from eucalyptus plantations with six-year felling cycles.
- Silvopastoral systems, which combine eucalyptus wood production with livestock in 12-year cycles.
- Multiple use that combines solid wood and biomass production.

⁶ The supporting documents of the staff profiles are at: Gestión documental/organizational structure

⁷ For more details please refer to the Ministry's web site: www.mades.gov.py

⁸ In the "Forest establishment design" the design of each production system is described in detail.

Each of the forestry activities⁹ carried out by Felber Forestal S.A. to guarantee timber production and the respective capture of CO₂e is described below:

Selection of forest species

Forestry is an emerging industry in Paraguay as it was mentioned in the additionality analysis. For this reason, the forestry industry largely depends on the destructive use of native forests and little is known about plantations' establishment and management, being the first source of knowledge the experiences of the nearby countries with similar environmental conditions that use non-native (exotic) species^{10 11}. Furthermore, there is little or no availability of technological packages nor genetic material providers for native species, having the use of native species a high risk and therefore becoming an economically unfeasible option¹².

Felber established an experimental plot to verify the viability of producing native species¹³. In this plot, Felber came to the conclusion that plantations with native species result in low productivity (Figure 1) and a high cost of production. Moreover, since the plantation with non-native species has shorter rotations and a lower risk, they will supply the demand for timber products in Paraguay. The growth of the forestry industry together with the lack of knowledge about the potential development of native species have led to the establishment of non-native species in order to supply the demand of biomass for energy purposes, which has a final consumption of 46% in Paraguay¹⁴.

Historically, native forests have been the main source of biomass for charcoal production to fulfill the basic needs of more than 60% of the Paraguayan population¹⁵. Thus, planting high-yielding species for charcoal production helps to reduce pressure on the natural forest and thus the deforestation and degradation rates in the country. For this reason, Felber Forestal S.A decided to use the exotic species listed in section 1.11 of the Project Document since they adapt to the natural and ecological conditions of the project area, ensuring the project viability and permanence over time. However, Felber considers the option to use native species in the future, when the technologies and knowledge required for their establishment and management are developed and tested.

9 For more details on forestry activities, visit the forest management plan at:Gestión documental/management plans

10 Szulecka, J. and Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. Land Use Policy, 60, 384-394.

11 The World Bank. 2020. A forest worth: Policy options for a sustainable and inclusive forest economy in Paraguay. Paraguay Country Forest Note. Report No: AUS0001921: Environment, Natural Resources, and Blue Economy Global Practice.

12 The World Bank. 2020. A forest worth: Policy options for a sustainable and inclusive forest economy in Paraguay. Paraguay Country Forest Note. Report No: AUS0001921: Environment, Natural Resources, and Blue Economy Global Practice.

13 Lapacho (*Tabebuia alba*, *Tabebuia hepta*, *Tabebuia impetiginosa*), Cedro (*Cedrela fissilis*), Peterevy (*Cordia Trichotoma*), Yvyra Pyta (*Peltophorium dubium*).

14 The photographic evidence from the test with native species is in the folder Document management/Monitoring/Soporte Ensayo Nativas

15 Borsy, et al. 2013. Producción y consumo de biomasa sólida en Paraguay.

Publication prepared in the framework of a project of the Ministry of Public Works and Communications (MOPC) through the Vice Ministry of Mines and Energy, with the support of the German Development Cooperation (GIZ). Available at: <https://www.stp.gov.py/v1/wp-content/uploads/2017/04/Produccion-y-Consumo-Biomasa.pdf>



Figure 4. Comparison between non-native and native species planted in December 2012 with the same environmental conditions

On the other hand, Felber is aware that the use of exotic species can trigger environmental impacts, including those on the native flora in the nearby natural ecosystems. Therefore, Felber considered these impacts and their respective mitigation measures in the annex Excel file “Impactos Socioambientales”, in section 2.3. The impacts highlighted in this document and their mitigation measures are:

Table 4. Species used and their ecological requirements.

Impacts	Measures
Loss of genetic material. Exotic species have competitive advantages compared to native species, which can lead to a displacement or inhibition of local species in the surrounding natural spaces.	Felber uses clones as a propagation system, which reduces the spread and colonization probabilities in natural forests compared to seed use.
Migration and concentration of species. The possible modifications of natural habitat could change the ecosystem equilibrium affecting the native diversity.	The strips for the protection of watercourses and natural ecosystems are maintained.

	• Forests in legal reserves and areas of environmental and social importance are preserved.
Impact on natural spaces or other economic activities (crops) by pests and diseases originating in forest plantations.	• Clones with resistance to pests and diseases are used. • Periodic controls in the plantations to evaluate their phytosanitary status and development are carried out. This way, the necessary measures are identified and applied on time.

With the aim to profitably supply the market demand for pulpwood and biomass, species of *Eucalyptus spp.* and *Pinus spp.* were selected due to their high yield and the fact that they do not have ecological limitations in terms of soil or water (quantity, quality, water table). The selection of the species and their respective clones were based on the site offer, the plantation purpose and the expected yield.

Among the species produced in the nursery and planted for the project are: *Eucalyptus grandis* W. Mill ex Maiden, *Eucalyptus urophylla* S.T. Blake, *Eucalyptus saligna* Sm., *Corymbia citriodora* (Hook.) K.D. Hill & L.A.S. Johnson, *Corymbia maculata* (Hook.) K.D. Hill & L.A.S. Johnson, *Eucalyptus urograndis*, *Eucalyptus grancam*, *Pinus elliottii* Engelm, and *Pinus taeda* L. (Table 5).

Table 5. Species used and their ecological requirements.

Species	Elevation (m)	Temperature (°C)	Rainfall (mm/year)	Soil and others
<i>E. grandis</i> <i>E. grancam</i> ¹⁶	1,000-2,200	15-22	1,000-4,000	High adaptability and optimal conditions: soil over 1 m deep, of light to medium texture, with a slightly acidic pH, fertile, humid and well drained, of both volcanic and alluvial origin. It is very sensitive to boron deficiencies and adapts to short flood cycles. <i>E. grancam</i> has a higher tolerance to frosts.
<i>E. urophylla</i> ¹⁷	0-3,000	8-34	700-3,500	High adaptability and optimal conditions: soil over 1.5 m deep, with a loamy texture, with a slightly acidic pH, fertile, humid and well drained.
<i>E. saligna</i> ¹⁸	1,000-2,100	15-22	800-4,000	It requires deep, well-drained, humid, with medium to high fertility soils. Also, texture must be clayey, clayey-loam,

¹⁶ <https://www.forestalmaderero.com/articulos/item/eucalipto-grandis.html>

¹⁷ <https://www.researchgate.net/profile/David-Palma>

¹⁸ https://www.researchgate.net/publication/328149690_APTITUD_PARA_EUCALIPTO_EN_LA_TERRAZA_DE_HUIMANGUILLO_TABASCO

[_MEXICO_2017/links/5b9bbca2a6fdcc9552da6e10/APTITUD-PARA-EUCALIPTO-EN-LA-TERRAZA-DE-HUIMANGUILLO-TABASCO-MEXICO-2017.pdf](https://www.researchgate.net/publication/328149690_APTITUD_PARA_EUCALIPTO_EN_LA_TERRAZA_DE_HUIMANGUILLO_TABASCO_MEXICO_2017/links/5b9bbca2a6fdcc9552da6e10/APTITUD-PARA-EUCALIPTO-EN-LA-TERRAZA-DE-HUIMANGUILLO-TABASCO-MEXICO-2017.pdf)

¹⁸ <https://elsemillero.co/semillas-forestales/145-semilla-de-eucalipto-saligna.html>

				sandy-loam or sandy. It supports a slightly acidic pH with a tendency to neutrality. It does adapt to compacted or flooded soils.
<i>C. citriodora</i> ¹⁹	100-1,300	16-27	600-1,600	Optimal: deep to moderately deep, well drained, sandy-loam to sandy and slightly acid soils with a tendency to neutrality. It can adapt to poor lateritic, gravelly, gray, reddish and loamy soils.
<i>E. urograndis</i> ²⁰	0-2,000	15-22	1,000-1,750	Optimal: Deep, clayey-loam soils with neutral to acidic pH.
<i>P. elliotii</i> ²¹		13-23	899-1,550	Optimal: deep, rich, humid and well-drained soils. It does not support dry periods of water deficit. It adapts to superficial, hydrometric soils and it supports both frosts and high heat.
<i>P. taeda</i> ²²		13-24	900-1,550	High adaptability and optimal: deep, rich, humid and well drained soils. Its fertility requirement is minimal and, in relation to acidity, soils with a pH range between 4.5 and 5.5 (acid soils) are recommended.

Forest nursery

Felber Forestal S.A. has a registered clonal forest nursery with the purpose to produce the genetic material that provides the plantations with high uniformity, guarantees timber origin and ensures adequate industrial performance.

The plant material is obtained by regrowing previously selected stumps, which get cuts of 30-45 cm in height at the end of the winter season in order to be used as mother plants. This material is then placed in inert substrates and greenhouse conditions (with average temperatures of 26 °C and a relative humidity greater than 80%) to stimulate rooting. After about 25 days, in spring, plants rooting is verified for their subsequent acclimation. For this, the seedlings are exposed to external environmental conditions for a period of 90 days, being covered with partial shade cloths during the hours of maximum sunshine.

Forest establishment design

The project has two types of production systems: pure plantations (for obtaining solid wood and/or for energy purposes) and plantations using silvopastoral systems (for meat and timber production). Depending on the final use of the wood, different sowing designs, species and silvicultural activities were used as described in Table 6, which shows that the parts of the plantation with the highest densities were managed for energy production, while the ones with lower densities were present in silvopastoral systems in order to enable the adequate development of natural or implanted pastures.

19 http://elsemillero.net/nuevo/semillas/listado_especies.php?id=47

20 http://repositorio.unsch.edu.pe/bitstream/handle/UNSCH/3164/TESIS%20AF03_Mau.pdf?sequence=1&isAllowed=y

21 <https://www.santafe.gob.ar/index.php/web/content/download/106405/522212/file/Boletin%20Forestal%20Diciembre%202010%20Nro.%204.pdf>

22 <https://www.santafe.gob.ar/index.php/web/content/download/106405/522212/file/Boletin%20Forestal%20Diciembre%202010%20Nro.%204.pdf>

Table 6. Forestry management based on the purpose of the plantation²³.

Parameters	Timber (rotation every 12 years)	Energy (rotation every 6 years)	Silvopastoral
Plantation density	Eucalyptus: 780 trees/ha Pine: 1,000 trees/ha	1,315 trees/ha	Eucalypts: 714 trees/ha
Spacing	4 x 2.5 m	4 x 1,9 m	7 x 2 m 7 x 2,5 m
Species	Eucalyptus hybrids Pine hybrids	Eucalyptus hybrids	Eucalyptus hybrids
Thinning	Years 2, 5 and 7	No thinning	Years 2, 5 y 8
Pruning	Years 1, 2, 3, 5 and 7	No pruning	Years 1, 2, 3 and 5
Harvest	Clear cut, year 12	Clear cut, year 6	Clear cut, year 12
Sprout management	No	Yes	No
Growth (IMA)	45 m ³ /ha ¹ /year ¹	35 m ³ /ha ¹ /year ¹	35 m ³ /ha ¹ /year ¹

The activities carried out for the forest plantation establishment including soils preparation are described below²⁴:

Mapping

The planting area is determined, and future plots are delimited with the help of computer programs (e.g., ArcGis, AutoCad), taking into account the presence of drainage channels, waterways and any other natural boundary observed in the field. As a result, a map with the boundaries and dimensions of the future forest stands is obtained. At the same time, plots, internal roads and channels are demarcated by using agricultural tractors with built-in GPSs.

Channel construction

The property has trapezoidal open channels built in accordance with the guidelines of Law 3239/14, with the purpose to drain accumulated water during rainy seasons. The channel system consists of primary, secondary and tertiary drains for the collection of runoff waters. Also, the

²³ Source: Forest Management Plan, Felber Forestal S.A., 2020

²⁴ For more details on forestry activities, see the Forest Management Plan at: Gestión documental/management plans

existing channels are cleaned and their weeds are removed. In addition, some expansions are considered in the future if required.

Soil preparation

To reduce compaction and enhance soil structural conditions, a cross harrow and a subsoiler are used until the soil is well crushed and clean, increasing aeration and water absorption. To complete the soil preparation process, a *taipeadora* tool is used for tracing and furrowing. Finally, calcareous products are added to correct the soils pH.

Fertilization

Before sowing, analyzes of the physical-chemical properties of the soil are carried out in order to determine the corrective activities and the necessary fertilization plans for every plot. The application of nitrogen (N), phosphorus (P) and potassium (K) (NPK 22-10-6) is considered the main corrective measure.

Ant and insect control

Ants and insects are controlled by spraying citrus peels together with Fipronil in the affected areas and in the nests that have been previously detected during the phytosanitary control campaigns. This activity requires periodic inspections of the threatened areas, in response to the findings of the permanent monitoring.

Sowing

Seedlings are planted manually, once the soil has been prepared through the following activities:

- **Hole digging:** The holes are opened with sharp-tipped shovels, deep enough to contain the trees and the chunks of earth around them. The plants should be buried 1 to 2 cm below the stem level.
- **Distribution:** The seedlings are transported in boxes or trays from the current to the temporary nurseries or elevations installed on the side of the secondary roads in the plantation plots. They are transported in trucks or tractors to later be distributed in the plantation rows.
- **Sowing:** The trees are vertically placed in the hole made by gently pressing its base and making sure that the soil surface is completely flat.
- **Replacement:** 15 or 20 days after the initial sowing, a replacement with specimens of the same age is made in order to keep the stand uniform. A replacement of 10%-15% of the total number of trees per hectare is estimated.

Weed control

Weed control is carried out depending on the plantation system – in pure plantations selective herbicides for forest use (whose active principle is isoxaflutole) are applied, while non-selective

agricultural herbicides are used in silvopastoral systems. The herbicide is sprayed from tractors before and after planting. Weed control will be carried out for the first two years after the plantation is established as follows:

- In the first year and a half after the establishment, six to eight herbicide applications between the rows of the plantation will be carried out. The application must avoid product excess in individuals of eucalyptus or pine. The first two applications are made in the first 90 days after planting.
- In the second year, two days of cleaning with insecticides for forest use will take place. They can be applied to the leaves, injected into trunks and stems, or sprayed onto stumps.
- For silvopastoral systems, weed control is carried out until the plantation reaches a considerable size so it is not affected by livestock (approximately 18 months).

Formative pruning

Formative pruning is carried out only in the stands whose objective is to obtain solid wood in the years detailed in Table 6. Pruning is carried out gradually until the free-of-branches stem reaches seven meters, considering the following recommendations:

- Carry out pruning in the autumn-winter season.
- Support the scissors or saw blades well on the trunk of each individual to make a clean cut, avoiding to touch the stumps on the main trunk.
- The branches of each individual must be cut in a clockwise direction to avoid mechanical damage.
- Remove all green and dry branches so that the stem is completely clean.

Thinning

For an optimal development of the trees for timber use and in order to reduce intraspecific competition, thinning is carried out. Through it, trees of poor shape (e.g., forked or tortuous), with health problems and growth deficits are removed. Thinning intensity will be between 50 and 550 trees/ha, according to the purpose of the stand and the age of the plantation (Table 6). The following recommendations are considered for the development of this activity:

- The residual mass distribution must be kept as homogeneous as possible.
- Sprouts must be managed to avoid new competition.
- The trees felling must be done flush with a chainsaw.
- The roads must be properly planned and planting lines must keep an adequate distance from each other so that they are accessible for equipment.
- It is recommended to thin in autumn-winter for the residual trees to grow mainly in spring-summer.

Final harvest

At the end of the plantation cycle, all the individuals are extracted manually or mechanically (with a harvester) according to the land conditions, and the harvested logs are stacked in storage areas

within the property. The suitable age of the trees for their extraction depends on the production purpose (see Table 6).

Tree spillage and cutting is carried out in line with their final destination (solid wood or biomass) and the market conditions, seeking the maximization of the stem use and reducing the volume of forest residues. For the production of wood chips for power generation, the project has a mobile chipper that is used at the collection sites.

Stump removal

After the harvest, the area is prepared for a new plantation. Old stumps are removed with a “standard” herbicide, being left on the land for decomposition.

1.12 Project Location

The project expansion area is located in the departments of Caazapá and Guairá, in eastern Paraguay. The first instance comprises an area of 2,716.7 ha²⁵ that was planted in the 2016-2020 period and is located in the municipalities of Caazapá, Maciel, Doctor Moisés Bertoni and Ñumi.

Table 7 details the coordinates of the six properties that are part of the project (in the first instance) and Figure 5 shows the location of the expansion area and of the first instance.

Table 7. Coordinates of each property

Property	X	Y
Curuzu	-56,513	-26,251
Bertoni	-56,63	-26,427
Laguna Kare	-56,449	-26,233
Ñumi	-56,342	-26,012
Pozo Azul	-56,678	-26,334
San Pablo	-56,577	-26,237

²⁵ The cartographic information in KML format is available at: Gestión documental/project area/KML

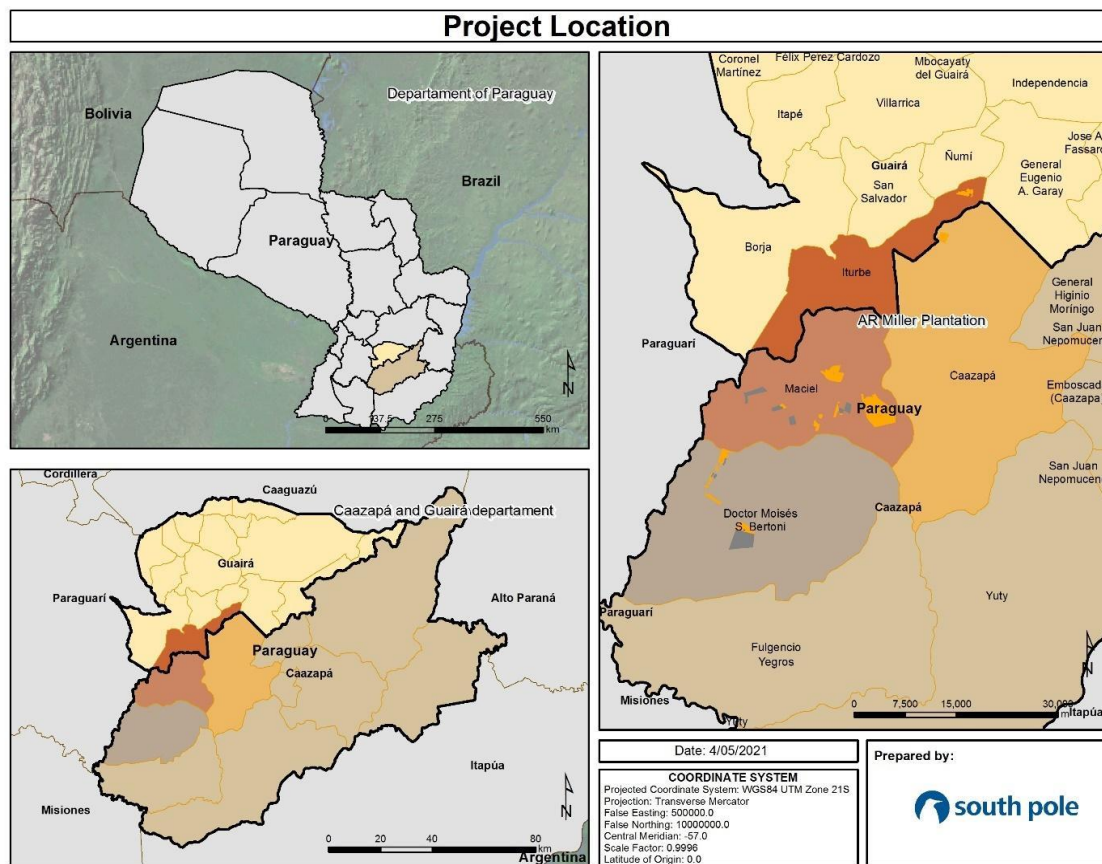


Figure 5. Location of the project area

1.13 Conditions Prior to Project Initiation

Below there is a general description of the existing environmental conditions of the region where the project takes place (departments of Caazapá and Guairá), which covers both the expansion region and the first instance area.

Physical characteristics

Weather

Eastern Paraguay has a subtropical climate, with an average 1,300 mm rainfall and a temperature of 23°C, which decreases along the forest from east to west and reaches its highest levels in the austral summer. Relative humidity ranges from 60% to 90% throughout the year and the average potential for evapotranspiration is 1,100 mm per year. This area has hot and humid springs and summers, mild and humid autumns, and cold and dry winters.

- *Rainfall*

The departments of Caazapá and Guairá are characterized by a humid-temperate climate, with rains throughout the year that reach their highest peaks in autumn and spring and the lowest in

winter²⁶ (see Figure 6). The rainfall distribution in Paraguay decreases towards the northwestern side. The rainiest zones of the project first instance and expansion areas are located in the south-east of the department of Caazapá, near the municipality of Tranvía, while the area in the northwest of the department of Guairá has evidenced to have a slight rainfall decrease. Given this distribution, the project's Zone 2 has an average rainfall of 1,500 mm per year while Zone 1 varies between 1,300 and 1,400 mm (Figure 7).

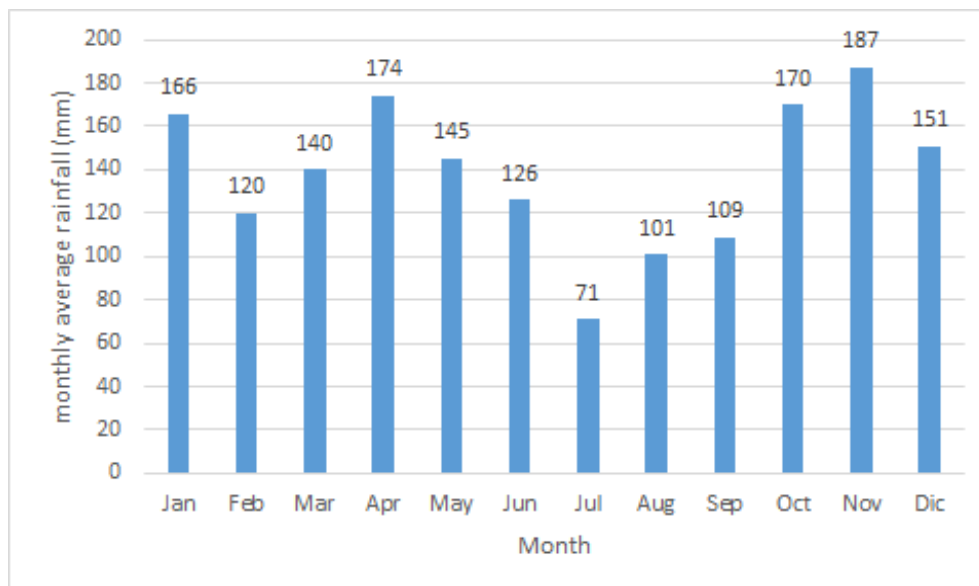


Figure 6. Temporal rainfall distribution in the municipalities of Caazapá and Guairá. Data provided by the Villarica Weather Station (1971-2000)²⁷.

26 Grassi, B., Vázquez, F. and Rodríguez, R. 2020: Evidencias científicas e impactos económicos del cambio climático en el departamento de Guairá. MADES-STP. Asunción, Paraguay. <<http://dncc.mades.gov.py/wp-content/uploads/2020/10/Guair%C3%A1-Evidencias-cient%C3%ADficas-e-impactos-econ%C3%B3micos-del-cambio-clim%C3%A1tico.pdf>>

27 Evidencias científicas e impactos económicos del cambio climático en el departamento de Guairá (2020).

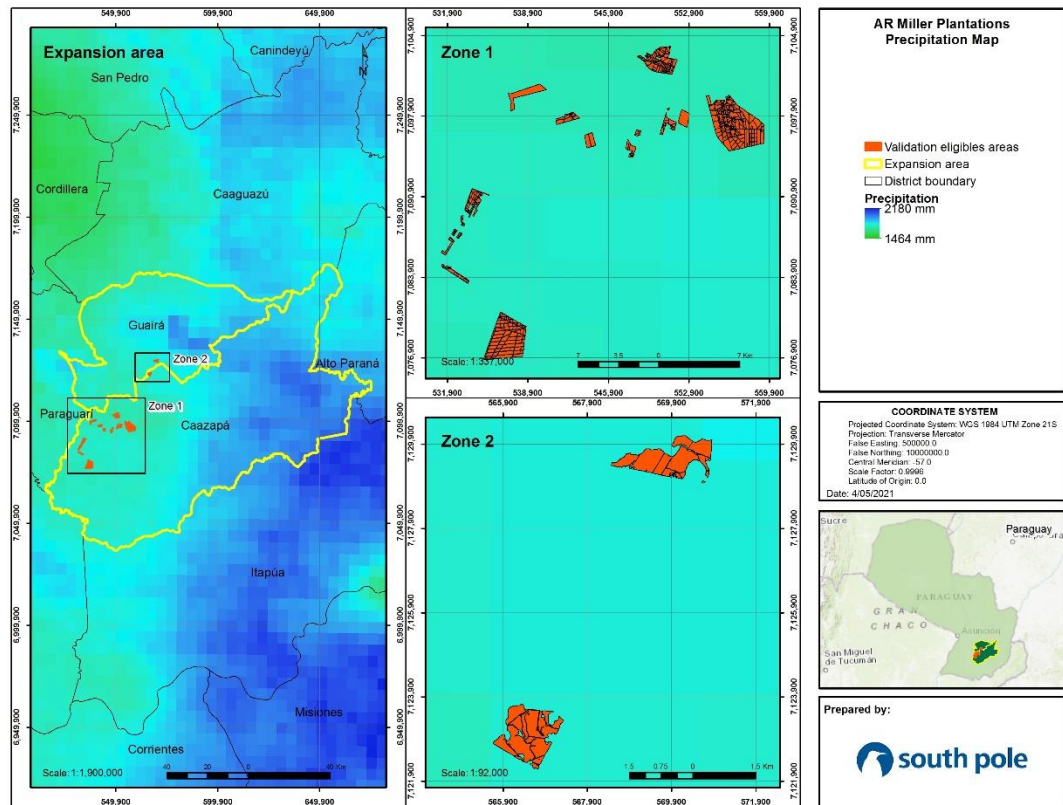


Figure 7. Spatial rainfall distribution in the study area²⁸.

- *Temperature*

According to climate information from WorldClim, the average temperature of the project's first instance and expansion area is approximately 21°C - 22°C. This information is consistent with data taken from the Villarrica (Guairá) Weather Station, which indicates that the average temperature is approximately 21.7 °C, reaching its highest values in the summer, when the monthly average temperature is 26.5 °C (in January); and the lowest in winter, with 16.8 °C (in June-July) (see Figure 8). In the study area, frost events frequently occur during winter, they being caused by the cold subarctic air²⁹.

