



**Verified Carbon
Standard**

AFFORESTATION IN COOPERATION WITH LOCAL LANDOWNERS FOR FORESTAL SAN PEDRO S.A

Document Prepared by UNIQUE forestry and land use

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The proposed VCS grouped project **“Afforestation in cooperation with local landowners for Forestal San Pedro S.A”** represents one of the first major afforestation projects of the private sector in Paraguay.

Forestal San Pedro is a company established in 2020 by an International Forestry Fund. The company aims to establish and manage an area of 7,000 ha of sustainable forest plantations for the sequestration of carbon and the production of quality timber in Eastern Paraguay. Plantations established on land previously used for mechanized agriculture and implanted pasture, but deforested decades ago, are expected to produce significant removal of carbon from the atmosphere.

Forestal San Pedro seeks to cooperate with local medium and large landowners to conduct tree planting on their properties. As a diversification strategy, plantations are largely established in silvopastoral systems on traditional cattle farms. Landowners lease their land to the company and get a share of the expected benefits. At the same time, they continue using the land for cattle grazing in a manner compatible with forestry. Leasing contracts cover at least one quality timber rotation period, of about 15 years. After this, trees are harvested for the production of quality timber and re-planted.

The expansion strategy provides an entry point for tree planting in the degraded and deforested landscape of Eastern Paraguay, dominated by cattle grazing and mechanized soy production. Despite the need to develop new models that can address environmental degradation and climate change, while at the same time offering a sustainable supply to the national wood and timber market, the tree component is still far from integrated into the regional productive landscape.

Target production areas encompass areas deforested decades ago that have been used for implanted pastures and mechanized soy, but are now degraded. This is very common in the region, where large-scale deforestation has been taking place for decades. The project is interesting for cattle ranchers that need to integrate sustainable intensification into their extensive grazing models to remain competitive in the area. It is also a good opportunity for landowners having experienced a decrease in agricultural productivity due to the marginal suitability of their land for mechanized agriculture and lack of soil management. On the other hand, the project offers an opportunity for diversification and reduces the economic risk related to the commodity price variations of soy and beef.

This is the first large scale project in the country operating under the Law 4890/13, which allows to legally decouple forest ownership from land ownership. Therefore, the project provides ground

proofing of new partnership models that build on local ownership structures while at the same time offering enough legal security to new investors.

Forestal San Pedro is currently (as of September 2020) purchasing 6,300 ha of already existing plantations, established by a Paraguayan agro-industrial company between 2014 and 2020. The remaining 1,700 ha will be established during the next 2-3 years by Forestal San Pedro. The **“San Pedro Carbon Project”** proposed in this PDD encompasses a part of this total area, compatible with VCS eligibility criteria, made up of 4,018 ha of existing plantations (referred to as “First instance”) and about 1,700 ha of future expansion (referred to as “Second instance”). Please note that the scope of first verification only includes around 1,600 ha on FMU 5, 6 and 8 as ownership for these properties has been secured to date. The remaining FMUs are in the process of being transferred to Forestal San Pedro and will be included in the scope of the carbon project in due course.

First instance plantations are distributed across nine different properties (referred to as Forest Management Units or FMUs hereinafter) leased from different landowners (see location in Figure 1). Thereof, 9 are located in the Department of San Pedro, and 1 in the Department on Canindeyú. Future expansion (second instance) is envisaged to take place close to existing plantations, through the same leasing model.

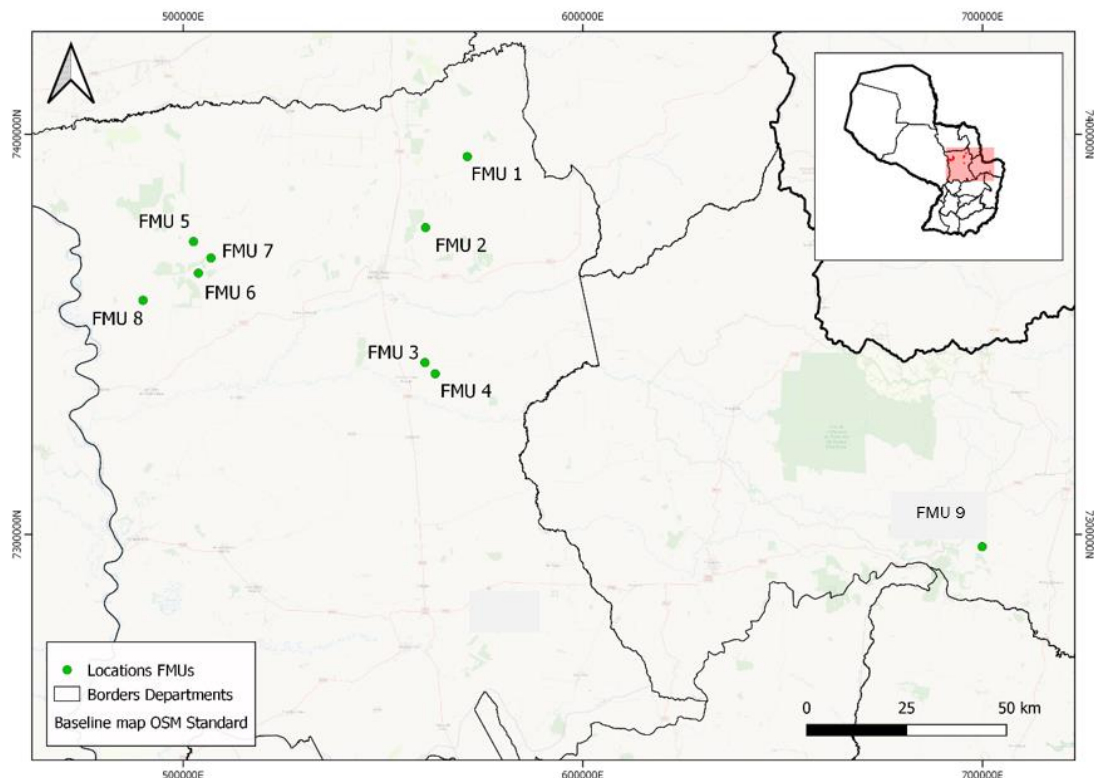


Figure 1. Location of the First project Instances in detail, 2020

The project is the first of its kind in the region introducing quality timber production from eucalypt species. This is different to most existing plantations in the region, established for biomass production, based on 6 to 7-year rotations and no silvicultural treatment. Quality timber production offers several advantages compared to existing production models in the region: It fosters long term investments and stewardship of the land, drives the local value addition and professionalization of the forest sector, provides more labour, and is better suited to restore degraded landscapes (for instance, by establishing biodiversity corridors in between natural forest fragments).

The plantations are managed by an experienced team and have been FSC certified in 2014¹. Forestal San Pedro has a service provision contract with UNIQUE for the technical management of the plantations.

The project will generate from its first activity instances removals of 849,056 t CO₂e over a crediting period of 20 years or 42,453 tCO₂ annually. Based on the Non-permanence Risk Assessment of this project, 20% buffer credits are to be deposited in the AFOLU pooled buffer account.

1.2 Sectoral Scope and Project Type

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

1.3 Project Eligibility

The proposed project activity supports the scope of the VCS program by initiating project activities that sequester carbon through afforestation of former agricultural and implanted pasture land on 6,350 ha of forest plantations (first project instance 4,018.5 ha).

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

10 years no deforestation of native ecosystems:

According to the VCS Standard (V4) Appendix 1.1., eligible AR areas must have been cleared of native ecosystems at least 10 years prior project establishment. Furthermore, according to chapter 3.2.4 activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program².

¹Please note while reading through this Document, that Forestal San Pedro is still in the process of purchasing the forest assets. Therefore, change of control is in process. The current FSC certification of the process (FSC® C117138) that can be verified online, is still registered in the name of PAYCO. Likewise, the scope of the ex-PAYCO project is different.

² https://verra.org/wp-content/uploads/2020/03/VCS-Standard-v4.0_Updated.pdf

The project area consisted of agricultural fields, mostly mechanized soy, or implanted pasture before tree planting took place. The project has been FSC certified since 2014 (FSC®- C117138), and follows FSC Principles and Criteria that establish a non-deforestation cut-off date of 1994.

For the carbon project, all plantation sites were assessed to ensure compliance with the VCS standard. On a few sites, deforestation by the owner took place more recently than 10 years ago. These sites were removed from the carbon project and are not accounted for GHG removals. The historical land use assessment was validated during the validation audit.

No Drainage

The VCS Standard Art 3.2.5 states: *“Activities that drain native ecosystems or degrade hydrological functions to generate GHG credits are not eligible under the VCS Program.”*³

Forestal San Pedro does not target areas that need drainage for planting, as can be seen in chapter 1.11 - soil preparation. Drainage has only been conducted outside the plantation areas and therefore soil drainage in the project is considered to be zero.

In summary, the project is eligible under the VCS requirements.

1.4 Project Design

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

Eligibility Criteria

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

Any new instance will meet the following criteria:

- 1) Meet the applicability conditions set out in the methodology applied to the project.
- 2) Use the technologies or measures specified in the project description and apply the technologies or measures in the same manner (See chapter 1.11).
- 3) Be subject to the baseline scenario determined in the project description for the specified project activity and geographic area.

³ <https://verra.org/wp-content/uploads/2020/03/VCS-Standard-v>

- 4) Show the same characteristics with respect to additionality consistent with the initial instances for the specified project activity and geographic area.

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

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

1.5 Project Proponent

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1.6 Other Entities Involved in the Project

Forestal San Pedro has a service provision contract with UNIQUE for the technical management of the plantations. The operational plantation management is conducted mainly by UNIQUE's Paraguayan subsidiary UNIQUE Wood Paraguay S.A., however monitoring, backstopping, reporting, and the development of the Carbon Project is conducted by UNIQUE forestry and land use GmbH.

Organization name	UNIQUE Wood Paraguay
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Role in the project	Project development and implementation
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Role in the project	Project development support
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1.7 Ownership

Forestal San Pedro is currently in the process of acquiring the plantation assets from an agroindustrial company. A purchase and sales agreement is in place. The transaction involves the change of control of all leasing agreements with property owners, as well as the transcription

of tree ownership to the new company. By June 2021 (date of validation), three of the nine properties have been legally acquired by Forestal San Pedro making up 1,646 ha⁴ (FMU 5, 6 and 8). The remaining FMUs are in the process of being transferred to Forestal San Pedro and will be included in the scope of the carbon project in due course. In addition, a Management Agreement has been signed between the new owner of the plantations (Forestal San Pedro) and UNIQUE for long-term plantation management, for all nine properties.

Table 1: Leasing agreements and plantation ownership registry

FMU	First planting year	Lease time (years)	Leased area (ha)	Characteristics of leased area
FMU 1	2017	14	1.092	Production area
FMU 2	2015	13	1.244	Production area
FMU 3	2017	14	299	Production area
FMU 4				
FMU 5	2017	14	465	Production area
FMU 6	2016	14	226	Production area
FMU 7	2017	14	489	Production area
FMU 8	2015	14	1.436	Production area only
FMU 9	2015	14	877	Whole property

Currently Forestal San Pedro has signed a leasing contract with landowners for the first rotation of the plantations over a period of 14 years. The contract foresees annual leasing payments as well as participation in the wood sales. After this period, new negotiations for a second rotation are expected to take place, since forestry under lease is expected to be the most attractive business vis-à-vis the most likely alternatives (opportunity costs). The scheme will be particularly attractive immediately after the final cut, when landowners receive their share of wood sales. Right now, property owners who previously conducted only cattle grazing on the areas leased are already making more annual profit with the current land lease than with traditional cattle grazing only.

Forestal San Pedro has also offered landowners an attractive share of the carbon credits in the form of a fix annual payment. To foster the continuation of the project after the first rotation, the offer has already been extended over a second rotation, regardless of the success in the first rotation. All landowners have been presented the offer and have shown interest in the scheme, however negotiations are ongoing.

Since forestry is an emerging sector in the country, subject to high levels of dynamism, profitability is expected to increase with the development of markets and the increasing

⁴ Please note that the scope of first verification only includes 1,517 ha on FMU 5, 6 and 8, comprising all areas subject to inventories to date.

investments of investors and industries. Industries like Paracel and the emerging plantations established for quality timber production are expected to foster industrialization, professionalization and value added. This is why the project is expected to be profitable after 12 years and economically more interesting than other land uses. Therefore, the project proponent foresees the extension indefinitely in time of the forest plantations in the areas for at least 50 years.

1.8 Project Start Date

Starting date of the proposed ARR project activity: 05-04-2015

The project start date is marked by the beginning of the plantations in April 2015 in FMU 8. Leasing agreements and documentations of work with contractors are provided in the Annex.

Forestal San Pedro proposes to include plantations that have turned 5 years of age in 2020 into the scope of the Forestal San Pedro Carbon Project. As part of the project documentation, the project proponent presents the approved extension letter issued by Verra to include these areas into the scope of the project, subject to validation being conducted until 31.07.2021. The reason for this request is the delay of the purchase of plantations assets and the difficulties of conducting carbon audits due to the COVID-19 pandemic. Paraguay has introduced one of the strictest travel bans in the region, which significantly slowed down all transactions and project development.

1.9 Project Crediting Period

Project start date	05.04.2015
Project end date	04.04.2035
Total Number of crediting years	20 years, renewable

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Project Year	Estimated GHG emission reductions or removals (tCO ₂ e)
04/2015 - 03/2016	1	2,710
04/2016 - 03/2017	2	30,511
04/2017 - 03/2018	3	63,198
04/2018 - 03/2019	4	152,299
04/2019 - 03/2020	5	185,939
04/2020 - 03/2021	6	168,149
04/2021 - 03/2022	7	161,445
04/2022 - 03/2023	8	43,176
04/2023 - 03/2024	9	25,094
04/2024 - 03/2025	10	16,535
04/2025 - 03/2026	11	0
04/2026 - 03/2027	12	0
04/2027 - 03/2028	13	0
04/2028 - 03/2029	14	0
04/2029 - 03/2030	15	0
04/2030 - 03/2031	16	0
04/2031 - 03/2032	17	0
04/2032 - 03/2033	18	0

Year	Project Year	Estimated GHG emission reductions or removals (tCO ₂ e)
04/2033 - 03/2034	19	0
04/2034 - 03/2035	20	0
Total estimated ERs		849,056
Total number of crediting years		20
Average annual ERs		42,453

1.11 Description of the Project Activity

From the total area, the first instance of the carbon project includes 4,018.5 ha, divided into 3,365 ha of silvopastoral systems and 6354,5 ha of pure plantations. Forestal San Pedro expects to continue the expansion of the area up to 7,000 ha until 2024 if suitable areas are found.

Plantations are either established in combination with grassland to form silvopastoral systems, designed with relatively low densities, or pure, exhibiting higher densities. Except for the densities and spacings, all silvicultural activities are the same and aim at the production of quality timber. The project implementation/ plantation timeline according to these different systems is presented in the Table below. The corresponding annual operational plan and the land use map for 2020 is presented in the Annex.

Table 2: Project land use and establishment plan

Land use	Total área (ha)	Plantation establishment (ha)					
		2015	2016	2017	2018	2019	2020
Pure Plantation – 1000 trees/ha	631.5	445.5	186				
Silvopastoral Systems – 714 trees/ha	3,365	866.5	199.5	1,748	422		129
Silvopastoral systems - 476 trees/ha	22					22	
Conservation – Native forest	509.0	509.0					

Silvopastoral systems

Silvopastoral systems combine livestock for the production of beef and forestry for the production of high value timber. These are implemented on existing implanted pastures, and where the property owners are interested to keep on using the land for grazing.

To leave more space for fodder and cattle, plantations are established in double-rows with large alleyways in between (double rows spaced 5 x 2 m in between alleyways of 9 m of width).

Throughout the forest cycle, fodder availability is expected to vary depending on the availability of light, influenced by tree growth, the form of the canopies, and pruning and thinning interventions. On average, the cattle stocking rate throughout the forest cycle is expected to reach around 60 % of the rate maintained in a pure beef production system.

To ensure a harmonious co-existence of the cattle and the forestry component, some conditions are introduced into the leasing agreements with the landowners. The most important ones are: 1) Cattle is only allowed into the system after one year of planting, when young trees are strong enough to resist potential cattle harassment; and, 2) The maximum cattle stocking rate is defined during the first few years of tree development.

Silvopastoral systems reduce the risk inherent in the market, due to a greater diversification in the production system of each plot. They also increase employment, since quality timber management requires more labour than beef production alone (24 FTE per 1,000 ha versus 1-3 FTE per 1,000 ha). In addition, they reduce compaction and soil erosion on areas used for cattle for a long time.

The combination of forestry and cattle offers operational synergies. The cattle controls weed and ensures biomass on the area is kept low, promoting fire prevention. Cattle management also ensures the presence of personnel which strengthens vigilance of these stands. At the same time, the microclimate created by the trees protects livestock from heat in the summer and frost in the winter (Frey et. al., 2008⁵). On the other hand, careful management is necessary, as cattle sometimes browses on tree barks, potentially damaging timber. Damages from cattle have been monitored annually and kept under control. According to the last inventory conducted by late 2019, only 10 % of trees were affected by cattle. Most of the affection was very mild, only 1% considered severe.

Species selection

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

⁵ Frey, G.E., Fassola, H.E., Pachas, N., Colcombet, L., Lacorte, S.M., Cubbage, F.W., Pérez, O., 2008. Perceptions of silvopasture systems in northeastern Argentina. Actas en CD 13as Jornadas Técnicas Forestales y Ambientales. Junio de 2008. Fac. Cs. Ftales. UNaM, INTA EEA Montecarlo. Eldorado, Misiones. 9 pp

On the best sites with fertile soils, *Eucalyptus grandis* and its hybrids are planted. This species is very productive, since it has a growth of 30 to 40 m³ per hectare per year. The species is suitable for the production of high value timber used for the manufacture of furniture, veneer and laminated wood. There is a high and growing national and international demand for the wood of *E. grandis*. *Eucalyptus grandis* x *camaldulensis* are employed on lower areas, as *E. camaldulensis* is more suited for more humid conditions.

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

Eucalypts have shown invasive behaviour in regions like South Africa. In tropical and sub-tropical regions employing the species we employ (*E. grandis*, *E. urophylla*, *E. camaldulensis*), the invasive potential of eucalypt species is deemed low. According to Stanturf et al. (2013)⁶, a review of general experience of *Eucalyptus* around the world (e.g., Brazil, Chile, and Australia) and the experience from regions similar to the Lower Coastal Plain (e.g., China and Brazil) concluded that the potential for *Eucalyptus* invasiveness is generally low due to poor dispersal, small seeds with limited viability that require bare soil to germinate, and light demanding seedlings that do not grow successfully under closed forest or understory canopies.

This is consistent with our experience, as eucalypts have not been found invading natural forest throughout the project history and other similar projects. *Eucalypt* species have been employed successfully in Eastern Paraguay since the 1950s. To date, they have not shown an invasive behavior or limitations in terms of their productive or environmental suitability. With annual rainfall higher than 1,300 mm and a positive water household (precipitation > evapotranspiration), eucalypts have not been associated to water shortages. Nevertheless, several trends increase the need for a specific site-species matching approach: i) Paraguay's climate has been changing, becoming more unpredictable and prone to more extreme weather (longer dry periods, floods, storms); and, ii) The advancement of pests and diseases. Therefore, Forestal San Pedro seeks to increase efforts in capitalizing on the knowledge build by the previous owner regarding the suitability of the species and clones employed.

One of the challenges in the past has been the limited availability of genetic material, however in the last few years, professional nurseries have developed and expanded. Forestal San Pedro will cooperate with these nurseries to keep improving the knowledge on the available genetic material.

In order to reduce the risk for pests and diseases, Forestal San Pedro seeks to limit the share of the area planted with one clone per FMU to 20 % of the total planted area.

Silvicultural regime for quality timber

Before planting, the silvicultural regime is established based on estimated production tables. Production tables have initially been modeled based on figures of similar plantations and data of the Brazilian Corporation for Agricultural Research (EMBRAPA). Later on, they are calibrated based on annual inventories.

The main features of the most widely applied silvicultural regimes applied are presented below.