²⁸ WordClim map

²⁹ Grassi, B., Vázquez, F. y Rodríguez, R. 2020: Evidencias científicas e impactos económicos del cambio climático en el departamento de Guairá. MADES-STP. Asunción, Paraguay. <<http://dncc.mades.gov.py/wp-content/uploads/2020/10/Guair%C3%A1-Evidencias-cient%C3%ADficas-e-impactos-econ%C3%B3micos-del-cambio-clim%C3%A1tico.pdf>>

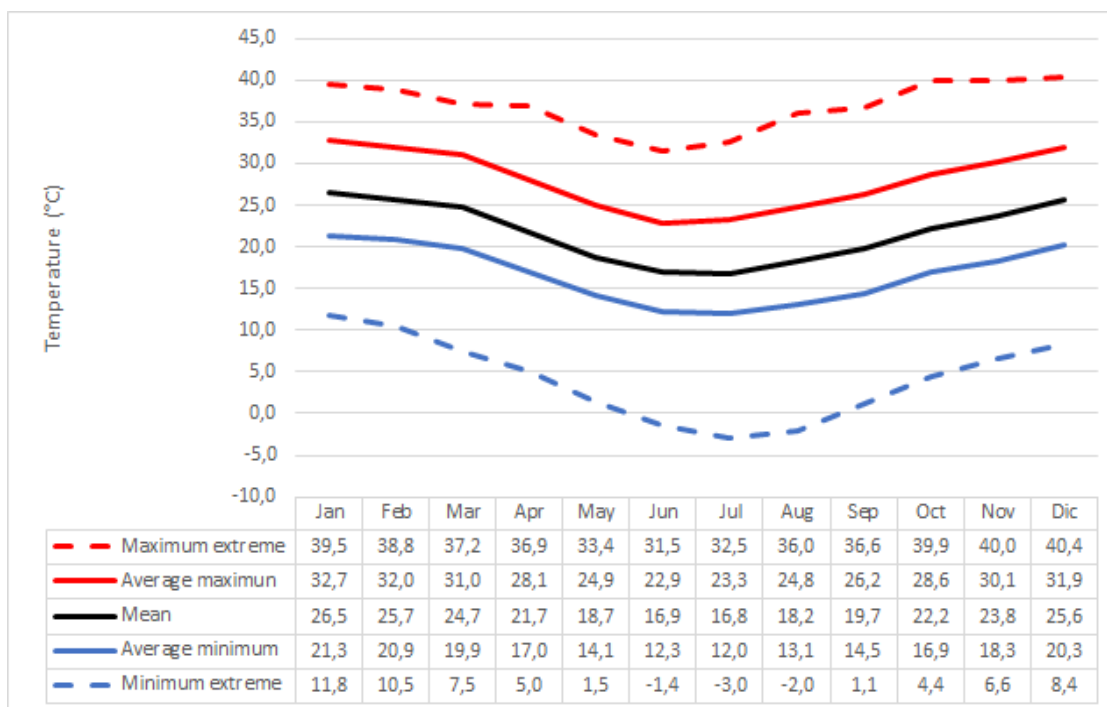


Figure 8. Temporal distribution of monthly average temperatures. Data provided by the Villarica Weather Station (1971-2000³⁰).

Geology, geomorphology and soils³¹

Expansion area

Eastern Paraguay is located on the western side of former Gondwana, where the Precambrian crystalline basements have been found (with Caapucú in the south and Alto Apa in the north setting the boundaries), being divided by a large faulted block (aulacogene in Bajo de San Pedro). This aulacogene is filled with sedimentary rocks possibly from the Cambrian to the Lower Mesozoic eras. It is located between the craton of the Río de la Plata (Alto de Caapucú) in the north and the craton of the Amazonas (Alto Apa) in the south. The distribution of Paleozoic-Mesozoic deposits in Paraguay have been greatly influenced by two major events: the separation of America from Africa and the Andean orogeny.

The geological base has resulted in large areas where sandstone and basalt are the source material. There is also a predominant alfisol and ultisol mosaic, which is interspersed with smaller areas of entisols and inceptisols. Carboniferous sandstones and tillites of fluvial and glacial origin also predominate.

³⁰ Evidencias científicas e impactos económicos del cambio climático en el departamento de Guairá (2020).

³¹ Fúlfaro, V. J. (1996). Geología del Paraguay oriental. Magmatismo Alcalino en Paraguay Central-Oriental Relaciones con Magmatismo Coeval en Brasil. Edusp/Fapesp, Sao Paulo, 11-29

Most of the Eastern region has a slightly undulating relief with gentle slopes towards the water courses. The extensive plains alternate with gentle hills that do not exceed 200 meters above sea level and rise towards the Ybytyruzú Mountain Range.

Its major orographic systems are the Amambay, Mbaracayú, Ybytyrusú and Caaguazú Mountain ranges. The highest point is Cerro Pero (Cerro Tres Kandú), which is located in the department of Guairá and has 842 m of height. Its topography consists of a low relief with numerous swampy areas locally called “estuaries”. The topographically highest points are elevations of granitic porphyritic rocks. The Caazapá Mountain Range, along with its branches Ybytyruzú, Monte Rosario and San Rafael, cross from east to west, with medium-height hills such as Mbatoví, Ñi Cañy, Pacurí and Morotí. This mountain range splits the territory in two differentiated zones – in the northwest, with low lands, estuaries, croplands and pastures; in the southeast, with undulating and elevated lands covered with forests.

First instance

The first instance is among plains and hills with flat to slightly flat reliefs that come from sandstones and sediments, resulting in the types of soils described in Table 8 and whose spatialization is outlined in

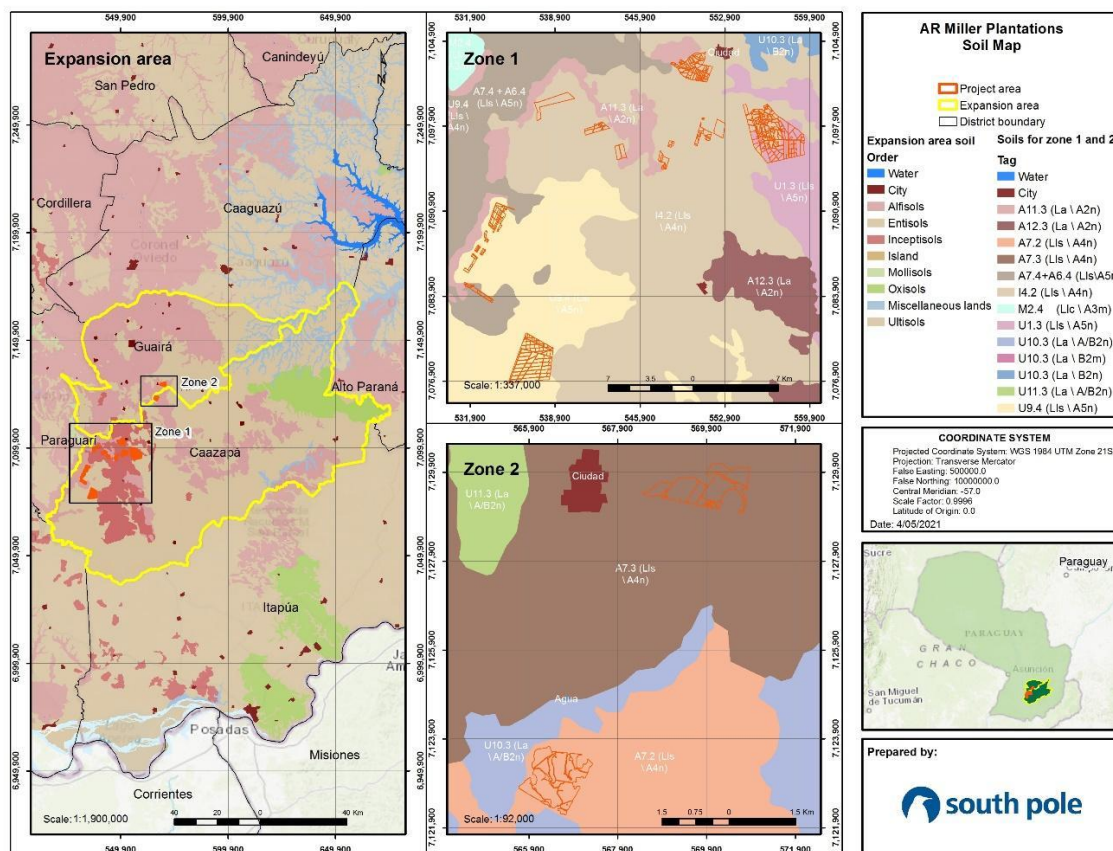


Figure 9. These soils generally have drainage or fertility restrictions, with the soils classified as 3Wd being saturated for short periods due to low to very low water drainage and infiltration capacity

(permeability). Soils with a 5Wi and 6Wi classification usually have flooding periods over two weeks or are constantly flooded. Finally, 3Sf soils are found in higher areas, but have fertility limitations given their base saturation of less than 35%, a sum of change bases of less than 3 cmol/kg and an aluminum saturation of less than 30%. Considering the characteristics of these soils, these areas have great potential for the development of agricultural, forestry and conservation activities.

Table 8. Soils of the first instance.

Department	Municipality	Taxonomic unit	Order	Taxonomic group	Relief	Elevation	Origin	Drainage	Limitations
Guairá	Iturbe	A7.3 (Lls\A4n)	Alfisol	Aquic Paleudalf	Plain	0-3%	Sediment	Poor	5Wd
Caazapá	Caazapá	U10.3 (La\A/B2n)	Ultisol	Rhodic Paleudult	Hill	0-8%	Sandstone	Good	3Sf
		A7.2 (Lls\A4n)	Alfisol	Aquic Paleudalf	Plain	0-3%	Sediment	Poor	5Wd
Caazapá	Maciel	U1.3 (Lls\A5n)	Ultisol	Typic Albaquult	Plain	0-3%	Sediment	Very poor	5Wi-6Wi
		I4.2 (Lls\A4n)	Inceptisol	Oxyaquic Dystrochrept	Hill	0-3%	Sediment	Poor	5Wi-6Wi
		A11.3 (La\A2n)	Alfisol	Rhodic Paleudalf	Hill	0-3%	Sandstone	Good	3Sf
Caazapá	Dr. Moisés S. Bertoni	A7.4 + A6.4 (Lls\A5n)	Alfisol	Aquic Paleudalf	Plain	0-3%	Sediment	Very poor	7Wi
		U9.4 (Lls\A5n)	Ultisol	Aquic Paleudult	Plain	0-3%	Sediment	Very poor	6Wi
		A11.3 (La\A2n)	Alfisol	Rhodic Paleudalf	Hill	0-3%	Sandstone	Good	3Sf

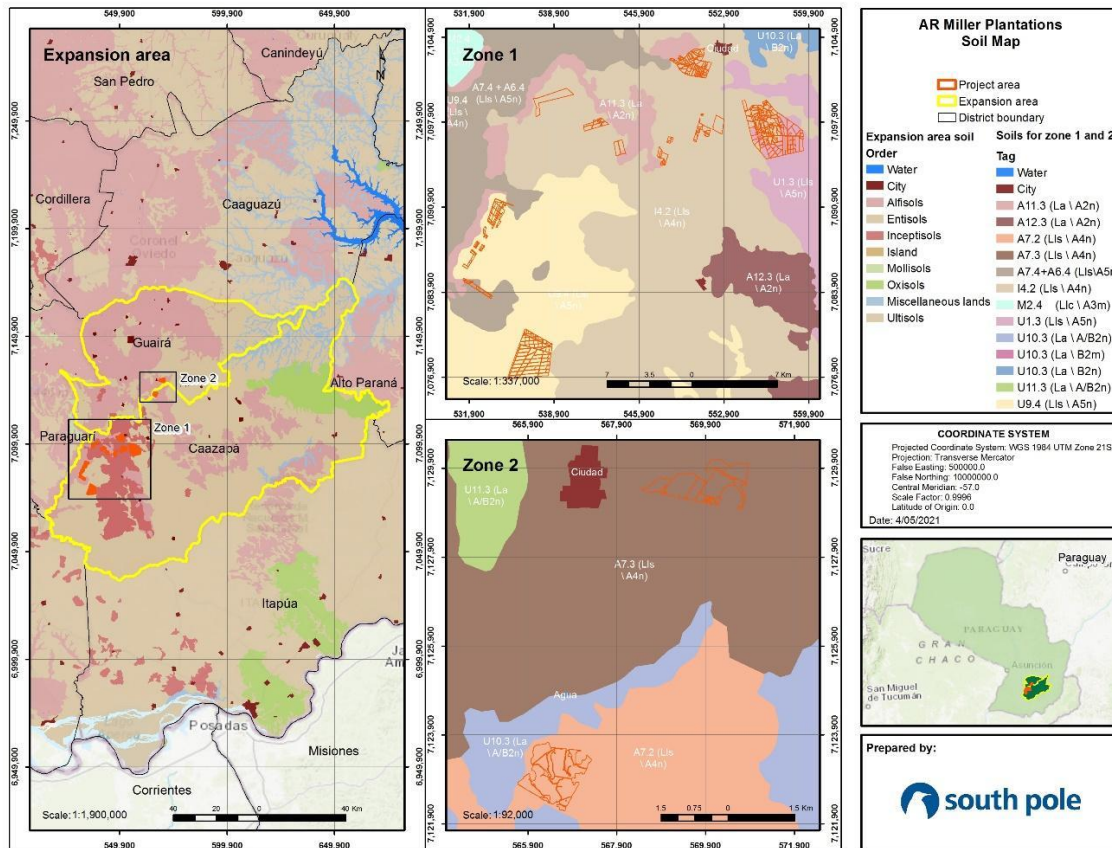


Figure 9. Soils in expansión área and first instance of the project

Hydrology

The first instance and the expansion area are part of the hydrographic basin of the Paraguay River, which is a tributary of the La Plata water system basin. The area of the first instance is included in the sub-basin of the Tebicuary River, this being the main tributary of the Paraguay River, with a drainage area of 37,314 km² and the main course having a length of 360 km and an average annual flow of 420.21 m³/s. The average rainfall of the basin is 1,568.52 mm per year, with a real evapotranspiration of 1,087.91 mm, which ensures that the basin has no water deficit but rather a significant surplus³². 50% of the middle basin is made up of estuaries and low fields that have been classified as wetlands by the National Wetlands Committee in 2004. The main tributaries within or close to the intervention area are listed in Table 8 and spatialized in Figura 10.

32 DINAC, UNESCO, PHI. 2018. BALANCE HIDRICO SUPERFICIAL DEL PARAGUAY. <http://www.mades.gov.py/wp-content/uploads/2018/07/ANEXO-BALANCE-HIDRICO-SUPERFICIAL-DEL-PARAGUAY-2018.pdf>

Table 9. Tributaries of the first instance area.

Departament	Municipality	Drainage
Guairá	Iturbe	Yhaca Guazú stream*
		Itacuá stream*
		Lobo Cua stream
Caazapá	Caazapá	Paso Pindo stream
		Lobo Cua stream
		Itacuá stream*
Caazapá	Maciel	Tebicuary river
		Yacarey stream
		Yacare-Río Pirapo stream*
		Pindoy stream*
		Paragua stream*
		Cerrito stream*
Caazapá	Dr. Moisés S. Bertoni	Tebicuary river*
		Pindoy stream

*Drainage adjacent to forest plantations.

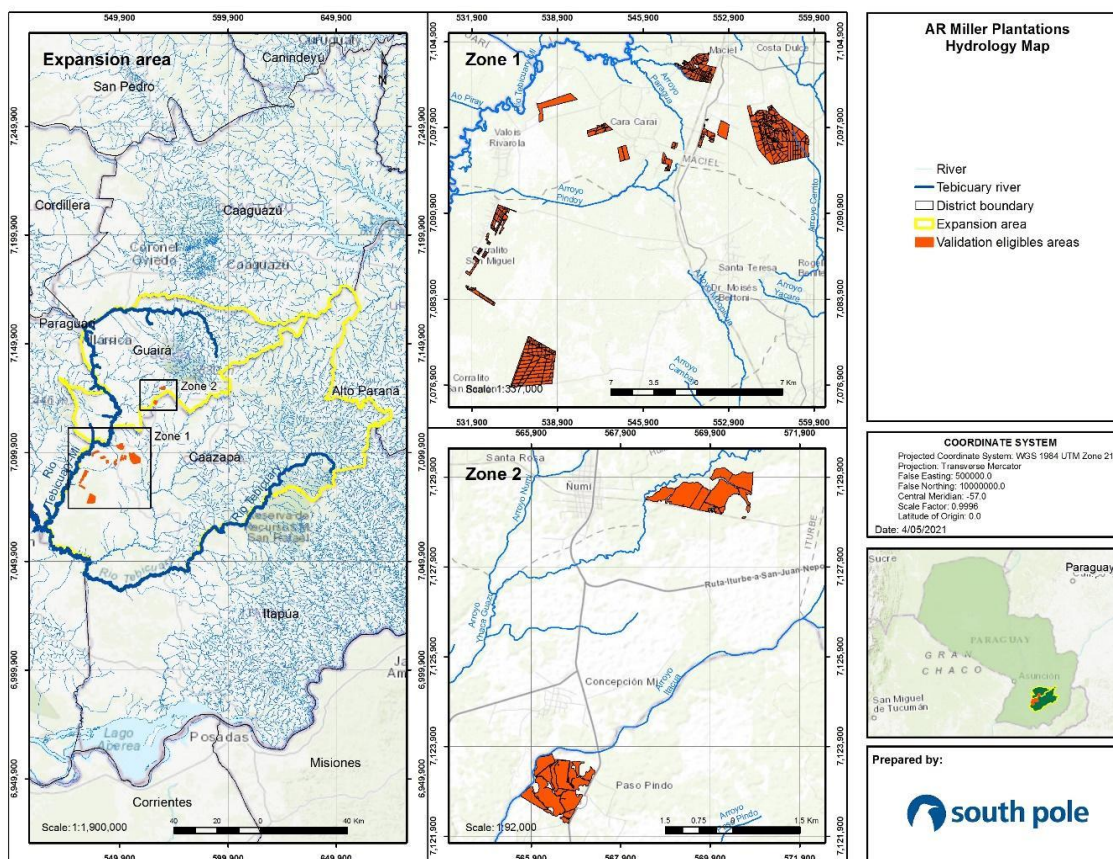


Figura 10. Water network in the expansion area and first instance area

Land uses³³

The agriculture and livestock sector is concentrated in the east end of the Eastern region, which has triggered the loss of natural ecosystems in this part of the country. In the project expansion area, agriculture and livestock are considered some of the most important economic activities. Agriculture is concentrated in the hilly reliefs on the eastern side and livestock activities in areas with poor drainage or in floodplains on the western side. This distribution is consistent with the classification of potential land uses presented in **Figura 11**.

³³ WWF. 2004. Managing the Soy Boom: Two scenarios of soy production expansion in South America. Jan Maarten Dros. A I D Environment

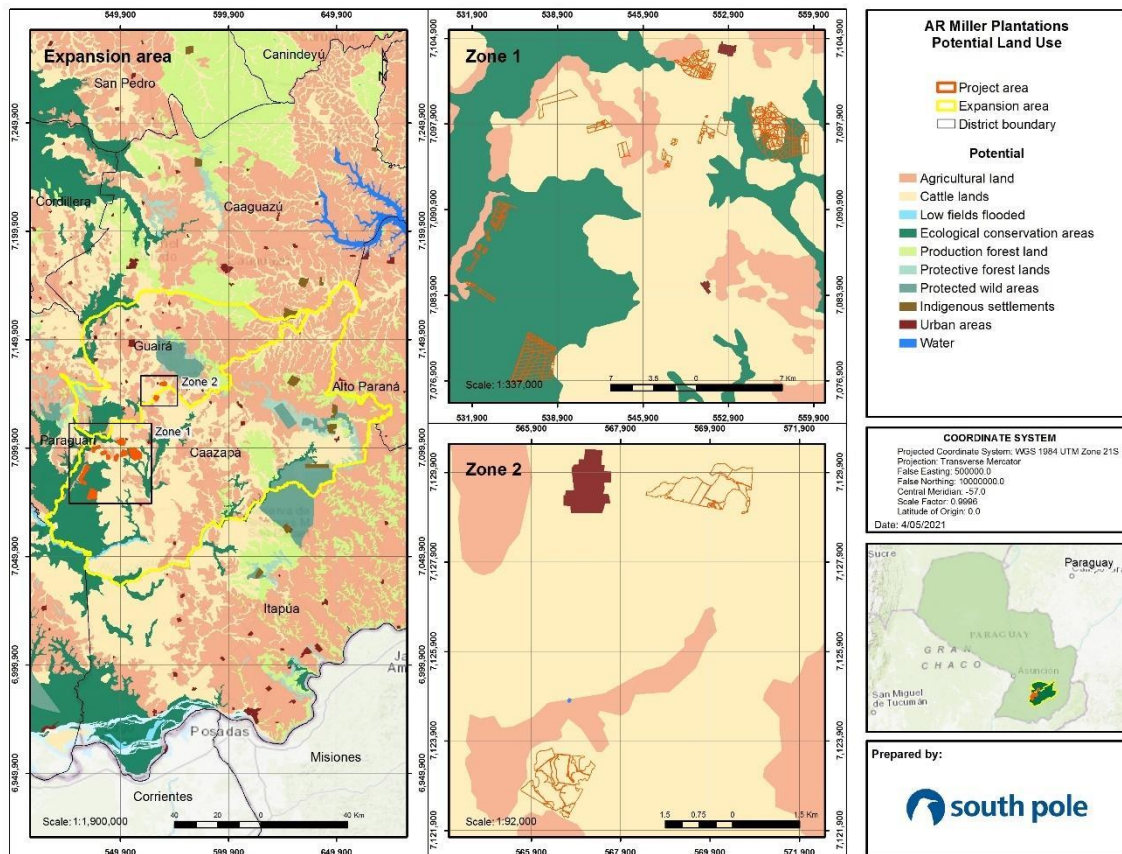


Figura 11. Potential land use in the project expansion area

Among the farming production activities in the project expansion area, livestock stands out with 478,822 cattle units (2017), as well as the growth of soybeans (main crop), corn and wheat, which are managed in rotation systems (see Table 10). The department of Guairá is the first sugarcane producer in the country, with 37.8% of the national share.

Table 10. Principales actividades agropecuarias del área de extensión del proyecto.

Crop	Paraguay	Guairá	Caazapá
Transitory crops on planted areas (ha) 2016-17			
Cotton	10,000	119	1,984
Irrigated rice	140,000	3,063	16,017
Dried rice	1,740	12	82
Pea	1,400	25	30
Sweet potato	5,000	51	108
Canola	8,900	138	7,460
Sugar cane	118,000	44,693	5,930
Sunflower	40,900	161	2,929
Corn	940,000	4,749	56,598
Cassava	182,000	12,000	16,000
Peanut	26,000	608	1,823
Beans	72,000	5,136	5,290
Sesame	55,000	70	1,746
Soybeans	3,380,000	12,603	168,045
Sorghum for grain	31,000		5,988
Wheat	510,000	3,400	55,250
Permanent crops on planted areas (ha) 2016-17			
Sweet orange	7,725	60	427
Grapefruit	1,100	10	129
Vine	350	228	
Yerba mate	20,650	3,774	657
Livestock (units in 2017)			
Livestock	13,821,526	150,923	327,899

Given its location in flat reliefs and the drainage limitations of its soils, the first instance area had pastures before the establishment of the plantations. This was confirmed by the analysis of

multispectral Landsat images, which were downloaded in August 2015³⁴, before the project start date. For the classification of the soil cover, the methodology used was based on supervised remote sensing techniques in order to identify soil cover such as forests, cropland, grasslands and wetlands³⁵.

Table 11 shows the coverage types and their corresponding area at the project site before project implementation. According to the results obtained, grassland cover is predominant.

Table 11. Amount of land cover before the start of the project.

Land cover	Area (ha)	Area percentage
Forests	5.06	0.13
Grasslands	3,022.74	99.98
Settlements	0.60	0.02
Total	3,833.53	100.00

Figure 12 shows the spatial distribution of the prevailing coverage types in the project area before project implementation in 2015.

34 These images were provided by the United States Geological Survey (USGS) and can be accessed and downloaded free of charge at <https://earthexplorer.usgs.gov/>.

35 See methodological details at: Gestión documental/land cover analysis

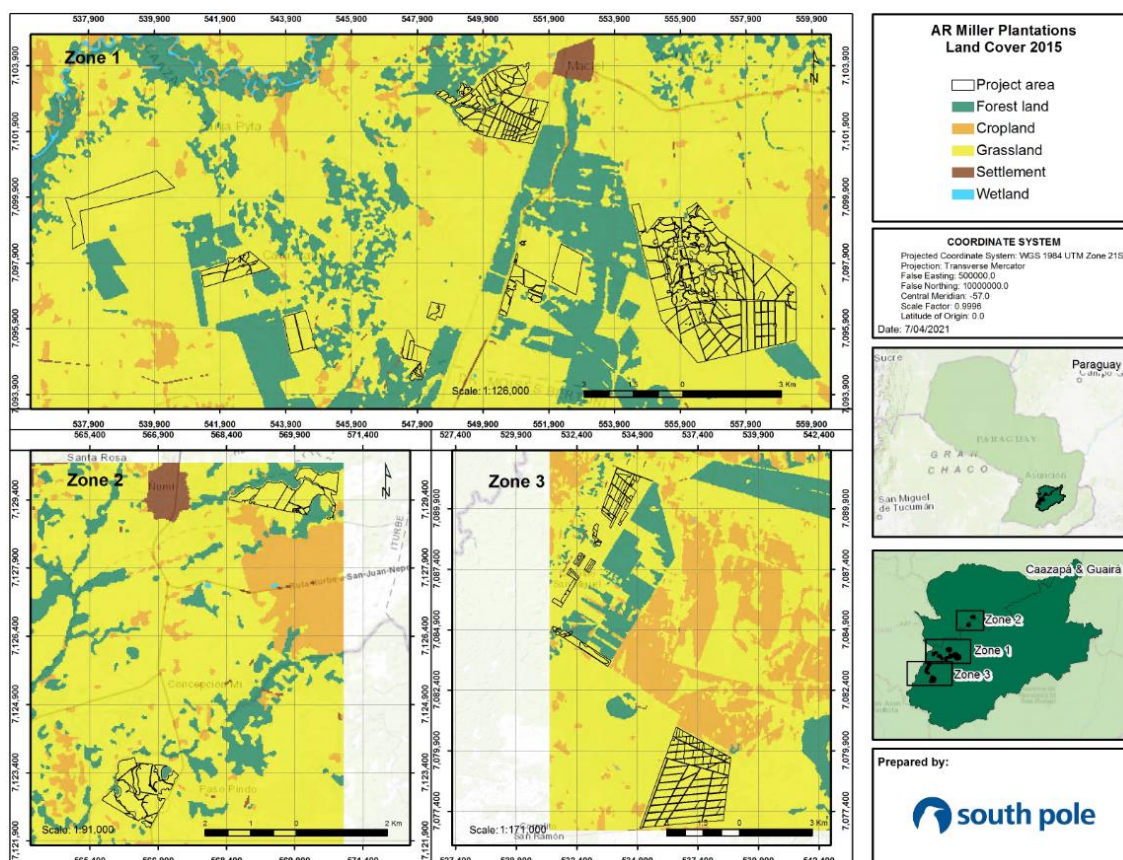


Figure 12. Land use before the start of the project.

Biotic characteristics

Vegetation

The project expansion area is distributed between the ecoregions of the Alto de Paraná Atlantic Forest and the Humid Chaco. The first is characterized by being the most humid region in Paraguay and by having high and humid subtropical forests, while the latter is characterized by presenting extensive savannas with wetlands, estuaries, islands of sub-humid forests, and gallery forests, mainly located in sedimentary soils³⁶.

Considering that the project expansion area is located in the transition zone between these two ecoregions, which contain a large amount of estuaries and are connected to one of the main basins of the country (the Tebicuary River), the area is of high importance for the conservation of water and biological diversity. Among the protected sites is the Ybytyruzú Managed Resources Reserve, which spans over 24,000 ha and is ruled by Decree No. 14.945 of October 2001 for having a significant cover of the Upper Paraná Atlantic Forest (BAAPA). In addition, there are six Important Bird Areas (IBA) of the Americas, which are listed in Table 12.

36 Lasting Initiative for Earth (LIFE). 2016. Ecorregiones del Paraguay - Definición de prioridades en conservación. Versión 1. <http://institutolife.org/wp-content/uploads/2018/11/Ecorregiones_del_Paraguay.pdf>

Table 12. IBAs in the project expansion area.³⁷

IBA Code	IBA name	Administrative unit	Area (ha)	Criteria (BirdLife International)
PY035	Ybyturuzú	Guairá	25,571	A1 (EN, VU, NT)/A2/A3
PY039	Ypeti	Caazapá	13,594	A1 (NT)/A2/A3
PY042	Caazapá National Park	Caazapá	13,323	A1 (EN, VU, NT)/A2/A3
PY043	Codas Rice Paddy	Caazapá	1,235	A1 (VU)
PY045	Tapyta	Caazapá	6,032	A1 (EN, VU, NT)/A2/A3/A4ii
PY047	Cabacué Estuary	Caazapá	681	A1 (VU)

BirdLife International criteria: A1 Globally threatened species (EN: Endangered, VU: Vulnerable, NT: Near Threatened); A2 Restricted-range species; A3 Biome-restricted species; and A4 Congregations, A4i: $\geq 1\%$ of a biogeographic population of a water bird species would congregate, A4ii: $\geq 1\%$ of the world population of a sea or land bird species would congregate and A4iii: $\geq 20,000$ water birds, assessing compliance with the different thresholds proposed (Guyra Paraguay, 2008).

Figura 13 shows the distribution of the land ecosystems existing in the project extension area, which are described below³⁸:

- **Mixed Montane Atlantic Forest of Araucaria:** These are humid montane forests up to 40 m high characterized by the presence of a conifer species of the *Araucaria* genus that forms mixed forests with broadleaf species. These forests can have a continuous and emergent canopy and generally form mixed forests with broadleaf species. Due to the intervention and logging that have impacted these areas, savannas with a continuous grassy cover and scattered *Araucaria* trees are now also forming. In the south, they stand cold winters with periodic frosts and even snowfalls and do not experience dry seasons. Their distribution is in the limits with communities of peatlands, montane rain forests, and grasslands montane or fields.

List of diagnostic species for this system: *Araucaria angustifolia*, *Podocarpus lambertii*, *Podocarpus sellowii*, *Cedrela fissilis*, *Phoebe porosa*, *Drimys brasiliensis*, *Weinmannia spp.*, *Ocotea pretiosa*, *Ocotea catharinense*, *Campomanesia xanthocarpa*, *Dicksonia sellowiana*, *Nectandra membranacea*, *Balfourodendron riedelianum*, *Cabralea oblongifolia*, *Holocalyx balansae*, *Ilex paguariensis*.

37 DEVENISH, C., DÍAZ FERNÁNDEZ, D. F., CLAY, R. P., DAVIDSON, I. & YÉPEZ ZABALA, I. EDS. (2009) Important Bird Areas Americas - Priority sites for biodiversity conservation. Quito, Ecuador: BirdLife International (BirdLife Conservation Series No. 16).

<http://datazone.birdlife.org/userfiles/file/IBAs/AmCntryPDFs/Paraguay_es.pdf>

38 NatureServe. 2021. NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: April 21, 2021).

- Transitional West Submontane Semi-deciduous Atlantic Forest with the Cerrado: These are submontane forests with 40%-50% seasonally deciduous tree species of short or relatively short height and a simpler structure than that of the Paraná humid forests. They reach a height of up to nine meters, but their average height is about six meters. Currently, large parts of their extensions are transformed into secondary forests. They are in locations of around 600 m of altitude and are interspersed among the high forests of Alto Paraná, mainly in the transition zones between these forests and grasslands or savannas. Generally, their smaller size is due to the sandy soils (*edafoxerophilous*) where they grow, but there are also variants of this system in poorly drained and clayey soils in forests and savanna mosaic areas. They occur under a seasonal climate, but less notably than in the Cerrado region.

List of diagnostic species for this system: *Acosmium dasycarpum*, *Acrocomia totai*, *Agonandra brasiliensis*, *Alibertia concolor*, *Alibertia macrophylla*, *Anadenanthera peregrina*, *Astronium fraxinifolium*, *Callisthene major*, *Dalbergia miscolobium*, *Diospyros hispida*, *Gomidesia lindeniana*, *Guatteria sellowiana*, *Luehea paniculata*, *Machaerium acutifolium*, *Margaritaria nobilis*, *Miconia* spp., *Myrcia tomentosa*, *Platypodium elegans*, *Pouteria gardneriana*, *Protium spruceanum*, *Qualea dichotoma*, *Pseudobombax tomentosum*, *Rudgea viburnoides*, *Salacia elliptica*, *Terminalia argentea*, *Virola sebifera*, *Vismia guianensis*. In Paraguay, characterized by: *Eugenia uniflora*, *Myrciaria ciliolata*, *Myrcia multiflora*, *Luehea divaricata*, *Gomidesia sellowiana*, *Diatenopteryx sorbifolia*, *Campomanesia xanthocarpa*, *Copaifera langsdorfii*, *Ceiba pubiflora*, *Matayba elaeagnoides*, *Hellieta apiculata*, *Ruprechtia laxiflora*, *Actinostemon concolor*, *Trichilia catigua*, *Trichilia elegans*, *Protium heptaphyllum*, *Cereus stenogonus*, *Schinus terebinthifolius*, *Blepharocalyx salicifolius*, *Amburana cearensis*, *Sterculia striata*, *Lithraea molleoides*.

- Semi-deciduous Humid Forest of Alto Paraná: These are subtropical evergreen and semi-deciduous forests with a closed canopy at 30 m high or lower (15-20 m) and a relatively open canopy and some emerging ones. They also have an abundance of lianas and epiphytes. These forests mainly have well-drained soils, but saturated ones are also included in this category. The climate is sub-humid subtropical with hot and humid summers. There are monodominant spots of *Araucaria angustifolia*, as this species are remnants of its original distribution under the Pleistocene climate. The topography is undulating or rugged in some parts due to the presence of mountainous areas of the basaltic plateau coming from the Serra Geral geological formation. The system represents the matrix where floodplain forests and different types of wetlands also coexist.

List of diagnostic species for this system: *Apuleia leiocarpa*, *Cabralea canjerana*, *Cedrela fissilis*, *Aspidosperma polyneuron*, *Tabebuia heptaphylla*, *Tabebuia impetiginosa*, *Anadenanthera colubrina*, *Astronium fraxinifolium*, *Syagrus romanzoffiana*, *Euterpe edulis*, *Annona amambayensis*, *Cariniana estrellensis*, *Machaerium stipitatum*, *Balfourodendron riedelianum*, *Parapiptadenia rigida*, *Peltophorum dubium*, *Patagonula americana*, *Pterogyne nitens*, *Cordia trichotoma*, *Enterolobium contortisiliquum*,

Myrcarpus frondosus, *Matayba elaeagnoides*, *Allophylus edulis*, *Garcinia brasiliensis*, *Myrciaria rivularis*, *Alsophila cuspidata*, *Sorocea bonplandii*, *Albizia hassleri*, *Alchornea triplinervia*, *Myrcarpus frondosus*, *Bambusa guadua*, *Chusquea spp.*

- Subhumid Transitional Forests of the Central Jungle of Paraguay: System formed by a set of predominant natural forest communities in the so-called Central Region. They are remnants of well-drained high to medium Paranense forests in transition to the Chaco, in a drier climate and on sandier substrates. The changes are visible in the structure, which is lower and open and has less plant diversity.

List of diagnostic species for this system: *Hellieta apiculata*, *Syagrus romanzoffiana*, *Ocotea puberula*, *Nectandra megapotamica*, *Apuleia leiocarpa*, *Copaifera langsdorffii*, *Alchornea triplinervia*, *Plinia rivularis* (*Myrciaria rivularis*), *Holocalyx balansae*, *Dendropanax cuneatus*, *Luehea divaricata*, *Cupania vernalis*, *Matayba elaeagnoides*, *Diatenopteryx sorbifolia*, *Styrax leprosum*.

- Dystrophic Cerradoes: Cerradoes are transitional systems between mesophytic forests and savannas with a woody cover between 50% and 90% and a canopy between 7 m and 15 m high. The coverage degree of the two woody strata (canopy and understory) has variations. In general, the vegetation has xeromorphic characteristics and in the case of the dystrophic Cerradao, it is associated with low-fertility, often well-drained soils that can also be seasonally saturated.

List of diagnostic species for this system: *Hirtella glandulosa*, *Emmotum nitens*, *Sclerolobium paniculatum*, *Vochysia haenkeana*, *Virola sebifera*, *Blaepharocalyx salicifolius*, *Siphoneugena densiflora*, *Ocotea spixiana*, *Phoebe erythropoda*, *Callisthene major*, *Sclerolobium paniculatum*, *Siparuna guianensis*, *Cardiopetalum calophyllum*.

- Riparian Vegetation Complex of Alto Paraná: Group of herbaceous, shrub and arboreal riverside communities, with a generally open canopy and irregular height. Riparian forests present an enormous number of vascular and non-vascular epiphytes on tree trunks. In some places there are tacuarals, which are monospecific bamboo forests of the *Guadua* and *Chusquea* genera. This ecosystem develops on soil mosaics originated by fluvial dynamics, with the herbaceous communities mainly growing on rocky soils with basaltic outcrops, while the shrub communities and middle and open successional forests are on sandy-stony soils. Gallery forests take up the most remote and relatively stable parts of the riparian area of influence.

List of diagnostic species for this system: *Zephyranthes flavissima*, *Chomelia obtusa*, *Panicum spathellosum*, *Cyperus iria*, *Echinodorus grandiflorus*, *Justicia sp.*, *Cephalanthus glabratus*, *Mimosa uraguensis*, *Calliandra selloi*, *Lafoensia nummularifolia*, *Phyllanthus sellowianus*, *Trichilia elegans*, *Sapium haematospermum*, *Croton urucurana*, *Dryopteris triphylla*, *Inga marginata*, *Nectandra lanceolata*, *Nectandra megapotamica*, *Lonchocarpus leucanthus*, *Guarea kunthiana*, *Euterpe edulis*, *Bastardiopsis densiflora*, *Alchornea triplinervia*, *Luehea divaricata*, *Inga vera ssp. affinis*, *Ruprechtia laxiflora*, *Enterolobium contortisiliquum*, *Myrciaria rivularis*, *Esenbeckia grandiflora*, *Pithecellobium*

scalare, Gleditsia amorphoides, Sebastiana brasiliensis, Celtis pubescens, Chusquea ramosissima, Guadua angustifolia, Cyathea atrovirens.

- Palm Savanna of the Eastern Region of Paraguay: Predominantly herbaceous vegetation with dominant palm species in the woody stratum. Currently, most of its area is composed of savanna systems of anthropic origin, although its natural distribution is related to the high and well-drained soils at the base of the hills and sandstone plateaus of the eastern region of Paraguay. This ecosystem grows on very sandy, friable and possibly acid soils. In the upper stratum the dominant species is *Acrocomia totai*, which under natural conditions may be the only species to be found and have different densities.

List of diagnostic species for this system: *Acrocomia totai, Trema micrantha, Celtis iguanaea, Sapium haematospermum, Peltophorum dubium, Schizachyrium condensatum, Setaria parviflora, Rhynchelitrum repens, Fimbristylis complanata, Andropogon bicornis, Cenchrus echinatus, Digitaria insularis, Panicum laxum, Panicum pernambucense, Bulbostylis capillaris, Solanum sisymbriifolium, Croton sp., Oxalis sp., Hyptis mutabilis, Heliotropium procumbens.*

- Floodable Savannas in Wide Valleys and Foothills of the Eastern Region of Paraguay: System related to plains of medium and minor watercourses that are periodically flooded as well as to lowlands that receive runoff water from the surrounding slopes and are temporarily saturated. This ecosystem has the appearance of an open grassy savanna, sometimes with high grasslands or low meadows. The woody stratum, if present, is very dispersed. In the most depressed parts, the water flow is almost permanent and floating and rhizomatous communities develop, although they are better represented in the wetlands that are permanently flooded.

List of diagnostic species for this system: *Paspalum plicatum, Setaria paucifolia, Rhynchospora globosa, Xyris jupicai, Ludwigia nervosa, Eryngium floribundum.*

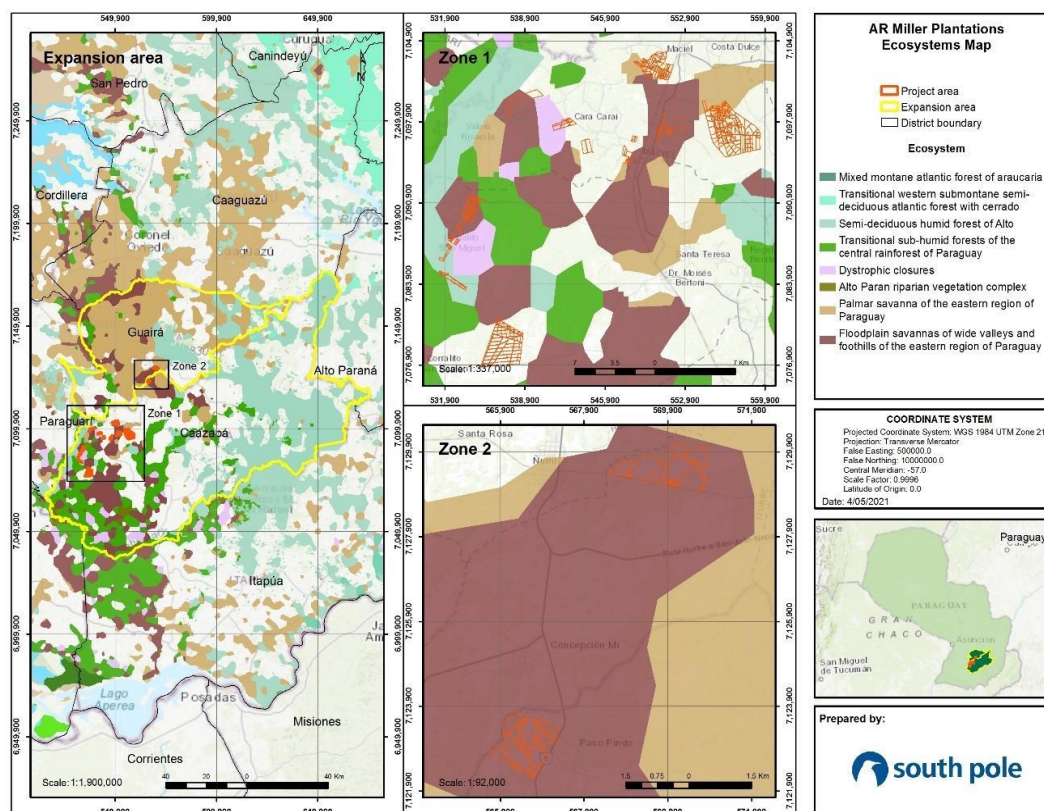


Figure 13. Land ecosystems of the first instance and the expansion area

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

Paraguay's environmental framework is based on article 7 of the National Constitution, which guarantees and promotes the right to a healthy environment. For this reason, through Law No. 1561/00 the National Environmental Council and the Secretariat of the Environment (SEAM) were created, having the latter the responsibility of regulating, controlling and creating laws aimed at studying and using the biological diversity of the national territory in a sustainable way. The SEAM has four thematic high directorates, being the General Directorate for the Protection and Conservation of Biodiversity the one of main relevance for the project, as it is the responsible for managing the protected areas and establishing strategies for the use and conservation of biodiversity. The project is also regulated by the National Forestry Institute (INFONA), which was created by Law No. 3464/08 and is in charge of regulating all forestry matters in the country; and by the Ministry of Environment and Sustainable Development (MADES), whose aim is implementing and controlling Paraguay's environmental regulations.

The social responsibility of the project over workers is governed by Law No. 213/93 (Labor Code, modified and partially updated by Law No. 496/95) and Law No. 742/61 (Labor Procedure Code). The environmental regulations that are most relevant to the project and the compliance with them are presented in Table 13.

Table 13. Project compliance with national regulations.

Regulation	Description	Project compliance
Law No. 294/93, Decree No. 453/13 and Decree No. 954/13	Environmental Impact Assessment. "Afforestation for Multiple Uses". The environmental impact assessment is declared mandatory and regulated for any project that affects the environment or any human activity that affects life quality, biodiversity, quantity and use of natural or environmental resources, welfare, health, safety, legitimate habits, customs, cultural heritage or livelihoods.	The project has all the Environmental Licenses (LA) or Generic Environmental Management Plans (PGAG) in place for every project property. In them, management measures for impact prevention, mitigation or compensation in forestry plantations and the adaptation of drainage channels are detailed. ³⁹
Law No. 4241/10 Decree No. 9824/12	Stream and river buffer zones will be protected. The exact width depends on the size of the water body.	According to the Environmental Licenses, the PGAGs and the compliance reports submitted by the project, the planted areas do not affect the forest covers that protect the tributaries surrounding the first instance area. In addition, it is the company's policy to preserve the water bodies in accordance with the provisions of the applicable laws.
Law No. 3239/14	It regulates the sustainable and comprehensive management of all water bodies and the producing territories.	The design, adaptation and construction of the channels were carried out taking into account the provisions of this law. The application for the environmental license required by this law was made together with the plantation licenses. ⁴⁰
Law No. 422/73	This law stipulates that forest plantations prior to timber use and commercialization activities must submit a Forest Management Plan and be registered in INFONA. In addition, this law declares that all rural farms with an area >20 ha must maintain 25% of the existing forest cover that existed in 1986 (article 42).	The project was implemented on grazing lands, so forest use was not carried out. See baseline and eligibility sections for more details. In addition, the project has already submitted the Forest Management Plan to INFONA ⁴¹ and plantations shall be registered prior to harvest in accordance with the law.
Law No. 2524/04, extended by laws No. 3139/06, No. 3663/08,	Its objectives are to protect, recover, and improve the native forest in the Eastern Region, reason why the conversion of forests to agricultural lands is prohibited.	The project was implemented on grazing lands, so forest use was not carried out. See baseline and eligibility sections for more details.

39 The supporting documents are available at: Gestión Documental/environmental licenses

40 The supporting documents are available at: Gestión Documental/environmental licenses

41 Location: Gestión Documental/management plans/07- Plan de Manejo Forestal_23_11_2020

No. 5045/13 and No. 6256/18	All rural farms with an area >20 ha must maintain 25% of the existing forest cover.	
Law No. 352/94	Protected Wild Areas Law. Forestry activities involving exotic species are not allowed in protected areas.	In the first instance, no areas declared within the National System of Protected Areas of Paraguay (SINASIP) ⁴² have been included.
Law No. 536/95	Law for afforestation and reforestation promotion. Afforestation is understood as the action of establishing forests by using native or exotic species on lands that lack them or where they are insufficient.	The project was implemented in areas whose main land use was grazing for extensive cattle ranching. The company is registered in INFONA as a forestry activities developer. However, to date it has not received the incentives stipulated by this law.
Law No. 4890	Real right over forest areas. The owner of a property with capacity to contain forest plantations or natural forests can confer third parties or entitled individuals with the right to use or decide over the forest assets planted on the corresponding land.	The project has all the land tenure documents that authorize forest use ⁴³ in place. Properties that are under the lease modality are not yet covered by this law.
Law No. 5875/17	Climate Change National Law. Establishes the general regulatory framework for planning and responding, in an urgent, adequate, coordinated and sustained manner, to climate change impacts.	The plantations established will help supply the country's demand for timber, thus reducing the pressure on natural forests and contributing to achieve the non-deforestation goals defined by Paraguay in international climate change agreements. In addition to carry out afforestation activities, the project will contribute with carbon sequestration rates during the growth cycle of the plantation.

1.14 Participation under Other GHG Programs

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

The project is not registered, nor does it intend to be registered before any other GHG program.

1.14.2 Projects Rejected by Other GHG Programs

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

⁴² See map in section 1.13.

⁴³ The supporting documents are available at: Gestión documental/land tenure

1.15 Other Forms of Credit

1.15.1 Emissions Trading Programs and Other Binding Limits

The project does not participate in emissions trading programs.

1.15.2 Other Forms of Environmental Credit

The project has not generated any other form of environmental credit.

1.16 Additional Information Relevant to the Project

1. Leakage Management

The results of the assessment on the leakages that the project may generate due to the shift from grazing to forest systems are presented in item 4.3, where it is concluded that project leakage is insignificant. For this reason, the management plan has not included a leakage component.

2. Commercially Sensitive Information

The project has not excluded commercially sensitive information.

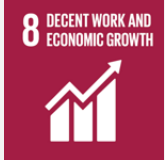
3. Sustainable Development

Paraguay, as a participant in the United Nations Conference on Sustainable Development, has been working since 2016 in the creation of an inter-institutional coordination committee for the implementation, follow-up and monitoring of the international commitments made in the framework of the Sustainable Development Goals, SDGs (2030 Paraguay SDG Committee). To date, this group has outlined 87 out of the 218 indicators that need to be covered. The contributions of the project to the country's sustainable development are listed below, taking the SDG indicators into account:

Table 14. Project contribution to the SDGs.

NDC or related program	SDG	Associated country goal	Project indicator	Project objective
National Development Plan of Paraguay (PND) for 2030 ⁴⁴		5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life.	Ratio of female-to-male labor force participation rate (%). Ratio of female-to-male mean training hours received (%).	Increasing women's participation by 40% in barrier-free sectors in a next verification. Guarantee 100% of equal access to

⁴⁴ <https://www.stp.gov.py/pnd/wp-content/uploads/2014/12/pnd2030.pdf>

				training hours for workers and others.
National Development Plan of Paraguay (PND) for 2030 ⁴⁵		8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.	Job creation. Compliance with occupational safety rules. Average hourly income of employees, broken down by occupation, age and people with disabilities.	Create formal employment relationships with 80% of the people involved in the project, providing guarantees by law. Reduce the rate of work-related accidents. Place 100% of safety signs according to work safety rules. Provide employees with 100% of safety required equipment. Conduct training sessions on occupational safety according to the rules and the Forest Management Plan.
Reduction of 10% of GHG emissions by 2030 based on the baseline ⁴⁶			Reduction of total GHG emissions. Training focused on the contribution of forestry activities to emissions reduction.	Remove of 84,991 tCO₂e/year GHG Establish a yearly training cycle (at least 2 per year) until the next verification.
National Development Plan of Paraguay (PND) for 2030 ⁴⁷		9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number	Research investment (research and development costs).	Establish a budget for research on natural resources and related topics and make progress on each verification.

⁴⁵ <https://www.stp.gov.py/pnd/wp-content/uploads/2014/12/pnd2030.pdf>

⁴⁶ <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Paraguay%20First/Documento%20INDC%20Paraguay%2001-10-15.pdf>

⁴⁷ <https://www.stp.gov.py/pnd/wp-content/uploads/2014/12/pnd2030.pdf>

		of research and development workers.		
National Climate Change Strategy: Forest Sector Development ⁴⁸		15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.	Progress towards sustainable forest management.	Comply with the applicable standards in the established areas by 100%. Have the Forest Management Plan updated and 100% executed. Generate annual reports on the Forest Management Plan.

4. Further Information

The additional information generated, and the supporting documents can be found in the “Gestión Documental” folder. This material is referenced in its respective section.

⁴⁸ <http://dncc.mades.gov.py/wp-content/uploads/2020/09/Estrategia-Nacional-de-Adaptacion-al-Cambio-Clim%C3%A1tico.pdf>

2 SAFEGUARDS

2.1 No Net Harm

The potential environmental and socioeconomic impacts that could be triggered by forestry activities (in both pure plantations and silvopastoral systems) were evaluated. For this, the pre-existing physical-biotic conditions in the first instance and the expansion areas, the results obtained from the stakeholder consultations, and the activities developed in every phase of the project (land acquisition, establishment, maintenance, harvest, production and commercialization of the final product) were taken into account.

Considering that the project was established in natural pastures degraded by livestock, these plantations have indirect effects on the conserved ecosystems and the biological diversity, while their effect on soil and water resources is direct and higher. The impacts generated are mainly linked to land preparation activities, the use of agrochemicals and the harvest phase. On the social side, the main impacts that may be generated with the project are the creation of expectations or the arise of conflicts between the owners and the local community.

In order to prevent or mitigate the impacts, continuous and open communication channels were established. Additionally, prevention and mitigation actions were designed and included in the Forest Management Plan, in compliance with Paraguayan environmental and social regulations. In sections 0, 2.3 and 2.4, the possible impacts and the proposed management measures are further detailed.

2.2 Local Stakeholder Consultation

To carry out the stakeholder consultation of the Afforestation of Degraded Grasslands in Caazapá and Guairá Project, a Participation, Communication and Knowledge Transfer Strategy (EPCAC) was designed and put into practice. The EPCAC is aligned with the principles of ARR projects and the sustainability policies of Felber Forestal S.A. as it makes use of methodologies and instruments that guide project development with a participatory approach. In it, communication plays an important role for the understanding and sense of belonging by the different actors involved and their pursuit for climate mitigation actions. A core objective of the EPCAC is that the processes are recognized, understood and mastered by different actors in order to promote the sustainability of the project and the ecosystems where it is developed.

In summary, the EPCAC consists of the development of planned and concerted actions that ensure the proper development of the ARR initiative, enhance its benefits among interested parties and reduce the socio-environmental risks that may be caused in the contexts where the same is developed. It also makes it possible to ensure participation, assertive communication and the adequate implementation and monitoring of the project via the baseline determination with workers, neighbors, institutions and local, regional and national authorities.

Methods and procedures

The EPCAC is implemented across the project cycles and, in methodological terms, is developed in five interlinked phases, as shown in Figure 14.



Figure 14. Phases of the Participation, Communication and Knowledge Transfer Strategy (EPCAC) of the AR Miller project.

- Phase .1 Preparation: The necessary information was collected in order to recognize the territory, approach key actors, and acquire a preliminary knowledge of the context. Groups or sectors of interest were identified, and a stakeholder mapping and analysis was carried out.
- Phase 2. Consultations and participatory construction of the baseline:
 - Meetings with the stakeholders to communicate them about the project and its objectives.
 - Activities for the collection of primary and secondary information.
 - Communication mechanisms.
 - Spaces for dialogue about reforestation projects, their connection with climate change and the actions carried out in the territories.
- Phase 3. Validation, information complements and perceptions: Activities were carried out to compile the perceptions of key actors about the AR initiative and its importance in the territory, as well as to identify changes associated with positive and negative impacts.
- Phase 4. Results feedback: Activities will be carried out to communicate the main results of the project, making possible the dialogue on the forestry initiative and the strengthening of the project outreach and ownership process.

- Phase 5. Implementation, monitoring and continuity: Interrelated process conducted by the project proponents and addressed to the stakeholders. Implementation, monitoring and follow-up activities will extend to new verification processes.

In accordance with the phases listed above, in the preparation phase for the Afforestation of Degraded Grasslands in Caazapá and Guairá Project, the EPCAC started with the collection and analysis of information provided by the proponent and other entities involved (contractors, environmental authorities, etc.). Subsequently, the preliminary mapping of key actors was outlined and validated through its socialization with the project stakeholders. Information on the mapping of project key actors is detailed in section 2.5.

In this phase, the communication and dialogue with the actors in the territory began with the aim to fulfill the project purposes related to consultation, knowledge transfer, participatory baseline elaboration, impact and mitigation measures identification, among other aspects. In this regard, the way in which actors were called and the activities carried out are described below.

Method for participatory meetings and workshops calls

This activity was carried out by making direct calls or sending messages via email and WhatsApp to each sector or stakeholder identified in the stakeholder mapping (Figure 15).



Figure 15. Digital card and screenshot of the invitation sent by email.