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Table 3: Silviculture regime for quality timber in silvopastoral systems

Planting density	Initial 714 trees/ha, final 200 trees/ha
Spacing	7 x 2 or 5 x 5 x 9 x 2
Species	Different Eucalyptus; mainly hybrids of <i>E. grandis</i> x <i>E. urophylla</i> (urograndis) and <i>E. grandis</i> x <i>E. camaldulensis</i> (grancam)
Rotation	11 to 14 years
Thinning	3 thinning interventions in years 2-3, 3-4, 5-7
Pruning	Up to 9 m of height
Commercial MAI	Overall average 33 m ³ /ha/year

Table 4: Silviculture regime for quality timber in pure plantations

Planting density	Initial 1 000 trees/ha or 800 trees/ha, final 200 trees/ha
Spacing	5 x 2 m
Species	Different Eucalyptus; mainly hybrids of <i>E. grandis</i> x <i>E. urophylla</i> (urograndis) and <i>E. grandis</i> x <i>E. camaldulensis</i> (grancam)
Rotation	11 to 14 years
Thinning	3 thinning interventions in years 2-3, 3-4, 5-7
Pruning	Up to 9 m of height
Commercial MAI	Overall average 37 m ³ /ha/year



Figure 2. Example of silvopastoral system development throughout the forestry cycle

The schedule for forest operations throughout the forestry cycle is presented in the table below. Each operation is described in the sub-sections below.

Table 5. Schedule example of forest operations

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

Forest planning

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

Soil preparation

The site is cleared mechanically only on the lines where trees are planted. Soil preparation practices on these lines include plowing, harrowing, deep plowing and manual drilling. Across all plantation densities applied, soil disturbance is less than 10 %. The planting line of about 50 cm on the densest plantations (with spacings of 5 x 2 m; meaning 5 m between tree lines and 2 m between trees in a line) results in soil disturbance on 10 % of the area.

On around 20 % of the area, lime is applied to prevent soil acidification, often accompanied by pre-emergent herbicide.

Planting

Initially, all areas which will be reforested are demarcated. During planting, the highest priority is to ensure good growth and seedling survival. Therefore, the plant rooting is facilitated by planting the seedlings in wide spacings (5x2m) and in a single pit. Sometimes, platforms have to be constructed to ensure a uniform ground, or stones and other objects have to be removed before planting. Compaction is avoided after planting, to ensure good root establishment.

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

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

Maintenance

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

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

Pruning

Pruning is conducted to ensure the production of clean timber free of knots. Pruning is planned to reach up to a height of 9 m, in around 4 to 5 pruning interventions, mostly during the first three to four years.

Thinning and harvesting

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

Thinnings are conducted at a plantation age of 2 (1st thinning), 4/5 years (2nd thinning), and 7/8 years (3rd thinning). Approximately 35% - 43% of the standing volume is harvested during thinning, leaving a target final density of 200 trees/ha for the final cut. The final harvest is conducted at age 11-14, depending on the planting design, tree development and competition.

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

Infrastructure

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

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

Conservation

Plantations are established on private properties in between other areas used for agriculture, livestock management, and conservation. All FMUs integrate areas that are protected by law that consist of natural forest fragments in different stages of degradation. **Please note that natural forests under conservation are not part of the carbon project and therefore not considered for GHG removals.**

Mostly, protection areas are related to a regulation from 1986 that requires property owners to maintain 25 % of natural forest cover. Any additional natural forest fragments on the properties maintained after the forest conversion moratorium (since 2004) are also protected. Furthermore, buffer zones and riparian forests must be maintained according to the specifications of the Decree 9824 from 2012 (see Table below).

Most FMUs also exhibit natural pastures on lowlands that are used for very extensive cattle grazing, and maintained in a close-to-natural state.

Table 6: Buffer zones according to law Decree N° 9824/12

Width of the stream/river (m)	Minimum buffer area (m on either side)
>100 m	100 m
50-99 m	60 m
20-49 m	40 m
5-19 m	30 m
1,5-4,9 m	20 m
<1,5 m	10 m
Springs	=> 30 m

The project does not include conservation sites on most FMUs, except for the FMU 9, where the whole property is leased, integrating 509 ha of natural forests. This area is not part of the carbon project here presented for carbon credits. A condition for the expansion of the project on leased land is the maintenance of an environmental license by the landowners. An environmental license is granted upon the delivery of an environmental impact assessment, in which landowners have to demonstrate their compliance to the national environmental law. Compliance

is monitored by the Ministry of Environment through so-called audits, usually conducted every 2 years by an accredited environmental consultant hired by the landowner.

Environmental and biodiversity baseline studies were conducted on all FMUs. The baseline study was followed by one further biodiversity monitoring assessments only in FMU 9, where the company kept full control of the protection sites. A list of species with conservation status is maintained by the management team for all FMUs.

Furthermore, the project introduces following safeguards to avoid impacts on protection sites: i) Plantations are only established on demarcated sites, monitored through geospatial data; ii) Hunting, uncontrolled logging, and the uncontrolled use of fire are forbidden and monitored; iii) Pesticides are used only when needed, and their management and use is controlled; iv) Roads and infrastructure is mostly existent or established on already modified areas; and, v) Road construction and maintenance, as well as plantations establishment, is conducted according to best practices to avoid erosion.

On some sites, ecological restoration measures are conducted. This was the case in FMU 9 where native trees were planted in 2017 and 2018 to restore the buffer zone of a natural spring used for water consumption by the field staff. Native species planted were produced in community nurseries which were established as part of a social projects.

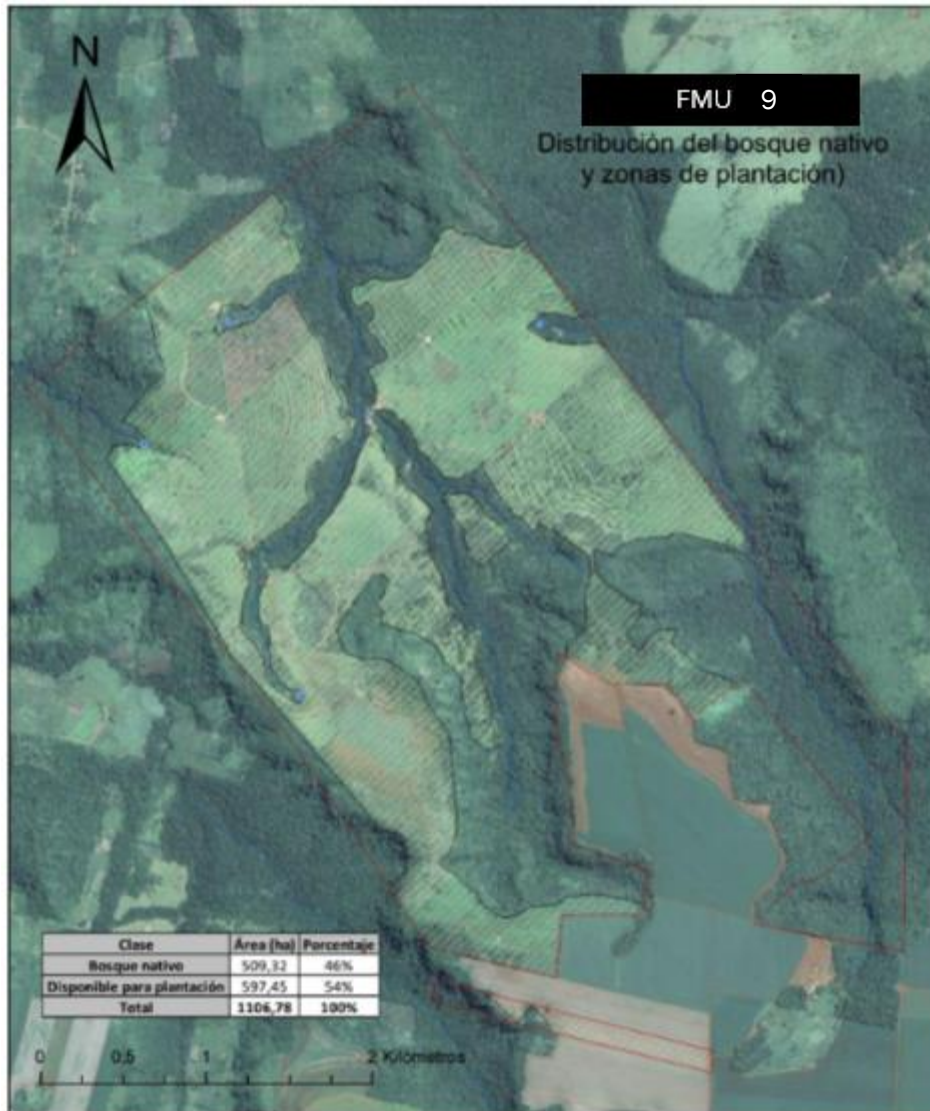


Figure 3. Protected areas of the FMU 9 (in black lines)

Jurisdiction of JNR

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

1.12 Project Location

The first instance of the grouped project is located in the province of San Pedro and Canindeyú. Project expansion (second instance) will most likely occur within a maximum radius of 100 km from existing FMU boundaries.

This could encompass the Departments of San Pedro, Canindeyú, Caaguazú, and/or Concepción. The political limits of these 4 contiguous Departments are considered the outer project boundary (64,204 km²).

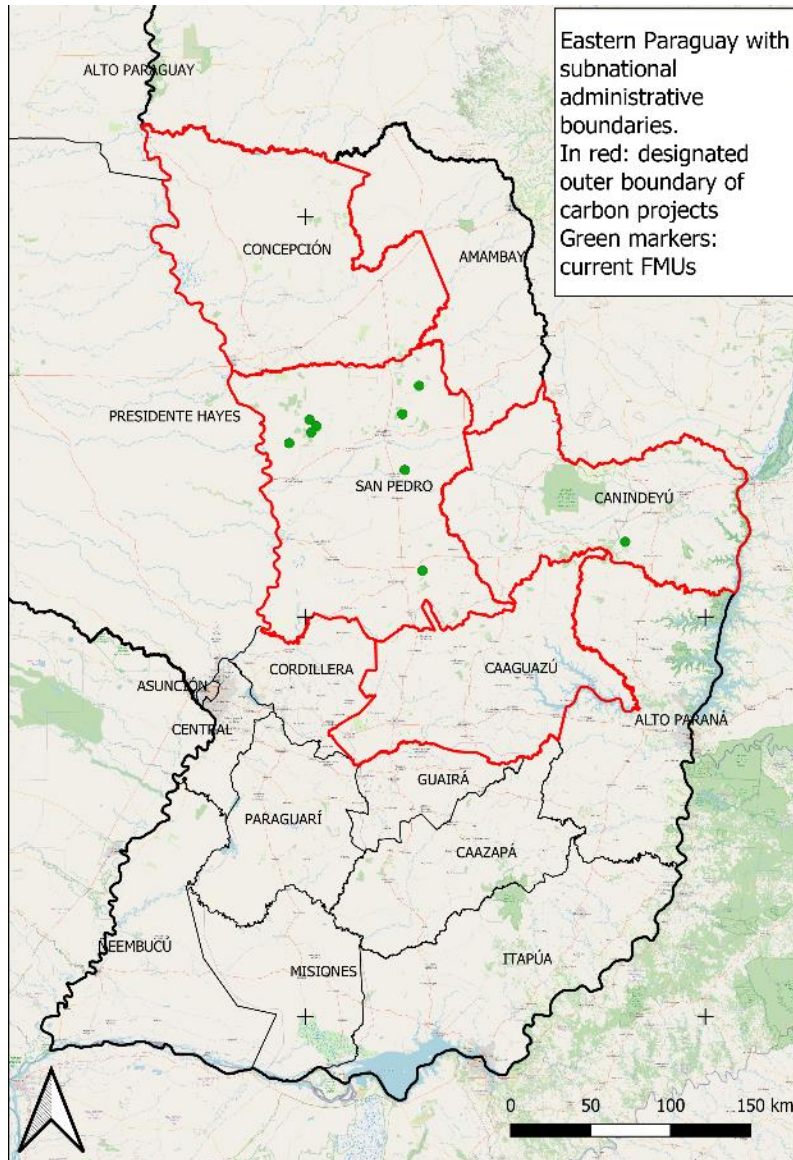


Figure 4: Project outer boundaries for future expansion

Project GIS maps are available as supporting documentation.

1.13 Conditions Prior to Project Initiation

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

Climate

Eastern Paraguay exhibits a sub-tropical climate, with annual average temperature and rainfall of around 23°C and 1,300 mm (see Figure 5).

In winter (May to August) the average temperature is between 16 and 18°C, with frosts occurring punctually, usually on a few nights in August. At this time, the deciduous tree species shed their foliage. Summer lasts from October to March, reaching temperatures of up to 41.7° C.

The region exhibits its dry season in winter, with peaks between July and September, in which average monthly precipitation is about 40 to 50 mm. The risk of fire is highest during these months. Fires are also a risk during the peak of the summer due to the high temperatures, depending on the rainfall of a given year (between December and February).

During the last years, weather patterns have been getting increasingly more unpredictable, with longer and out-of-season extremes.

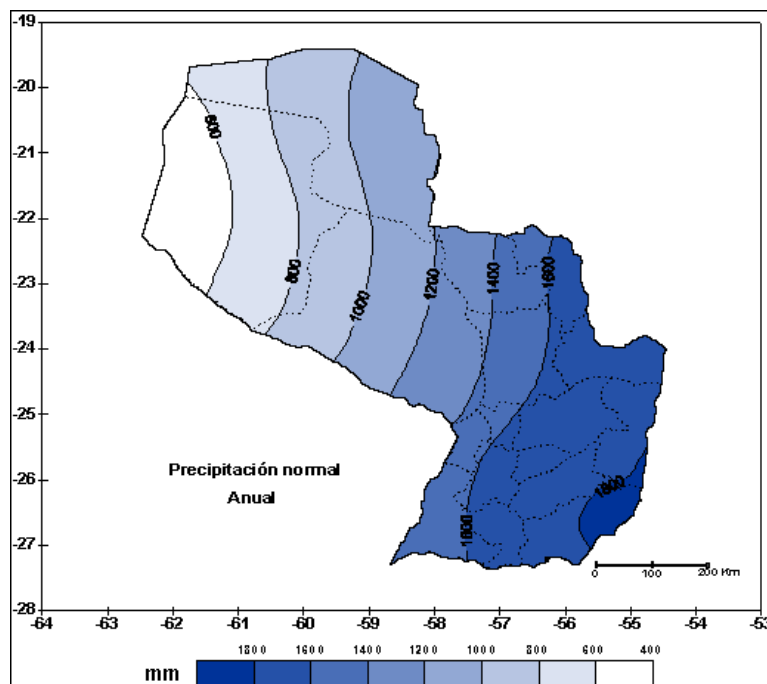


Figure 5: Precipitation gradient in Paraguay⁷

⁷ Source: www.camposparaguay.com.py

Topography and soil

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

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

On transition areas between lowlands and higher areas, where limitations for forestry are a bit stronger, the soils belonging to the sub-group “Psamment Rhodic Kandiodult” are common, which, under certain conditions, can be used for reforestation.

Hydrology

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

Socioeconomic situation

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

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

The agro-exporting model has made the country dependent on the international commodity prices of only two products (soy and beef). In the context of an absent state in many rural areas, this model has failed to create local sustainable socio-economic value, leading to the rural exodus of smallholders and traditional farmers. 2019 and 2020 have been years of economic crisis, affecting the rural poor disproportionately.

Vegetation and ecosystems

The Forestal San Pedro Carbon Project is officially located in a transition region between two ecoregions, the "Chaco Húmedo" (mosaic forests and savannas on sedimentary soils, originating

from rivers), and the "Atlantic Forests" (subtropical broadleaf forest). Usually, lowlands associated to watercourses feature Chaco-like characteristics, while high areas with deeper soils belong to the Atlantic Forest ecoregion. In between, some environments feature characteristics of "Cerrado" (savannas). This is typical for the region, as the Chaco integrates characteristics of other biomes as well.

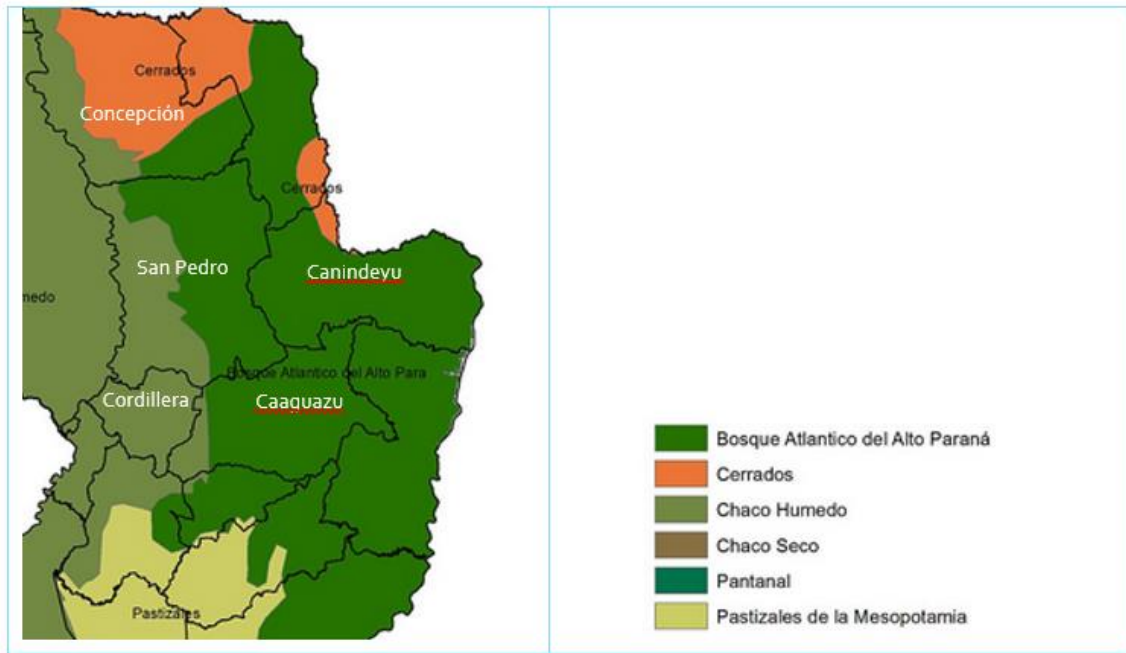


Figure 6. Ecoregions of Eastern Paraguay according to Dinerstein et al. (2017)

The San Pedro Carbon Project targets higher areas, which usually belong to the Atlantic Forest. This ecoregion features a deforested and degraded landscape, classified as critically endangered⁸ (Dinerstein et al., 2017). Deforestation has been rampant in the region in the last 50 years (see Figure 7). The subtropical Atlantic Forest which once dominated the landscape has been replaced by implanted pastures and mechanized grain production, leaving only 10-15 % of the original forest cover (2 M ha) distributed in highly fragmented and mostly degraded patches.