Initial consultations with project stakeholders

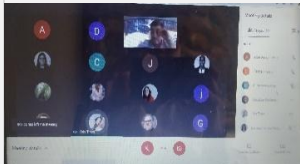
Due to the health emergency caused by COVID-19, most stakeholder consultations were conducted through virtual platforms such as Google Meet, with the exception of those held with employees and members of nearby communities, which were carried out in person. For each of these meetings, a PowerPoint⁴⁹ presentation was elaborated based on the needs of every target audience.

Table 15 and Table 16 show the main results of the meetings held. It is concluded that they facilitated the achievement of various objectives defined in the EPCAC such as project presentation and outreach, compilation of information for the sociocultural and territorial baseline, dialogues on the initiative and its alignment with climate change mitigation actions, validation and complement

49 Information available at: Gestión documental/EPCAP/Socializations

of available information, as well as knowledge about the perceptions on territorial changes, benefits, improvement actions and the communication and outreach mechanism of the initiative.

Table 15. EPCAC preparation and consultation meetings with key stakeholders.

Activity and key actors	Date	Attendees	Supporting documents	Photographs
Communication of the ARR initiative to key actors: institutional and educational sectors.	February 11, 2021	17	Presentation Minutes Attendance record	
Communication of the ARR initiative to employees of Felber Forestal S.A.	February 10, 2021	14	Attendance record Photographs Video	

Meetings for the validation, complement and collection of primary information and perceptions

In March 2021, meetings were held in order to address some validation-related issues, finish the stakeholder map, collect primary information to complement the baseline, inform the main advances of the initiative, and identify the expectations and perceptions on the impacts generated in the territory once the plantations are established. Similarly, dialogues were established about the project cycle and certification, some governance issues, the history of the territory, and the alignment of the initiative with climate change issues, among other topics.

The main results of these activities were included throughout this document and in the supporting reports. In addition, they were communicated in a workshop with employees of Felber Forestal, where suggestions and improvement actions expressed by the interest groups were received. Table 16 lists the activities carried out ⁵⁰.

Table 16. Summary of spaces and actions for stakeholder consultations.

Activity	Date	Attendees	Supporting documents
Meeting for progress communication and workshop for information collection and validation.	March 15, 2021	5	Minutes Attendance record Meeting recording
Institutional and academic sectors.			
Virtual meeting for progress communication and workshop for	March 15, 2021	11	Minutes Attendance record

50 Information available at: Gestion documental/EPCAP/Socializaciones

Activity	Date	Attendees	Supporting documents
information collection and validation.			Meeting recording
Institutional sector.			
Meeting for progress communication and workshop for information collection and validation.	March 16, 2021	6	Minutes Attendance record
Employees of Felber Forestal S.A.			
Meeting for progress communication and workshop for information collection and validation.	March 16, 2021	32	Minutes Attendance record Photographs Videos Meeting recording
Employees of Felber Forestal S.A.			
Meeting for progress communication and workshop for information collection and validation.	March 17, 2021	16	Minutes Attendance record Photographs Videos Meeting recording
Middle management and operational employees of Felber Forestal S.A.			
Meeting for progress communication and workshop for information collection and validation.	March 17, 2021	7	Minutes Attendance record Photographs Meeting recording
Residents and producers from the areas neighboring the plantations.			
Meeting for progress communication and workshop for information collection and validation.	March 19, 2021	9	Minutes Attendance record Photographs
Institutional sector at the municipal and regional levels. Education sector at the regional level.			
Meeting for the communication of project progress and main results of the field visit.	March 19, 2021	3	Minutes Attendance record Photographs
Directors of Felber Forestal S.A.			

	
Meeting- workshop with middle management and operational employees of Felber Forestal S.A. March 16, 2021	Meeting- workshop with operational employees of Felber Forestal S.A. March 17, 2021
	
Meeting- workshop with residents and producers from the areas neighboring the plantations. March 17, 2021	Meeting- workshop with the institutional and educational sectors of the municipal and regional levels. March 19, 2021

Figure 16. Photographs of the stakeholder consultations

Dialogues and semi-structured interviews with employees of Felber Forestal

Some information gathering instruments and techniques were defined, such as semi-structured interviews and questionnaires, which were shared and applied with key actors and directors of Felber Forestal S.A. The aim was to complement the information and learn first-hand about some of the activities developed in the territory. Table 17 lists the activities carried out.

Table 17. Information gathering techniques and instruments.

Instrument	Objective	Sector/actor	Objectives/observation
Survey to collect information on employment for the project proponent	Complement the information received on employment, training, risks and occupational safety.	Project proponent	During the field work, a guided conversation was held in order to understand labor aspects and country regulations, the way the company incorporates them in the plantation activity, as well as how training, risks and safety at work are managed.

Questionnaire for collecting perceptions about the project and its potential impacts	Be aware of the perceptions of the institutional and academic sectors on the AR initiative and its impacts.	Institutional academic actors, employees, neighbors	The questionnaire was sent to several actors. Given that no answers were received, workshops were held to collect their perceptions.
Interview with the company directors	Be aware of the directors' perceptions on the work carried out in the plantations.	Felber directors	Interview carried out on March 18 to find out the perceptions and expectations of the company directors on the work carried out in the plantations, the comments received from the neighbors and the forms of communication used with them, the history of the initiative, challenges, etc.

Main results of the consultation⁵¹

Based on the meetings, workshops, surveys and interviews listed in tables: Table 15, Table 16 and Table 17, the following conclusions were obtained:

During the face-to-face and virtual meetings with key stakeholders in the framework of the local consultation and socialization, several questions and comments were received, which were answered directly during the sessions⁵². The project design has not been updated since no comments were received during the consultation.

Regarding the labor aspect, the company Felber Forestal S.A has included in its principles the prioritization of workforce from the communities living near the project, giving them equal opportunities and treatment. This has led to the promotion of technical, technological and professional training in the municipalities where the initiative is developed for the acquisition of basic skills in forestry and related areas, contributing to the elimination of barriers in this regard and generating greater benefits for the territory and its inhabitants.

For project implementation, the hiring of women and men regardless of their ethnic condition or sexual orientation is a principle embraced by the company. However, in cultural terms, this issue is complex to handle given that communities of the project area still consider that women belong to the private and domestic sphere, while men are in charge of supplying family needs. This dynamic is reflected in the forestry field.

For contributing to employees' capacity building and qualification, the company has conducted several training sessions based on its own guidelines and in compliance with the forest management plans. The trainings frequency varies depending on the project activities, focusing

⁵¹ for more details of the epcap and its results go to the route: Gestion documental/EPCAP/supporting documents

⁵² for more details of the epcap and its results go to the route: Gestion documental/EPCAP/supporting documents/EPCAP

The concerns, comments or complaints received are addressed by the company in a closely manner as the directives state that many neighbors have their WhatsApp contacts, through which their messages are communicated. Residents also visit the offices located in the plantations of the municipality of Maciel looking for a face-to-face communication or to inform they are resigning a job, concerns that are responded in an agile way. Likewise, communications from neighbors or other interested parties are received through email.

The consultation and results delivery phase is under development. For it, a virtual or face-to-face meeting (as appropriate) with the interest groups will be held to report project results, mainly related to climate, credits accounting, audit process, registry and the communication, information and dissemination mechanisms of the initiative. The information resulting from the latter will be included in this document during the audit phase.

Finally, the implementation phase (new mitigation measures identified) is led and developed by the proponent once the incentive becomes effective. The main activities to take into account are those defined in the monitoring process and the ones related to the communication mechanisms for Petitions, Complaints, Claims and Suggestions.



Job opportunities in the territory

As previously mentioned, the Afforestation of Degraded Grasslands in Caazapá y Guairá Project has included in its principles the prioritization of workforce from the communities living near the project, giving them equal opportunities and treatment.

To achieve this, the company (through its forestry initiative) has promoted technical, technological and professional training for the acquisition of basic skills in forestry and related areas, contributing to the elimination of barriers in this regard and generating greater benefits for the territory and its inhabitants. This way, it has qualified personnel who can perform the different types of tasks demanded by the forestry activities carried out by the company. Table 18 lists the number of employees of Felber Forestal and its partner companies at present.

Table 18. Number of jobs by sex.

Company	No. of male employees	No. of female employees	Total No. of employees
Felber Forestal	75	21	96
INCON S.A.	61	1	70
LYA Inversiones S.A.	38	-	38
MTY S.A.	24	2	26
Total	198	24	222

For project implementation, the hiring of women and men regardless of their ethnic condition or sexual orientation is a principle embraced by the company. However, in cultural terms, this issue is complex to handle given that communities of the project area still consider that women belong to the private and domestic sphere, while men are in charge of supplying family needs. This is reflected in a lower number of employed women (in comparison to men) – 24 out of 222, that is 10.8% of the total number of employees.

When there are open job offers, the company informs the employees, who share the type of position and the hiring conditions with the communities as established by Law 213/93, which regulates the Labor Code of Paraguay. This way, the company promotes access to activities and job opportunities that improve the living conditions of the communities. Currently, the company and its partners employ a total of 222 people, who are geographically distributed as follows: 77% of the employees live in the department of Caazapá, mainly in the districts of Maciel, Dr. Moisés Bertoni and Caazapá; 17.5% in the department of Guairá; and the remaining 5.5% in districts of nearby departments such as Itapúa and Asunción.

The employees work mainly in establishment and management activities in the plantations as well as in forestry tasks such as plant material production, work in the nurseries, and in the administrative area, among others. Technical assistance for monitoring plantations growth through forest inventories and other relevant services are provided by the company Red Forestal.

During the 2016-2020 period Felber Forestal has strengthened the work supply and demand in the areas where the initiative is developed (Table 19).

Table 19. Number of jobs created by the project during the 2016-2020 period.

Year	No. of male employees	No. of female employees	Total No. of employees
2016	79	5	84
2017	64	5	69
2018	77	7	84
2019	174	14	188
2020	198	24	222

2.3 Environmental Impact

The activities, socio-environmental impacts and mitigation measures for the project are identified⁵⁴. These impacts were obtained from the environmental management plans or environmental impact studies submitted to MADES by each of the properties⁵⁵ were supplemented through public consultation and professional judgment.

In order to comply with the requirements of Paraguay's environmental legislation, Felber S.A. has conducted environmental audits in each of the properties. In each audit, the environmental management plan proposed to the authority for each of the properties was monitored and controlled. This evaluation showed that Felber S.A. has mostly complied with the mitigation measures proposed and required by the authority, with the exception of the fuel storage area conditions, for which a period of two years was established to comply⁵⁶.

2.4 Public Comments

The project is currently listed on the VCS platform under ID 2498. Through Felber Forestal's S.A social networks it has been communicated that the project is under public comment but to date no comments have been received.

2.5 AFOLU-Specific Safeguards

Stakeholder identification

⁵⁴ The summary of the evaluations carried out in the Environmental Audits can be found on the following sheet "Impact assessments" of document "Impactos Socioambientales.xlsx" in Gestión documental/Safeguard

⁵⁵ Environmental impact studies or general environmental management plans for property can be found at Gestión ambiental/environmental licenses

⁵⁶ The reports provided can be found at Gestión documental/Safeguard/environmental audit reports

Stakeholders were determined through the stakeholder mapping and analysis methodology, which has the main objective to identify and characterize the stakeholders (sectors and actors) with their respective roles and interests regarding the Afforestation of degraded grasslands in Caazapá y Guairá project.

Likewise, the actors⁵⁷ identification and characterization (mapping) are a tool to identify the different interest groups at the local, regional, national and international levels, along with their respective roles, capacities, abilities, resources and interests within the territories where the project is developed. This stakeholder analysis is a methodological route in connection with the guidelines of the South Pole Colombia stakeholder engagement team and the company partners.

The methodological route consists of the following stages:

- Elaboration of the draft list of actors based on secondary information.
- Review, adjustment and complement of the list with the project proponent and later with the identified sectors.
- Classification of the actors in the key variables defined based on the territorial study and the review of specialized literature about actors mapping and analysis.
- Establishment of minimum key variables for analysis and mapping: sector, role, interest and territorial scope of action⁵⁸.

The roles will be understood as the actions or functions of each actor in the territory and regarding the project, such as:

- a. Direct user carrying out conservation activities.
- b. Control and follow up
- c. Knowledge, support, and advice
- d. Impact and risk

On the other hand, interest refers to the motivations for participating or getting involved in the project and its implementation:

1. Forest conservation
2. Compliance with rules and regulations
3. Academic and research activities
4. Economic purposes and/or benefits from productive activities

In this sense, Table 20 lists the sectors and actors identified for the AR Miller project with their respective roles and interests. Subsequently, Figure 18 shows the scheme adjusted after the validation and complement process carried out by applying the participation strategy with the stakeholders involved.

⁵⁷ As a concept, actor will be understood as the "individual or social organization [...] that is defined by their identities, purposes and interests, which are resolved through the interaction with society and the environment. The actor is a relational unit, that is, someone is an actor as long as he/she has a position and a role in a relational scheme with peers and heterogeneous entities in his/her environment"(Palacio, Dolly. *Redes, Actores y Gobernanza desde un enfoque relacional*. Alexander von Humboldt Biological Resources Research Institute, 2015. Bogotá, Colombia). These actors can be concentrated in or belong to sectors that share some characteristics regarding their role, interest, vision, mission or competence.

⁵⁸ The scope of action refers to the territorial scale at which each actor performs their actions, defining his/her level of influence and where he/she has a broader territorial presence. Scales are defined as local, regional, and national.

Table 20. Identification and classification of project actors.

Sector	Actor	Territorial scale	Role	Interest
Employees of the Felber Forestal S.A. Group	Administrative staff	Local	a. Direct user carrying out conservation activities	1. Forest conservation
	Service providers	Local		
	Field staff	Local		2. Compliance with rules and regulations
	Technical staff	Local	c. Knowledge, support and advice d. Impact and risk	4. Economic purposes and/or benefits from productive activities
Public Institutional	INDERT (National Institute for Rural and Land Development)	National	a. Direct user carrying out conservation activities	1. Forest conservation
	INFONA (National Forestry Institute)	National		2. Compliance with rules and regulations
	MADES (Ministry of Environment and Sustainable Development)	National	b. Control and follow up	
	MAG (Ministry of Agriculture and Livestock)	National	c. Knowledge, support and advice	
	STP (Technical Secretariat for Economic Development Planning)	National		
	DNCC (National Directorate of Climate Change)	National		
	AFD (Development Finance Agency)	National		
	REDIEX (Investment and Export Network), agency associated to the Ministry of Industry and Commerce	National		
	BNF (National Development Bank)	National		
	Departmental Government of Caazapá	Regional		

Sector	Actor	Territorial scale	Role	Interest
	Departmental Government of Guairá	Regional		
	Municipality of Coronel Maciel (Caazapá)	Local		
	Municipality of Doctor Moisés Santiago Bertoni (Caazapá)	Local		
	Municipality of Caazapá (Caazapá)	Local		
	Municipality of Ñumi (Guairá)	Local		
Educational	Rural educational institutions	Local - regional	c. Knowledge, support and advice	3. Academic and research activities
	Universities	Local - regional		
	Agricultural School of Caazapá	Local - regional		
Productive	Agricultural and producer associations	Local - regional	a. Direct user carrying out conservation activities	
			c. Knowledge, support and advice	
			d. Impact and risk	
	Sectoral companies	Local - regional	a. Direct user carrying out conservation activities	1. Forest conservation
	FEDAMA	Local - regional	d. Impact and risk	4. Economic purposes and/or benefits from productive activities
	ARP (Rural Association of Paraguay)	Local - regional		

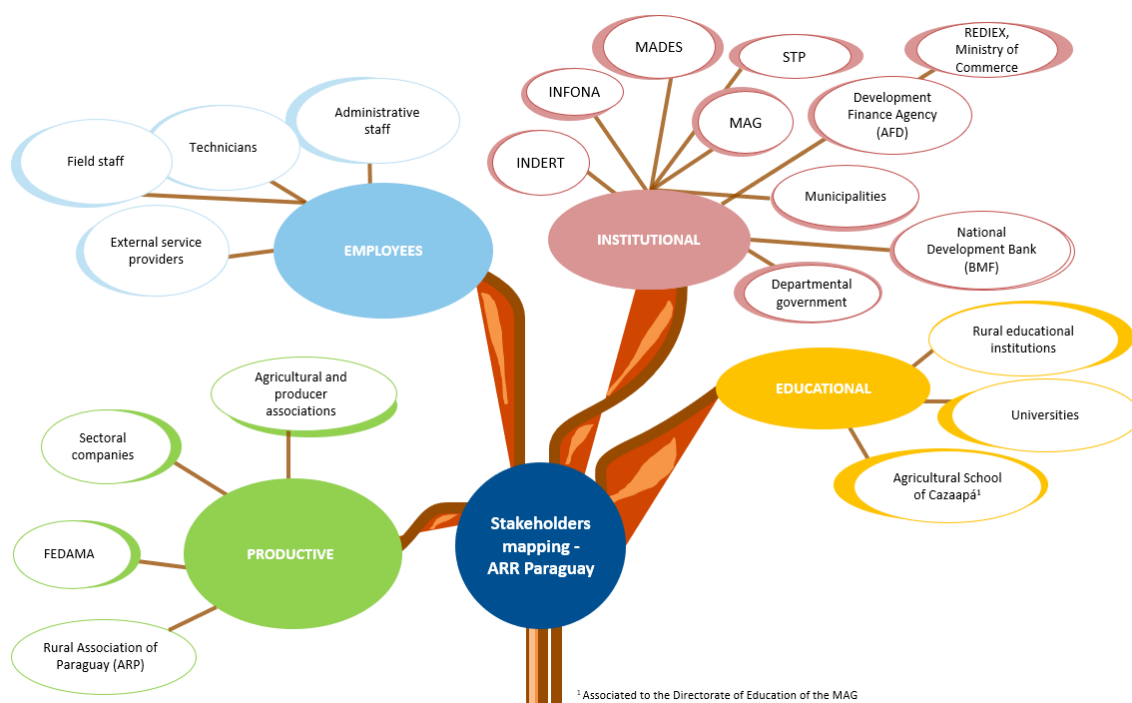


Figure 18. Outline of the AR Miller Paraguay stakeholder map.

Both the stakeholder analysis and the development of the EPCAC strategy made it possible to identify (by using participatory techniques) the perceptions of different interest groups on the possible risks and benefits of the initiative, as well as the measures that are currently being taken to mitigate these risks.

Risks for local actors and mitigation measures

Risk identification requires the recognition of the socio-economic, cultural and political conditions of the territorial actors (mapping of actors and their level of vulnerability) as well as their relationship with threats from various sources (natural and anthropic phenomena)⁵⁹.

⁵⁹ For more information on the risks, impacts and mitigation measures, see the document Participation, Communication and Knowledge Transfer Strategy (EPCAC) of the AR Miller project, which is available at: [Gestión documental/EPCAP/supporting documents/EPCAP](https://gestiondocumental/EPCAP/supportingdocuments/EPCAP).

Table 21. Risks identified during the stakeholder consultations.

Type of risk	Local actor affected	Mitigation measure
Reduction of investment resources and loss of jobs due to the absence of forestry activities (investment barrier)	Employees Communities Local government	Participation of investors seeking to receive profitability in the long term. Access to incentives or financing.
Forest fires	Academy	Installation of natural barriers and compliance with the Forest Management Plan. Generation of clear communication channels with the community.
Extreme weather events (frosts, droughts, extreme rains)		Climate adaptation of forestry activities. Generation of clear communication channels with the community.

During the application of the EPCAC in the consultation meetings, three risk situations were identified for local actors, in addition to the impacts listed in Table 20. The risks are associated to anthropic factors such as economic fluctuations due to market dynamics and the long time required for the return of the forestry activities investment. There are also factors caused by extreme weather events such as droughts, frosts, extreme rains and forest fires.

The project does not put the property rights of the communities or stakeholders at risk since the company's reforestation activities are carried out on properties that evidence land tenure (section 1.7).

Continuous communication and consultation with stakeholders

Regarding the current and future actions and strategies that guarantee communication and consultation with local stakeholders, including a complaint procedure to resolve any tension, expectation or concern that may arise between local stakeholders and the project proponent, the following mechanisms are considered:

Mechanism for Questions, Complaints, Claims and Suggestions

A way to ensure transparency and the consideration of citizen opinions regarding a service, process or project in charge of a public or private institution is the questions, complaints, claims and suggestions mechanism. In the case of the AR project, its formal implementation is essential, in accordance with the VCS Requirements, making sure that the procedure to receive and address complaints, queries or any type of comment regarding the project is laid on the foundation of a

transparent communication and, based on various tools, that solutions can be provided in every case.

In this sense, the initiative has the PQCS (for its Spanish acronym) mechanism aimed at collecting and responding to those questions, complaints, claims and suggestions (or even congratulations) from interested parties. On the other hand, the proponent will keep the communication channels currently used with the stakeholders active and will incorporate new ones, which will be launched for the next verification.

Methodological process of the PQCS mechanism

The information to be received will be managed as follows:

- **Questions or request for information:** When the sender wants to ask a specific question about the project and its different phases or processes.
- **Complaints, disagreements or management of difficulties or conflicts:** If there is any discomfort, disagreement, difficulty or conflict regarding the project implementation.
- **Comments, suggestions or congratulations:** For comments, suggestions or contributions to the project implementation and monitoring. Also, if the interested parties want to express congratulations on any aspect of the project.

In this respect, the mechanism of participation and communication with key actors consists of the inclusion of tools for continuous contact with the interested parties along the project. For this, it is crucial to provide information on project design and implementation as well as means that allow receiving and addressing any concern communicated by stakeholders as shown below.

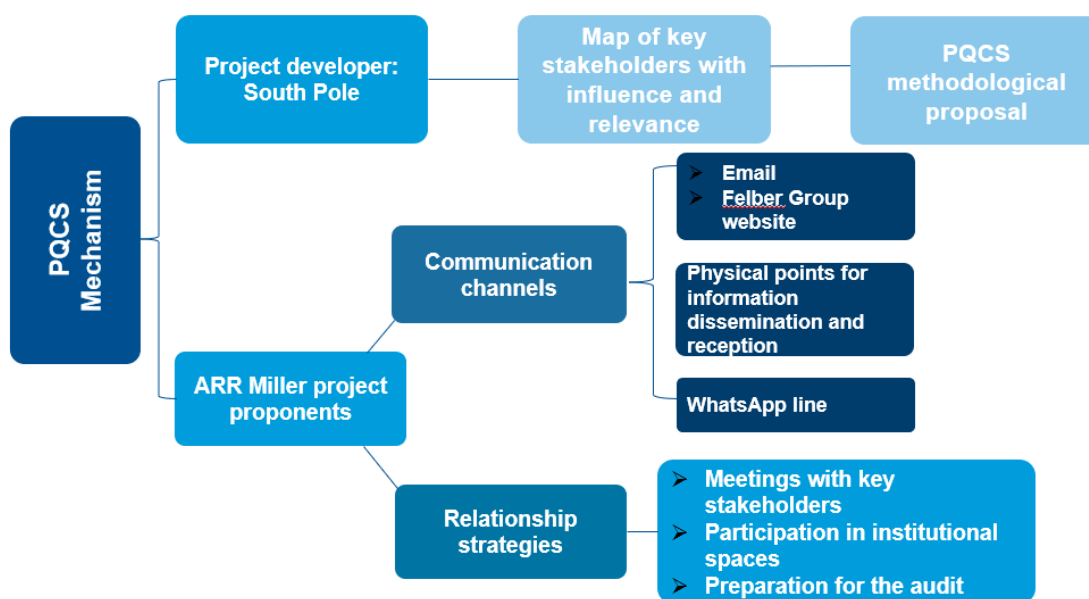


Figure 19. PQCS participation, communication, and engagement mechanisms.

Based on the proposal presented in Figure 19, the following means and spaces will be available for citizens, who will have the option to file their concerns related to the project:

- Email
- Website of the Felber Forestal S.A. Group
- WhatsApp line
- Physical points for information reception and dissemination (offices)
- Meetings with key stakeholders
- Participation in institutional spaces

The proponent has a format for receiving the PQCS and has established a response time of 15 business days.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The removals generated by the project plantations were estimated based on the AR-ACM0003 methodology “A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands”⁶⁰, version 2.0, proposed by the United Nations Framework Convention on Climate Change (UNFCCC) in the sectorial scope 14 of Agriculture, Forestry and other Land Uses (AFOLU). The tools applicable to the version 2.0 of the AR-ACM003 methodology are:

- “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” version 04.2;
- “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” version 03.1;
- “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities” version 01.1.0;
- “Estimation of non-CO2 greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity” version 04.0;
- “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” version 02.0;
- “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities” version 01.

3.2 Applicability of Methodology

⁶⁰ <https://cdm.unfccc.int/methodologies/DB/C9QS5G3CS8FW04MYXXDFOQDPXWM40E>

Table 22. Applicability conditions of the AR-ACM0003 methodology.

Applicability condition	Compliance description
The land subjected to the project activity does not fall in the wetland category.	According to the distribution map of RAMSAR Sites in Paraguay ⁶¹ and to information provided by CIFOR, the project area is not within areas with wetland or peatland ecosystems.
Soil disturbance attributable to the project activity does not cover more than 10% of area in each of the following types of land, when these lands are included within the project boundary: - Land containing organic soils. - Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 of the AR-ACM0003 methodology.	Organic soils were defined by the IPCC (2006) as those that have at least 12% organic carbon by weight (around 20% organic matter), are subject to water saturation, and are defined as histosols and other soils with histic horizons⁶². The project area does not have soils classified as organic, according to the information in the database of the GLOSIS-GSOCmap V1.5.0⁶³ (soil organic carbon map) of the Food and Agriculture Organization of the United Nations (FAO) and in the international soil database ISRIC World Soil Information⁶⁴. Most of the soils are in the ultisol (Arquic Paleudul) category with a distribution of 98.23%, and only 1.77% are inceptisol (Oxyaquic Dystrochrept)⁶⁵. This is the general condition of the soils in the Eastern region of Paraguay, where sandstone and basalt are the source material and, in turn, there is a mosaic of predominantly alfisol and ultisol, interspersed with smaller areas of entisol and inceptisol (see section 1.13). These soils have some limitations in terms of erosion due to superficial sand layers, acidity and fertility, and this Eastern region is dominated by highly fertile red soils. These characteristics hinder the accumulation of organic matter and the presence of organic soils in the project boundaries. The land uses prior to project implementation did not include activities described in appendices 1 and 2 of the AR-ACM0003 methodology, since the area was mainly covered by grasslands⁶⁶ (99.98%) with a minimal presence of livestock. In the absence of project activities, the baseline is expected to remain as unmanaged grasslands, which contain less carbon in comparison to plantations and forest cover.

⁶¹ <https://www Ramsar.org/es/humedal/paraguay>

⁶² IPCC (Intergovernmental Panel on Climate Change), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston, In: H. S., Buendia L., Miwa K., Ngara T., and Tanabe K. (Eds.), IGES, Japan

Table 23. Applicability conditions of the AR-ACM0003 methodology tools

Tool	Applicability condition	Compliance description
AR Tool 8- Estimation of non-CO ₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity- Version 4.0.0 ⁶⁷ .	This tool is applicable for all fire events that occur within the project boundary. All non-CO ₂ GHG emissions resulting from any fire that occurs within the project boundary will be accounted when it affects an area larger than the minimum established by Paraguay in its forest definition (0.5 ha), provided that the accumulated area affected by such fires in a given year is $\geq 5\%$ of the total project area. All non-CO emissions resulting from any fire that occurs within the project limits are accounted for and discounted, provided that the accumulated affected area in a given year is $\geq 5\%$ of the project area.	All non-CO ₂ emissions resulting from any fire that occurs within the project limits are accounted for and discounted, provided that the accumulated affected area in a given year is larger than or equal to 5% of the project area.
AR Tool-12- Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities - Version 3.1 ⁶⁸ .	This tool has no internal applicability conditions.	This tool has no internal applicability conditions.
AR-Tool 14- Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities - Version 4.2 ⁶⁹ .	This tool has no internal applicability conditions.	This tool has no internal applicability conditions.
AR-Tool 15- Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project	This tool is not applicable if the displacement of agricultural activities that will directly or indirectly affect the drainage of wetlands or peatlands is anticipated.	Since the project area does not have wetlands or peatlands, the tool is applicable. In other words, the displacement of grazing activities (baseline) in the project area will not directly or indirectly cause the drainage of wetlands or peatlands.

63 <http://54.229.242.119/GSOCmap/>

64 <https://www.isric.org/explore/wosis/accessing-wosis-derived-datasets>

65 Relatorio de Impacto Ambiental. Available at: Gestión documental/Licencias ambientales

66 See section 3.4, Baseline Scenario

67 https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf/history_view

68 https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v1.1.0.pdf/history_view

69 https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v2.1.0.pdf/history_view

activity – Version 2.0 ⁷⁰ .		
AR-Tool 16- Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities – Version 1.1.0.	This tool is applicable when the areas of land, the baseline scenario, and the project activity meet the following conditions: a. The areas of land to which this tool is applied: (i) Do not fall into wetland1 category; or (ii) Do not contain organic soils as defined in “Annex A: Glossary” of the IPCC GPG LULUCF 2003; (iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2. b. The project activity meets one of the following conditions: (i) Litter remains on site and is not removed in the A/R project activity; and (ii) Soil disturbance attributable to the A/R project activity, if any, is in accordance with appropriate soil conservation practices, e.g., follows the land contours; and it is limited to soil disturbance for site preparation before planting and such disturbance is not repeated in less than twenty years.	Plantation activities are carried out for each forest shift. Therefore, given the soil preparation conditions and following the conservativeness principle, the soil organic carbon is not taken into account.
AR-Tool 2- Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities.	a. Afforestation 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. b. This tool is not applicable to small-scale afforestation and reforestation project activities.	a. The land afforestation activities will not lead to the violation of any applicable law (See section 3.5 Additionality and section 1.14 Compliance with Laws, Statutes and other regulatory frameworks). b. Not applicable.

⁷⁰ https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v2.0.pdf/history_view

3.3 Project Boundary

Below is the location of the project in the first instance with the type of destination of each lot and Table 24 shows the carbon pools applicable to the project.

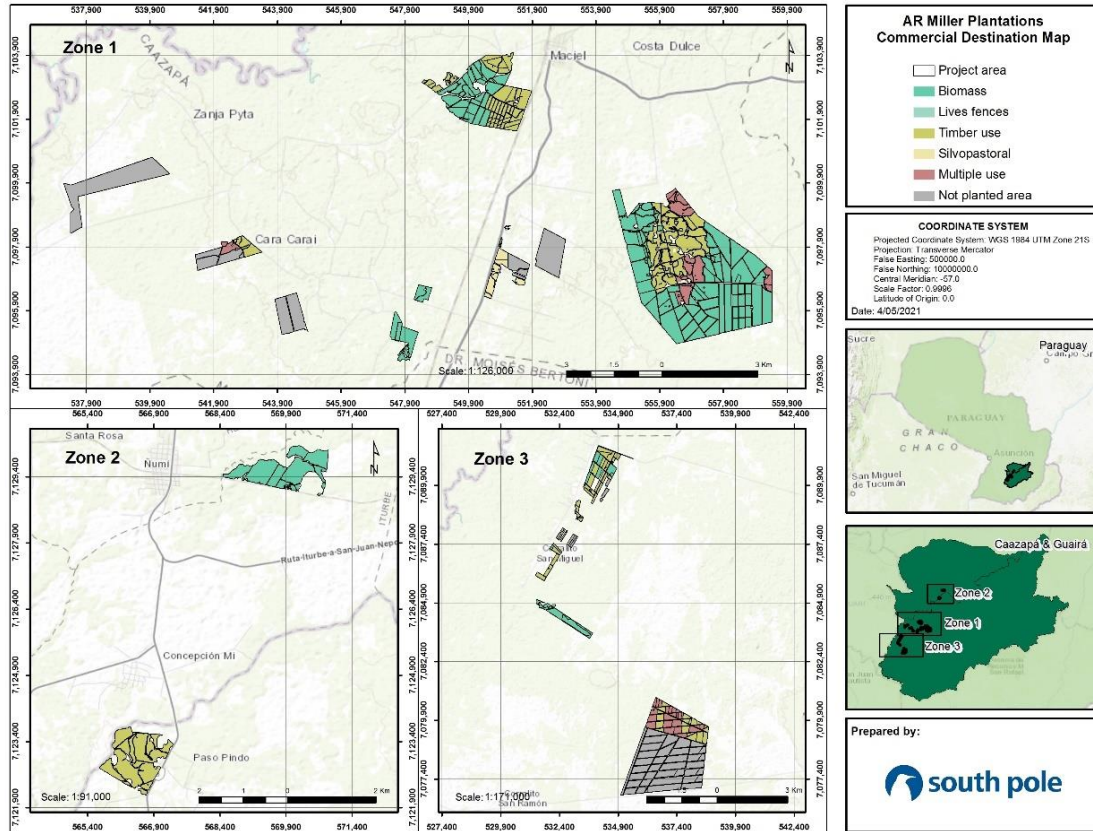


Figura 20. Location of the project

Table 24. Carbon sinks with emission sources.

Sink		Gas	Included?	Justification/Explanation
Baseline	Aboveground and belowground biomass	CO ₂	Yes	Given that the burning practices for grasslands renovation do not lead to carbon accumulation, it is zero.
	Aboveground and belowground biomass	CO ₂	Yes	This is the largest carbon pool included in the project activity. Carbon storage in aboveground and belowground biomass is expected to increase as a result of the implementation of the project activity.
Project	Litter and dead wood	CO ₂	Yes	Carbon storage in this sink may increase as a result of the reforestation project activity.
	Soil carbon	CO ₂	No	Due to soil removal activities during every plantation shift, this sink is not included.

Source	Gas	Included?	Justification/Explanation
Biomass burning	CO ₂	Yes	CO ₂ emissions from biomass burning are accounted for as a change in carbon stocks.
	CH ₄	Yes	The project does not use biomass burning practices as part of its activities. In the case a fire event occurs, it will be reported and accounted for in the monitoring report.
	N ₂ O	Yes	The project does not use biomass burning practices as part of its activities. In the case a fire event occurs, it will be reported and accounted for in the monitoring report.

3.4 Baseline Scenario

The baseline scenario for the project first instance is described in section 3.5, Additionality.

3.5 Additionality

The additionality analysis was carried out according to the guidelines of the CDM tool “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities”- Version 01.

According to the additionality tool, the following steps have been followed:⁷¹

STEP 1. Identification of alternative scenarios

STEP 2. Barrier analysis

STEP 4. Analysis of common practice

Step 1. Identification of alternative scenarios

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

Paraguay's economy is highly dependent on the farming sector, which represents 30.4% of the gross domestic product. The same is classified in the activities of agriculture (22.2%), livestock (6.6%), forestry (1.5%) and fishing (0.1%). The Eastern region, where the project is located, covers 39% of the national territory, houses 97% of its population and is the area with most of the country's agricultural and economic activity ⁷².

Scenario 1. Extensive livestock

Livestock farming is an activity with approximately 480 years of tradition in the country and meat is the main product exported due to its high quality. Historically, livestock in Paraguay has extended over vast natural grasslands and wetlands, with intensive production (animal housing) having been barely implemented⁷³. As a result, prairies and pastures in the country, which cover an area of about 17 million hectares, are mainly dedicated to agricultural uses⁷⁴. Due to its economic predominance and the high dependence of the population, as well as its contribution to the general income of the country and the growth trends in meat exports, livestock plays a key role in Paraguay, making it one of the world's largest beef exporters in the world. Paraguay is a member of the Five Nations Beef Alliance (FNBA)⁷⁵.

In 2010, 63% of the cattle population was located in the Eastern region.⁷⁶ Likewise, the Rural Association of Paraguay (ARP) indicates that in 2017, 60% of the cattle population was in this region⁷⁷. According to the country's livestock statistics provided by the National Animal Health and Quality Service (SENACSA)⁷⁸, there were 13,801,993 bovines in Paraguay in 2019, of which

71 Step 3 (investment analysis) is not applied according to the decision tree of the "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities"- Version 01.

72 World Bank, 2015.

73 Costantini, M., Vázquez-Rowe, I., Manzardo, A., & Bacenetti, J. (2021). Environmental impact assessment of beef cattle production in semi-intensive systems in Paraguay. *Sustainable Production and Consumption*, 27, 269-281.

74 <http://www.fao.org/faostat/en/#data/QC>

75 <https://internationalbeefalliance.com/about-us/>

76 Montes Narbondo, Esteban. Ganadería. Paraguay y su ganadería. In: *Revista Plan Agropecuario*. Page 31. Available at: https://www.planagropecuario.org.uy/publicaciones/revista/R139/R_139_30.pdf

77 Rural Association of Paraguay (ARP). 2017. *Introducción a Paraguay y su sector cárnico*. April 2017. Available at: <https://www.arp.org.py/images/Paraguay-y-el-Sector-Carnico.pdf>

78 <https://www.senacsa.gov.py/index.php/informacion-publica/estadistica-pecuaria>

7,285,545 were in the Eastern region, and specifically 308,731 in the department of Caazapá⁷⁹. Meat production throughout the country totaled around 560,000 metric tons of dressed weight, of which 365,000 were exported⁸⁰.

Figure 21 illustrates the evolution of the cattle grazing area (in hectares), the growth of the cattle herd (thousands of bovines) and the carrying capacity of the pastures between the years 1950 and 2010⁸¹. The number livestock units per hectare have decreased from 2.81 to 2.48 between 1956 and 2010.

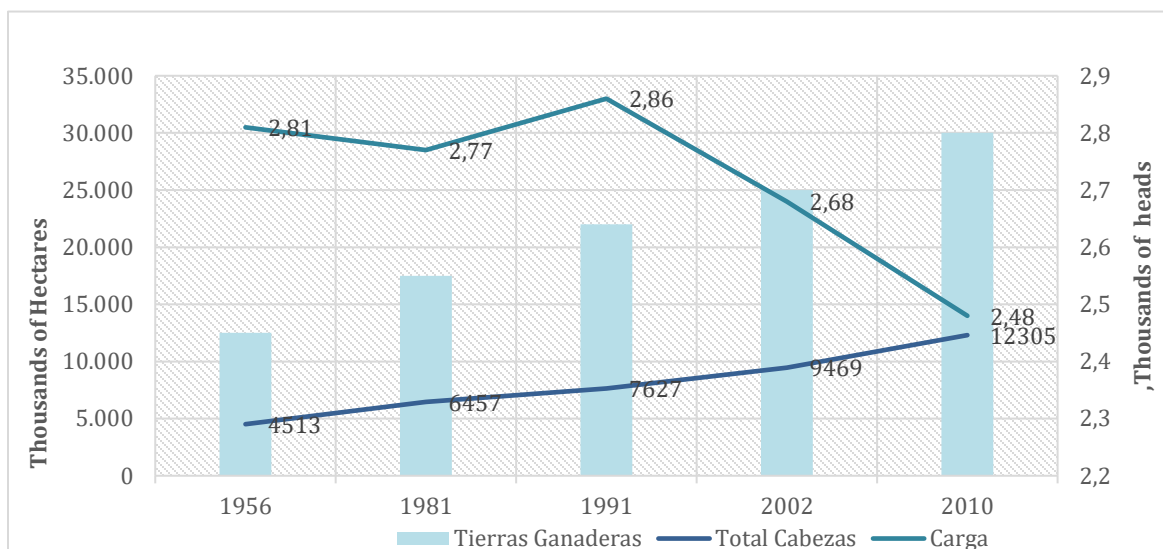


Figure 21. Evolution of the relationship between cattle grazing lands, cattle herds and land capacity).⁸²

*The blue line indicates the total area (in ha) and the green line the carrying capacity (of livestock units per ha).

In recent years, the livestock sector has made progress in terms of genetic enhancement and production chain efficiency, which has contributed to improve export competitiveness. This is evidenced in the increase of exports, going from 155,000 tons of meat in 2008 to 247,000 in 2019 (SENACSA 2019). Those advances are added to the government efforts to maintain high sanitary standards that position the sector at the international level⁸³. In the cases when some areas of the Eastern region are no longer used for livestock, these are commonly dedicated to the expansion of soybean crops since small farmers find in the sale or lease of their lands to soy producers an attractive source of income⁸⁴. The traditional extensive livestock system is no longer

79 SENACSA (Servicio Nacional de Calidad y Salud Animal - National Service for Animal Quality and Health), 2020. Estadística Pecuaria. Available at: <https://www.senacsa.gov.py/index.php/informacion-publica/estadistica-pecuaria>. Consulted on February 2021.

80 USDA, 2019. Paraguay, Livestock and products, annual 2019. Available at: GAIN (Global Agricultural Information Network) database: <https://gain.fas.usda.gov/>. Consulted on February 2021.

81 Vasconcellos (2008) citado por Medina, Asociación Rural del Paraguay (Montes 2010).

82 Vasconcellos (2008) cited by Medina, Rural Association of Paraguay (Montes 2010).

83 World Bank, 2015

84 OECD. (2018). Estudio Multidimensional de Paraguay. Volume I. Evaluación Inicial. Chapter 4. Hacia un entorno sostenible en Paraguay. Available at: <https://www.oecd-ilibrary.org/sites/9789264301924-9-es/index.html?itemId=/content/component/9789264301924-9-es>

attractive when compared to the returns of mechanized agricultural activities such as soy and rice production and intensive livestock.

On the other hand, according to the information collected in the stakeholder consultation, the main activity in the low fields (coverage existing before the first instance plantations) is livestock, although this situation has changed in recent years because the agribusiness has begun to buy or rent these properties due to the reduction of available areas with appropriate conditions for the expansion of agricultural crops. However, the land use change from livestock to mechanized agriculture has been slow, since the adaptation of the lands requires a high initial investment.

Scenario 2. Agricultural crops

According to the statistics of the National Bank of Paraguay⁸⁵, the agricultural sector represents 30% of GDP, with a growth of 13.2% in the third quarter of 2020 that was associated with better levels of soy production and other agricultural products such as sugarcane, rice and corn⁸⁶. Paraguay (along with Argentina, Brazil and Uruguay) is part of the Group of Producing Countries from the Southern Cone that provide about 30% of food in the world⁸⁷ and is also one of the main soybean producers.

Soybean cultivation is a clearly defined business with a high export share⁸⁸. Considering that in 2019 the country was in the fourth position of the global ranking of soy exporters, the increase in its cultivation continues to be notable in many regions, and particularly in the Eastern region of Paraguay, where soybean production and growth has been evident during the last decades^{89,90,91}. This trend was also clear in the project expansion area, in the departments of Guairá and Caazapá, where an increase from approximately 3,568 ha to 138,737 ha was reported between 2001 and 2019⁹². Farmers are organized into business associations and trade chains, and receive considerable support from the government⁹³.

Scenario 3. The reforestation activity is not registered under the VCS

85 Banco Central del Paraguay (BCP) (2020), Boletín de Cuentas Nacionales. Available at: <https://www.bcp.gov.py/boletin-de-cuentas-nacionales-trimestrales-i371>

86 <https://www.bcp.gov.py/userfiles/getFile.php?file=userfiles/files/Informe%20III-2020%283%29.pdf>

87 <https://www.py.undp.org/content/paraguay/es/home/presscenter/pressreleases/2020/produccion-sostenible-paraguay.html>

88 IDB. (2010). Movilizando el sistema bancario para la financiación de inversiones forestales en Paraguay. Proyecto PR-T1077. Producto 6. Caso Paraguay. Inter-American Development Bank; Capital Markets and Financial Institutions Department; Institutional Capacity and Finance Sector; Environment, Rural Development and Disaster Risk Management Department; and Infrastructure and Environment Department, Washington, D.C.

89 Estudio satelital. Soja 2018-2019. <https://capeco.org.py/soja-satelital-es/> y tendencia histórica del cultivo: <http://capeco.org.py/wp-content/uploads/2015/06/Hist%C3%B3rico-Area-sembrada-soja-x-departamento-2001-a-2015.pdf>

90 Dros, J. M. (2004). Managing the Soy Boom: Two scenarios of soy production. Amsterdam, AID Environment.

91 <https://www.oecd-ilibrary.org/sites/9789264301924-9-es/index.html?itemId=/content/component/9789264301924-9-es>

92 Estudio satelital. Soja 2018-2019. <https://capeco.org.py/soja-satelital-es/> y tendencia histórica del cultivo: <http://capeco.org.py/wp-content/uploads/2015/06/Hist%C3%B3rico-Area-sembrada-soja-x-departamento-2001-a-2015.pdf>

93 Szulecka, J., & Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. Land Use Policy, 60, 384-394.

Deforestation and the geographical conditions of the country make reforestation a strategic activity to meet the domestic demand for timber, create jobs and maintain rural contributions to GDP by reducing the use of natural forest resources. However, plantations are not considered as lucrative as other land uses like agriculture (especially soybeans cultivation) or cattle ranching given the long payback period and the high initial costs that they require⁹⁴.

In 2012, the National Reforestation Plan was launched with the purpose to establish 450,000 ha of forest plantations (390,000 ha of solid wood and 60,000 ha of species for energy production) across the country in 15 years. However, by 2020 there were only 193,852 ha (Figure 22), which has demonstrated the need for incentives to achieve the proposed objectives and overcome the barriers of commercial reforestation in Paraguay (Step 2. Barrier analysis).

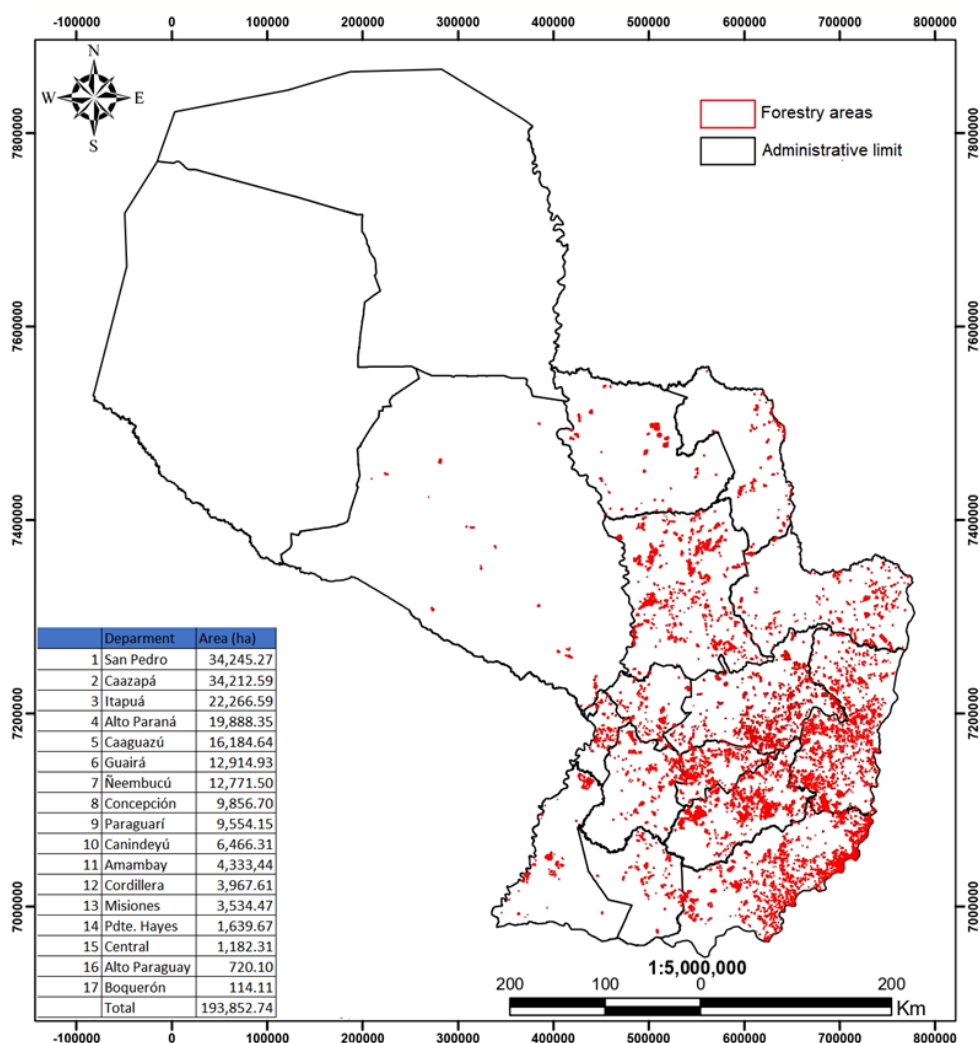


Figure 22. Forest plantations in 2020⁹⁵.

94 Szulecka, J., & Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. Land Use Policy, 60, 384-394.

95 INFONA (2020). Available at: <https://nube.infona.gov.py/index.php/s/mfz32nixiep39ZK>

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

Alternative land use activities comply with the national laws. For instance, cattle ranching is regulated by a set of provisions included in the Compilation of Laws and Regulations Related to the Production of Natural Meat⁹⁶, which do not define restrictions for the development of this activity in the region and, on the contrary, highlight its advantages as a mean to promote meat consumption in both the domestic and international markets.

In regards to agriculture, Law No. 1863 of 2002 (the Agrarian Statute) details the aspects related to family farming and states that this activity can be carried out on soils with suitable agrological conditions except for mandatory forest reserve areas (Forestry Law No. 422/73 and Law of Forest Resources No. 542/95), privately-owned protected wilderness areas (Law No. 352/94) and natural forests and areas dedicated to the supply of environmental services as defined by the corresponding authority. Finally, forestry activities (plantations) are regulated by the laws referenced in section 1.14, being Law No. 422/73 the one applicable for forestry activities, establishing that these must have a Forest Management Plan in place and be registered in INFONA before timber use and commercialization.

Step 2. Barrier analysis

Sub-step 2.a. Identification of barriers that would prevent the application of alternative scenarios

Below is a list of applicable barriers for the identified land use alternatives:

- Investment barriers
 - Financing mechanisms: Various programs have been created in the country with the aim to encourage the establishment of forest plantations:
 - I. Paraguay has a second-tier public bank called the Development Finance Agency (AFD), which seeks to promote economic development and job creation by channeling long-term financing to the private sector. This agency takes long-term funds with a state guarantee and makes them available for the interested parties through the financial system⁹⁷. Also, the Financing Program for Commercial Reforestation Products, also known as “Proforestal”⁹⁸ of the AFD has the objective to finance forest projects using fast-growing native or exotic species with a focus on responsible cultivation. The program finances up to 100% of the project total value in a 12-year term, with an AFD rate of 6% and an IFI (Intermediary Financial Institution) rate of 9%-12%. In theory, with this mechanism a loan application with funds from the AFD can be requested through any of the Intermediary Financial

⁹⁶Rural Association of Paraguay. 2015. Compilación de leyes y reglamentos relacionados a la producción de carne natural. Asunción, Paraguay. Available at: [http://www.arp.org.py/images/files/COMPILACION%20DE%20LEYES%20RELACIONADOS%20\(8\).pdf](http://www.arp.org.py/images/files/COMPILACION%20DE%20LEYES%20RELACIONADOS%20(8).pdf)

⁹⁷ National Forest Institute, National University of Asunción, and Rural Association of Paraguay. 2013. Programa de Apoyo a las Exportaciones Paraguayas 1916/BL-PR Proyecto “Promoción de inversión en plantaciones forestales. Available at: <http://www.agr.una.py/descargas/forestal/cif.pdf>

⁹⁸ <https://www.afd.gov.py/producto/proforestal>

Institutions (IFI). However, it has not been fully operational in the practice as it has been mentioned⁹⁹ that private banks (despite being supposed to act as intermediaries), have not implemented this credit line.

- II. The forestry credit of the National Development Bank (BNF) also has financing lines for the agricultural and livestock sector that are applicable to silvopastoral systems¹⁰⁰. They offer a 10-year term with a one-year guarantee, and an interest rate ranging between 7.95% and 9.95% per year¹⁰¹.
- III. Law No. 4890 (Real Forest Surface Law) that created the formal right on forest surface¹⁰², whose objective is to provide guarantees to investors in the forestry sector to establish plantations without the need to carry out land transactions. The leasing contracts under this law limit the landowners to use the plantations or tree masses resulting from the forestry activity, and define that such properties cannot have any other destination than the one authorized by the owner while covered by the law or for a maximum period of 50 years. This reduces the risks related to land tenure and landowners' priority changes, ensuring the continuity of the project in the long term and providing a greater guarantee to the banks for loan applications. However, the benefits generated by this law have been constrained by the lack of advice regarding its implementation and the fact that most owners are not interested in receiving them since they would limit the access to future alternatives with a higher profitability.
- IV. Law No. 536/95 for Afforestation and Reforestation Promotion. The economic incentive provided by this law consists of a one-time bonus for each afforested or reforested area in rural properties whose soils are classified as forest priority. The bonus is 75% of the direct costs incurred by individuals or companies for the implementation. 75% of the direct costs for the maintenance of afforestation and reforestation activities during the first three years are also reduced, provided that they have been carried out in accordance with the approved Forest Management Plan. However, these benefits are not available in practice since the country did not allocate the determined budget to comply with this law. This affected investors in the forestry sector who considered this incentive within their financing plan, increasing the non-permanence risk due to lack of capital. In addition, this issue resulted in an unfavorable rating for future investments due to the lack of guarantees and financial support to help investors pay for the high initial deposits.
- V. REDIEX (2019) points out benefits in terms of real estate tax and tax regime exemptions. According to the entity, the soils of rural properties classified as forest priority and the forests established in them as a result of afforestation or

99 Szulecka, J., & Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. *Land Use Policy*, 60, 384-394.

100 https://www.arp.org.py/images/files/10_ManuelFerreira-PresentacionForestal-PNUD-16-09-2016.pdf

101 <https://www.bnf.gov.py/prestamos/prestamos-inversiones-sector-agropecuario-comercial-e-industrial-y-servicios->

102 http://www.infona.gov.py/application/files/6914/2902/7121/Ley_N_4890_DERECHO_REAL_DE_SUPERFICIE_FORESTAL.pdf

reforestation activities are exempt from any other fiscal, municipal and departmental tax already in force or to be created. The real estate tax has a 50% exemption as long as it is subject to the afforestation or reforestation program.

According to Szulecka & Monges¹⁰³ and the results obtained from the project consultations conducted with stakeholders from the institutional sector, the existing mechanisms are not fully operational and have access barriers. In addition, it was mentioned that credit lines exist, but there is evidence of the difficulties for banks to grant credits, even when having the fund in their portfolios, due to their low profit (compared to loans to other sectors) and the risks related to plantations given the long time period that landowners require before initiating the payments. For this reason, it is considered that the relationship between banks and the forestry sector has mainly existed through loans to owners, instead of specific credit mechanisms for plantations, which explains the greater interest of banks in granting loans to other sectors with guaranteed income in shorter periods of time.

Thus, plantations generally use a 100% private investment and do not access to state subsidies or credits. On the other hand, despite the good environmental conditions for species biological growth and wood production, as well as the large areas available in the country, plantations in Paraguay are not considered a land use that can compete with other more financially attractive activities, including soybean cultivation and livestock farming.