⁸ <https://academic.oup.com/bioscience/article/67/6/534/3102935>

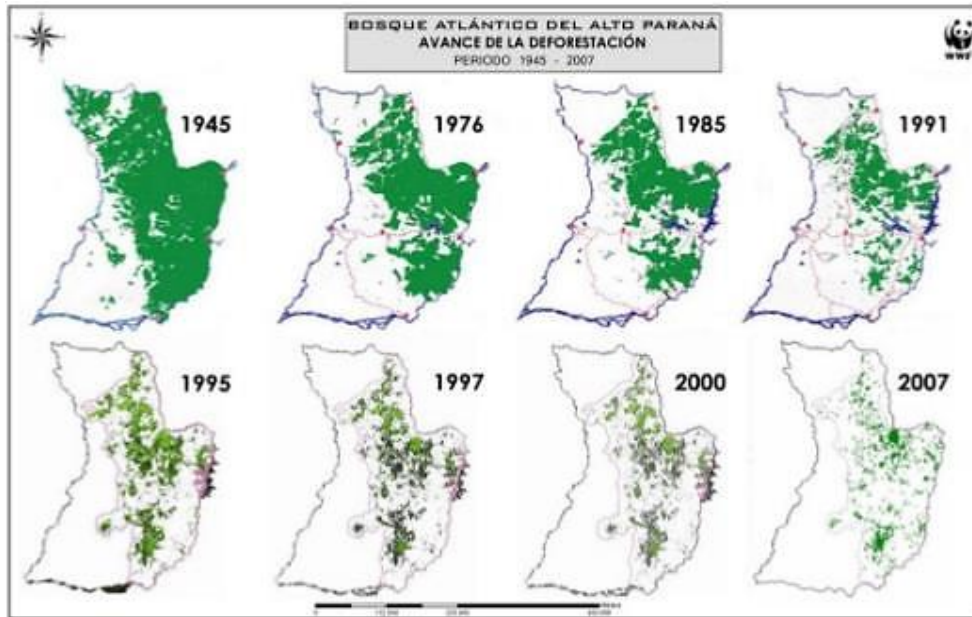


Figure 7. Deforestation development in Eastern Paraguay

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

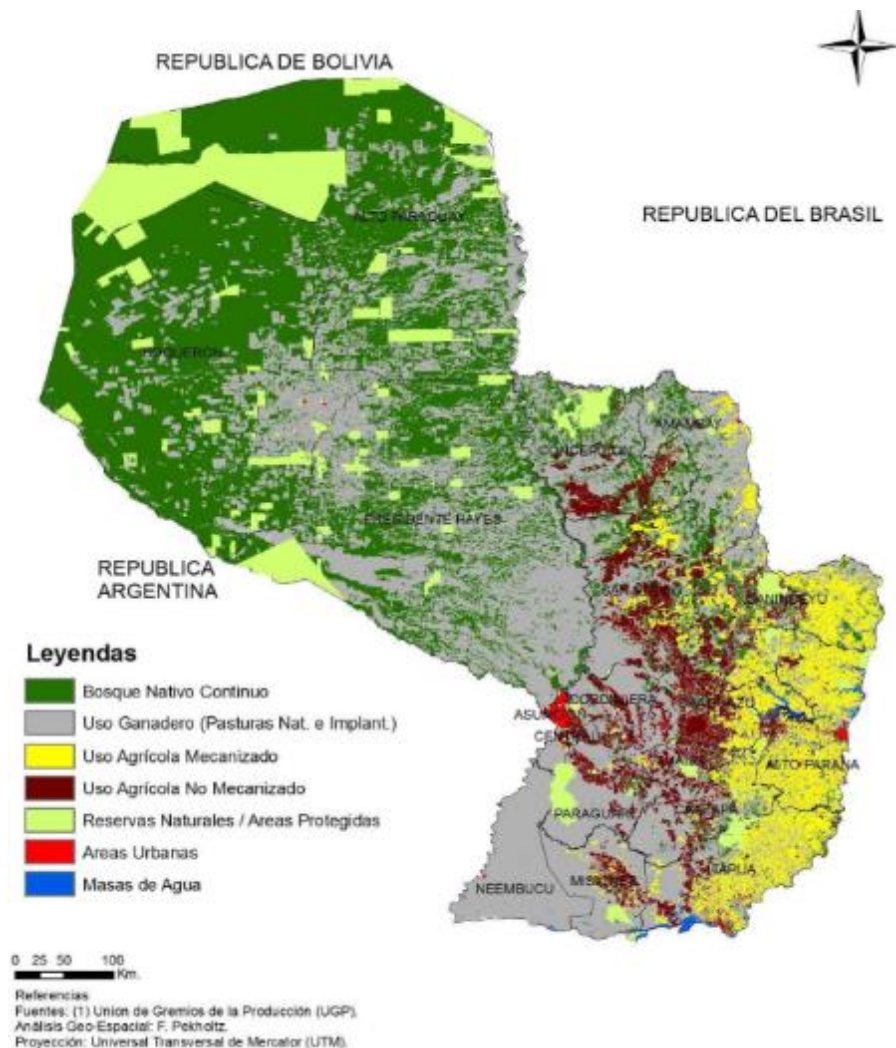


Figure 8. Land use of Paraguay (2009)

The land uses on the different FMUs encountered previous to project initiation correspond to the most common land uses found in the region: mechanized soy on 1,008 ha and implanted pastures on 3,393 ha. Mechanized soy is a high input land use model, where genetically modified seeds are sourced from large agro industrial companies (mostly Monsanto) and employed together with a technological package. The whole area is mechanized, and subject to two harvests in one year: Soy in Summer (January/February) and corn in Spring (September).

Cattle, on the other hand, is quite extensive. On many FMUs, much of the implanted pasture was in a compacted/degraded state and used very extensively when bought by the company, while a few were used more intensely. The latter means cattle is rotated more often, the grass is better managed, and supplementary feeding is conducted more intensely. Usually, cattle is bought with 9 months of age and around 90 kg/animal and sold after 1.5 to 2 years of fattening, with around 450 kg/animal. Fattening is conducted through grazing, sometimes with supplementary feeding

conducted in winter to avoid weight loss. Besides veterinary inputs and supplements, the inputs used on the grass are low, sometimes using broadleaf herbicides and ant or termite control.

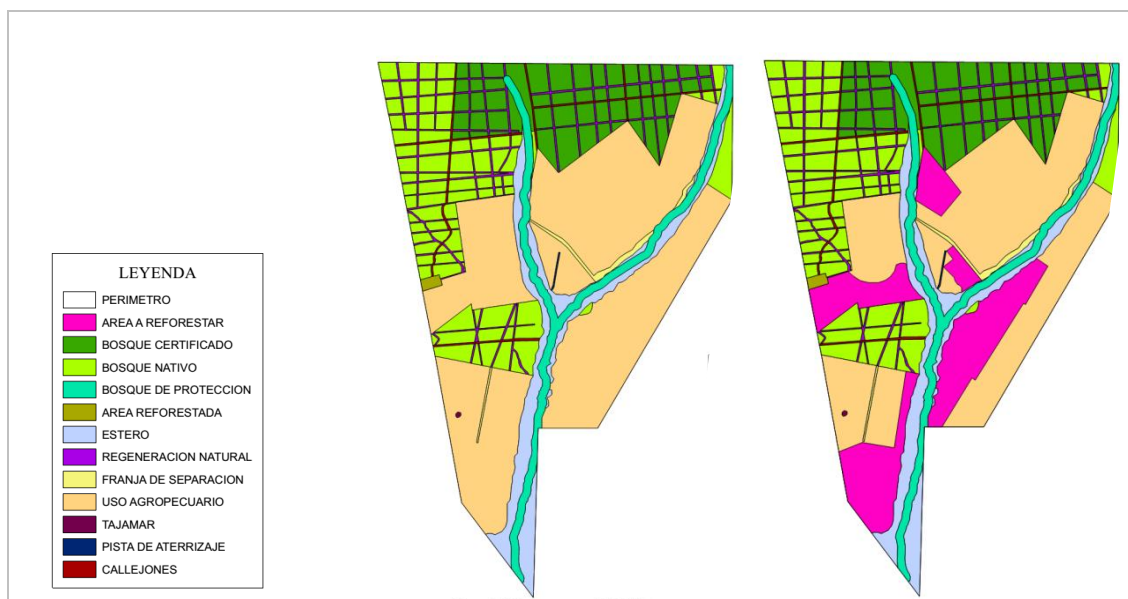


Figure 9. Example of land use before and after project initiation in FMU 2 (pink areas are plantations, and light orange areas are implanted pastures)

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The ARR project activity is in compliance with all applicable legal and regulatory requirements, which are implemented and scrutinized. A list of the main laws concerned can be found below (Table 7).

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

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

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

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

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

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

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

Table 7. Main laws relevant for the Forestal San Pedro Carbon Project in Paraguay

Aspect	Main laws	Description
Main environmental laws	▪ Environmental Impact Assessment Law N° 294/1993 Decrees N° 453/2013 and 954/13 introduce relevant changes to this law. ▪ Crimes against the environment are defined by Law 716/96	The most important requirement for private property owners is the need for an environmental license, subject to an Environmental Impact Assessment. Rural estates larger than 20 ha are subject to the environmental licensing process. The law defines environmental crimes and the sanctions applicable.
Forest and land use laws	▪ Forest law Law N° 422/1973 and decree N° 18.831/1986. ▪ Moratorium on land use change of natural forests in Eastern Paraguay Law N° 2524/2004, followed by Laws N° 3139/ 2006, 3663/2008, 5.045/2013, N° 5.266/18, and N° 6676/2020. ▪ Water resources and buffer areas Law N° 3239/07, N° 4241/10 and Decree N° 9824/12 ▪ Protected Areas N° 352/1994 and Resolution N° 200/2001 ▪ Wildlife is protected by Law 96/92 ▪ Environmental services by Law 3001/06	▪ In Eastern Paraguay, conversion of forest land is forbidden. ▪ All rural estates with a surface > 20 ha need to maintain 25 % of the forest cover existing in 1986. ▪ The law also establishes minimum buffer areas along streams and rivers, and restrictions on steep areas. ▪ Forestry activities involving exotic species is not allowed in protected areas. ▪ Plantations are subject to registration before INFONA for the legal commercialization of timber. ▪ Uncontrolled hunting is forbidden. ▪ Through an environmental service scheme, the law allows to offset lacking conservation areas in rural

Aspect	Main laws	Description
	▪ Tree Ownership Decouple from land through 4890/13	properties by additional conservation elsewhere.
Main laws related to labour	▪ Labour Code, Law 213/93, modified and partially updated by Law 496/95, and the Labour Procedural Code, Law 742/61. ▪ All fundamental ILO conventions were ratified by Paraguay.	▪ The law establishes minimum wage, obligatory social security provisions, benefits, freedom of association.
Main laws related to indigenous peoples	▪ Paraguay is a signatory to the core international human rights treaties, including the ILO Indigenous and Tribal Peoples Convention, 1989 (No. 169). ▪ Art. 64 of the Constitution	▪ Paraguay recognizes the right of indigenous communities to communal ownership of their lands.

1.15 Participation under Other GHG Programs

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

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

1.15.2 Projects Rejected by Other GHG Programs

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

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

1.16.2 Other Forms of Environmental Credit

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

1.17 Additional Information Relevant to the Project

Leakage Management

The Forestal San Pedro Carbon Project aims to increase the carbon stock of former agricultural land and implanted pastures through afforestation. Leakage could only be expected if the landowners leasing their land to the project would shift their pre-project activity towards forested areas, causing conversion.

Commercially Sensitive Information

None.

Sustainable Development

The San Pedro Carbon Project is the first of its kind in Paraguay. It is the first large scale project in the country establishing plantations in silvopastoral systems based on a leasing model, using long rotations for the production of quality timber, and FSC certified. The project contributes to the national forest sector by providing proof of concept and implementation of models aligned to political goals, such as the national plan of reforestation (Decree N° 10,147 of 2012), governmental efforts to formalize the biomass sector (Decree N° 4056/2015), and the contribution to the National Determined Contributions of the country, where afforestation is highlighted as a prominent measure.

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

Further Information

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

2 SAFEGUARDS

2.1 No Net Harm

Summary of environmental impact

- The project is developed on land leased on private properties, and only targets areas already heavily modified (used for beef production or mechanized agriculture) for planting. These areas have been deforested decades ago. Tree planting on these sites reduces erosion, contributes to an improved water household, sequesters carbon and in some cases, provides better condition for the connection of natural forests (natural corridors for biodiversity).
- Landowners are required by contract to have a valid environmental license. While the environmental license is not subject to exhaustive monitoring by authorities, it is a good tool to ensure compliance to the most important environmental regulation (such as non-deforestation, maintenance of the minimum natural forest reserve, and buffer zones), which is evaluated by the Environmental Ministry through satellite imagery at a frequency of about 2 years.
- The plantations require input such as lime, fertilizer, and pesticides for ant and weed control (Glyphosate and Fipronil). These are common products in Paraguay, already used previous to the activity on these sites. The input use of the plantations is much lower when compared to agriculture, and roughly the same or slightly higher when compared to beef production.
- While fires are common in Paraguay during the dry season, the fire prevention and combat work implemented by the previous owners has showed results. Only 39 ha (0.6 %) of plantations have been affected by fire and only 9 ha (0.1 %) have been lost due to fire since 2014.

Summary of socio-economic impact

- Landowners must have a legal title, and sites on which long-lasting or non-resolved conflicts between the property owners and local communities or other local stakeholders are identified are ruled out.
- Neighboring community members do not depend on the resources on production sites, meaning plantations do not restrict local people's access or use of resources of critical importance to their livelihoods, or negatively affect ecosystem services. Mostly, community members have small plots for cultivation and animal husbandry, or work in neighboring properties.
- Compared to previous land uses, the plantations provide benefits to local people, by providing local jobs. Plantations forestry provides around 25 Full Time Equivalents per 1,000 ha compared to 2-3 Full Time Equivalents on traditional cattle ranches. In the last years, an average of about 200 FTE were recorded, with more than 50 % coming from local communities.
- Labour is conducted through local service providers. The contractor's practices are monitored to ensure compliance to the minimum working conditions established by law. All

labour complies with social security and the labour code. This can be seen as positive impact in an environment where 80 % of labour is informal.

- Health and safety procedures have been effective. In the last 2 years, 3 accidents were recorded, none of them very serious. To date, no serious accidents involving long-lasting injuries or death have occurred.
- The project currently involves 23 beneficiaries participating in a long-term cooperation project to produce timber on smallholder land. Forestal San Pedro seeks to expand this project in the future. More details on the project are presented below.

General safeguards

- The project operated according to the previous owner's environmental policy in the past, and will operate according to the forestry Fund's ESG policies and requirements, and the FSC Principles & Criteria. The plantations have been FSC® certified in 2014 and are subject to annual audits by independent auditors ever since.

2.2 Local Stakeholder Consultation

Engagement with local communities and sub-contracted personnel

Plantations are established on traditional farms (private properties) that have been well established for decades (not on community land). The direct surroundings of the plantations are usually agricultural or cattle fields conducted by the property owners. The properties are surrounded by other medium and large properties dedicated to cattle and agriculture, as well as rural communities and smallholders.

Every time a new FMU is incorporated into the project, the management team identifies the communities directly neighboring the plantation sites, and those that share the use of resources (water courses) and infrastructure (access roads), as "direct local stakeholders". In some communities, full Participatory Rural Appraisal were conducted, whereas in others, interviews and inception meetings were conducted. In addition, local contractors and workers were identified, usually from the neighboring communities. Both local community members, as well as sub-contracted field workers, are considered the most vulnerable stakeholders, and therefore, several forms of engagement have been implemented to avoid negative impacts on them.

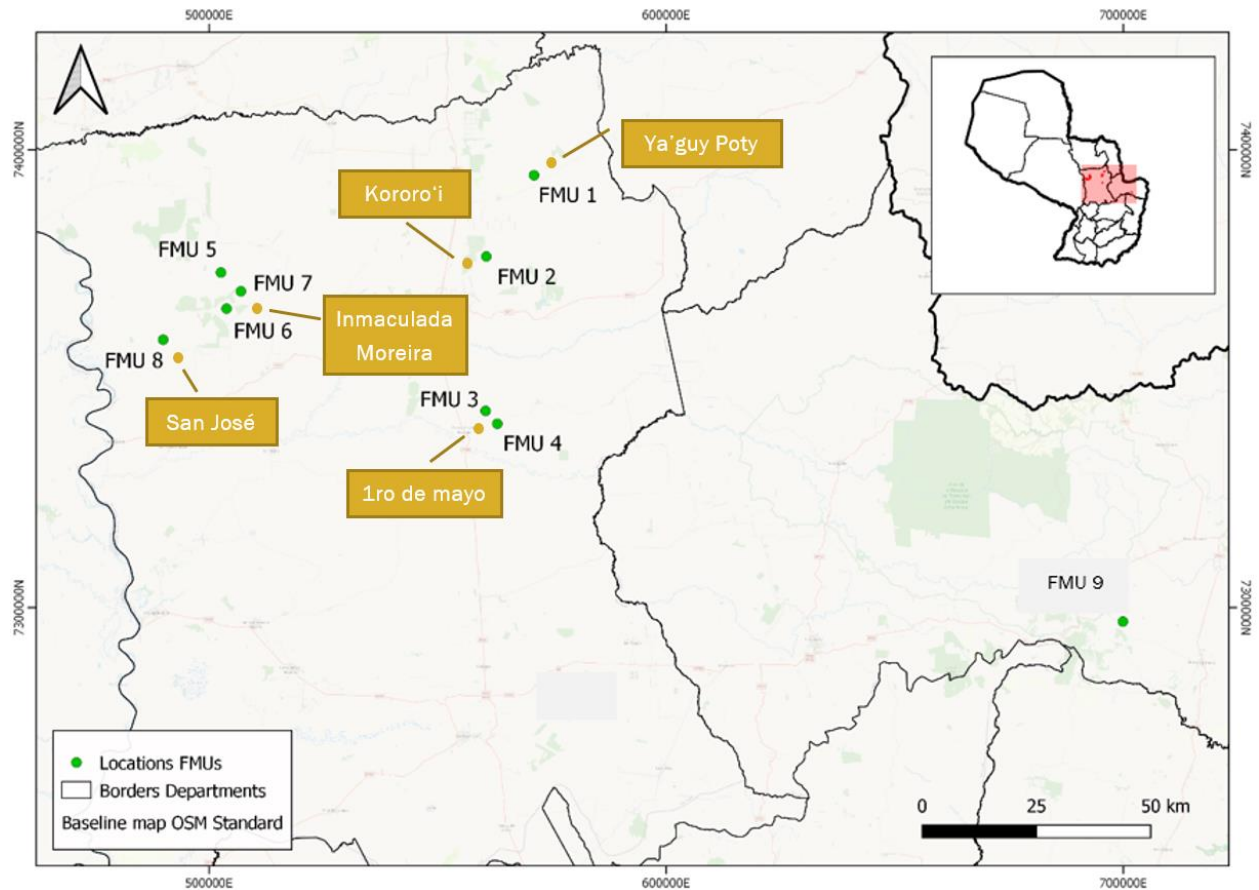


Figure 10: Map of communities surrounding the FMUs

The local stakeholder engagement strategy involves:

- Collection of basic baseline information of the community (location, number of families and main livelihood, land tenure and available infrastructure) and identification of key community representatives and local organizations. All baseline assessments were provided to the auditor during the validation audit.
- Inception meeting with the community to introduce the project and the team, its expected impacts, and the communication and grievance mechanism.
- Introduction of a Community Liaison Officer (CLO) to manage the Communication and Grievance Mechanism. The CLO acts as the main contact person between community members and sub-contracted field workers and the company. The previous company recorded five grievances in 2018 and one in 2019 related to road maintenance, dust from vehicles, provenance of workers and ant infestation in community land.
- Introduction of the social monitoring system, which among health and safety aspects also includes the monthly assessment of labour relations, to ensure sub-contracted personnel is employed according to the conditions of the national labour code, and an annual or bi-annual assessment of job-satisfaction among sub-contracted personnel.

Please refer to the annually published Sustainability Reports for the summary of the results:
<https://www.unique-wood.com/en/home/#sustain>

- Implementation of outgrower schemes in selected communities. Outgrowers are conducted in partnership with community members who have some spare land and are interested in planting eucalypts. The company enters into a long-term partnership with these smallholders, offering annual rent payment, as well as inputs and technical assistance. The income for the timber produced is divided in equal parts between the producer and the company. This project currently involves 23 beneficiary families and extends on 35 ha in two communities. Forestal San Pedro plans to expand outgrowers in the future. The project is considered positive as it does not only create long-term benefits for smallholders, but it aligns the interests of the neighbours and plantation project (for instance for fire prevention).
- Punctual support on demand, for instance annual donations to schools or maintenance of public roads.

Table 8: Communities surrounding the FMUs, number of families, participation in outgrower schemes, and date of the first meeting or assessment.

FMUs	Communities	Date of first meeting or assessment	No of participants in first meeting	No of families	No participants in outgrower scheme
FMU 1	Ya'guy Poty (indigenous)	July 2017	7	24	
FMU 2	Kororo'i	November 2014	30	75	13
FMU 3	1ro de Mayo	November 2017	n.d.	96	
FMU 4					
FMU 5	---			---	
FMU 6	Inmaculada Moreira	November 2016	9	102	
FMU 7	---			---	
FMU 8	San José	November 2014	22	80	10
FMU 9	---			---	

Third-party stakeholder consultations

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

During so-called principle audits (first audit and then every 5 years), a more exhaustive consultation phase is conducted, during which the certification agency consults national, regional, and local stakeholders about the project. This includes environmental and forest

authorities, NGOs and experts, local community members and associations, contractors, and workers. The management team keeps a complete list of stakeholders per FMU.

Stakeholder consultation when assessing High Conservation Values (HCV)

Public consultations are conducted for specific topics, such as the High Conservation Value assessments. When these assessments are made, local stakeholders are consulted, when relevant, to assess whether the area is considered important for the use of resources by neighboring communities, or the provision of ecosystem services. Also, national stakeholders were consulted for the validation of the assessment results, including civil society representatives and national authorities.

Public disclosure

A public summary of the management plan and monitoring results has been disclosed for the public on an annual basis. The annual public summary for 2019-2020 can be retrieved here: https://www.unique-wood.com/wp-content/uploads/2020/09/2019-2020-PAYCO_Resumen-P%C3%BAblico-del-Plan-de-Manejo-y-Resultados-de-Monitoreo.pdf

Results

Stakeholder consultation revealed that:

- Overall, neighbouring communities are in favour of the project, particularly when it implies in significant job creation.
- The project has maintained and built up a number of local service providers, which is viewed as positive by community members.
- In those management units where plantations have reached more than 5 years of age there has been dissatisfaction over decreasing job opportunities for local people, as maintenance work decreases in favour of mechanical harvesting that requires professional labour (mostly not local). The challenge here is to introduce a more even age distribution to keep a steady workforce throughout time.
- All stakeholder consultations conducted in the context of FSC certification have not resulted in critical comments.

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

2.3 Environmental Impact

Procedures to mitigate potential environmental of the project are in place. A summary of the potential impacts and implemented mitigation measures is presented in the Table below. This is documented and can be verified through the company's records, the ESDD conducted by the Fund, the Management Plan, and other project documentation.

Table 9: Environmental impact and mitigation measures implemented

Environmental impacts	Mitigation measures
Habitat destruction and conversion through plantations Plantations could have negative impacts on local ecosystem and biodiversity if they are established on natural ecosystems.	▪ Plantations are established on areas previously used for implanted pastures (beef production) or mechanized agriculture. To date, no habitat destruction has taken place, as plantations are always established on heavily modified areas. ▪ Under no circumstances does forest conversion take place for the establishment of plantations. A historical land use assessment is conducted before planting. ▪ A condition for land lease is the existence of a valid environmental license by the owner. ▪ On each FMU, a baseline biodiversity study is conducted documenting the state of the site before planting.
Impacts of eucalypts on water availability Eucalypts are characterized by high water consumption. Such behavior may cause water scarcity in dry environments.	▪ The project region, exhibits annual precipitation > 1,300 mm. Also, the region is natural forest area, highly fragmented and degraded, meaning the plantations may contribute in improving the water household (increased water retention in the soil compared to agriculture, etc.). ▪ Eucalypts are not planted in areas important for water recharge (in lowlands subject to flooding). ▪ Buffer zones of rivers and streams are protected.
Invasive behavior of exotic species In some areas, eucalypts have been described as having an invasive behavior. However, this has not been observed in Paraguay until now.	An invasive behavior of eucalypts has not been observed in the project to date. Following practices are applied to further diminish this risk: ▪ Exotic trees are planted only in demarcated areas. ▪ Genetic eucalypt material planted mostly encompasses clones (not seeds), with limited capacity to produce seeds and spread. ▪ Plantations are combined with grazing systems where cattle controls any unwanted regeneration.
Soil erosion Most of the FMUs are located on terrain that is either flat or shows soft declinations. Only FMU 9 has parts steeper than 15°. Due to the absence of steep terrain, the risk of erosion is low.	▪ Roads are built respecting good practices to facilitate proper drainage and prevent erosion. ▪ In areas dedicated to plantations with fragile soils, contour lines, ridges or other measures are implemented to control surface runoff to counteract erosion.

Environmental impacts	Mitigation measures
However, forestry activities may still potentially cause erosion, during the installation and use of roads and, particularly, during harvesting.	▪ Thinning and harvesting are carried out in a controlled manner, with heavy machinery circulating only on the roads and tracks of the extraction of signs.
Pesticides and inputs Plantations require the application of chemical inputs, such as calk for soil acidity, fertilizer, herbicides (glyphosate) and Fipronil for ant control. Such inputs, when used without care, can affect non-target organisms and affect human health negatively.	▪ Inputs are quantified and applied only when needed, following specific dosage and recommendations of the producer. ▪ Pesticides and other chemical inputs are stored in deposits with impermeable floors, ventilation and fire-extinctors. ▪ The products are only received if they are in their original containers, are still valid, and accompanied by the security sheet. ▪ Packaging of potentially toxic waste is disposed according to national regulations and recycled by an accredited company.
Fuels and oils The machinery used in the finca requires oils and fuels. If not well maintained, these may leak into the soil or waterways.	▪ Machinery used is well maintained. ▪ Fuels and oils are organized, stored and labelled appropriately. ▪ Fuel and oil exchange are conducted on impermeable platforms.
Illegal activities Hunting, fishing and the uncontrolled extraction of timber and plants may in the finca by company workers or external people may further contribute to the degradation of ecosystems.	▪ Permanent presence of company staff in the FMU ensures the control of activities in the area. ▪ Hunting, fishing and uncontrolled logging of natural timber species is strictly forbidden. ▪ Appropriate signs are installed, and workers are continuously instructed about prohibited activities.
Forest fires Eucalyptus plantations are susceptible to fire, which can have devastating environmental consequences	▪ During the dry season, permanent vigilance is conducted. ▪ Staff are continuously trained in fire prevention and firefighting. ▪ Firebreaks are installed, the fuel on site is maintained low, particularly during the dry season. ▪ Appropriate fire prevention and firefighting tools are available at each site, as well as the protective equipment for firefighting. ▪ Cooperation with neighbors is in place in all units for vigilance and combat.

Environmental impacts	Mitigation measures
	Up to now in about 8 years, forest fires have affected less than 0,6 % of the total plantation area.

2.4 Public Comments

During the public comment period, no comments were received regarding the San Pedro Carbon Project.

2.5 AFOLU-Specific Safeguards

AFOLU-Specific Safeguards are addressed as follows:

- Local stakeholder identification process and a description of results.

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

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

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

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

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

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

A grievance mechanism is in place and publicly available in the Annex of the annually updated public summary of the forest management plan⁹.

- Sexual harassment/gender equality

The management team of UNIQUE works according to a code of conduct that explicitly includes the organization anti-discrimination's stance regarding gender equality¹⁰. In addition, it should be noted

⁹ https://www.unique-wood.com/wp-content/uploads/2021/07/2020-2021-PAYCO_-Plantaciones_Resumen-Publico-PMF.pdf

¹⁰ https://www.unique-landuse.de/images/Verhaltenskodex_UNIQUE_UFL.pdf

that 25 % of the management team (in Full Time Equivalent) involved in the project to date are women (according to the latest registry late 2020).

The Fund investing in Forestal San Pedro has high gender equality standards (using as a reference the GCF gender policy). The newly established company will seek to identify entry points to increase the project's impact in terms of gender equality. To date, the share of women in the operative workforce is very low (of about 0.5 %), particularly because the project does not involve operative work typically conducted by women (such as nurseries).

Table 10: Social impact and mitigation measures implemented

Risk	Affected stakeholders	Mitigation measures
Displacement/livelihoods /access to ecosystem services	Local community members	▪ The project is taking place on private properties. ▪ The legality of the titles is assessed, as well as the absence of disputes. ▪ Initial consultation with local communities and the grievance mechanism are used to rule out or act upon disputes and/or conflicts. No serious conflicts about land use or access has been raised to date. To date, the project has not caused displacement, eviction, or any form of limited access to critical resources to local community members. All projects have been established on rightful private properties previously used for cattle or soy production.
Risks of accidents / Health and safety Forestry is characterized by dangerous work, particularly when harvesting. Other jobs, such as the application of pesticides and chemical products, also bear risk for human health.	Field workers	▪ Constant on-the-job trainings and trainings for specific dangerous work are implemented (e.g.: chainsaw operation). ▪ Procedures for the correct use, storage and application of pesticides and chemical products. ▪ Provision of security equipment adequate for the different types of work. ▪ Trainings in emergency preparedness, first aid and health and safety. ▪ Provision and monitoring of first aid kits.

Risk	Affected stakeholders	Mitigation measures
		▪ Installation of warning signs in dangerous places. ▪ Provision of appropriate food and accommodation for workers. ▪ Annual consultations with workers on job satisfaction. While accidents have been recorded, the rate remains low (about 3 to 4 accidents a year), and to date, none of these have resulted in severe and long-term injury or death.
Non-observation of minimum labor benefits (wage, social security, etc.). In rural Paraguay, labor is usually informal. Therefore, benefits such as social security are not observed.	Sub-contracted workers	▪ Monitoring of minimum working standards among contractors and sub-contracted personnel. Any deviation of minimum standards is corrected immediately. ▪ Semi-professional contractors with little experience in administration and staff management were required to work with a bookkeeper that assists them with formalities, such as social security.
Dust and noise /accidents on the road Transport of wood products and inputs in and out of the FMU could increase traffic and increase dangers to the communities located on the access road. Workers circulating in motorbikes could also be at risk by increased traffic and dust.	All workers and neighboring community members	▪ Speeding signs are introduced along internal roads. ▪ The use of helmets is required and monitored when using motorbikes. ▪ Instruct drivers in safe driving, particularly on the community access road. ▪ Grievance mechanism
Reputational risks / political risks Eucalypts have been criticized by environmental groups in Paraguay, as well as large landholdings.	The company (Forestal San Pedro)	▪ Engaging environmental and social actors in management decisions ▪ Implementing best practices ▪ Grievance mechanism ▪ FSC certification

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

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

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

- “Combined tool to identify the baseline scenario and demonstrate additionality”, version 01
- “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, version 4.2
- “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities, version 3.1”
- “Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity”, version 4.0
- “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, version 01.1.0
- Tool “Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities”, version 1.0.1

3.2 Applicability of Methodology

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

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

San Pedro plantations are established on former agricultural and pasture lands. Wetlands, degraded forests and other sites are protected as part of the FSC certification scheme.

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

According to internal SOP's, plantations are not established on wetlands. Soil analysis of the plantations, which were conducted by independent consultants confirm this procedure. The most represented soil types on the FMU 9 are Rhodic Ferralsol and Rhodic Acrisols. The data of a Rhodic Ferralsol, which occurs on 1,100 ha of the FMU 9 is shown in Table 11. Very common are also Rhodic Acrisols in FMU 9 (700 ha). These soil types belong to the IPCC class of “Low activity clay soils”. However, some FMUs, incorporate gleysols typical for wetlands. Whenever this is the case, these areas are protected and not used for afforestation or any other purposes. This is supported by baseline and project land use plans. The plantations are established only on former agriculture or pasture land. Further, soil analysis results are available upon request.

Table 11. Sample data of a Rhodic Ferralsol soil type, data HWSD

Parameter	Value
Dominant soil group	Rhodic Ferralsol
Topsoil texture	Fine
Drainage class	Moderately Well
Topsoil sand fraction (%)	13
Topsoil silt fraction (%)	25
Topsoil clay fraction (%)	62
USDA Texture classification	Clay (heavy)
Reference Bulk density (kg/dm ³)	1.18
Topsoil gravel content (%)	0
Topsoil organic carbon (% weight)	1,2
Topsoil pH	5.3
Topsoil CEC (cmol/kg)	9

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

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

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

- A line of trees every 5 m results in 20 lines/ha
- 20 lines * 0,5 m of width * 100 m of length/ha = 1,000 m² of soil disturbance/ha

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

This tool has no internal applicability conditions

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

This tool has no internal applicability conditions

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

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

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

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

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

3.3 Project Boundary

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

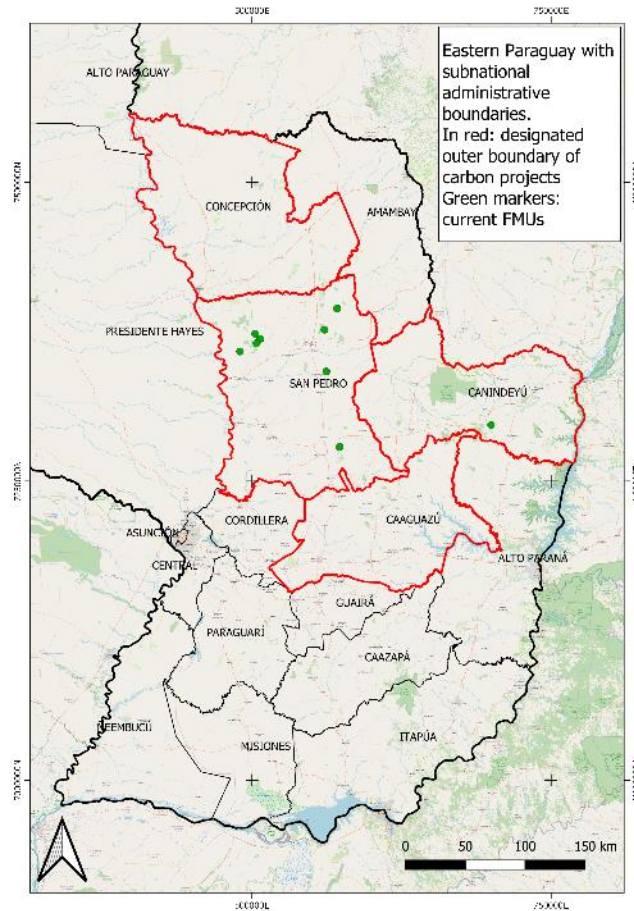


Figure 11. Forestal San Pedro Outer Boundary (red) and First Project Instances (green)

3.4 Baseline Scenario

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

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

The plantations acquired by Forestal San Pedro were established between 2015 and 2019, with the first planting activities starting in April 2015. This is before the registration date and after 31 December 1999.

The forestry Fund considered the generation of carbon credits from the beginning: ‘The Fund aims to invest in forestry projects where the sale of timber and derived products represents the main source of revenues. Nevertheless, carbon sequestration will be a major ecological benefit of all projects. The potential to generate carbon credits for the voluntary and compliance carbon market will be assessed for each project as one potential source of additional return’ (Source: the forestry Fund Documentation 2014).

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

In Eastern Paraguay, the dominant land uses are mechanized soy production and cattle. These have expanded into areas traditionally occupied by family farmers, given through rental contracts or sales by family farmers, mainly in the departments of Caaguazú, San Pedro, and Caazapa (World Bank¹¹ 2015).

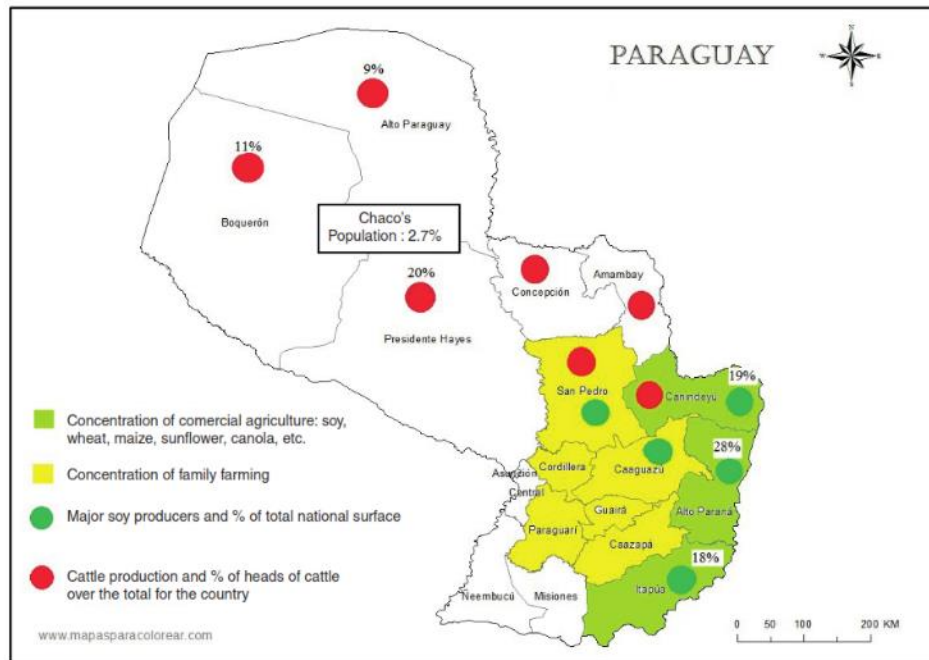


Figure 12. Spatial Distribution of the Main Agriculture Activities (Arce et al. 2015)

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

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

The plantations are established on medium farms, with property surfaces ranging between 1,000 and 10,000 ha. Most of these farms exhibit the typical land use patterns in the region:

The sites most valued are those suited for mechanized agriculture, usually located on higher, well drained, terrain. They used to be covered by natural forest decades ago, and are now used for grain crops, mainly the intercropping of soy and maize. 23% (1,008 ha) of the plantations are established on these areas.

Other well drained sites, also located on areas previously deforested, and sometimes exhibiting limitation for mechanized agriculture, are used for beef production on implanted pastures. 77 %

¹¹ <http://documents1.worldbank.org/curated/en/556311467986343378/pdf/93943-REVISED-Box393201B-PUBLIC-53889TA-No-3-Paraguay-Ag-Sector-Risk-Assessment-WEB-26-06-2015-jtc.pdf>

(3,393 ha) of the plantations are established on these areas, of which 3,162 ha under silvopastoral regimes in cooperation with the landowner.

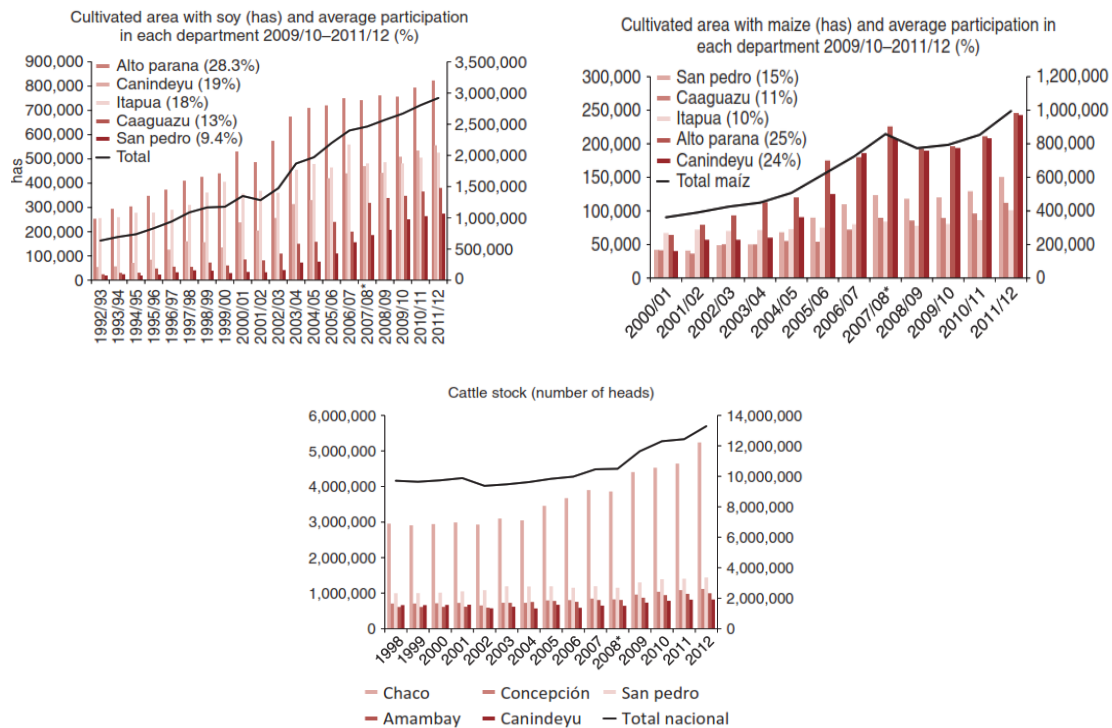


Figure 13. Cultivated areas of soy (upper left), maize (upper right) and cattle stock in departments of Paraguay and their national shares (Arce et al. 2015)

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

Overall, landowners are weary of establishing forest plantations, particularly due to its long term horizon. Most landowners are either traditional cattle ranchers that strongly identify with cattle production, or belong to the newer generation agroindustry, that establishes soy production that is heavily input-based and mechanized. Although according to current official estimations the country has about 180,000 ha of forest plantations, experienced forest experts assume the figure to be lower. Considering only actively managed plantations, there are most likely about 100,000 ha of forest plantations in Paraguay, whereas around 400,000 ha of plantations would be needed to provide the sustainable supply of the country's need in terms of fuelwood and timber. Therefore, there is a need of incentives to foster long term plantations.