- Investment barriers in the forestry sector: Due to the high initial investments required and the long payback periods compared to common land uses such as agriculture and livestock farming. Sustainable and profitable production of timber products requires a high initial investment for land preparation, establishment and maintenance of the plantations and transport of the final product. Given the absence of financing mechanisms that make the business attractive in a shorter time, it becomes very difficult for owners and especially small and medium-sized farmers to cover the costs of the activity, in particular if they are located in areas where productivity and income are low and they do not have access to loans or credits. Additionally, the long-term return for plantations implies that most owners cannot wait for so long to receive their profits so the activities would be only possible through the involvement of investors. In short, given the absence of financing mechanisms, the reforestation activity becomes viable by having investors willing to receive its profitability in the long term.
- Barriers in relation to the stability of timber price: The price and the market for timber and forest products influence the capacity to attract and retain investors. The projected timber price (given the difference between supply and demand) is below the marketed value, as evidenced in the record provided by the company Felber Forestal S.A.¹⁰⁴. Some of the reasons for this situation are the following:
 - The prices of timber for sawmill and biomass are not regulated.

¹⁰³Szulecka, J., & Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. *Land Use Policy*, 60, 384-394.

¹⁰⁴ Supporting information available at : Gestión documental/additionality.

- In the project region (and in the country) there are difficulties in controlling the supply of timber from natural forests.
- The available raw material from native forests requires less investment. Currently, the costs of timber production are limited to extraction and transport.
- The raw material from plantations requires an investment in property acquisition, land preparation, seedlings purchase or generation, planting work, individual maintenance in accordance with the commercial objective (sawmill or biomass), harvest, road construction and maintenance, and transport. In addition, the planting cycle can take between 7 and 12 years. When defining the optimal price of the plantation products, the profitability for the investor must be considered.

The expected market price at the time of involving investors, given the high investment costs and the long payback period, is not competitive. In the case of plantations managed by Felber Forestal, there have been times when biomass stands have been standing more than 3 years after the completion of their shift due to low market prices¹⁰⁵. The strategy to maintain the plantations that are currently under certification has consisted of establishing alliances for the creation of transformation centers close to the project area (ARSEN SA, LYA SA, MTI SA), in which products are diversified to get a better price (e.g., charcoal).

However, current prices continue to be lower than initially expected and the main barrier of the project has been related to meeting investors' expectations. Therefore, carbon credits are an incentive for investor engagement as they improve the profitability of the plantation and certify the results of the good practices already incorporated by Felber Forestal S.A., such as the generation of local employment, the compliance with applicable regulations and the contribution to climate change mitigation.

- Institutional barriers
 - Limited capacity of the institutions to ensure compliance with forest management laws in force (Forestry Law N° 422 of 1973, Law for Forestation and Reforestation Promotion No. 536 of 1995, and Law for the Prohibition of Transformation and Conversion Activities in Areas with Forest Cover in the Eastern Region No. 2524 of 2004): Although this regulation has contributed to reduce deforestation, it has not managed to achieve "zero" deforestation, as referenced in the report on deforestation of the Upper Paraná Atlantic Forest (WWF 2013-2014)¹⁰⁶ and presented in the satellite images of Global Forest Watch (2001-2018) in a MONGABAY¹⁰⁷ post by Aldo Benítez on May 26, 2020. For this reason, the commercialization of native forest products affects the market for forest plantations as products acquired require a lower initial investment and a shorter payback period.
 - In recent years, the National Forestry Institute (INFONA) has been promoting the establishment of productive forest plantations in order to sustainably supply the country's

¹⁰⁵In addition to Felber's experience in extending the shift while waiting for a better sale price, a reforestation manager mentioned in a consultation meeting that the lack of profitability of the project due to the low prices of timber has led him to change the plantation to a land for intensive livestock in a part of his property. (see recording at: gestión documental/ additionality)

¹⁰⁶ http://d2ouvy59p0dg6k.cloudfront.net/downloads/informe_deforestacion_agosto2014.pdf

¹⁰⁷ <https://es.mongabay.com/2020/05/marihuana-en-bosque-atlantico-paraguay-asi-se-esta-deforestando/>

energy and timber demands. Some actions have been developed mainly through plantation promotion days and under the leadership of the General Directorate of Forest Plantations, which has the aim of promoting, encouraging, and establishing regulations and technological applications for genetic improvement and the development of forest plantations with productive and protective purposes, in accordance with the legislations in force¹⁰⁸. Additionally, INFONA has been involved in the provision of seeds, seedlings and inputs for this type of project; the monitoring of plantations established by private companies, in order to have national statistics and update the coverage map at the national level; and the compliance with the agreement signed with the Inter-American Institute for Cooperation on Agriculture (IICA) to support sustainable forest management. Despite these efforts, to date INFONA's activities remain limited in practice due to: i) the investment barriers mentioned above, ii) the lack of knowledge of the State on the country's forestry sector, iii) the deficit of research in the forestry sector, iv) the lack of inter-institutional and academic agreements that strengthen innovation and research.

- Additionally, the evident corruption scenario of Paraguay discourages foreign investment since there is a general lack of compliance with the laws, of infrastructure in some regions and of political support to strengthen the sector. This scenario imposes strong barriers to investors and is associated to institutional weakness and intersectoral conflicts, in particular confirmed by the shortage of personnel and resources to carry out the tasks established by law¹⁰⁹.
- Barriers due to local ecological conditions
 - Despite the high potential of the country and the Eastern region for the establishment of commercial plantations given their good environmental conditions for biomass production and their large extensions of suitable areas, the establishment of forest plantations has been concentrated in areas with agrological limitations such as low grasslands with drainage and compaction limitations or tall grasslands with soil nutrient deficiencies. This happens because the forestry sector cannot strongly compete with the agricultural sector for the acquisition of land due to the constraints mentioned above in the "Financing mechanisms" paragraph of the "Investment barriers" section. These conditions cause cost overruns in the initial investment as the lands need greater adaptations to ensure the survival of the plantation as well as high growth and biomass production rates.
- Technological barriers
 - The technical capacities of Paraguayan institutions to support reforestation activities are under development. This situation is reflected in the shortage of qualified labor and the limited technical capacity to carry out all activities and to use hybrid technologies in combination with the appropriate machinery to achieve the highest Annual Average Increases (AAI) in biomass. Therefore, reforesting agents must build their own capacities

108 INFONA. 2017. Balance Anual De Gestión Pública Instituto Forestal Nacional Año 2017. Presupuesto por Resultados. Available at: <https://chm.cbd.int/api/v2013/documents/4406F62E-6E7A-1826-E2B9-082208FCC685/attachments/INFONA%202017.pdf>

109 Szulecka, J., & Zalazar, E. M. (2017). Forest plantations in Paraguay: Historical developments and a critical diagnosis in a SWOT-AHP framework. *Land Use Policy*, 60, 384-394.

by acquiring machinery and technological (genetic) packages that are usually developed abroad, by hiring foreign consultants and firms, or by conducting training programs for professionals in the forestry field. In conclusion, the progress experienced by reforestation agents with respect to technical capacities has occurred due to the capital injection from investors.

- Barriers related to local traditions
 - Local people still choose the most traditional land uses such as cattle ranching or agriculture – most traditional owners are cattle ranchers who are not interested in investing in new productive uses or models. The reason for this refusal is that extensive livestock farming is a low-risk activity mostly developed in areas that are traditionally inherited, which does not demand costs for land acquisition or leasing and requires little and non-qualified labor (even a single family can manage a large area of land). In addition, livestock is an activity with hundreds of years of tradition in the region, which results in greater knowledge of the producers and stronger support from the government that empowers the sector. Therefore, if a trade-off between the agricultural and the forest plantation activity is made, the latter will have a significant disadvantage since its condition as a relatively new activity in the country implies the lack of experienced labor force in the plantations. This situation has been gradually addressed through training provision for professionals in the agricultural area, personnel hiring from other regions of the country and consultancies provided by third parties. All this has increased the direct and indirect costs of the forestry sector.

Based on the barriers identified above, it can be concluded that Miller Forest Investment and Felber Forestal S.A. have been developing different mechanisms to implement and maintain the project. However, the marginal profitability of this project for investors is not as expected. For this reason, the issuance of carbon credits is a fundamental alternative for maintaining and involving new investors that support the expansion of the planted area.

Among the efforts made by the company to overcome the barriers listed above are:

- The creation of alliances with the forestry industry to ensure the demand for produced timber.
- The constant promotion of training and professional education of the staff.
- The execution of agreements with the University of Asunción for research, especially in matters of genetics and forestry.
- Strengthening the production chain through the establishment of an in-house nursery and the purchase of machinery.

Sub-step 2.b. Elimination of alternative scenarios that are constrained by the identified barriers

Table 25 shows the list of land use scenarios and the barriers identified for them.

Table 25. Land use and barriers identified.

Alternative scenario	Type of barrier
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Livestock	It does not face barriers as it is an activity with a long tradition and low production costs (for both inputs and labor).
Agriculture	Barriers due to local ecological conditions: The establishment of agricultural crops in the areas of interest for forestry activities requires a high initial investment due to the limitations of soil structure and quality.
Forest plantation that has not been registered in the VCS	Financing, institutional capacity, technical capacity and regional orientation. Most of these barriers have been managed thanks to the participation of investors willing to obtain a return in the long term. Therefore, the main barrier for the forestry project that has not been registered in the VCS is the sales price of the timber, a condition that has generated a marginal profitability for investors, which discourages their permanence in the business and limits the involvement of new ones.

Sub-step 2c. Determination of the baseline scenario

Is the plantation that has not been registered as an A/R CDM project activity included in the list of land use scenarios not constrained by any barriers? → NO

- If the answer is NO, does the list contain only one land use scenario that is not constrained by a barrier? → YES
- If the answer is YES, indicate the activity representing the remaining land use or the baseline scenario → Livestock
- Continue with Step 4, Common practice analysis

The application of the decision tree of the “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project (Version 1.0)” demonstrated that the reforestation that has not been registered as a VCS A/R project activity is included in the list of land use scenarios constrained by the listed barriers, while livestock is determined as the baseline scenario.

Step 4. Common practice analysis

According to INFONA, in 2020 the plantations in Paraguay covered 193,852 ha, which represent 43% of the area projected by 2027 (450,000 ha) according to the National Reforestation Plan of 2012. This area is still not very significant if compared to the country expectations, and although forest plantations could be expected to become the main land use in Paraguay given its geographical conditions and commitments for climate change mitigation that prohibit to cut down natural forests, planting efforts have been barely implemented, unlike neighboring countries (such as Argentina and Brazil). Additionally, forestry is not considered a common practice in the country as it only contributed approximately 1% of the Gross Domestic Product (GDP) between 2015 and 2018¹¹⁰, while agricultural and livestock activities are highly competitive, making Paraguay one of the main exporters of products like meat and soybeans.

¹¹⁰ https://www.icex.es/icex/wcm/idc/groups/public/documents/documento_anexo_mdiw/odq3/~edisp/dax2020847242.pdf

The afforestation project to be registered under the VCS has characteristics that do not represent the common practice: creation of a group of more than 520 investors, investment in infrastructure and technical capacity, training of internal qualified staff and creation of alliances with timber processing industries in order to ensure the demand for raw materials and improve market competitiveness via products with higher added value such as charcoal, immunized wood and carpentry items. The permanence of the project has been possible due to the diversification of the business through new alliances and the involvement of investors, both helping overcome the above-mentioned barriers (in line with the main country barriers, such as the lack of regional infrastructure, little availability of genetic materials adapted to the soil and the environment, sanitary problems, lack of knowledge and field limitations like drainage and little qualified labor)¹¹¹.

3.6 Methodology Deviations

The project does not have methodological deviations.

¹¹¹ <http://www.campoagropecuario.com.py/notas/578/innovador-modelo-forestal>

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Following the AR-ACM0003 “Afforestation and reforestation of lands except wetlands” methodology, version 02.0, the baseline GHG removals by sinks are calculated based on equation 1:

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

Where:

- $\Delta C_{BSL,t}$: Baseline net GHG removals by sinks in year t ; tCO₂e.
- $\Delta C_{TREE_BSL,t}$: Change in carbon stock in baseline tree biomass within the project boundary in year t , as estimated in the “AR-TOOL 14 Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”, version 4.2; tCO₂e.
- $\Delta C_{SHRUB_BSL,t}$: Change in carbon stock in baseline shrub biomass within the project boundary, in year t , as estimated in the “AR-TOOL 14 Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”, version 4.2; tCO₂e.
- $\Delta C_{DW_BSL,t}$: Change in carbon stock in baseline dead wood biomass within the project boundary, in year t , as estimated in the “AR-TOOL 12 Methodological tool: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” version 3.1; tCO₂e.
- $\Delta C_{LI_BSL,t}$: Change in carbon stock in baseline litter biomass within the project boundary, in year t , as estimated in “AR-TOOL 12 Methodological tool: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”, version 3.1; tCO₂e.
- $\Delta SOC_{AL,t}$: Change in soil organic carbon (SOC) stock in the project, in year t ; tCO₂e.

The carbon stock (storage) in the biomass of the pre-project trees is considered to be zero, since some of the following conditions set out in numeral 5 (“Conditions under which carbon stock and change in carbon stock may be estimated as zero”) of the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (version 4.2) are met.

- The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity.

In addition to the above, according to Tool 14, the changes in carbon stocks in trees and shrubs in the baseline are also zero since the following condition is met:

- Land is subjected to slash-and-burn periodic cycles.

Before the reforestation activity, the project area consisted of grasslands that were subjected to annual burns for their renovation, a common practice in the regional agricultural production (Figure 23). As this activity does not allow carbon accumulation, the baseline carbon storage is zero. Likewise, the trees present at the beginning of the project were not removed but remain standing to date (see section 3.4). Therefore, the baseline estimates in the project are zero.



Figure 23. Grassland conditions and burns performed as a common practice for pasture renovation¹¹².

4.2 Project Emissions and removals

The actual net GHG removals by carbon sinks is calculated for the entire plantation area following the procedure in section 5.5 of the AR-ACM0003 “A/R Large scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands” methodology, version 2.0.

$$\Delta C_{ACTUALt} = \Delta C_{p,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUALt}$	Actual net GHG removals by sinks, in year t ; tCO ₂ e.
$\Delta C_{p,t}$	Change in the carbon stocks in project, occurring in the selected carbon pools, in year t ; tCO ₂ e.
$GHG_{E,t}$	Increase in non-CO ₂ GHG emissions within the project boundary as a result of the implementation of the project activities, in year t , as estimated in the tool

¹¹² Information confirmed during the stakeholder consultation carried out in March 2021.

“Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity”; tCO₂e

In addition, the actual project net GHG removals occurring in the selected carbon pools in year t were calculated by using the following equation:

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

Where:

$\Delta C_{P,t}$: Change in the carbon stocks in project, occurring in the selected carbon pools, in year t ; tCO₂e.

$\Delta C_{TREE_PROJ,t}$: Change in carbon stock in tree biomass in project in year t ; tCO₂e.

$\Delta C_{SHRUB_PROJ,t}$: Change in carbon stock in shrub biomass in project in year t ; tCO₂e.

$\Delta C_{DW_PROJ,t}$: Change in carbon stock in dead wood (DW) in project in year t ; tCO₂e.

$\Delta C_{LI_PROJ,t}$: Change in carbon stock in litter (LI) in project in year t ; tCO₂e.

$\Delta SOC_{AL,t}$: Change in carbon stock in soil organic carbon (SOC) in project, in year t ; tCO₂e.

Estimation of carbon stocks in trees

The estimation was made based on section 8.2 of the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology. The *ex-ante* estimates were made according to mean annual increments data taken from specialized literature, which provide a measure of stand development. These values were obtained from a literature review for the project area and the regions with plantations of commercial species of the same type and with similar ecological conditions to those used in the project activity, which can be consulted in the studies analyzed (see Table 26).

Table 26. Mean annual increment values in the project.

Species	Mean annual increments (m ³ ha ⁻¹ year ⁻¹)	Source	Division
<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	49,5	Taking the site index for the baseline treatment of traditional fertilization	Broad-leaved
<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	49,5		Broad-leaved
<i>Eucalyptus resinifera</i> x <i>Eucalyptus camaldulensis</i>	49,5		Broad-leaved

Species	Mean annual increments (m ³ ha ⁻¹ year ⁻¹)	Source	Division
Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	49,5	without irrigation (TNU) by Stape et al. (2010). ¹¹³	Broad-leaved
Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	49,5		Broad-leaved
<i>Eucaliptus</i> spp.	49,5		Broad-leaved
<i>Pinus elliottis</i>	30	Plantation values in Brazil, taken from FAO (2001) ¹¹⁴	Conifer
<i>Pinus taeda</i>	32	Plantation values in Paraguay, taken from Cubbage et al. (2010) ¹¹⁵	Conifer
<i>Pinus</i> spp.	31	Plantation values in Paraguay, taken from Cubbage et al. (2010) and FAO (2001)	Conifer

The estimation of carbon stocks in trees was calculated according to equations 12 and 13 of the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology:

$$b_{TREE} = V_{tree} * BECF_i * (1 + R_{TREE})$$

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

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

Where:

C_{TREE} Carbon stock in tree biomass (tCO₂e).

¹¹³ Stape, J. L., Binkley, D., Ryan, M. G., Fonseca, S., Loos, R. A., Takahashi, E. N., & Azevedo, M. R. (2010). The Brazil Eucalyptus Potential Productivity Project: Influence of water, nutrients and stand uniformity on wood production. *Forest Ecology and Management*, 259(9), 1684-1694.

¹¹⁴ FAO. 2001. Mean Annual Volume Increment of Selected Industrial Forest Plantation Species. Available at: <http://www.fao.org/3/ac121e/ac121e.pdf>

¹¹⁵ Cubbage, F., Koesbandana, S., Mac Donagh, P., Rubilar, R., Balmelli, G., Olmos, V. M., & Phillips, R. (2010). Global timber investments, wood costs, regulation, and risk. *Biomass and bioenergy*, 34(12), 1667-1678.

CF_{TREE}	Carbon fraction of tree biomass; tC (t d.m.). ¹¹⁶
B_{TREE}	Tree biomass by area; t d.m.
b_{TREE}	Tree biomass strata per hectare.
R_{TREE}	Root-to-shoot ratio for trees.
A	Sum of areas of the strata (ha).
BEF_i	Biomass conversion and expansion factor (dimensionless).
V_{tree}	Tree volume (m ³).

The estimates of the biomass conversion expansion factor, the carbon fraction, the carbon conversion factor and the root-to-shoot ratio are default values taken from the IPCC “Guidelines for National Greenhouse Gas Volume 4 Agriculture, Forestry and Other Land Use” (2006). The values of the root-to-shoot ratio (R) and the expansion factor (BEF_i) were taken based on the type of vegetation (conifer and broad-leaved) and the ecological zone of the project area.

Table 27. Default parameters used.

Parameter	Value		
	Volume (m ³)	Volume of broad-leaved species (m ³)	Volume of conifer species (m ³)
Biomass conversion and default expansion factor ^a	V < 20	1.50	1.50
	21 < V < 40	0.50	0.40
	41 < V < 80	0.55	0.45
	V > 80	0.66	0.54
Root-to-shoot ratio ^b	0,20 for subtropical humid forest. Above-ground biomass <125 tons ha ⁻¹ 0,24 for subtropical humid forest. Above-ground biomass >125 tons ha ⁻¹		
Carbon fraction ^c	0.47		
Conversion factor from C to CO ₂ ^d	3.667		

Source: IPCC Guidelines for National Greenhouse Gas Inventories (2006). ^a Table 4.5 - BCEFI for conversion of net annual increment; ^b Table 4.4 - Ratio of Belowground Biomass to Aboveground Biomass (2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4); ^c Table 4.3 - Carbon Fraction of Aboveground Forest Biomass; ^d Section 3.2.1 - Good Practice Guidance for LULUCF.

Estimation of carbon stocks in dead wood and litter

Carbon in dead wood and litter is calculated using equations 9 and 15 of the tool “A/R Tool 12: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities” of the AR-ACM0003 methodology, which accepts the use of a conservative default value by estimating the carbon content (in dead wood and litter) as a percentage of the total carbon of the tree biomass.

¹¹⁶ t d.m. stands for tons of dry matter.

Estimation of carbon stocks in dead wood

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

Where:

$C_{DW,i,t}$: Carbon stock in dead wood in stratum i at a given point of time in year t ; tCO₂e.

$C_{TREE,i,t}$: Carbon stock in tree biomass in stratum i at a point of time in year t ; tCO₂e.

DF_{DW} : Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; tCO₂e.

Estimation of carbon stocks in litter

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

Where:

$C_{LI,i,t}$: Carbon stock in litter in stratum i at a given point of time in year t ; tCO₂e.

$C_{TREE,i,t}$: Carbon stock in tree biomass in stratum i at a point of time in year t ; tCO₂e.

DF_{LI} : Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; tCO₂e.

Table 28. Values to estimate dead wood and litter in the project¹¹⁷.

Parameter	Value	Source
DF_{DW}	6%	Tropical sites with elevation values less than 2,000 meters above sea level and rainfall greater than 1,600 mm/year due to the annual rainfall of 1,730 mm ¹¹⁸ (according to the historical average of 2010-2019), and the average elevation of 101 meters above sea level ¹¹⁹ .
DF_{LI}	1%	

Estimation of non-CO₂ GHG emissions

The tool “Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity” considers that:

¹¹⁷ AR-TOOL12 A/R Methodological tool Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities.

¹¹⁸ Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell & Joel Michaelsen. "The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015.

¹¹⁹ T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

- Non-CO₂ GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is $\geq 5\%$ of the project area.
- Aboveground biomass of living trees shall be considered not to result in significant non-CO₂ GHG emission in case of fire, when:
 - A forest fire burns through the understory but does not climb into the tree canopy; or
 - A forest fire singes trees but does not cause mortality such that leaf regeneration can be observed within six months.

Burns for pasture or stubble removal are not part of the project forestry activities¹²⁰. In the case that a fire event occurs in the project area, the impact of the disturbance will be estimated and reported in order to make the relevant discounts. Considering the above, the emissions due to non-CO₂ GHG emissions are zero.

4.3 Leakage

According to section 6 of the AR Tool 15 “A/R Methodological tool: Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity”, the leakage emissions attributed to the displacement of grazing activities are considered insignificant when meeting the following conditions:

- 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.
- 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.
- Animals are displaced to cropland that has been abandoned within the last five years.
- 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.
- Animals are displaced to zero-grazing systems.

Pre-existing livestock units (before the start of reforestation activities) are sold gradually while others are kept in the project in a silvopastoral system, without exceeding the carrying capacity of the farms. Thus, project leakage is considered insignificant and is not accounted for.

¹²⁰ This practice is carried out occasionally and only in the event that the machinery cannot work properly due to the cover caused by pastures. However, it is not a common practice, and compared to the baseline scenario the emissions are insignificant and do not exceed those of the baseline.

4.4 Estimated net GHG emission reductions and removals.

According to Section 5.7 of the AR-ACM0003 methodology, the net anthropogenic GHG removals by sinks are estimated through the following equation:

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

Where:

$\Delta C_{AR-CDM,t}$: Net anthropogenic GHG removals by sinks, in year t ; tCO₂e.

$\Delta C_{ACTUAL,t}$: Actual net GHG removals by sinks, in year t ; tCO₂e.

$\Delta C_{BSL,t}$: Baseline net GHG removals by sinks, in year t ; tCO₂e.

LK_t : GHG emissions due to leakage, in year t ; tCO₂e.

The $\Delta C_{BSL,t}$, LK_t and $GHG_{E,t}$ estimates are considered zero, as mentioned in the sections above. The removals in the project crediting period are detailed below.

Table 29. Ex-ante estimation

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2016	0	0	0	0
2017	0	68.703	0	68.703
2018	0	117.209	0	117.209
2019	0	137.541	0	137.541
2020	0	169.047	0	169.047
2021	0	185.984	0	185.984
2022	0	246.791	0	246.791
2023	0	229.647	0	229.647
2024	0	209.196	0	209.196
2025	0	229.701	0	229.701
2026	0	251.859	0	251.859
2027	0	260.953	0	260.953
2028	0	241.997	0	241.997
2029	0	204.151	0	204.151
2030	0	225.343	0	225.343
2031	0	191.981	0	191.981
2032	0	204.045	0	204.045
2033	0	233.726	0	233.726
2034	0	225.933	0	225.933

Year	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2035	0	232.845	0	232.845
2036	0	255.902	0	255.902
2037	0	229.647	0	229.647
2038	0	211.552	0	211.552
2039	0	230.999	0	230.999
2040	0	250.039	0	250.039
2041	0	241.219	0	241.219
2042	0	183.377	0	183.377
2043	0	250.506	0	250.506
2044	0	232.692	0	232.692
2045	0	191.984	0	191.984
Total	0	6.144.569	0	6.144.569

The Long-Term Average (LTA) was calculated as the total removals during the crediting period divided by the number of years (30). They were used the sections 3.2.20 and 3.2.21 of VCS standard 4.1 and the AFOLU Guidance: Example for Calculating the Long-Term Average Carbon Stock for ARR Projects with Harvesting to calculate the LTA.

The following equation was used to calculate the long-term average GHG benefit:

$$LA = \frac{\sum_{t=0}^n PE_t - BE_t}{n}$$

Where:

LA = The long-term average GHG benefit.

PE_t = The total to-date GHG emission reductions and removals generated in the project scenario (tCO₂e). Project scenario emission reductions and removals shall also consider project emissions of CO₂, N₂O, CH₄ and leakage.

BE_t = The total to-date GHG emission reductions and removals projected for the baseline scenario (tCO₂e).

Based on that, it is expected to have 530.981 tCO₂e available for their issuance. The removals to be issued in the crediting period are shown below in the projected scenario for the area planted in the first instance¹²¹.

¹²¹ Available at: Gestión documental/Estimaciones/Estimaciones_proyectadas.xlsx sheet "LTA"

Table 30. Long-Term average estimation

Year	Annual change in GHG benefit (tCO2e)	Expected total GHG benefit to date (tCO2e)	Total credits available each year (tCO2e)
2016	-	-	-
2017	45.150	45.150	45.150
2018	82.342	127.492	82.342
2019	21.817	149.309	21.817
2020	162.421	311.730	162.421
2021	184.190	495.920	184.190
2022	53.539	549.459	35.061
2023	63.892	613.351	-
2024	- 140.869	472.482	
2025	43.234	515.716	
2026	165.719	681.435	
2027	166.264	847.699	
2028	108.072	955.771	
2029	- 218.287	737.484	
2030	79.909	817.393	
2031	- 223.708	593.685	
2032	- 151.564	442.121	
2033	97.398	539.519	
2034	10.952	550.471	
2035	- 32.155	518.316	
2036	217.310	735.626	
2037	- 27.269	708.357	
2038	- 73.595	634.762	
2039	34.558	669.320	
2040	105.210	774.530	
2041	51.915	826.445	
2042	- 334.198	492.247	
2043	233.176	725.423	
2044	81.208	806.631	
2045	- 230.024	576.607	
2046	- 20.206	556.401	
2047	- 48.166	508.235	
2048	70.683	578.918	
2049	95.679	674.597	

Year	Annual change in GHG benefit (tCO ₂ e)	Expected total GHG benefit to date (tCO ₂ e)	Total credits available each year (tCO ₂ e)
2050	120.812	795.409	
2051	- 161.961	633.448	
2052	- 99.676	533.772	
2053	- 88.010	445.762	
2054	75.894	521.656	
2055	- 333.804	187.852	
2056	60.391	248.243	
2057	52.326	300.569	
2058	- 44.212	256.357	
2059	- 48.855	207.502	
LA		530.981	530.981

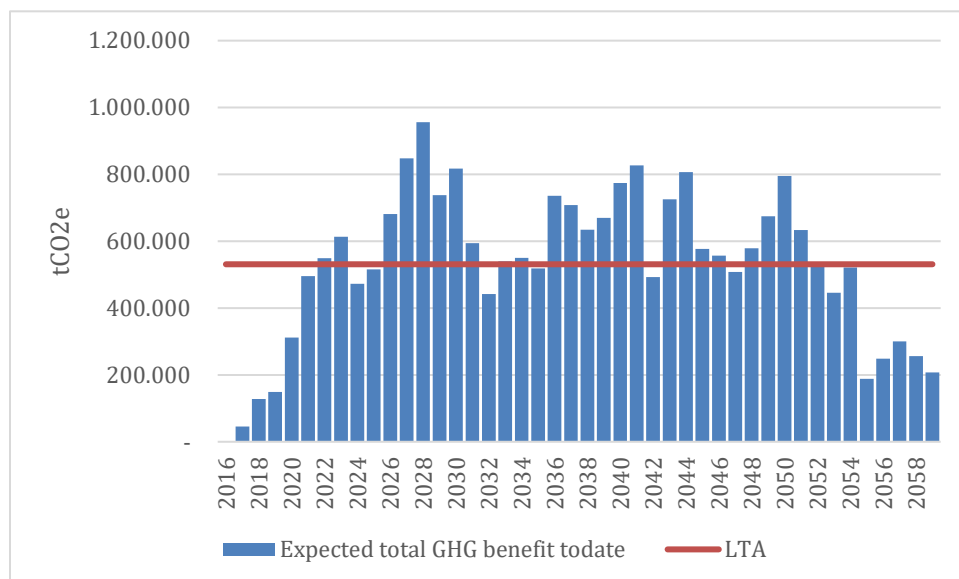


Figure 24. Expected total GHG benefit to date (tCO₂e) and LTA

5 MONITORING

5.1 Data and Parameters Available at Validation

Data/Parameter	Avalidation
Data unit	Ha
Description	Project validation area
Source of data	Measurement in the field
Value applied:	3,827.91
Justification of choice of data or description of measurement methods and procedures applied	Area of the plots planted or intended to be planted for future verifications.
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	Avalidation_i		
Data unit	Ha		
Description	Project validation area per stratum		
Source of data	Measurement in the field		
Value applied:	Species	Establishment year	Area (ha)
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2016	389.48
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2017	362.46
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2018	322.76
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2019	75.44
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2016	701.00

	<i>Eucalyptus urophylla</i> <i>x Eucalyptus grandis</i>	2017	217.96
	<i>Eucalyptus urophylla</i> <i>x Eucalyptus grandis</i>	2019	131.77
	<i>Eucalyptus resinifera</i> <i>x Eucalyptus camaldulensis</i>	2016	3.29
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2018	14.38
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2019	16.46
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2018	25.14
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2019	20.55
	<i>Pinus elliottii</i>	2016	3.79
	<i>Pinus taeda</i>	2016	90.82
	<i>Pinus taeda</i>	2019	105.91
	<i>Eucalyptus spp.</i>	2020	148.42
	<i>Pinus spp.</i>	2020	42.07
	<i>Eucalyptus spp.</i>	2021	289.06
	<i>Eucalyptus spp.</i>	2021	289.06
	<i>Pinus spp.</i>	2021	289.06
	<i>Eucalyptus spp.</i>	2021	289.06
Justification of choice of data or description of measurement methods and procedures applied	Area of the plots planted or intended to be planted for future verifications		
Purpose of Data	Calculation of project removals		
Comments	N/A		
Data/Parameter	IMAs		

Data unit	m ³ ha year			
Description	Volume mean annual increment			
Source of data	See table in “Value applied”			
Value applied:	Species	Mean annual increment (m ³ ha year)	Source	Division
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	49.5	Taking the site index for the baseline treatment of traditional fertilization without irrigation (TNU) by Stape et al. (2010) ¹²²	Broad-leaved
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	49.5		Broad-leaved
	<i>Eucalyptus resinifera</i> x <i>Eucalyptus camaldulensis</i>	49.5		Broad-leaved
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	49.5		Broad-leaved
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	49.5		Broad-leaved
	<i>Eucalyptus spp.</i>	49.5		Broad-leaved
	<i>Pinus elliottii</i>	30	Plantation values in Brazil, taken from FAO (2001) ¹²³	Conifer
	<i>Pinus taeda</i>	32	Plantation values in	Conifer

122 Stape, J. L., Binkley, D., Ryan, M. G., Fonseca, S., Loos, R. A., Takahashi, E. N., ... & Azevedo, M. R. (2010). The Brazil Eucalyptus Potential Productivity Project: Influence of water, nutrients and stand uniformity on wood production. *Forest Ecology and Management*, 259(9), 1684-1694.

123 FAO. 2001. Mean Annual Volume Increment of Selected Industrial Forest Plantation Species. Disponible en: <http://www.fao.org/3/ac121e/ac121e.pdf>

			Paraguay, taken from Cabbage et al. (2010) ¹²⁴	
	<i>Pinus spp.</i>	31	Plantation values in Paraguay, taken from Cabbage et al. (2010) and FAO (2001)	Conifer
Justification of choice of data or description of measurement methods and procedures applied	Reported values for sites with similar conditions			
Purpose of Data	Calculation of project removals			
Comments	N/A			

Data/Parameter	D _E
Data unit	t d.m. m ³
Description	Basic density of <i>Eucalyptus spp.</i>
Source of data	Da Cunha, T. Q. G., Santos, A. C., Novaes, E., Hansted, A. L. S., Yamaji, F. M., & Sette Jr, C. R. (2021). Eucalyptus expansion in Brazil: Energy yield in new forest frontiers. Biomass and Bioenergy, 144, 105900.
Value applied:	0.54
Justification of choice of data or description of measurement methods and procedures applied	Density reported for eucalyptus clones in Brazil
Purpose of Data	Calculation of project removals
Comments	N/A

124 Cabbage, F., Koesbandana, S., Mac Donagh, P., Rubilar, R., Balmelli, G., Olmos, V. M., ... & Phillips, R. (2010). Global timber investments, wood costs, regulation, and risk. Biomass and bioenergy, 34(12), 1667-1678.

Data/Parameter	D _P
Data unit	t d.m. m ³
Description	Basic density of <i>Pinus spp.</i>
Source of data	IPCC GPG LULUCF 2003
Value applied:	0.50
Justification of choice of data or description of measurement methods and procedures applied	Value taken from table 3A.1.9 of the IPCC GPGLULUCF 2003 document, unless transparent and verifiable information is provided to justify a different value. The value is the average of the pines presented for the American tropics.
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	BEF
Data unit	Dimensionless
Description	Biomass expansion factor for the conversion of tree trunk biomass to above-ground tree biomass.
Source of data	IPCC GPG LULUCF 2003
Value applied:	1.2 for pines and 2.0 for eucalyptus
Justification of choice of data or description of measurement methods and procedures applied	Conservative value (lower limit) in Table 3A.1.10 of IPCC GPGLULUCF 2003 for tropical areas.
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	R
Data unit	Dimensionless
Description	Root-to-shoot ratio

Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4.
Value applied:	- 0.20 for subtropical humid forest with belowground and aboveground biomass <125 tons ha⁻¹ - 0.24 for subtropical humid forest with belowground and aboveground biomass >125 tons ha⁻¹
Justification of choice of data or description of measurement methods and procedures applied	Subtropical humid forest according to the Holdridge Life Zones classification system due to the average temperatures of 22 °C ¹²⁵ and annual rainfall of 1,730 mm ¹²⁶ , based on the historical average of the 2010-2019 period.
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	CF _{TREE}
Data unit	t C (t.d.m.) ⁻¹
Description	Carbon fraction of tree biomass
Source of data	A/R tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" of the AR-ACM0003 methodology.
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied	A default value of 0.47 t C (t.d.m.) ⁻¹ is used unless transparent and verifiable information is provided to justify a different value.
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	C to CO ₂ factor
Data unit	Dimensionless

125 Muñoz Sabater, J., (2019): ERA5-Land monthly averaged data from 1981 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS). (<date of access>), doi:10.24381/cds.68d2bb30.

126 Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell & Joel Michaelsen. "The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015.

Description	Carbon fraction to CO ₂
Source of data	A/R tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology.
Value applied:	44/12
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	DF _{dw}
Data unit	Percentage
Description	Value expressing the carbon stock in dead wood as a percentage of the carbon stock in tree biomass (tCO ₂ e).
Source of data	A/R tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities”.
Value applied:	6
Justification of choice of data or description of measurement methods and procedures applied	The tool criterion for sites in the tropics with elevation values less than 2,000 meters above sea level and rainfall greater than 1,600 mm year ⁻¹ is used due to the annual rainfall of 1,730 mm, according to the historical average in the 2010-2019 period and the average elevation of 101 meters above sea level ¹²⁷ .
Purpose of Data	Calculation of project removals
Comments	N/A

Data/Parameter	DF _{li}
Data unit	Percentage
Description	Value expressing the carbon stock in litter as a percentage of the carbon stock in tree biomass (tCO ₂ e)

127 T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

Source of data	A/R tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities”.
Value applied:	1
Justification of choice of data or description of measurement methods and procedures applied	The tool criterion for sites in the tropics with elevation values less than 2,000 meters above sea level and rainfall greater than 1,600 mm year ⁻¹ is used due to the annual rainfall of 1,730 mm, according to the historical average in the 2010-2019 period and the average elevation of 101 meters above sea level ¹²⁸ .
Purpose of Data	Calculation of project removals
Comments	N/A

5.2 Data and Parameters Monitored

Data/Parameter	Averification
Data unit	Ha
Description	Project verification area
Source of data	Delimitation of lots by using a GPS receiver
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before each verification report
Value applied:	2,424.52
Monitoring equipment	GPS
QA/QC procedures applied	N/A
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

128 T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

Data/Parameter	Averification_i		
Data unit	Ha		
Description	Project verification area per stratum		
Source of data	Delimitation of lots by using a GPS receiver		
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan		
Frequency of monitoring/recording	Before each verification report		
Value applied:	Species	Establishment year	Total area (ha)
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2016	391.78
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2017	362.46
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2018	322.76
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2019	75.44
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2016	701.00
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2017	217.96
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2018-2019	131.77
	<i>Eucalyptus resinifera</i> x <i>Eucalyptus camaldulensis</i>	2016	3.29
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2018	14.38
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2019	16.46
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2017-2018	25.14

	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2019	20.55
	<i>Pinus elliottii</i>	2016	3.79
	<i>Pinus taeda</i>	2016	90.82
	<i>Pinus taeda</i>	2018	46.93
Monitoring equipment	GPS		
QA/QC procedures applied	N/A		
Purpose of data	Calculation of project removals		
Calculation method	N/A		
Comments	N/A		

Data/Parameter	Ap_i
Data unit	m ²
Description	Sample plots
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before every verification report
Value applied:	400
Monitoring equipment	Measuring tape
QA/QC procedures applied	After carrying out the forest inventory, some sample plots were re-measured at random. Then, based on the number of individuals re-measured, their delimitation was checked.
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	Coordinates of sample plots
Data unit	Latitude/Longitude
Description	Location of every sample plot
Source of data	Measurement in the field
Description of measurement methods and procedures applied	N/A
Frequency of monitoring/recording	Before every verification report
Value applied:	See forest inventory of plantations
Monitoring equipment	Measurement through Global Position System (GPS)
QA/QC procedures applied	After carrying out the forest inventory, some sample plots were re-measured at random. With the data obtained, their location was checked.
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	DBH
Data unit	cm
Description	Trunk diameter at breast height
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before every verification report
Value applied:	See forest inventory of plantations ¹²⁹
Monitoring equipment	Tree caliper

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QA/QC procedures applied	After monitoring, 9 plots that had data far from the averages by stratum were re-measured. A comparison of averages was made through a t test for paired data and no significant difference was evidenced, with a p-value of 0.05. ¹³⁰
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	H
Data unit	m
Description	Total tree height
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before every verification report
Value applied:	See forest inventory of plantations
Monitoring equipment	Measured with a hypsometer or inclinometer
QA/QC procedures applied	After monitoring, 9 plots that had data far from the averages by stratum were re-measured. A comparison of averages was made through a t test for paired data and no significant difference was evidenced, with a p-value of 0.05. ¹³¹
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	Form factor of <i>Eucalyptus spp.</i>
Data unit	Dimensionless

¹³⁰ Available at: Gestión documental/ Estimaciones/gestion de la calidad de la información.Xlxs

¹³¹ Available at: Gestión documental/ Estimaciones/gestion de la calidad de la información. Xlxs

Description	Taper factor that relates a cylinder volume to the trees volume
Source of data	Measurement in the field through research work within the framework of an agreement with the University of Asunción ¹³²
Description of measurement methods and procedures applied	The trunk diameter is measured at the height of 0, 0.5, 1 and 1.30 m. Then, it is measured every meter until the minimum diameter of 2.5 cm is reached. The total height of the tree is recorded and once the data from 60 trees is collected, the real volume is calculated using the Smalian formula and the form factor is subsequently calculated.
Frequency of monitoring/recording	N/A
Value applied:	0.43
Monitoring equipment	- Measuring equipment: Vertex IV hypsometer, diameter tape, measuring tape, tree caliper, GPS, stakes, spray. - Cutting equipment: chainsaw, cut resistant pants, helmet, gloves, steel-toed boots.
QA/QC procedures applied	N/A
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

In this section, the monitoring plan is designed and described in order to obtain reliable results of the carbon captured through the growth of the planted trees in each of the monitoring periods. This section is divided into the presentation of the work team, the establishment of sample plots, the internal audit procedure and data processing.

Work team and responsibilities

The system's structure involves a cyclical process of data collection, decision-making and evaluation of the results obtained in accordance with the responsibilities. Felber Forestal's role, as the plantation operator, is to coordinate the installation of the sample plots with the Forestry Manager, who is the person with the overall responsibility for the management and monitoring of the sample plots and lots and, therefore, for the Monitoring Plan (including selecting the subcontractor in charge of the sample plots, which in the case of the first verification period is Red

¹³² Available at: Gestión documental/Estimaciones/Estimaciones_actuales.xlsx hoja "Form_Factor"

Forestal)¹³³. The Forestry Manager, together with the staff of Red Forestal, is responsible for the managing the personnel for inventories and plantation management, the control and coordination of activities, as well as the supervision of field assistants and the elaboration of the forest inventory general report.

The responsibilities of the company members are presented in the organization chart in Figure 25, being distributed across different stages according to the positions in the business structure. The field technicians participating in the preparation stage are responsible for recording in worksheets the information collected during the forest inventory and for the quality of the reported values. Additionally, they are in charge of transcribing the values contained in the paper forms to digital files (in Excel or Word formats). The information is delivered by Red Forestal to the Felber Forestry Manager, who reviews and groups it for later review by the Organization Manager. Finally, the President and other officials of the partner companies can verify compliance with the established commitments.



Figure 25. Responsibilities for the results of the forest inventory.

Sample plots

- Sampling design

To estimate the growth of the trees planted in the entire project verification area, taking into account that it would be very difficult to measure each of them, samples with a statistical uncertainty of less than 10% must be carried out. For this, areas with similar conditions (strata) are considered, and a number of sample plots are randomly selected using ArcGIS 10.5 together with the tools for the creation of random points.

- Stratification: The sample plots are distributed according to the stratification, based on the type of genetic material used, the type of use (final destination of the

¹³³ See staff resumes at: Gestión documental/soportes/Hojas de vida

timber) and the year of establishment. However, since the type of use is not relevant in the first verification, a stratification will be carried out taking into account only the type of genetic material and the year of establishment.

- Monitoring period: for the first verification, monitoring is carried out between January 13, 2016 and November 19, 2020.
- Location: 194 sample plots were established in the project (101 in Laguna Kare, 33 in Tacuary, 23 in Pozo Azul, 10 in Section D, 9 in Ñumi 3, 6 in Ñumi 2, 6 in Section F and 6 in Section S).

The location of the sample plots can be seen in **Figure 26**.

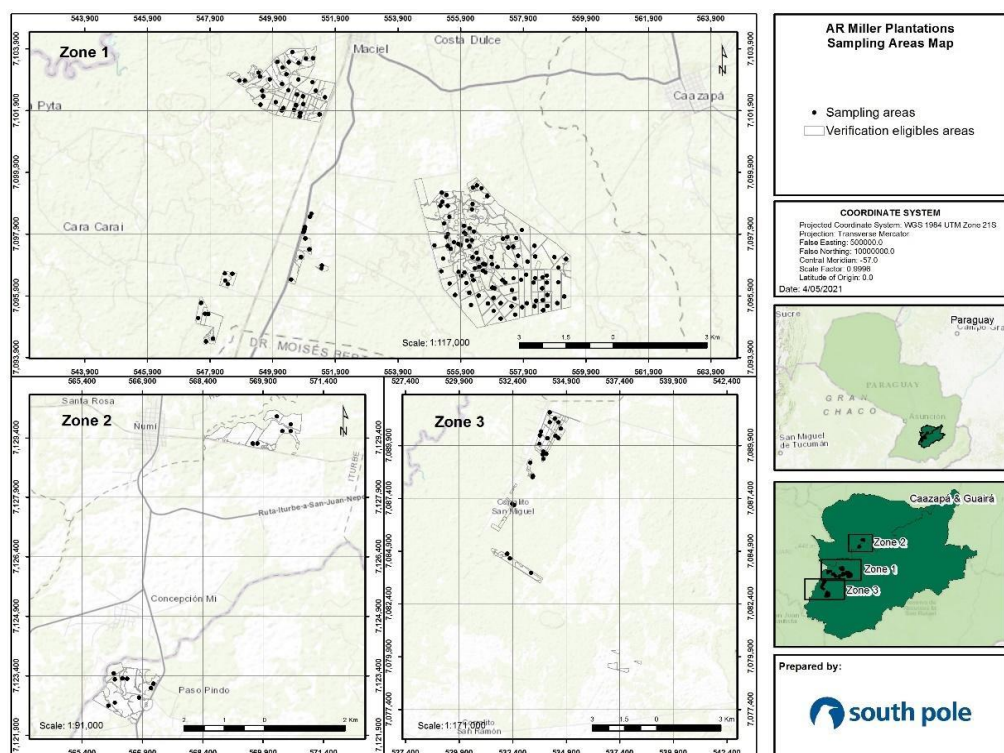


Figure 26. Sample plots' location map

- Type, shape and size of the sample plot: The sample plots are temporary and circular in shape of 400 m² (11.28 m radius, Figure 27).

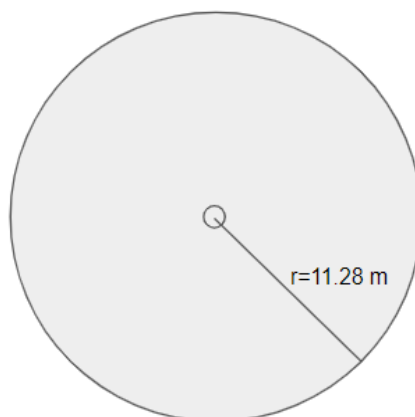


Figure 27. Temporary sample plots in a circular shape

- Installation of the sample plot
 - Materials and tools used:
 - GPS receiver and extra batteries
 - 2 measuring tapes with automatic rewinding of 20-50 m
 - 2 tree calipers for measuring diameters
 - Equipment for measuring tree heights and terrain slopes (Vertex IV)
 - 1 m long wooden stakes for marking the sample plots
 - Waterproof bags to protect measuring instruments and forms
 - Tree marking sprays
 - Mobile phone (if preferred)
 - Photography camera
 - Waterproof boots and suits
 - Machetes
 - Personal protective equipment (helmets, vests, leg warmers, gloves, emergency kit)
 - Topographic maps
 - Printed forms for data collection and table
 - Permanent markers and pens
 - *Delimitation and access to sample plots*

The access procedure to the sample plots includes finding their location with maps support. For orientation in the field, the GPS receiver is used, recording the initial points of each sample plot as guiding points. Once the central point of the sample plot is reached, the geographic coordinates are verified and marked with a stake painted with a fluorescent-colored spray. The sample plots are identified using an ID code and a rope the size of the sample plot radius is used to determine the trees within it.
 - *Data collection*

Once in the sample plot, the general information is recorded in the Inventory Sheets¹³⁴. The coordinates of each reference point are read in the GPS device, reference photographs of the site are taken and the corresponding codes are included in the form. The sites that correspond to the starting point must be reported together with their coordinates in decimal degrees (latitude and

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longitude). The order for measuring the sample plots varies depending on the access conditions.

The sample plots have the following unique identifiers:

(= name of the plantation) + # (= name of the genetic material) + # (= type of use) + # (= number of the sample plot).

In the field forms, in addition to the basic data of the person carrying out the measurement, the ID of the sample plots, the spacing and the measurement date, information related to quality of the stem is also recorded. Regarding the latter aspect, the physical and phytosanitary conditions of the inventoried trees are recorded, indicating the following criteria:

- Living tree
- Dead tree (M)
- Mechanical damage
- Undeveloped tree
- Fallen or flipped
- Presence of pathogens
- Forked below DBH (1.30 m): “B” letter
- Forked above DBH: “A” letter
- Stem: straight (R) or tortuous (T)

Additionally, other relevant information about the sample plot is taken so that different observations during the field work must be recorded, such as the type of use, that is, the timber destination (sawn or laminable timber), energy purpose (biomass) or multipurpose (combination of both final uses), and whether the sample plot has presence of animals (silvopastoral systems). All information collected about individual trees and data taken in the sample plots are found in field forms called Inventory Worksheets¹³⁵. The result is all the sample plots measured and marked following the corresponding procedures for all the plantations of interest, as shown in Figure 28.

¹³⁵ Inventory sheets can be found at: Gestión documental/Inventario/planillas



Figure 28. Measured and marked sample plot.

Once the measurements are completed and the information of a certain sample plot is recorded, the remaining time required to finish the process is estimated and the procedures with the next sample plots are carried out, according to the roadmap of the forest plantation.

○ *DBH and H data collection*

Data collection starts at the initial point of the sample plot and continues in a direction that has been previously defined, that is, north (0°) is identified and all individuals are measured clockwise by using a rope with the radius length (11.28 m). The sample plot is divided into four quadrants and each of them is measured, respecting their limits with the help of the rope and following the direction illustrated in Figure 29.

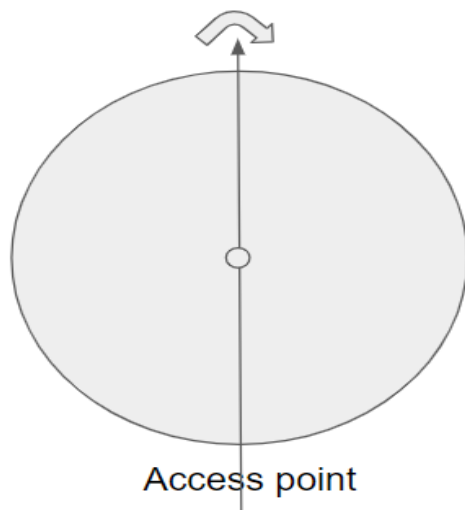


Figure 29. Simplified representation of the sample plot measurement.

○ *Tree measurement*

The diameter at breast height (DBH) and the height of all living trees within the sample plot are measured; then, the values are recorded on the field forms. In the case of the trees located on the sample plot boundary, they are considered as part of it only if more than half the diameter of the trunk is inside. Individuals below 5 cm DBH are recorded in the sheet but are not measured.



Figure 30. Tree marking.

The DBH is measured on the tree bark at 1.3 m from the ground (Figure 31), considering some particular cases as detailed below. Generally, tree measurements are made using a caliper and marking a line as indicated below.

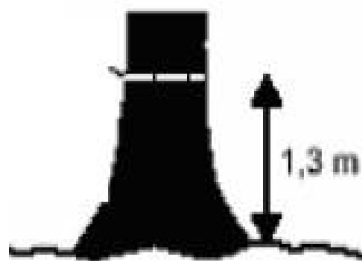


Figure 31. DBH measurement in individual trees.

Sometimes measuring adjustments must be made considering the particular conditions of the site and the trees. The following cases require special attention when measuring:

- *Sloping lands:* Measuring instruments are held in a position that perpendicularly crosses the tree axis at 1.3 m. Therefore, on sloping lands, the DBH measurement is performed from the uphill position (Figure 32).

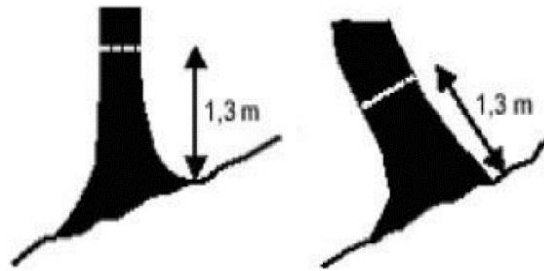


Figure 32. DBH measurement on sloping lands.

- *Forked trees:* There are several cases depending on the point where the tree is forked:
 - If the fork (point where the heartwood splits) begins below 1.3 m of height and each log has the required diameter (≥ 10 cm the complete sample part, ≤ 10 cm and ≥ 2.5 cm), it is measured 1 m above the beginning of the fork.
 - If the fork begins between 30 cm and 1.3 m of height, each log will be considered as an independent tree and will be measured accordingly. The diameter will be measured 1 m above the beginning of the fork.
 - If the fork begins at 1.3 m or a little higher, the tree will be counted as a single one. The diameter will be therefore measured below the fork intersection point, just below the bulge that could influence the DBH.

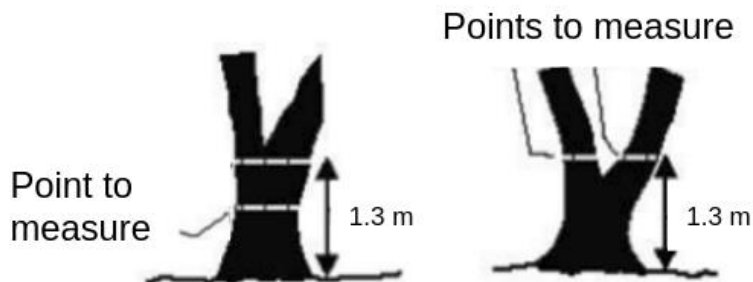


Figure 33. DBH measurement in forked trees.

For its part, the height of individual trees is measured indirectly using the Vertex IV hypsometer and following the measurement principles as presented in Figure 33.

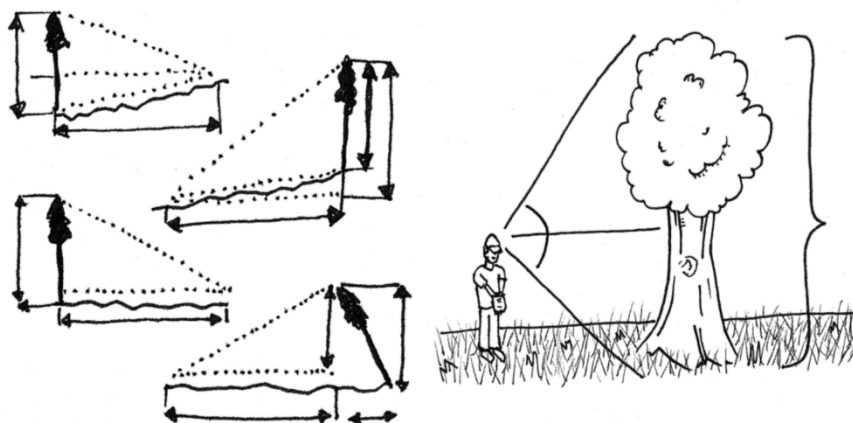


Figure 34. Height measurement of individual trees.