As this is a brownfield investment, the project has largely been established without the A/R CDM component. However, being an innovative project in the region, it faces many economic risks related to immature markets, uncertainties about growth and yield, changing climatic patterns, and the lack of professional service providers (see Barriers analysis in this section below). The carbon component would increase overall economic performance and decrease the risks brought

The purchase of the project and the expansion proposed by Forestal San Pedro entails the introduction of the carbon component coupled to a higher focus on monitoring, ES impact, and benefit sharing. This includes:

- Higher investments on company-community cooperation models, by expanding current outgrower models in the upcoming years.
- Increase the team of Community Liaison Officers, from currently 1 FTE to 2 FTE, to strengthen community-company relations.
- Strengthen cooperation with local landowners. In a scenario without the carbon component, the project would be subject to higher risks in terms of permanence. Carbon credits would allow some early revenue streams otherwise not possible due to the long term rotation. The income provided by carbon credits provides the opportunity to establish additional incentives for partner landowners to expand cooperation and land lease over one rotation.

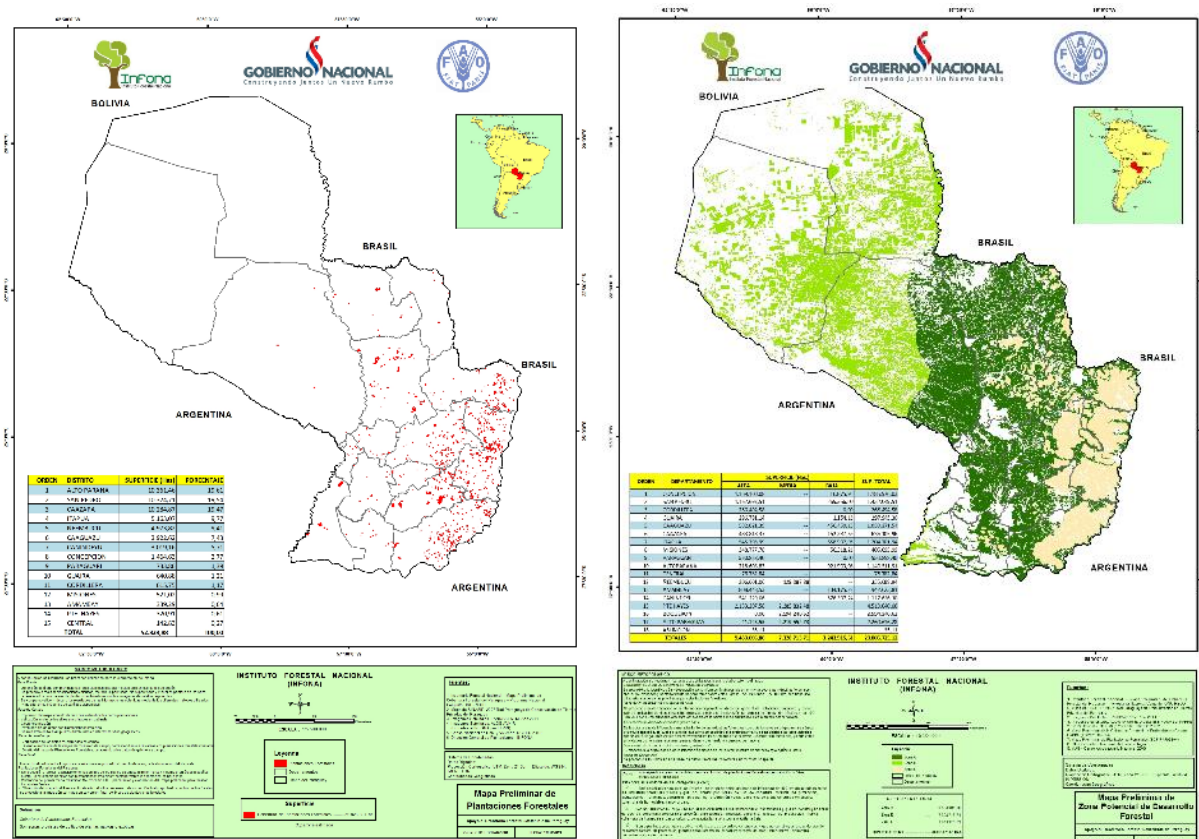


Figure 14. Left: Locations of commercial plantations in Paraguay (INFONA Maps Project TCP PAR 3304) - Caazapá, San Pedro and Alto Paraná departments concentrate almost 60% of plantations (31,000 hectares); Right: Areas for potential forestry development (INFONA Maps Project TCP PAR 3304) - High potential areas (less than 100 km from ports or industries) add up to 9:000.000 hectares, mainly in central Paraguay.

3. Other alternatives

No other possible alternative scenarios have been identified.

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

In principle, all land use alternatives identified above comply with all mandatory regulations in the country (see applicable Laws and regulations in Section 1.14). However, it should be noticed that mechanized soy production and beef production have often been implemented without complying to the national environmental law in the past (see sub-section below). In addition, the lack of the enforcement of the labour code in rural Paraguay is systematic, with around 80 % of rural labour working informally¹². This is common among all sizes of rural establishments.

The Forestal San Pedro Carbon Project, on the other hand, complies with all relevant Paraguayan laws and regulations, which is an aspect regularly verified by third party audits conducted within the scope of the projects FSC certification (FSC® C117138).

Weak environmental law enforcement in the country

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

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

In 2004, Paraguay had the highest deforestation rate in America when the Government passed a moratorium on forest conversion in Eastern Paraguay (Law N° 2524/2004 and subsequent extensions), also known as the “zero deforestation law”, now until December 2030.

¹²http://www.ilo.org/wcmsp5/groups/public/---americas/---ro-lima/documents/publication/wcms_245620.pdf

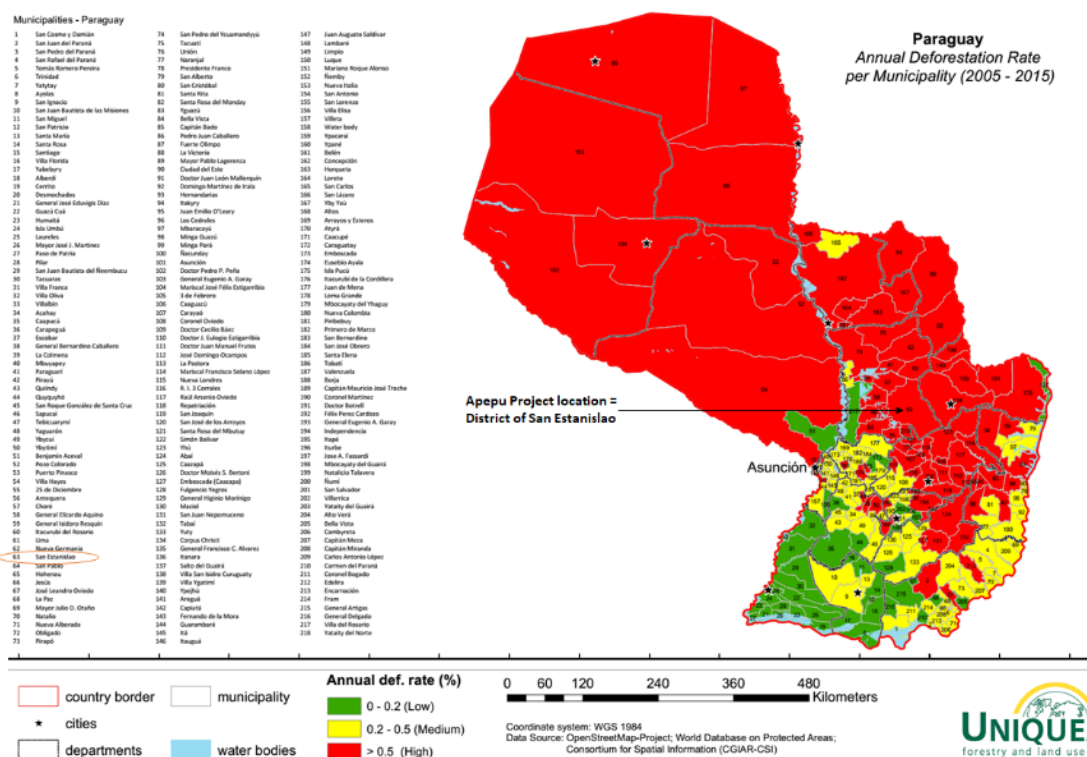


Figure 15. Deforestation risk per Department in Paraguay (2005-2015)

While large-scale deforestation significantly reduced after the moratorium on forest conversion was introduced in 2004, forest degradation continues. The maintenance of 25 % of the natural forest cover of a property as established by law is seen as a liability by producers. The extraction of firewood and timber, uncontrolled hunting, and informal occupations spurred by unresolved land conflicts are widespread. This leads to the degradation of the forest which makes it more vulnerable to fires and/or extreme natural phenomena such as droughts and storms (GIZ13, 2013; Clark, 2005; FMB, 2007¹⁴).

The continuous forest degradation process is plausible when looking at Paraguay's energy matrix, which is still largely based upon the informal extraction of biomass. According to the GIZ (2013), there is a deficit in supply of sustainable biomass, of more than 10 million tons annually. The share of biomass in the country's energy production is as high as 46 %, of which over 70% is informally sourced from natural forests.

In the context of weak law enforcement, authorities have realized that forest protection is difficult in the absence of incentives. To encourage the protection of forests, a Payment for Environmental Services scheme was implemented at the national level (Law 3.001/06). The law allows for the

¹³<http://www.unique-landuse.de/images/publications/vereinheitlicht/ProduccionyConsumodeBiomasaSolidaaenParaguay.pdf>

¹⁴https://www.researchgate.net/publication/284691422_Biodiversidad_en_el_Paraguay_una_aproximacion_a_sus_realidade

compensation of those owners who maintain a forest cover greater than that defined by law (more than 25%) by those owners who have environmental liabilities (a debt with respect to such reserves), applying referential market prices and in a free payment arrangement between owners. So far, the impact of this law has been marginal, as it is failing to create the environment for a functioning market (Clark, 2005¹⁵).

Step 2. Barrier analysis

• Sub-step 2a. List of barriers

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

- Investment barriers
 - Financial risk related to long term uncertainties in a context with a lack of similar experience
 - High hurdles to invest in forestry due to high initial investment and long paypack period compared to common land uses, mainly grain and beef production.
 - Higher management and labour costs compared to other land uses due to the complexity of stakeholder management on 10 properties, the application of international standards and FSC certification.
- Barriers related to land tenure, ownership, inheritance and property rights, inter alia:
 - Financial risk related to the leasing model (no land ownership and/or appreciation component to reduce project operational risks)
 - Non-leveled playing field due to the competition with the highly informal woodfuel market (low prices for woodfuel), and under-developed market for quality timber. Possibilities of price risks due to the fluctuations in the prices of products over the project period in the absence of efficient markets and insurance mechanisms.
- Barriers due to local ecological conditions, inter alia:
 - Changing climatic patterns and increase of extreme weather events
 - Incidence of pests and diseases
- Technological barriers
 - Lack of capacity to predict systems productivity (e.g. lack of long-term forestry experience, first ground proof of growth models)
- Barriers related to local tradition, inter alia:
 - Traditional equipment and technology of the forest industry, based on natural forest species that were depleted

¹⁵ <http://parquesnacionalesdelparaguay.blogspot.com/2014/11/salvando-el-bosque-atlantico-en-paraguay.html>

- Local culture still opts for the most traditional/common land uses
 - Absence of professional service providers
 - The land use scenario is the “first of its kind”: No activity of this type is currently operational in the host country or region
- **Sub-step 2b. Elimination of scenarios prevented by barriers**

Alternative 1

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

Alternative 2

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

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

This project is the first of its kind in Paraguay. It is the first large scale project in the country establishing plantations in silvopastoral systems based on a leasing model, using long rotations for the production of quality timber, and FSC certified. This brings about a number of benefits, such as:

- proof of concept for diversified production models based on cooperation with existing local landowners in the context of a largely deforested and degraded forest landscape, dominated by cattle and mechanized soy production.
- proof of concept and implementation of models aligned to political goals, such as the national plan of reforestation (Decree N° 10,147 of 2012), governmental efforts to formalize the biomass sector (Decree N° 4056/2015), and the contribution to the National Determined Contributions of the country, where afforestation is highlighted as a prominent measure.

- the local production of sustainable timber and wood, in the context of a market gap of sustainable timber. According to a market study conducted by Forestal San Pedro's investors, there is a sustainable production gap of around 11-12 m³ per year (mainly fuelwood), which translates into a need of 360-400,000 ha of plantations (in line with the Governmental reforestation plan).
- the introduction of best practices for quality timber production and increased value addition, fostering national professionalization and industrialization.
- the production of sustainable biomass reducing pressure on natural forests.
- the introduction of best practices and standards in a highly informal context.
- the introduction of benefit-sharing models with local landowners and local community members through outgrower schemes.

The previous owner has been able to overcome many of the typical barriers for forestry projects in the country, leading to the successful plantation of 6,300 ha between 2014 and 2016. Nevertheless, given it is a long-term investment, the project faces uncertainties that translate into financial and productive risks:

- Risks related to the long investment horizon
- Risk related to the land lease model
- Currency exchange rate risk
- Natural and sanitary risks
- Market risks related to an underdeveloped quality timber market and an informal biomass market
- Uncertainties regarding the production model, growth & yield
- Risks related to insufficient technical capacity and absence of professional service providers

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

Risks related to the long investment horizon

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

The Paraguayan Government has been fostering forest plantations in the country since the 1990s. The first incentive scheme developed by the Paraguayan Government was introduced through the forestry law 422 in the 70s, which failed due to a poor technical design, budgetary constraints, and mismanagement (FAO, 2006). Then, in the 90s, the Afforestation and Reforestation Law (N° 536/95) should have represented a turning point in the development of forest plantation. The incentive scheme subsidized 75 % of payments for plantation establishment and maintenance costs in the first three years. In addition, plantation forests receive a 50% property tax exemption. Initially after the promulgation of this law, from 1995 till 2004, about 34,000 ha of plantations were established (Szulecka et al. 2017). However, due to many project planning mistakes, poor management, lack of institutional capacity and lack of dedicated funds, the subsidy law quickly became un-operational (Szulecka et al. 2017). According to FAO¹⁶ (2006), the implementation of this law was discontinued after a few years due to budgetary constraints, with the State owing about USD 6 million of subsidies to producers.

Most commercial credit lines have not been appropriate to fund forestry projects. Only in 2019 the Government introduced an attractive credit line to fund forestry projects through the National Development Bank (Banco Nacional de Fomento). This was aimed to spur investments into sustainable biomass production through forest plantations, to halt forest degradation driven by informal sourcing of biomass. However, these credits could not be accessed for this project, due to the fact that the Bank requires property titles as collateral, and does not accept the tree asset on leased sites.

The previous owner could overcome this limitation through equity investments, and similarly, the Fund invested in Forestal San Pedro has been able to secure the funds to purchase the project through equity investments and loans from international lenders. Nevertheless, the long-term nature of the project and its unique features compared to other projects in the region increase its financial risk, as explained in the following sub-chapters.

¹⁶ FAO (2006). Tendencias y perspectivas del sector forestal en América Latina y el Caribe.

Risk related to land lease model

One factor hindering new actors to invest into forestry have been the high property prices. Land prices in Eastern Paraguay have been rising steeply until 2014, related to soy commodity prices and speculation. They have had little relation to expected return on investment for forestry.

Therefore, the business model for the project was modified during its conception. Instead of buying land, the investment is based on land lease for one quality timber forest rotation (up to 14 years). This arrangement could be implemented through the Law N° 4,890 issued in 2013, which allows the separation between the ownership of the land and the forest on it.

Through the project expansion model based on land lease and cooperation with landowners, the project fosters land use diversification in a landscape dominated by monoculture mechanized soy production and beef. Silvopastoral systems provide land owners with more diversified income streams, through land lease, a participation in timber sales, and the possibility to keep producing beef on the area, albeit with a reduced intensity. In addition, it makes them more resilient to the shocks of the international commodity markets of beef and grains. They bring about environmental and socio-economic benefits related to an increase of rural labour, erosion control, and carbon sequestration compared to baseline land uses.

Another positive effect is the project's contribution to providing opportunities for sustainable intensification for cattle ranchers in Eastern Paraguay. In the midst of increasing market pressure and competition, cattle ranchers have been migrating to Western Paraguay. There, they expand their cattle herd on forested land, driving deforestation (this effect has been described by several authors, such as Larsen¹⁷ 2017, Baumann¹⁸ et al., 2017; Waroux¹⁹ et al. 2016).

This is the first large scale project making use of this law. While the law provides legal security on the forest asset, there are no experiences to draw on to date. This is an important factor, as the purchase of land usually is seen as providing security to forest investments, particularly a context where the timber market is underdeveloped, as in Paraguay.

Currency exchange rate risk

The depreciation of the local currency against USD is perceived as a major financial risk by international investors. For the Forestal San Pedro Carbon Project, 50% of overall costs are to be paid in USD (mainly land lease and payment to project manager), while timber revenues are harnessed mainly in local currency. Having an alternative revenue stream in USD from carbon credits would act as a hedge against changes in currency exchange rates.

¹⁷https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/14210/Larsen_MP_Paraguay_Deforestation_and_Agriculture_Duke.pdf?sequence=1&isAllowed=y

¹⁸https://www.researchgate.net/publication/312927028_Deforestation_and_cattle_expansion_in_the_Paraguayan_Chaco_1987-2012

¹⁹ <https://www.pnas.org/content/early/2016/03/22/1602646113>

Natural and sanitary risks

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

In Forestal San Pedro plantations, the loss of plantations and carbon stocks due to fire or flood is highly unlikely, as the plantations are distributed among different FMUs, fires were successfully controlled in the past, and sites are selected to avoid floods. But the changing weather may have other implications, such as the decreasing productivity of the plantations, and the incidence of unknown pests and diseases which affect timber quality in unknown ways.

Project plantations are subject to constant adaptive management due to the incidence of new pests and diseases. While project management seeks to increase genetic diversification of the plantations to reduce this risk, the array of genetic material available in the country is limited. Professional nurseries have been established in the last years and expanding its business, increasing the options continuously, however historically the lack of diversified material available has been a problem.

In the past, the project has been affected by several pests, such as the gall wasp *Lectocybe invasa* and the beetle *Costalimaita ferruginea*. These could be partially controlled by better selection of genetic material, and partially through the use of pesticides. In 2019, a fungal disease caused by the canker *Teratosphaeria zuluensis*, also known as *Coniothyrium zuluensis*, has affected an important share of the plantations.

The inventory conducted late in 2019 showed that, overall, close to 30 % of trees are infected. While the infestation seems to be mild on most areas, the implications are unclear. The canker may affect the color of the timber, having an important impact on the market price. Therefore, a more intensive thinning regime will be applied on these areas. According to the Fund's estimations, the canker may reduce the income from plantations on affected stands by 40 % (based on 1-ha models).

Table 12. Share of trees affected by Fungus per management unit

Production site	Total	Heavy	Medium	Mild	No infection
FMU 1	2 %	0 %	0 %	2 %	98 %
FMU 2	38 %	2 %	32 %	3 %	62 %
FMU 3/ FMU 4	28 %	0 %	5 %	24 %	72 %
FMU 5	1 %	0 %	0 %	1 %	99 %
FMU 6	38 %	0 %	0 %	38 %	62 %
FMU 7	34 %	0 %	0 %	34 %	66 %
FMU 8	51 %	0 %	7 %	43 %	49 %
FMU 9	2 %	0 %	1 %	2 %	98 %

Market risks related to an underdeveloped quality timber market and an informal biomass market

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

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

The project has already suffered delays due to the low biomass prices. First thinning interventions were delay due to the low prices for biomass production, and the difficulty of paying service providers. The delay in thinning is expected to reduce the overall income of plantations by about 8 % (based on 1-ha model). Therefore, the carbon component is fundamental to achieve early financing for the continuation of operations.

Uncertainties regarding the production model, growth and yield

The plantations have been established based on predictions on growth and yield, using only limited national data, and models developed by the Brazilian Agricultural Research Corporation (EMBRAPA). Due to the lack of long-term experiences in the country, models are based on estimations that have not been proven in the past. This increases the level of uncertainty regarding growth and yield, when compared to other plantation forestry projects in countries with more mature forest sectors, such as Brazil.

Growth and yield models are constantly adapted according to annual inventories, which will greatly contribute to the knowledge base for the timber and wood sector. However, currently, these adjustments can result in a decrease in income streams when expectations are not met.

While growth and yield has been meeting expectations, the assortment structure has been lagging behind, meaning the plantation needs more time than initially expected to produce higher quality products. According to the original business plan, around 50 % of the timber harvested during second thinning was expected to yield quality timber, with the other 50 % yielding low-value biomass. In reality, however, the quality segments for the first interventions were lower than expected, with first thinning yielding around 66 % of biomass, reducing income from first thinning substantially.

Risks related to insufficient technical capacity and absence of professional service providers

Besides this project, only POMERA is producing quality timber in Eastern Paraguay, located close to the Brazilian border. Most other plantations in Paraguay are established for biomass production, with little value added, high densities, and no silvicultural complexity. Longer rotations bring about a number of benefits, of which the most important is a higher value addition. Increasing the area of these plantations is expected to contribute to the forest sector, in two ways:

- The increasing supply from plantations with improved quality is expected to drive the wood processing industry modernization; and,
- The need for more silvicultural interventions for quality timber requires specialized labour, which will bring about positive impacts in terms of employment and the development of professional service providers.

Other benefits include an increased stewardship of the land due to long-term interest. Also, the lower densities combined with silvopastoral systems, established in between fragments of natural forests provide a higher value in terms of ecological corridors for biodiversity when compared to the previous land use or biomass plantations.

Due to the fact that there are no other plantations with these features in the region, and due to high informality and lack of professionalization of service providers and rural labour, project managers had to invest considerable efforts in professionalizing its labour and service providers. According to the national domestic census conducted in 2017, informality affects 65 % of the working population²⁰. Most affected are men living in rural areas, of which 80 % are considered to be engaged in an informal labour situation²¹. This is further accentuated in case seasonal work is required, commonly employed for activities such as planting.

Conclusions of the risk assessment

As shown throughout this Chapter, the forest project faces many risks that are related to its long term investment horizon. The carbon finance component would reduce these risks by diversifying

²⁰ <https://www.ultimahora.com/informalidad-laboural-no-hay-avances-y-afecta-al-65-los-ocupados-n2775685.html>

²¹ http://www.ilo.org/wcmsp5/groups/public/---americas/---ro-lima/documents/publication/wcms_245620.pdf

the product portfolio, introducing an early income stream, and allow for greater flexibility in terms of benefit sharing arrangements.

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

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

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

3.5 Additionality

Additionality has been demonstrated through application of Steps 0 to 2 above and through Common Practice Analysis in Step 4 (in this section below) which results in only one land use scenario and according to the “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities” it is the baseline scenario. This is complemented with the investment analysis in this section to support the conclusion that forest activity in the area faces significant barriers in terms of financial investment indicators and that the project registered in a carbon scheme and generating carbon certifies would allow to create a more favorable cash flow in particular compared to the baseline scenario (agriculture).

Investment analysis

- **Sub-step 3a. Determine appropriate analysis method**

The Investment analysis will determine which of the land use scenarios is the most economically or financially attractive. Option II - investment comparison analysis is selected to compare the two identified alternative land use scenarios discussed above.

- **Sub-step 3b. Apply investment comparison analysis**

To compare the agricultural and cattle land uses with the Forestal San Pedro project activity, the project proponent developed a financial model using the data of the most common silvicultural regime of San Pedro, applied to 8,000 ha, assuming the plantation of 1,000 ha/year (target project size), comparing it to 8,000 ha of mechanized soy under comparable conditions.

The actual Business Plan of the San Pedro project could not be used for this comparative analysis as it includes the current purchase of the brownfield project proponent.

The analysis includes all relevant costs, including operational and management costs (EBIT based cash flow analysis) and revenues. Land costs were not included (acquisition, lease) for both scenarios. It should be noted that forestry and cattle areas represented in a better light than agriculture by not accounting for land costs, as these are associated to great capital expenses that cannot be covered in the first years due to the lack of positive cashflow. In the case of cattle, the inclusion of land prices actually turn the business case unviable. This shows that the

operative cattle business on its own does not justify the purchase of land in the region, unless its an add on to land speculation.

The inputs concerning productivity, prices and production costs represent a realistic average from literature review²² and match the experiences of the Fund's due diligence process of the Forestal San Pedro investment and the experiences of relevant business partners operating in the agriculture sector in Paraguay. The cashflow was modelled for a period of 30 years. Estimates correspond to real, pretax values.

Following financial indicators for this comparison analysis were selected:

- IRR real (%)
- Investment needed (USD)
- Payback period (years)

These financial indicators are seen as the most critical indicators for land use investments and are therefore assessed for the proposed project activity without the financial benefits from carbon finance and for the agriculture land use scenario that is not prevented by any barrier.

The comparison analysis was done in Excel which is available to the validator, the main assumptions and results are summarized here.

²² All references available as supporting documentation:

Nienke Sleurink 2014. Large scale soy producers in Paraguay. Attitudes and behaviors towards sustainability. University of Utrecht, Faculty of Geosciences Master Thesis, August 2014

GAIN Report 2017. Paraguay. Oilseeds and Products Annual

GAIN Report 2019. Paraguay. Oilseeds and Products Annual

- Sub-step 3c. Calculation and comparison of financial indicators

Table 13. Main input parameters agriculture land use scenario:

Production area	<i>Ha</i>	8,000
Expenses		
Initial investment*	<i>USD</i>	4,000,000
Operations and overheads	<i>USD per ha and year</i>	900
Revenues		
First crop yield	<i>t per ha</i>	2,8
First crop price	<i>USD per t</i>	300
Second crop yield	<i>t per ha</i>	4,5
Second crop price	<i>USD per t</i>	120

*encompass 1.000 USD/ha for site and soil preparation on areas previously used for cattle (estimated at 50 % of the area)

Justification and assumptions of parameters:

Two agricultural seasons are common practice in the project region with soy in the summer season and maize in winter season. For both seasons, the operational costs are estimated as 60% of the gross revenues. The prices for both commodities are well known and an average price of the past years (from the literature above) is assumed with 300 USD/t for soy and 120 USD for maize. For management/overhead costs 70 USD per ha is assumed.

Table 14. Main input parameters cattle land use scenario (without carbon finance)

Production area	<i>Ha</i>	8.000
Operational assumptions		
Timespan	<i>Years</i>	30
Loss	<i>% of cattle/year</i>	1,5%
Initial weight at purchase	<i>kg/cattle</i>	180
Final weight at sale	<i>kg/cattle</i>	440
Weight yield	<i>kg/cattle/year</i>	162
Average stocking rate	<i>cattle/ha</i>	1,2
Average time for fattening	<i>Months</i>	19
Price		
Purchase price	<i>USD/Cattle</i>	350
Sales price	<i>USD/cattle</i>	685
Initial Investment		
Soil preparation and grass sowing	<i>USD</i>	1.000.000
Infrastructure	<i>USD</i>	250.000

Costs

Maintenance costs	USD/cattle/year	120
Average costs of cattle loss	USD/cattle lost	400

Justification and assumptions of parameters:

Based on general data of traditional cattle practices in the region, a stocking rate of 1.2 cattle per hectare and a fattening time of 19 months was assumed. Investment costs include first-time purchase of cattle for a production area of 8,000 ha, infrastructure improvements needed on part of the area (including fences, wires). Due to the fact that much of the land is already prepared for cattle ranching, initial investments were calculated to only reflect partial improvements and refurbishment. Soil preparation includes all necessary inputs (herbicides, cletodim, seeds, salt) and the labour required to conduct grass sowing on 30% of the total production area. The rest of the area is assumed to be already prepared to be used for cattle production based on the traditional baseline land uses in the region of eastern Paraguay.

Table 15. Main input parameters forestry land use scenario (without carbon finance)

Production area	<i>Ha</i>	8,000*
Production		
MAI	<i>m³ per ha and year</i>	34
Thinnings	<i>years</i>	2, 5 and 8
Final cut	<i>years</i>	12
Expenses		
Operations over one rotation	<i>USD per ha</i>	1,878
Harvest	<i>USD per m³</i>	8-10
Overheads	<i>USD per ha and year</i>	124
Initial CAPEX	<i>USD per ha</i>	35
Wood prices at forest road		
Fuelwood	<i>USD per m³</i>	19
Logs	<i>USD per m³</i>	29-53

* planted over 8 years, 1,000 ha/year

Table 16. Results comparison analysis

Indicator	Agriculture	Forestry	Cattle
IRR real (%)*	96%	18%	16%
Investment needed (USD)	4 M	14.2 M	4 M
Payback period (Years)	2	12	8

**Please note that IRR are unrealistic since land prices were not considered*

This analysis clearly shows that the financial hurdles are high to invest in forestry. As already described in Section 3.4, most landowners expect short-term returns, and there is a lack of credits and funding options for these long-term productive models. While the initial investment for forestry is much larger than for agriculture (3.5 times), and the payback period much longer, the average annual income over a period of 30 years is 7 % higher. This means that, once forestry investments are established, and enter a permanent rotation, they are competitive compared to alternative land uses.

In other words: Only in the first rotation when land use is changed back to forestry, there is a gap of economic competitiveness between forestry and agriculture. This gap can be decreased when forestry realizes alternative revenue streams, e.g. income from carbon credits. When entering in the second rotation and having established a sustainable forestry company with steady woodflows, then forestry can compete with agriculture. This is important to secure longevity of forestry production schemes.

Cattle systems, on the other hand, are financially less attractive, with an average annual income over 30 years being 85 % less when compared to the other models. Beef production is only economically viable if land purchase is not included. However, in comparison to forestry, many producers still prefer to continue with cattle. This is mainly related to: 1) It is a much simpler system than agriculture and forestry, requiring little input and low management complexity; 2) Most of the times, on areas not adequate for agriculture, production sites are already prepared for cattle, requiring little investment. In some cases, traditional producers are inheriting a farm from their parents that is fully prepared for cattle ranching; and, 3) The business is known and traditional, leading to many producers strongly identifying with cattle.

In the case of silvopastoral systems, IRR are between a pure forestry model and a pure cattle model. IRR positively correlates with the intensity of the tree component introduced to a traditional cattle model. While the forest component increases return, the upfront investment for planting trees is often prohibitive.

Therefore, early financing of tree planting activities is crucial. In the case of this project, access to financing by investors and credits institutions are conditioned to the carbon component.

The results confirm the view and analysis of the forestry Fund, that only a more positive cashflow within early years will trigger more investments in the forestry sector, which is essential for Paraguay to close the wood and timber gap leading to a more sustainable wood and timber balance and to contribute to climate change mitigation.

Using carbon finance from the plantations under the Long-term-Average approach of the VCS offers a significant pathway towards a shorter payback period and more positive cashflow in early years.

- **Sub-step 3d. Sensitivity analysis**

The sensitivity analysis is summarized below for the selected financial indicators with 5% sensitivity steps.

Sensitivity Agriculture

Table 17. Expenses: all expenses

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	145%	3.400.000	1
-10%	127%	3.600.000	1
-5%	111%	3.800.000	1
0%	96%	4.000.000	2
5%	83%	4.200.000	2
10%	71%	4.400.000	2
15%	60%	4.600.000	2

Table 18. Revenues: yields or prices

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	55%	4.000.000	2
-10%	68%	4.000.000	2
-5%	82%	4.000.000	2
0%	96%	4.000.000	2
5%	110%	4.000.000	1
10%	124%	4.000.000	1
15%	137%	4.000.000	1

Sensitivity Cattle

Table 19. Expenses: all expenses

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	31%	3.242.003	5
-10%	25%	3.432.709	5
-5%	21%	3.687.660	6
0%	16%	4.054.800	8
5%	12%	4.421.940	10
10%	8%	4.789.080	13
15%	3%	5.156.220	20

Table 20. Revenues: yields or prices

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	0%	4.548.000	29
-10%	7%	4.383.600	14
-5%	12%	4.219.200	10
0%	16%	4.054.800	8
5%	20%	3.890.400	6
10%	24%	3.814.121	6
15%	28%	3.814.121	5

Sensitivity Forestry

Table 21. Expenses: all expenses

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	21%	11.544.436	12
-10%	20%	12.436.708	12
-5%	19%	13.328.981	12
0%	18%	14.221.253	12
5%	17%	15.113.526	12
10%	16%	16.005.799	13
15%	15%	16.898.071	13

Table 22. Revenues: yields or prices

Change (%)	IRR real (%)	Investment needed (USD)	Payback period (years)
-15%	14%	14.764.883	13
-10%	16%	14.583.673	13
-5%	17%	14.402.463	12
0%	18%	14.221.253	12
5%	19%	14.040.043	12
10%	20%	13.858.834	12
15%	20%	13.677.624	12

Step 4. Common practice analyses

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

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

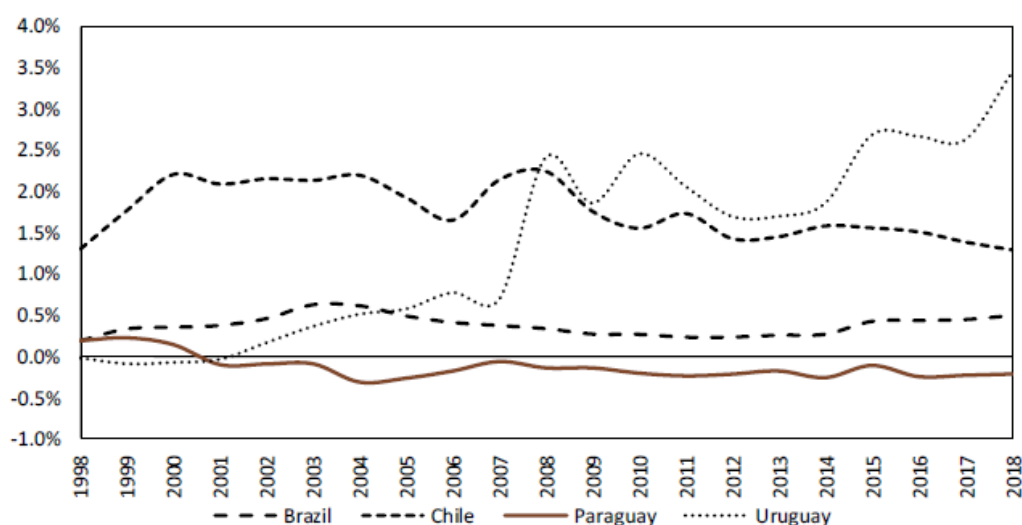
While countries with significant investment in plantation forestry such as Brazil, Chile and Uruguay established or maintained significant forest product trade surpluses over the last two decades, Paraguay turned into a net forest product importer in 2001.

Foreign investors continue to be discouraged by bureaucracy and corruption, biased or inconsistent enforcement of laws and a general lack of infrastructure. At the same time timber demand for industrial use keeps growing while the offer decreases with a bigger gap since 2013. FAO calculated that to fulfill demand of installed industries by 2020, planting should average 10.000 hectares/ year²³.

²³ <https://www.gatewaytosouthamerica-newsblog.com/forestry-development-in-paraguay/>

Table 23. Summary of timber plantation development in Paraguay (FAO 2004, 2006; FRA 2015c; INFONA 2011, 2013; Gonzales 2004, in Szulecka et al. 2017)

Time	Driving Paradigm	Relevant developments of Paraguay's timber plantations
1940s	National	First documented tree plantation efforts for energy purposes
1955–1966	National	National Agricultural Institute starts producing seedlings and exotic trial plots
1970s/80s	National	National plan under the Law n. 422/73; 10,025 ha of new plantations
1980s – on	Social, Global political	Agreements establishing a forestry extension program between the governmental forestry and development agencies (Swiss Technical Mission, Peace Corps, GTZ, European Union, Japan, others)
1991 – 1994	National, Corporate, Social	Reforestation for energy purposes; 1,763 ha of new plantations
1992 – 1993	Corporate, Social	Compensation regime (Decree n. 14047); 1,227 ha of new plantations
1995	Corporate	Plantation Promotion Law n. 536/95
1997 – 1998	National	Model forests; 115 ha of new plantations
1996 – 2004	Corporate	Plantations under the Law n. 536/95; 34,023 ha of new plantations
2006	Corporate	Investment and export network to promote forest products and timber plantations (REDIEX)
2010 – on	Corporate	Creation of first credit funds for timber plantations from different institutions (Fondo Ganadero, Agencia Financiera de Desarrollo)
2010 – 2013	Corporate, Social, Corporate-modified, Global-political	Plantation area added under monitoring of INFONA: 31,996 ha
2013	All	Total plantation area 81,125 ha (0.2% of the country's territory)



Source: FAO and IMF

Figure 16. Paraguay's forest production trade balance

According to Szulecka et al. (2017), Law N° 536 of 1995 had a visible impact on the plantation sector in Paraguay, as the country saw new projects of afforestation and reforestation that were implemented rapidly afterwards. The law encouraged especially medium and bigger private corporate plantation investments. In particular, three large plantation estates can be seen as important industrial projects linked to this law. It encouraged the Shell Group to invest in *Eucalyptus grandis* and *Eucalyptus urophylla* plantations in Alto Parana and Caazapá. Some 7,000 ha of plantations were later taken over by the Argentine company POMERA Maderas, which has developed the plantation until the present, combining tree planting with their own research on eucalyptus clones. Another example is the reforestation project of Copetrol that was launched in 1997. The company possesses the largest plantation area in the country, 13,000 ha (Copetrol, 2015). The third large company organizing commercial timber plantation is Ganadera Vista Alegre

(VASA) with 3,500 ha eucalyptus and teak in the San Pedro department (Szulecka et al. 2017). More recently, several other players entered the market, such as Silvipar and Felber.

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

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

Soybean cultivation is a clearly defined business model, where 75% of the production goes for export (BID, 2010). Soybean and beef producers are organized into business association and chambers of commerce, and certainly have more government support (Szulecka et al. 2017).

This is also underpinned by cultural factors. Many of the most traditional landowners are cattle ranchers. They own large properties inherited by the family, and are not interested in innovation. This has also been the previous owners experience during the initial stages of the project. The expansion through land lease was difficult due to the landowners mistrust with implementing forestry and long-term lease contracts.

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

3.6 Methodology Deviations

No deviations

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

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

Where:

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

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

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

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

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

Two baseline strata are distinguished based on the land use and canopy cover: agricultural and pasture areas.