Once the measurements are completed and the information of a certain sample plot is recorded, the remaining time required to finish the process is estimated and the procedures with the next sample plots are carried out, according to the roadmap of the forest plantation.

Internal audit and QA/QC procedures¹³⁶

The monitoring of plantations requires having quality assurance (QA) and quality control (QC) measures in place, including steps to minimize errors in measurements and data analysis, and providing the necessary information to follow the progress of the activities and be aware of the consistency of archived data over time.

- *Collection of reliable field measurement data:* The responsibilities of all staff members as well as the importance of certain field activities are defined in order to ensure that reliable results are produced. The company personnel who carry out the inventories is trained in the relevant tasks to guarantee data collection by using the appropriate instruments and applying the procedures required by the certifying standards. Likewise, the Field Technicians attend the general recommendations of the Forestry Manager to produce reliable data in forms and later in Excel databases.
- *Verification of methods used for field data collection:* The relevance of the tools used for data collection and the quality of the instruments such as the tree caliper and the hypsometer are verified.
- *Data storage:* Data recorded in the printed form are transcribed into Excel files and accompanied with supporting site photographs and coordinates images. Felber Forestal uses Autocad to manage its GIS information, and it reviews synchronously with a database managed in other software developed by themselves. They have backup of the information every midnight on 2 servers in Paraguay and another in Germany.
- *Procedures to ensure reliable field measurements:* After monitoring, a document called “Information quality management” is generated, containing the re-measurement of the sample plots with data that are far from the averages per stratum and of some other sample plots that are randomly selected. Then, a comparison of averages is carried out

¹³⁶ information provided by felber forestal

through a t test for paired data to verify that no significant difference with a p-value of 0.05 exists. The software that Felber Forestal uses to manage the data bank was developed by themselves, where they have all the information on the forest parcels and clients. This software is parameterized and has controls to prevent the entry of errors. With this software they do a cross control of the number of plants that come out of the nursery, planted plants, quantity of materials, plants planted by each person. They make an identification of the sizes of the trees before harvesting and according to that they hope to obtain a harvested volume; the values are annotated when using the harvester, with additional information to the one exported by the harvester and then that annotated data is reviewed by crossing with the values exported by the harvester; the harvester has a calibration protocol that they have to do and if errors are found later, the information can be corrected. With the software they take reports of activities carried out by the staff, which is then validated by the areas and then accounting. In Germany they corroborate the information again.

- *Procedures used for handle internal audit:* new controls are constantly being implemented in the software to avoid errors, based on the inconsistencies that are identified. Errors are reviewed by the harvest supervisor and Jonas. If they find inconsistencies or outliers, the physical reports stored in the office are reviewed. Physical documents are stored for a minimum of 5 years. As it is already known what the average values per log of wood are, then it is verified that they have a behavior that is not strange. Constant efforts are being made to improve in this regard and to better document this information.

Data processing

Below is a description of each of the steps required to achieve carbon capture:

- *Volume estimation*

Based on the tree DBH and height data, volume is estimated by means of a form factor for the eucalyptus species and of volume equations published in the technical literature for pine species. The form factor for eucalyptus was estimated through tree field measurements in the project plantations, thanks to a research work within the framework of an agreement with the University of Asunción¹³⁷. The procedure consists of measuring the volume of a considerable number of trees. For this, the trunk diameter is measured at the height of 0, 0.5, 1 and 1.30 m. Then, it is measured every meter until the minimum diameter of 2.5 cm is reached. The total height of the tree is recorded and once the data from 60 trees are collected, the real volume is calculated for each of the cross sections using the Smalian formula¹³⁸ as follows:

$$V_s = \pi * h * (d_l^2 + d_u^2)/8$$

¹³⁷ Available at: gestión documental/Estimaciones/Estimaciones actuales.xlsx en la hoja "Form_Factor"

¹³⁸ West, Philip W. "Stern Wood Volume" Tree and Forest Measurement. Springer, Berlin, Heidelberg, 2004. 19-26.

Where:

V_s	Volume of each section (m ³)
h	Height of each section (m)
d_l	Diameter at bottom height (m)
d_u	Diameter at top height (m)

Subsequently, the commercial volume of each tree is calculated by adding the volume of all its cross sections. Finally, the form factor is obtained by dividing the total tree volume calculated based on the Smalian's formula by the cylinder volume calculated for each tree:

$$V_c = \pi * DBH^2 * h$$

Where:

V_c	Cylinder volume (m ³)
H_t	Total tree height (m)
DBH	Diameter at breast height (m)

To calculate the volume of the two pine species, a search for equations was carried out and their selection was based on the general adjustment level (R^2), the location and the quality of the studies according to the primary information used. Based on the A/R Methodological Tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities" (version 01.0.0), the equation presented is considered appropriate since it was derived from the growth of trees of the same species planted in the project. Additionally, these species are in edaphoclimatic conditions similar to those of the project area, the coefficient of determination (R^2) resulted in a value higher than 0.85 and enough trees were used for its adjustment (225).

Based on the form factor for eucalyptus and the technical literature available for pines, the total commercial volume of every tree is calculated using the equations presented in Table 31.

Table 31. Volume equations used.

Species	Equation	Location	R^2	N	Source
<i>Eucalyptus spp.</i>	$(DBH^2 * H_t) / 40000 * \pi * 0,43$	Paraguay	NA	60	Monitored with project data
<i>P. elliotti</i>	$0,02732 * (DBH)^{(1,92678)} * (H_t)^{(1,22459)} / (10^3)$	Argentina	0.99	303	Kolln & Viola (1988) ¹³⁹

¹³⁹ Kolln R F, Viola J. 1988. Tablas de Volumen con corteza para Pinus elliottii y Pinus taeda en el norte de Misiones. Simposio sobre silvicultura y mejoramiento genético de especies forestales cited in: Ramiro, V; Matías, F. 2001. Desarrollo y Uso de Ecuaciones de Volumen y Tablas de Volumen en la República Argentina- Parte II -. AR., National University of La Plata. 39 p.

<i>P. taeda</i>	$0,02237 * (DBH)^{(2,01157)} * (H_t)^{(1,13125)} / (10^3)$	Argentina	0.99	225	
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- *Biomass estimation*

The calculated commercial volume for every tree within each sample plot is added and the total commercial volume of timber in every sample plot is obtained. Then, this volume is taken to units of $m^3 ha^{-1}$ and finally the formula for the estimation of the total biomass proposed in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology is used:

$$b_{TREE_j} = V_{TREE} * D_j * BEF_i * (1 + R_{TREE})$$

Where:

b_{TREE_j}	Total tree biomass by sample plot ($m^3 ha^{-1}$)
R_{TREE}	Root-to-shoot ratio (dimensionless)
BEF_i	Biomass expansion factor (dimensionless)
D_j	Wood density of each species ($ton m^{-3}$)
V_{tree}	Total commercial volume of trees by sample plot ($m^3 ha^{-1}$).

- *Sampling error*

With the total tree biomass per sample plot ($m^3 ha^{-1}$), the average and the standard deviation are calculated for each stratum (grouping the plots included in each one of them). Then, the sampling error is obtained using the A/R Tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology:

$$b_{TREE} = \sum_{i=1}^m w_i * b_{TREE_i}$$

$$u_c = \frac{t_{val} * \sqrt{\sum_{i=1}^m w_i^2 * \frac{S_i^2}{n_i}}}{b_{TREE}}$$

Where:

b_{TREE}	Mean tree biomass in strata ($m^3 ha^{-1}$).
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w_i	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata.
b_{TREE_i}	Mean tree biomass in stratum i ($m^3 ha^{-1}$).
u_c	Uncertainty (%).
t_{val}	Two-sided Student's t -value for a confidence level of 90% and degrees of freedom equal to $n - M$, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata.
s_i	Standard variance of mean tree biomass in stratum i .
n_i	Number of sample plots in stratum i .

- Carbon estimation

Estimation of carbon storage (stock) in trees (ΔC_{TREE})

$$B_{TREE} = A * b_{TREE_i}$$

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

Where:

C_{TREE}	Carbon stock in tree biomass per stratum ($tCO_2\text{-equ}$).
CF_{TREE}	Carbon fraction of tree biomass (tC)
B_{TREE}	Tree biomass per stratum (ton)
b_{TREE_i}	Mean tree biomass in stratum i ($m^3 ha^{-1}$)
A	Area per stratum (ha)

Estimation of carbon storage (stock) in dead wood and litter (ΔC_{DW} , ΔC_{LI})

Carbon in dead wood and litter is calculated based on the proposal of the AR-Tool 13 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities”, version 3.1. of the AR-ACM0003 methodology, which relates the carbon content (in dead wood and litter) as a percentage of the total carbon in tree biomass by using the following equations:

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

Where:

$C_{DW,i,t}$: Carbon stock in dead wood in stratum i at a given point of time in year t (tCO₂e).

$C_{TREE,i,t}$: Carbon stock in trees biomass in stratum i at a point of time in year t (tCO₂e).

DF_{DW} : Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass (tCO₂e).

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

Where:

$C_{LI,i,t}$ Carbon stock in litter in stratum i at a given point of time in year t (tCO₂e).

$C_{TREE,i,t}$ Carbon stock in trees biomass in stratum i at a point of time in year t (tCO₂e).

DF_{LI} Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass (tCO₂e).

Finally, the tree carbon stock is added to that of the litter and dead wood per stratum and the total project removals from the verification areas per stratum are obtained. Then, the values by stratum are added in order to obtain the total removals of the project.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data/Parameter	Averification
Data unit	Ha
Description	Project verification area
Source of data	Delimitation of lots by GPS
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before each verification report
Value applied:	2,424.52
Monitoring equipment	GPS
QA/QC procedures applied	N/A
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	Averification_i
Data unit	Ha
Description	Project verification area by stratum
Source of data	Delimitation of lots by GPS
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before each verification report

Value applied:	Species	Establishment year	Total area (ha)
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2016	391.78
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2017	362.46
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2018	322.76
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus camaldulensis</i>	2019	75.44
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2016	701.00
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2017	217.96
	<i>Eucalyptus urophylla</i> x <i>Eucalyptus grandis</i>	2018-2019	131.77
	<i>Eucalyptus resinifera</i> x <i>Eucalyptus camaldulensis</i>	2016	3.29
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2018	14.38
	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2019	16.46
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2017-2018	25.14
	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2019	20.55
	<i>Pinus elliottii</i>	2016	3.79
	<i>Pinus taeda</i>	2016	90.82
	<i>Pinus taeda</i>	2018	46.93
Monitoring equipment	GPS		
QA/QC procedures applied	N/A		

Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	A_{pi}
Data unit	m ²
Description	Area of the sample plots
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before each verification report
Value applied:	400
Monitoring equipment	Measuring tape
QA/QC procedures applied	After carrying out the forest inventory at random, some sample plots were re-measured. Based on the number of individuals re-measured, their delimitation was checked.
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	Coordinates of sample plots
Data unit	Latitude/Longitude
Description	Location of each sample plot
Source of data	Measurement in the field
Description of measurement methods and procedures applied	N/A

Frequency of monitoring/recording	Before each verification report
Value applied:	See forest inventory of plantations
Monitoring equipment	Measurement using a Global Position System (GPS)
QA/QC procedures applied	After carrying out the forest inventory at random, some sample plots were re-measured. Based on the resulting information, location was checked.
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	DBH
Data unit	cm
Description	Trunk diameter at breast height
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before each verification report
Value applied:	See forest inventory of plantations ¹⁴⁰
Monitoring equipment	Tree caliper
QA/QC procedures applied	After monitoring, 9 plots that had data far from the averages by stratum were re-measured. A comparison of averages was made through a t test for paired data and no significant difference was evidenced, with a p-value of 0.05 ¹⁴¹
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

¹⁴⁰ Available at: Gestión documental/Estimaciones/Estimaciones_actuales.xlsx hoja "Forest_Inventory_Trees"

¹⁴¹ Available at: Gestión documental/ Estimaciones/ gestión de la calidad de la información.xlsx

Data/Parameter	H
Data unit	m
Description	Total tree height
Source of data	Measurement in the field
Description of measurement methods and procedures applied	See section 5.3 Monitoring Plan
Frequency of monitoring/recording	Before every verification report
Value applied:	See forest inventory of plantations
Monitoring equipment	Measured with a hypsometer or inclinometer
QA/QC procedures applied	After monitoring, 9 plots that had data far from the averages by stratum were re-measured. A comparison of averages was made through a t test for paired data and no significant difference was evidenced, with a p-value of 0.05 ¹⁴²
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

Data/Parameter	Form factor of <i>Eucalyptus spp.</i>
Data unit	Dimensionless
Description	Taper factor that relates a cylinder volume to the trees volume
Source of data	Measurement in the field through research work within the framework of an agreement with the University of Asunción ¹⁴³
Description of measurement methods and procedures applied	The trunk diameter is measured at the height of 0, 0.5, 1 and 1.30 m. Then, it is measured every meter until the minimum diameter of 2.5 cm is reached. The total height of the tree is recorded and once the data from 60 trees are collected, the real volume is calculated using the Smalian formula and the form factor is subsequently calculated.

¹⁴² Available at: Gestión documental/ Estimaciones/ gestión de la calidad de la información.xlsx

¹⁴³ Available at: Gestión documental/Estimaciones/Estimaciones_actuales.xlsx hoja "Form_Factor"

Frequency of monitoring/recording	N/A
Value applied:	0.43
Monitoring equipment	- Measuring equipment: Vertex IV hypsometer, diameter tape, measuring tape, tree caliper, GPS, stakes, spray. - Cutting equipment: chainsaw, cut resistant pants, helmet, gloves, steel-toed boots.
QA/QC procedures applied	N/A
Purpose of data	Calculation of project removals
Calculation method	N/A
Comments	N/A

6.2 Baseline Emissions

The results presented in Chapter 4 are used since the baseline is not monitored. Before the reforestation activity, the project area consisted of grasslands that were subjected to annual burns for their renovation, a common practice in the regional agricultural production. As this activity does not allow carbon accumulation, the baseline carbon storage is zero.

6.3 Project Emissions

The steps to obtain the removal generated between 13/01/2016 and 19/11/2020, are stratification, volume estimation, biomass estimation, sampling error and carbon quantification. The description of each item is presented below:

○ Stratification

The stratification was made by type of genetic material and year, as follows:

Table 32. Area per stratum.

Strata	Species	Year	Area (ha)
1	<i>Eucaliptus urophylla</i> x <i>Eucaliptus camaldulensis</i>	2016	391.78
2	<i>Eucaliptus urophylla</i> x <i>Eucaliptus camaldulensis</i>	2017	362.46
3	<i>Eucaliptus urophylla</i> x <i>Eucaliptus camaldulensis</i>	2018	322.76
4	<i>Eucaliptus urophylla</i> x <i>Eucaliptus camaldulensis</i>	2019	75.44
5	<i>Eucaliptus urophylla</i> x <i>Eucaliptus grandis</i>	2016	701.00
6	<i>Eucaliptus urophylla</i> x <i>Eucaliptus grandis</i>	2017	217.96
7	<i>Eucaliptus urophylla</i> x <i>Eucaliptus grandis</i>	2018-2019	131.77

8	<i>Eucalyptus resinifera</i> x <i>Eucalyptus camaldulensis</i>	2016	3.29
9	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2018	14.38
10	Hybrid (<i>E. grandis</i> x <i>E. camaldulensis</i>) x <i>E. urophylla</i>	2019	16.46
11	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2017-2018	25.14
12	Hybrid (<i>E. urophylla</i> x <i>E. tereticornis</i>) x <i>E. pellita</i>	2019	20.55
13	<i>Pinus elliottis</i>	2016	3.79
14	<i>Pinus taeda</i>	2016	90.82
15	<i>Pinus taeda</i>	2018	46.93
Total			2,424.52

○ Volume estimation

Based on the tree DBH and height data, volume is estimated by means of a form factor for the eucalyptus species and of volume equations published in the technical literature for pine species. The form factor for eucalyptus was estimated through tree field measurements in the project plantations, thanks to a research work within the framework of an agreement with the University of Asunción¹⁴⁴. The procedure consists of measuring the volume of a considerable number of trees. For this, the trunk diameter is measured at the height of 0, 0.5, 1 and 1.30 m. Then, it is measured every meter until the minimum diameter of 2.5 cm is reached. The total height of the tree is recorded and once the data from 60 trees are collected, the real volume is calculated for each of the cross sections using the Smalian formula¹⁴⁵ as follows:

$$V_s = \pi * h * (d_l^2 + d_u^2)/8$$

Where:

V_s	Volume of each section (m ³)
h	Height of each section (m)
d_l	Diameter at bottom height (m)
d_u	Diameter at top height (m)

Subsequently, the commercial volume of each tree was calculated by adding the volume of all its cross sections. Finally, the form factor was obtained by dividing the total tree volume calculated based on the Smalian's formula by the cylinder volume calculated for each tree:

$$V_c = \pi * DBH^2 * h$$

Where:

¹⁴⁴ Available at: gestión documental/Estimaciones/Estimaciones actuales.xlsx en la hoja "Form_Factor"

¹⁴⁵ West, Philip W. "Stern Wood Volume" Tree and Forest Measurement. Springer, Berlin, Heidelberg, 2004. 19-26.

V_c Cylinder volume (m³)

H_t Total tree height (m)

DBH Diameter at breast height (m)

To calculate the volume of the two pine species, a rigorous search for equations was carried out and their selection was based on the general adjustment level (R^2), the location and the quality of the studies according to the primary information used. According to the A/R Methodological Tool “Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities” (version 01.0.0), the equation presented is considered appropriate since it was derived from the growth of trees of the same species planted in the project. Additionally, these species are in edaphoclimatic conditions similar to those of the project area, the coefficient of determination (R^2) resulted in a value higher than 0.85 and enough trees were used for its adjustment (225).

Based on the form factor for eucalyptus and the technical literature available for pines, the total commercial volume of every tree is calculated using the following equations:

Table 33. Volume equations used.

Species	Equation	Location	R^2	N	Source
<i>Eucalyptus</i> spp.	$(DBH^2 * H_t) / 40000 * \pi * 0,43$	Paraguay	NA	60	Monitored with project data
<i>P. elliotti</i>	$0,02732 * (DBH)^{(1,92678)} * (H_t)^{(1,22459)} / (10^3)$	Argentina	0,99	303	Kolln & Viola (1988) ¹⁴⁶
<i>P. taeda</i>	$0,02237 * (DBH)^{(2,01157)} * (H_t)^{(1,13125)} / (10^3)$	Argentina	0,99	225	

○ Biomass calculation

The calculated commercial volume for every tree within each sample plot was added and the total commercial volume of timber in every sample plot was obtained. Then, this volume was taken to units of m³ ha⁻¹ and finally the formula for the estimation of the total biomass proposed in the tool “Estimation of carbon stocks and change in carbon stocks of trees and

¹⁴⁶ Kolln R F, Viola J. 1988. Tablas de Volumen con corteza para-Pinus elliottii y Pinus taeda en el norte de Misiones. Simposio sobre silvicultura y mejoramiento genético de especies forestales cited in: Ramiro, V; Matías, F. 2001. Desarrollo y Uso de Ecuaciones de Volumen y Tablas de Volumen en la República Argentina- Parte II -. AR., National University of La Plata. 39 p.

shrubs in A/R CDM project activities” of the AR-ACM0003 methodology was used as follows:

$$b_{TREE_j} = V_{TREE} * D_j * BEF_i * (1 + R_{TREE})$$

Where:

b_{TREE_j}	Total tree biomass by sample plot ($m^3 \text{ ha}^{-1}$)
R_{TREE}	Root-to-shoot ratio (dimensionless)
BEF_i	Biomass expansion factor (dimensionless)
D_j	Wood density of each species (ton m^{-3})
V_{tree}	Total commercial volume of trees by sample plot ($m^3 \text{ ha}^{-1}$).

$$b_{TREE_j} = V_{TREE} * D_j * BEF_i * (1 + R_{TREE})$$

Tabla 34. Default parameters used ¹⁴⁷.

Parameter	Value
Root-to-shoot ratio ^a	0,20 for subtropical humid forest. Above-ground biomass <125 tons ha-1 0,24 for subtropical humid forest. Above-ground biomass >125 tons ha-1

○ *Sampling error*

With the total tree biomass per sample plot ($m^3 \text{ ha}^{-1}$), the average and the standard deviation was calculated for each stratum (grouping the plots included in each one of them). Then, the sampling error was obtained using the A/R Tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology:

¹⁴⁷Guidelines for National Greenhouse Gas Inventories IPCC (2006), a Table 4.4 – Ratio of Below Ground Biomass to Above Ground Biomass (2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4).

$$b_{TREE} = \sum_{i=1}^m w_i * b_{TREE_i}$$

$$u_c = \frac{t_{val} * \sqrt{\sum_{i=1}^m w_i^2 * \frac{S_i^2}{n_i}}}{b_{TREE}}$$

Donde:

b_{TREE}	Mean tree biomass in strata ($m^3 \text{ ha}^{-1}$).
w_i	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata.
b_{TREE_i}	Mean tree biomass in stratum i ($m^3 \text{ ha}^{-1}$).
u_c	Uncertainty (%).
t_{val}	Two-sided Student's t -value for a confidence level of 90% and degrees of freedom equal to $n - M$, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata.
S_i	Standard variance of mean tree biomass in stratum i .
n_i	Number of sample plots in stratum i .

A sampling error of 3.91% was obtained, which indicates that the estimates of the carbon stock stored by the project have low uncertainty and meets the tool requirements.

○ Carbon estimation

Estimation of carbon storage (stock) in trees (ΔC_{TREE})

To estimate tree carbon storage, the formula proposed in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” of the AR-ACM0003 methodology was used:

$$B_{TREE} = A * b_{TREE_i}$$

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

Where:

C_{TREE}	Carbon stock in tree biomass per stratum (tCO ₂ -equ).
CF_{TREE}	Carbon fraction of tree biomass (tC)
B_{TREE}	Tree biomass per stratum (ton)
b_{TREE_i}	Mean tree biomass in stratum i (m ³ ha ⁻¹)
A	Area per stratum (ha)

Table 35. Default parameters used ¹⁴⁸.

Parameter	Value
Carbon fraction ^a	0.47

Table 36. Actual tree removals (tCO₂e) by stratum.

Strata	Aboveground biomass (t ha ⁻¹)	btree (t ha ⁻¹)	Btree (t)	Ctree (tCO ₂ e)
1	126	156	61,005	105,132
2	83	100	36,249	62,469
3	47	57	18,289	31,519
4	31	37	2,794	4,815
5	130	161	112,795	194,383
6	112	135	29,418	50,696
7	53	64	8,434	14,534
8	98	118	388	669
9	49	58	838	1,444
10	24	29	472	814
11	52	62	1,556	2,682
12	10	13	259	446
13	17	20	77	133
14	15	19	1,688	2,908
15	2	2	104	180
Total				472,824

¹⁴⁸ Guidelines for National Greenhouse Gas Inventories IPCC (2006), a Table 4.3 – Carbon Fraction of Aboveground Forest Biomass.

Estimation of carbon storage (stock) in dead wood and litter (ΔC_{DW} , ΔC_{LI})

Carbon in dead wood and litter was calculated based on the proposal of the AR-Tool 13 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM projects activities”, version 3.1. of the AR-ACM0003 methodology, which relates the carbon content (in dead wood and litter) as a percentage of the total carbon in tree biomass by using the following equations:

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

Where:

$C_{DW,i,t}$:	Carbon stock in dead wood in stratum i at a given point of time in year t (tCO ₂ e).
$C_{TREE,i,t}$:	Carbon stock in trees biomass in stratum i at a point of time in year t (tCO ₂ e).
DF_{DW} :	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass (tCO ₂ e).

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

Where:

$C_{LI,i,t}$	Carbon stock in litter in stratum i at a given point of time in year t (tCO ₂ e).
$C_{TREE,i,t}$	Carbon stock in trees biomass in stratum i at a point of time in year t (tCO ₂ e).
DF_{LI}	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass (tCO ₂ e).

Table 37. Values to estimate dead wood and litter in the project¹⁴⁹.

Parameter	Value	Source
DF_{DW}	6%	Tropical sites with elevation values less than 2,000 meters above sea level and rainfall greater than 1,600 mm/year due to the annual
DF_{LI}	1%	

149 AR-TOOL12 A/R Methodological tool Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities.

		rainfall of 1,730 mm ¹⁵⁰ (according to the historical average of 2010-2019), and the average elevation of 101 meters above sea level ¹⁵¹ .
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Table 38. Actual deadwood and litter removals (tCO₂e) by stratum.

Strata	Cdw (tCO ₂ e)	ClI (tCO ₂ e)
1	6,308	1,051
2	3,748	625
3	1,891	315
4	289	48
5	11,663	1,944
6	3,042	507
7	872	145
8	40	7
9	87	14
10	49	8
11	161	27
12	27	4
13	8	1
14	174	29
15	11	2
Total	28,369	4,728

Finally, the tree carbon stock was added to that of the litter and dead wood per stratum and the total project removals from the verification areas per stratum were obtained. Then, the values by stratum were added to obtain the total removals of the project with a non-permanence buffer of 14%. This risk was performed following the AFOLU Non permanence Risk tool V4.0¹⁵²

Table 39. Actual total tCO₂e removals by stratum.

Strata	C actual (tCO ₂ e)	C actual including buffer (tCO ₂ e)
1	112,491	96,742
2	66,842	57,484
3	33,724	29,002

150 Funk, Chris, Pete Peterson, Martin Landsfeld, Diego Pedreros, James Verdin, Shraddhanand Shukla, Gregory Husak, James Rowland, Laura Harrison, Andrew Hoell & Joel Michaelsen. "The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes". Scientific Data 2, 150066. doi:10.1038/sdata.2015.66 2015.

151 T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

152 Para mas detalles ver el anexo I localizado en la ruta: Gestión documental/NPRT

Strata	C actual (tCO ₂ e)	C actual including buffer (tCO ₂ e)
4	5,151	4,429
5	207,989	178,870
6	54,245	46,650
7	15,551	13,373
8	715	614
9	1,544	1,327
10	871	749
11	2,869	2,467
12	476	409
13	142	122
14	3,111	2,675
15	192	165
Total	505,913	435,078

6.4 Leakage

As presented in Chapter 4 above, pre-existing livestock units (before the start of reforestation activities) are sold gradually while others are kept in the project in a silvopastoral system, without exceeding the carrying capacity of the farms. Thus, project leakage is considered insignificant and is not accounted for.

6.5 Net GHG Emission Reductions and Removals

According to Section 5.7 of the AR-ACM0003 methodology, the net anthropogenic GHG removals by sinks are estimated by using the following equation:

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

Where:

$\Delta C_{AR-CDM,t}$: Net anthropogenic GHG removals by sinks, in year t ; tCO₂e.

$\Delta C_{ACTUAL,t}$: Actual net GHG removals by sinks, in year t ; tCO₂e.

$\Delta C_{BSL,t}$: Baseline net GHG removals by sinks, in year t ; tCO₂e.

LK_t : GHG emissions due to leakage, in year t ; tCO₂e.

The $\Delta C_{BSL,t}$, LK_t and $GHG_{E,t}$ estimates are considered zero, as mentioned in the sections above. After discounting for non-permanence risk of 14% according to the results of the risk analysis, it is determined that the amount of credits to reserve is 70,835 tCO₂e. Thus, the credits available in the project are 435,078 tCO₂e as shown in the following table.

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
2016	0	64,890	0	64,890	9,085	55,805
2017	0	95,879	0	95,879	13,424	82,455
2018	0	112,882	0	112,882	15,805	97,077
2019	0	116,131	0	116,131	16,261	99,871
2020	0	116,131	0	116,131	16,261	99,871
Total	0	505,913	0	505,913	70,835	435,078