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

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

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

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

For this different sub-steps applied:

1. Random sample points were identified among the stratified areas using QGIS (v. 3.10). In total 50 points were assessed and due to availability of imagery and 45 effectively showed results.
2. A survey was designed using Open Foris Collect (version 3.26.12). This survey created a sample design covering the identified random samples with a 0.5 ha big area cluster, encompassing a 5x5 sub-point grid. Each of the points could be ticked with the following covers: "Tree", "Shrub", "Grass" and "other".
3. Both, the survey and the QGIS grid were imported to "Collect Earth" (v. 1.10.18), which uses Google earth and the Google earth engine. Since satellite imagery was very difficult to acquire for the respective areas, imagery from the years 2007 – 2015 has been used. Whenever, the imagery was not desirable (years <2011), a NDVI-image from Landsat 7 and 8 from the required and desired years was used to confirm the baseline land use and its permanence. These NDVI images are available as part of the Google earth engine, however have a slightly coarser resolution (Figure 17). The same was used for areas with the reference image from 2015. Since the project started in 2015 the baseline land use was ensured, that no areas were classified with project activities already implanted.
4. The canopy cover was classified in the respective images as show in Figure 18. The entire assessment resulted in the following canopy cover estimates for Agriculture and Pasture:



Figure 17. Plot layout using Collect Earth in Google Earth

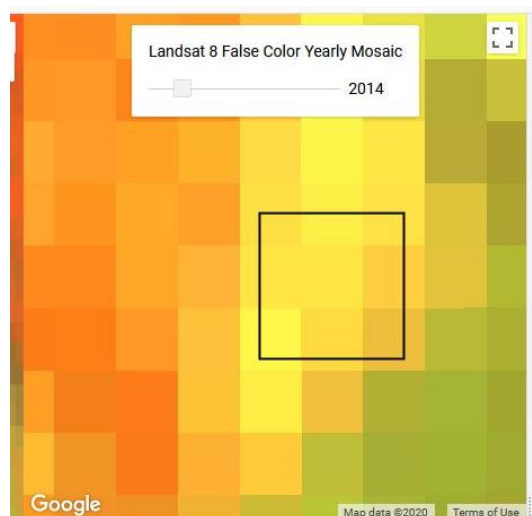


Figure 18. NDVI image of a plot using Landsat 8, to confirm the long term land use.

Table 24. Baseline stratums in San Pedro First Instance project

Coverage (%)	Baseline Stratum		
	Agriculture	Pasture	Bushland (Pasture)
Tree	0%	1.3%	2.3%
Shrub	0%	3.5%	0.7%
Grass	100%	94.8%	0.2%
Unknown	0%	0.2%	0.02%

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

Baseline shrub carbon stock

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

Baseline tree carbon stock for agriculture and pasture

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

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

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

Where:

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

Parameter	Value	Unit	Source
CF_{TREE}	0.47	dimensionless	AR-Tool 14
R_{TREE}	0.25	dimensionless	AR-Tool 14
$CC_{TREE_BSL,PASTURE}$	1.3%	%	Canopy cover assessment
$CC_{TREE_BSL,BUSHLAND}$	2.3%	%	Canopy cover assessment
b_{Forest}	80	t dm/ha	de Sy et al (2015), tropical moist deciduous forest

Baseline tree and shrub carbon stock change

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

According to section 5 of the Tool, changes in carbon stocks in trees in the baseline are accounted as zero, as the following conditions are met:

Based on the evidence and documentation presented above under 1.13 and 3.4 the project lands were under continuous pasture and agricultural management for decades with continuous degradation and forest deforestation prevailing in the region. In summary, Paraguay and the project region suffers from severe environmental degradation. Paraguay's deforestation rate was until recently one of the highest in Latin America. This deforestation, combined with further unsustainable land management practices including slash-and-burn agriculture, extensive grazing and the practice of mono-cultivation of crops like soybeans and sugarcane, are also leading to soil erosion, loss of soil fertility and decreased quantity and quality of water resources. This very low level of pre-existing trees assessed in the project area is included in the project as carbon stocks, however, no change is assumed since these trees have all reached maturity. In addition, the trees will be left on site and are not part of the carbon monitoring system.

Baseline dead wood and litter carbon stock

The dead wood carbon stock is calculated using conservative default factor method of equation 9 in the AR-Tool12.

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

Where:

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

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

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

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

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

Where:

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

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

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

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

As result, the baseline carbon estimation is summarized below:

Table 25. Baseline emissions

Year	Project year	Annual planted area (ha)	$C_{TREE_{BSL}}$ (t CO2e)	$C_{DW,i,t}$ and $C_{LI,i,t}$ trees (t CO2e)	Total Baseline emission (t CO2e)
2015	1	1,312	621	9	630
2016	2	386	10	0	10
2017	3	1,748	647	9	656
2018	4	422	197	3	200
2019	5	22	9	0	10
2020	6	129	56	1	56
Total	-	4,019	1,540	22	1,562

4.2 Project Emissions

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

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

Where:

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

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

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

Further:

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

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

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

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

No shrub biomass will be accounted in this project

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

No dead wood biomass will be accounted in this project

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

No litter biomass will be accounted in this project

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

The change in carbon stock in tree biomass in this grouped project is estimated using the A/R methodological tool “estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” (Version 04.2). Based on the tool the stock difference method is applied and the ex-ante tree biomass is estimated using the method of “Estimation by modelling of tree growth and stand development, presented in section 8 of the tool. The ex-ante estimation of carbon stock changes is based on an average growth assumption (MAI) for the entire project area according to its planting strata.

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

For the diameter growth of Eucalyptus, company internal assumptions were used for the Ex-ante estimation. Different planting strata follow different growth increment assumptions depicted in Table 26.

Table 26. Mean annual increment according to planting schemes

Planting scheme	MAI	Unit
1000 trees/ha	≈ 40	m ³ /ha yr.
714 trees/ha	≈ 34.5	m ³ /ha yr.
476 trees/ha	≈ 34.5	m ³ /ha yr.

The root-to-shoot ratio is a mean of published ratios of *E. camaldulensis* and *E. globulus* in Barton and Montagu (2006)²⁴ and Fabiao et al. (1995)²⁵ and is estimated to be 0.37.

²⁴ Barton, C. V. M. and Montagu, K.D. (2006) Effect of spacing and water availability on root:shoot ratio in *Eucalyptus camaldulensis*, *Forest Ecology and Management* 221 (2006) 52–62

²⁵ Fabiao, A. Madeira, M. Steen, E. Kätterer, T. Ribeiro, C. and Araujo C. (1995): Development of root biomass in an *Eucalyptus globulus* plantation under different water and nutrient regimes, *Plant and Soil* 168 – 169: 215-223

Even though the plantations have different stem densities and are stratified according to this, the major silvicultural measures are across all strata the same. The entire rotation cycle is 11-14 years, while in year 2, 5 and 8 thinning operations or natural mortality reduce the stem density (Table 27). Default carbon fraction: 0.47 as per AR Methodology. Wood density is estimated to be 540 g/cm³, based on average wood densities of three *Eucalyptus grandis* and *E. urophylla* published in the global wood density database (Zanne et al., 2009). The biomass expansion factor is used from IPCC Good practice guidance for LULUCF for temperate broadleaf trees (lower confidence interval): 1.15, since table 3A 1.10 mentions no sub-tropical climate (IPCC, 2003).

Table 27. Stem density of strata in different years, thinning operations in years 2, 5 and 8

Year	Planting scheme/Strata		
	1000 trees/ha	714 trees/ha	476 trees/ha
1	1,000	714	476
2	850	680	450
3	850	680	450
4	550	450	450
5	550	450	450
6	550	450	450
7	350	300	300
8	350	300	300
9	350	300	300
10	200	200	200
11	200	200	200
12	200	200	200

Table 28. Biomass model for Eucalyptus – 1000 trees/ha

Project year	Stock (m ³ /ha)	Total ABG (tCO ₂ e)	Total BGB (tCO ₂ /ha)	Total Biomass (tCO ₂ /ha)
1	1.9	2.1	0.8	2.9
2	24.8	20.4	7.6	28.0
3	47.2	52.5	19.6	72.1
4	103.2	114.7	42.7	157.4
5	227.7	185.6	69.2	254.8
6	157.9	175.4	65.4	240.8
7	215.6	239.5	89.3	328.8
8	387.9	301.8	112.5	414.2
9	195.8	217.6	81.1	298.7
10	232.3	258.1	96.2	354.3
11	265.1	294.6	109.8	404.4
12	292.5	-	-	-

13	1.9	2.1	0.8	2.9
14	24.8	20.4	7.6	28.0
15	47.2	52.5	19.6	72.1
16	103.2	114.7	42.7	157.4
17	227.7	185.6	69.2	254.8
18	157.9	175.4	65.4	240.8
19	215.6	239.5	89.3	328.8
20	387.9	301.8	112.5	414.2
21	195.8	217.6	81.1	298.7
22	232.3	258.1	96.2	354.3
23	265.1	294.6	109.8	404.4
24	292.5	-	-	-
Long-Term Average		155.2	57.8	213.0

Table 29. Biomass model for Eucalyptus – 714 trees/ha

Year	Stock (m³/ha)	Total ABG (tCO2e)	Total BGB (tCO2/ha)	Total Biomass (tCO2/ha)
1	1.5	1.7	0.6	2.3
2	19.6	16.3	6.1	22.4
3	37.4	41.5	15.5	57.0
4	82.3	91.4	34.1	125.5
5	178.2	148.5	55.4	203.9
6	132.7	147.5	55.0	202.5
7	181.6	201.8	75.2	277.0
8	305.4	254.5	94.9	349.4
9	192.9	214.3	79.9	294.2
10	229.0	254.4	94.8	349.3
11	261.5	290.6	108.3	398.9
12	288.6	0	0	0
13	1.5	1.7	0.6	2.3
14	19.6	16.3	6.1	22.4
15	37.4	41.5	15.5	57.0
16	82.3	91.4	34.1	125.5
17	178.2	148.5	55.4	203.9
18	132.7	147.5	55.0	202.5
19	181.6	201.8	75.2	277.0
20	305.4	254.5	94.9	349.4
21	192.9	214.3	79.9	294.2
22	229.0	254.4	94.8	349.3
23	261.5	290.6	108.3	398.9
24	288.6	0	0	0
Long-Term Average		138.6	51.6	190.2

Table 30. Biomass model for Eucalyptus – 476 trees/ha

Year	Stock (m³/ha)	Total ABG (tCO2e)	Total BGB (tCO2/ha)	Total Biomass (tCO2/ha)
1	10.3	11.4	4.3	15.7
2	39.5	43.9	16.4	60.3
3	87.0	96.7	36.0	132.7
4	193.7	157.1	58.6	215.7
5	132.7	147.5	55.0	202.5
6	181.6	201.8	75.2	277.0
7	305.4	254.5	94.9	349.4
8	192.9	214.3	79.9	294.2
9	229.0	254.4	94.8	349.3
10	261.5	290.6	108.3	398.9
11	288.6	-	-	-
12	-	1.2	0.4	1.6
13	10.3	11.4	4.3	15.7
14	39.5	43.9	16.4	60.3
15	87.0	96.7	36.0	132.7
16	193.7	157.1	58.6	215.7
17	132.7	147.5	55.0	202.5
18	181.6	201.8	75.2	277.0
19	305.4	254.5	94.9	349.4
20	192.9	214.3	79.9	294.2
21	229.0	254.4	94.8	349.3
22	261.5	290.6	108.3	398.9
23	288.6	-	-	-
24	-	1.2	52.0	191.4
Long-Term Average		139.5	54.1	199.4

Table 31. Annual estimation of tree biomass GHG removals by sinks in the project scenario for the first project instances (4,401 ha).

Project year	Accumulated tree biomass GHG removals by sinks, tCO2e	Annual estimation of tree biomass GHG removals by sinks; tCO2e
1	2,710	2,710
2	33,221	30,511

3	96,419	63,198
4	248,719	152,299
5	434,658	185,939
6	602,807	168,149
7	764,252	161,445
8	807,427	43,176
9	832,521	25,094
10	849,056	16,535
11	849,056	-
12	849,056	-
13	849,056	-
14	849,056	-
15	849,056	-
16	849,056	-
17	849,056	-
18	849,056	-
19	849,056	-
20	849,056	-
Total		849,056

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

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

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

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

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

Where:

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

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

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

The approved IPCC spreadsheet to facilitate the calculation of changes in soil organic carbon stocks was used for calculating a one-hectare based model which is up-scaled for the planting area according baseline land use. The factors applied are 0.07 t C/ha yr. for all areas formerly being pasture and 0.8 t C/ha yr. for all areas formerly being agriculture. The following Table 32 shows the aggregated SOC changes.

Table 32. Aggregated SOC Changes

Project year	Planting 2015	Planting 2016	Planting 2017	Planting 2018	Planting 2019	Annual SOC (tC/yr.)	Cumulative SOC (tC)
1	104	-	-	-	-	104	104
2	104	291	-	-	-	395	498
3	104	291	524	-	-	919	1,417
4	104	291	524	78	-	997	2,414
5	104	291	524	78	2	999	3,413
6	104	291	524	78	2	999	4,412
7	104	291	524	78	2	999	5,410
8	104	291	524	78	2	999	6,409
9	104	291	524	78	2	999	7,407
10	104	291	524	78	2	999	8,406
11	104	291	524	78	2	999	9,405
12	104	291	524	78	2	999	10,403
13	104	291	524	78	2	999	11,402
14	104	291	524	78	2	999	12,401
15	104	291	524	78	2	999	13,399
16	104	291	524	78	2	999	14,398
17	104	291	524	78	2	999	15,396
18	104	291	524	78	2	999	16,395
19	104	291	524	78	2	999	17,394
20	104	291	524	78	2	999	18,392

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

Table 33. Total SOC removals in the project

Project year	Annual SOC GHG removals by sinks; tCO ₂ -e	Cumulative SOC GHG removals by sinks; tCO ₂ -e
1	380	380
2	1,447	1,827
3	3,370	5,197

4	3,656	8,853
5	3,662	12,514
6	3,695	16,209
7	3,695	19,904
8	3,695	23,598
9	3,695	27,293
10	3,695	30,988
11	3,695	34,682
12	3,695	38,377
13	3,695	42,072
14	3,695	45,766
15	3,695	49,461
16	3,695	53,156
17	3,695	56,851
18	3,695	60,545
19	3,695	64,240
20	3,695	67,935
Total		67,935

4.3 Leakage

According to the methodology AR-AM0003 (Version 02.0), the leakage emission has to be assessed with the tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” (Version 02). This tool evaluates the displacement of crop cultivation and grazing activities. Section 6 of this tool indicates that leakage emissions can be considered insignificant if they meet the following requirements:

The Forestal San Pedro Carbon Project aims to increase the carbon stock of former agricultural land and implanted pastures through afforestation. Leakage could only be expected if the landowners leasing their land to the project would shift their pre-project activity towards forested areas, causing conversion.

The risk of leakage is low, due to following reasons:

- The project provides opportunities for sustainable intensification of beef production, meaning it provides alternatives to increase revenues without shifting beef production to western Paraguay (Chaco), where deforestation is rampant.
- Mostly, the project works with traditional landowners settled in Eastern Paraguay. Any forest conversion in Eastern Paraguay is forbidden, and while law enforcement is weak, blatant deforestation has become unusual (partially due to the lack of large forest areas and partially due to social control). Deforestation in the project region does not usually happen as clear cutting anymore, but rather as long-term and continuous degradation of forests (see chapter 3.4).

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

4.4 Estimated Net GHG Emission Reductions and Removals

Long-term average

As part of an afforestation reforestation for commercial timber and rotation cycles, the calculations have been done based on the AFOLU Requirements and guidance for calculating the Long-Term Average Carbon Stock (LTA) for ARR Projects with Harvesting²⁶, This includes all carbon pools in the project.

The calculation of the LTA was made for each stratum, including above and belowground biomass, SOC and excluding baseline, as presented in the table below. The complete tables for all ten strata can be found in the Excel Ex-Ante San Pedro – 1st project instance.

²⁶ https://verra.org/wp-content/uploads/2018/03/VCS-Guidance-Harvesting-Examples_0.pdf

Table 34. Example of the LTA per ha calculation according to XXX for the Stratum PAST714 (Pasture with 714 trees per ha)

Year	Total AGB+BGB tCO ₂ /ha	SOC tCO ₂ /ha	Total GHG Benefits tCO ₂ /ha	Baseline Carbon Stocks – Stratum Pasture 714 tCO ₂ /ha	PE – PE tCO ₂ /ha	Average accountable carbon – LTA tCO ₂ /ha
1	2.3	0.0	2.3	0.4	1.9	1.9
2	22.4	0.3	22.6		22.6	22.6
3	57.0	0.5	57.5		57.5	57.5
4	125.5	0.8	126.3		126.3	126.3
5	203.9	1.0	204.9		204.9	193.1
6	202.5	1.3	203.8		203.8	193.1
7	277.0	1.5	278.5		278.5	193.1
8	349.4	1.8	351.2		351.2	193.1
9	294.2	2.1	296.3		296.3	193.1
10	349.3	2.3	351.6		351.6	193.1
11	398.9	2.6	401.5		401.5	193.1
12	0.0	2.8	2.8		2.8	193.1
13	2.3	3.1	5.4		5.4	193.1
14	22.4	3.3	25.7		25.7	193.1
15	57.0	3.6	60.6		60.6	193.1
16	125.5	3.9	129.3		129.3	193.1
17	203.9	4.1	208.0		208.0	193.1
18	202.5	4.4	206.8		206.8	193.1
19	277.0	4.6	281.6		281.6	193.1
20	349.4	4.9	354.3		354.3	193.1
21	294.2	5.1	299.4		299.4	193.1
22	349.3	5.4	354.7		354.7	193.1
23	398.9	5.6	404.5		404.5	193.1
24	0.0	5.9	5.9		5.9	193.1
Total	190.2		193.2		193.1	

Cumulative emission removals

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

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

Where:

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

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

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

$$LK_t = \text{GHG emissions due to leakage, in year } t; t \text{ CO2-e}$$

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

Table 35. Total ex-ante net anthropogenic GHG emission reductions and removals in the project shown for the first activity instances

Project year	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	VCS buffer credits (20% risk buffer) (tCO2e)	Estimated net GHG emission removals (tCO2e)
1	630	2,710	-	650	2,060
2	10	30,511	-	7,323	23,188
3	656	63,198	-	15,168	48,031
4	200	152,299	-	36,552	115,747
5	10	185,939	-	44,625	141,314
6	56	168,149	-	40,356	127,793
7	-	161,445	-	38,747	122,698
8	-	43,176	-	10,362	32,814
9	-	25,094	-	6,022	19,071
10	-	16,535	-	3,968	12,567
11	-	-	-	-	-
12	-	-	-	-	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
17	-	-	-	-	-
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
Total	1,562	849,056	-	203,773	645,283

5 MONITORING

5.1 Data and Parameters Available at Validation

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

Data / Parameter	Conversion factor from C to CO ₂
Data unit	tCO ₂ /tC
Description	Carbon coefficient times the fraction oxidized times the ratio of the molecular weight of carbon dioxide to carbon
Source of data	Default as per IPCC
Value applied:	44/12
Justification of choice of data or description of measurement methods and procedures applied	44/12 is the molecular weight ratio to convert tonnes of carbon to tonnes of CO ₂ as used per IPCC default value
Purpose of Data	Conversion factor from C to CO ₂

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

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

Data / Parameter	b_{Forest}
Data unit	t d.m. ha ⁻¹
Description	Total Aboveground biomass of trees in the country, where the AR CDM project activity is located
Source of data	Value for tropical moist deciduous forest in Paraguay, de Sy et al. (2015) ²⁷
Value applied:	80
Justification of choice of data or description of measurement methods and procedures applied	Scientific study
Purpose of Data	Calculation of baseline emission removals
Comments	-

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

²⁷ De Sy, V., Herold, M., Achard, F., Beuchle, R., Clevers, J. G. P. W., Lindquist, E., & Verchot, L. (2015). Land use patterns and related carbon losses following deforestation in South America. Environmental Research Letters, 10(12), 124004.

Purpose of Data	Calculation of baseline emission removals
Comments	-

Data / Parameter	ΔC_{LI_BSL}
Data unit	percent
Description	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass
Source of data	Default factor
Value applied:	1%
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool " Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities ", the project mean annual precipitation is 1,300 mm/yr.
Purpose of Data	Calculation of baseline emission removals
Comments	-

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

Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	R _{TREE} , project
Data unit	dimensionless
Description	Mean of Root : Shoot ratios published for <i>Eucalyptus globulus</i> and <i>E. camaldulensis</i>
Source of data	Average
Value applied:	0.37
Justification of choice of data or description of measurement methods and procedures applied	According to Barton and Montagu (2006) ²⁸ & Fabiao et al. (1995) ²⁹
Purpose of Data	Calculation of ex-ante and ex-post project emission removals
Comments	-

Data / Parameter	Wood density
Data unit	t/m ³
Description	Weight to volume relation of <i>Eucalyptus grandis</i> and <i>E. urophylla</i>
Source of data	Zanne et al. (2009)
Value applied:	0,54

²⁸ Fabião, A., Madeira, M., Steen, E., Kätterer, T., Ribeiro, C., & Araújo, C. (1995). Development of root biomass in an *Eucalyptus globulus* plantation under different water and nutrient regimes. *Plant and Soil*, 168(1), 215-223.

²⁹ Barton, C. V., & Montagu, K. D. (2006). Effect of spacing and water availability on root: shoot ratio in *Eucalyptus camaldulensis*. *Forest Ecology and Management*, 221(1-3), 52-62.

Justification of choice of data or description of measurement methods and procedures applied	According to Zanne et al. (2009) ³⁰ a mean of all available wood densities of <i>E. grandis</i> and <i>E. urophylla</i> was calculated.
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	SOC _{REF,i}
Data unit	t C ha ⁻¹
Description	Reference SOC stock corresponding to the reference condition in native lands
Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	47
Justification of choice of data or description of measurement methods and procedures applied	According to the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" a default value of 47 for tropical moist climate regions and soils with low activity clay (LAC).
Purpose of Data	Calculation of project emission removals
Comments	-

Data / Parameter	f _{LU, i}
Data unit	dimensionless
Description	Relative stock change factor for baseline land-use in stratum I of the areas of land

³⁰ Zanne, A.E., Lopez-Gonzalez, G.*, Coomes, D.A., Ilic, J., Jansen, S., Lewis, S.L., Miller, R.B., Swenson, N.G., Wiemann, M.C., and Chave, J. 2009. Global wood density database. Dryad. Identifier: <http://hdl.handle.net/10255/dryad.235>.

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

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

Data / Parameter	$f_{IN,i}$
Data unit	dimensionless
Description	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum I of the areas of land.
Source of data	IPCC Default value, See CDM Tool 'tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities'
Value applied:	Medium/cropland: 1 Medium/grasslands: 1
Justification of choice of data or description of measurement methods and procedures applied	According the Table 5 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" an input factor of 1 is used when medium manure input is applied, while table 6 shows an input factor of 1 for medium manure inputs in grasslands.
Purpose of Data	Calculation of project emission removals
Comments	-

5.2 Data and Parameters Monitored

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

Data / Parameter	Ai
Data unit	Ha
Description	Area of tree biomass stratum i
Source of data	GIS or/and GPS

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

Data / Parameter	wi						
Data unit	Dimensionless						
Description	Relative weight of the area of stratum I, the area of the stratum i divided by the project area.						
Source of data	Calculated						
Description of measurement methods and procedures applied	N/A						
Frequency of monitoring/recording	Calculated for each monitoring event, at least every five years						
Value applied:	For ex ante situation the following values are estimated from the first project instance: <table border="1"> <tr> <td>Stratum (Year)</td><td>Wi</td></tr> <tr> <td>2015</td><td>0.57</td></tr> <tr> <td>2016</td><td>0.11</td></tr> </table>	Stratum (Year)	Wi	2015	0.57	2016	0.11
Stratum (Year)	Wi						
2015	0.57						
2016	0.11						

	2017	0.30
	2018	0
	2019	0.01
Monitoring equipment	N/A	
QA/QC procedures applied	N/A	
Purpose of data	Calculation of project emissions/removals	
Calculation method	Area of the stratum i divided by the project area	
Comments	-	

Data / Parameter	s_i												
Data unit	t d.m. (or t d.m. ha ⁻¹)												
Description	Estimated standard deviation of biomass stock in stratum i												
Source of data	Project based monitoring system												
Description of measurement methods and procedures applied	N/A												
Frequency of monitoring/recording	s_i is calculated for each monitoring event, at least every five years												
Value applied:	For ex ante situation the following values are estimated from the first project instance: <table><tr><td>Stratum (Year)</td><td>S_i</td></tr><tr><td>2015</td><td>30.11</td></tr><tr><td>2016</td><td>28.11</td></tr><tr><td>2017</td><td>11.26</td></tr><tr><td>2018</td><td>0</td></tr><tr><td>2019</td><td>0.95</td></tr></table>	Stratum (Year)	S_i	2015	30.11	2016	28.11	2017	11.26	2018	0	2019	0.95
Stratum (Year)	S_i												
2015	30.11												
2016	28.11												
2017	11.26												
2018	0												
2019	0.95												
Monitoring equipment	N/A												

QA/QC procedures applied	N/A
Purpose of data	Calculation of uncertainty of project emissions/removals
Calculation method	Excel or tool available to calculate standard deviation
Comments	-

Data / Parameter	n_i												
Data unit	Dimensionless												
Description	Number of sample plots in stratum i												
Source of data	Calculated												
Description of measurement methods and procedures applied	N/A												
Frequency of monitoring/recording	n_i is calculated for each monitoring event, at least every five years												
Value applied:	For ex ante situation the following values are estimated from the first project instance: <table border="1"> <tr> <th>Stratum (Year)</th><th>n_i</th></tr> <tr> <td>2015</td><td>216</td></tr> <tr> <td>2016</td><td>38</td></tr> <tr> <td>2017</td><td>111</td></tr> <tr> <td>2018</td><td>0</td></tr> <tr> <td>2019</td><td>6</td></tr> </table>	Stratum (Year)	n_i	2015	216	2016	38	2017	111	2018	0	2019	6
Stratum (Year)	n_i												
2015	216												
2016	38												
2017	111												
2018	0												
2019	6												
Monitoring equipment	N/A												
QA/QC procedures applied	N/A												

Purpose of data	Calculation of project emissions/removals
Calculation method	The calculation method is described in the Chapter 5.3
Comments	-

Data / Parameter	$A_{p,i}$
Data unit	Ha
Description	Size of a sample plot in stratum i
Source of data	Field measurement
Description of measurement methods and procedures applied	After calculating the No of sample plots required to achieve the desired precision level (90/10) a stratified random selection is carried out.
Frequency of monitoring/recording	Yearly
Value applied:	200 and 280m ²
Monitoring equipment	N/A
QA/QC procedures applied	Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible; all field team members are trained in GPS/GIS application
Purpose of data	Calculation of project emission removals
Calculation method	It is calculated based on the area needed to include 20 trees in the Permanent Sample Plot, varying strictly by tree planting density

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

Data / Parameter	H
Data unit	m
Description	Height of tree planted

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

Data / Parameter	T
Data unit	Year
Description	Time period elapsed between two successive estimations of carbon stock in a carbon pool
Source of data	Recorded time
Description of measurement methods and procedures applied	N/A

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

5.3 Monitoring Plan

Monitoring system structure

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

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

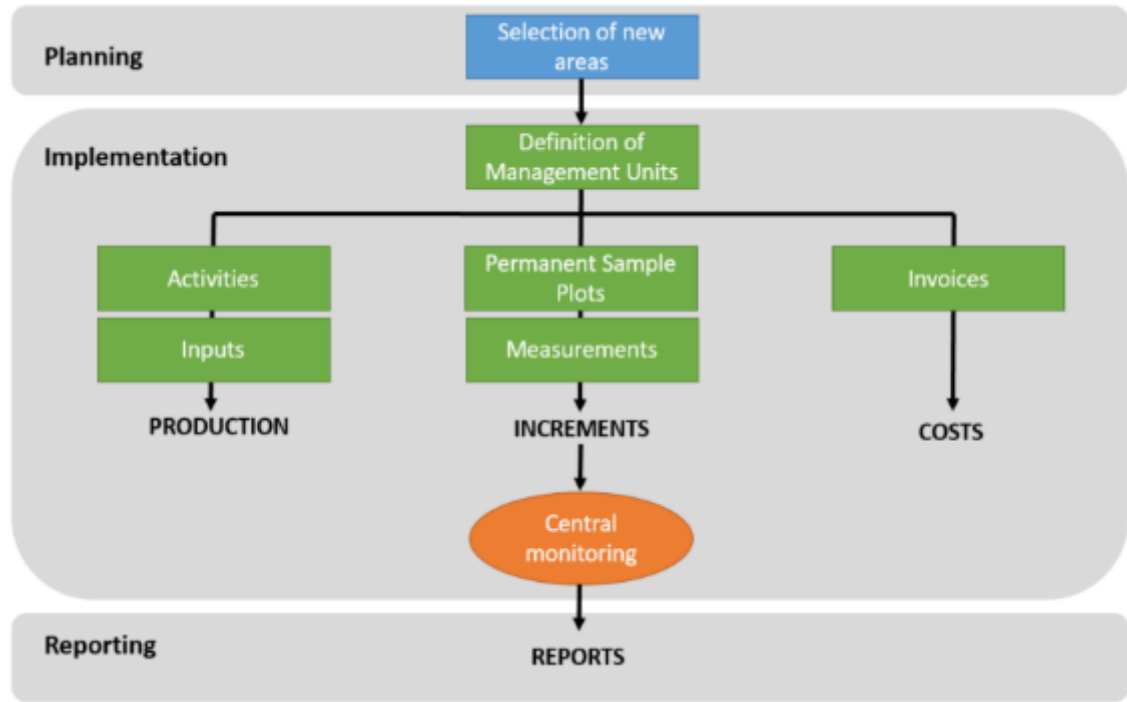


Figure 19: Overview of the production monitoring system of the project

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

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

Geographical delimitation of project boundaries

The area of the project has been delimited using satellite imagery. Each FMUs planted are delineated using GPS tracking function. Each compartment is tracked and recorded as polygon and sent to the GIS department. The GPS track in the first approach, and later, the overall plantation boundaries, are improved and updated with GIS and satellite imagery.

Stratification and update of effective areas

Stratification is primarily conducted based solely on soil analysis conducted before planting. The classification refers to differences expected in the Mean Annual Increment (MAI) and is therefore a sensitive step for overall growth calculation. However, to date, differences between soil qualities

have not been significant enough to be considered for the carbon project, and therefore, an average growth value per planting year has been applied.

Each FMU is divided into smaller compartments for better management called blocks (bloques). Each compartments has between 20 and 50 hectares and shares a common stratum (same age, species and ideally soil quality and growth). This is the smallest unit used for all silvicultural measures.

Sampling design, plot selection and location

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

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

Table 36. PSP size depending on planting density

Spacing	Plot size (m ²)
9 x 5 x 2	280
5 X 2	200

Trees in PSPs are numbered as shown in Figure 20 and their coordinates are recorded. Measurements are performed every year between November and December. The first measurement takes place at least one year after planting (e.g. if one block is planted in June or October 2019 the first measurement takes place between November and December 2020).

Data Collection

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

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

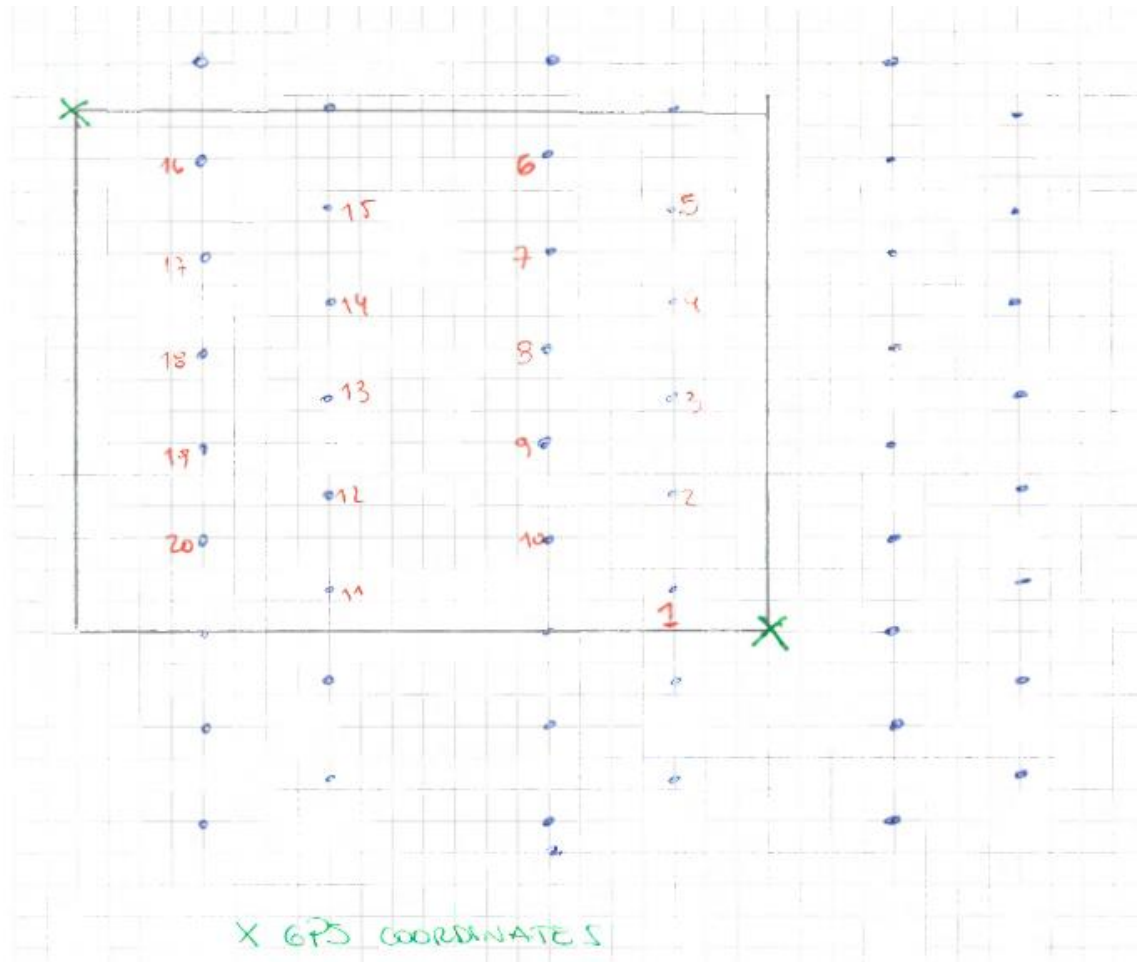


Figure 20. Design of a permanent sample plot

Data analysis

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

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

*These values are calculated per hectare and require the area of the plot for interpolation. The area of the plot depends on the planting density and were presented in Table 36.

Calibration of growth and yield tables

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

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

Procedures for internal auditing and QA/QC

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

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

Collecting reliable field measurement data

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

Verifying methods used to collect field data

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

Verifying data entry and analysis techniques

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

Procedures to ensure reliable field measurements

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

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

Data maintenance and archiving

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

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

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

The achieved GHG emission reductions presented in this chapter refer to the first monitoring period of this project **m1** from 05.04.2015 until 31.12.2020.

The total area included in m1 from the first project instances (FMU 5, 6 and 8) is 1,518 ha. The remaining area of the first instances will be verified in the next verification period as well as plantation from 2020. Therefore, the 'no biomass increase approach' of the Methodology is applied here, since the seedlings had not reached the dimensions eligible for the annual inventory and measurement of DBH.

6.1 Data and Parameters Monitored

Data / Parameter	A_i	
Data unit	Ha	
Description	Area of tree biomass stratum i	
Value applied:	Stratum (Plantation year)	Area
	2015	867
	2016	173
	2017	457
	2018	0
	2019	22
Comments	Areas are yearly updated using satellite imagery	

Data / Parameter	$A_{p,i}$	
Data unit	Ha	
Description	Size of a sample plot in stratum i . This varies depending on the plantation density. Permanent Sample Plots always measure 20 trees.	
Value applied:	Type of Plantation	Area (m ²)

	Silvopastoral Systems (5x9x2m)	280
	Pure Plantations (5x2)	200
Comments	-	

Data / Parameter	DBH
Data unit	Cm
Description	The diameter at breast height (1.3 m from the ground)
Value applied:	See Excel File "Forestal San Pedro Inventory Database"
Comments	-

Data / Parameter	W_i	
Data unit	Dimensionless	
Description	Relative weight of the area of stratum I, the area of the stratum I divided by the project area	
Value applied:	Stratum (Year)	W_i
	2015	0.57
	2016	0.11
	2017	0.30
	2018	0.01
Comments	-	

Data / Parameter	S_i	
Data unit	t.d.m. (or t dm.m. ha ⁻¹)	
Description	Estimated standard deviation of biomass stock in stratum i	
Value applied:	Stratum (Year)	S_i
	2015	30.11
	2016	28.11

	2017	11.26
	2018	0
	2019	0.95
Comments	-	

Data / Parameter	n_i	
Data unit	Dimensionless	
Description	Number of sample plots in stratum i	
Value applied:	Stratum (Year)	n_i
	2015	216
	2016	38
	2017	111
	2018	0
	2019	6
Comments	-	

Data / Parameter	H	
Data unit	m	
Description	Height of tree planted	
Value applied:	See Excel "Forestal San Pedro Inventory Database"	
Comments	-	

Data / Parameter	T	
Data unit	Year	
Description	Time period elapsed between two successive estimation of carbon stock in a carbon pool	
Value applied:	4 years	

Comments	-
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6.2 Baseline Emissions

Baseline emissions for this monitoring period m1 was calculated following the approach demonstrated in section 4.1. The table below displays the baseline carbon stocks for the pre-existing trees for the planting years 2015-2018 which are subject to this monitoring period.

Table 37. Baseline biomass for this monitoring period

Year	Areas planted / restored per year (ha)	C _{TREE_BSL} Pre-existing biomass of trees (tCO ₂ -e)	C _{CW_BSL} Dead wood pre-existing trees (tCO ₂ -e)	C _{SHRUB_BSL} Pre-existing shrub biomass (tCO ₂ -e)	C _{BSL_TOTAL} Total Biomass baseline (tCO ₂ -e)
2015	867	271	5	104	381
2016	173	3	0	1	4
2017	457	142	3	55	199
2018	0				0
2019	22	7	0	3	10

6.3 Project Emissions

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

$$\Delta C_{\text{ACTUAL},t} = \Delta C_{P,t} - \text{GHG}_{E,t}$$

Where:

$\Delta C_{\text{ACTUAL},t}$ = Annual actual net greenhouse gas removals by sinks at time t ; t CO₂-e yr⁻¹

$\Delta C_{P,t}$ = Change in carbon stocks in project, occurring in the selected carbon pools, at time t ; t CO₂-e yr⁻¹

$GHG_{E,t}$ = Increase of non-CO₂ GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t, t CO₂-e

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

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

Where:

$\Delta C_{P,t}$ = Change in carbon stocks in project, occurring in the selected carbon pools, at time t; t CO₂-e yr⁻¹

$\Delta C_{TREE_PROJ,t}$ = Change in carbon stock in tree biomass in project in year t, as estimated in AR-TOOL14; t CO₂-e yr⁻¹

$\Delta C_{SOC_PROJ,t}$ = Change in carbon stock in the soil organic carbon (SOC) pool within the project boundary, as estimated in AR-AM0014, in year t; t CO₂-e yr⁻¹

Estimation of carbon stock changes in trees and shrubs

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

Estimation of carbon stock change in trees

The following sections and equations of the tool are applied:

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

8.1. Estimation by measurement of sample plots

8.1.1. Stratified random sampling

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

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

The following equations of the methodology have been applied:

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

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

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

Where:

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

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

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

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

A = Project area; ha

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

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

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

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

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

Table 38. Values applied to calculate tree biomass

Equation value	Description	Value applied	Source
$V_{TREE,j} (BA_{p,i})$	$V_{TREE} = DBH \times \text{height} \times \text{form factor}$ Stem volume per hectare of trees of species j in sample plot p of stratum i estimated by using the basal area of the plot as entry data into a volume table or volume equation; $m^3 \text{ ha}^{-1}$. The form factor applied is 0.4.	See Excel inventory data 2019	Published and project volume tables.
D_j	Density (over-bark) of tree species j; $t \text{ d.m. m}^{-3}$	0.54	Zanne et al (2009) ³¹
$BEF_{2,j}$	Biomass expansion factor for conversion of tree stem biomass to above-ground tree biomass, for tree species j; dimensionless	1.15	IPCC value, Table 3A.1.10, Broadleaf Temp
R_j	Root-shoot ratio for tree species j; dimensionless	0.37	Barton and Montagu (2006) ³² & Fabiao et al. (1995) ³³

The calculation of the tree biomass was done in Excel. The file ‘2020-10-05 San Pedro Carbon Inventory M1’ is available as supporting documentation.

³¹ <https://datadryad.org/stash/dataset/doi:10.5061/dryad.234>

³² Fabião, A., Madeira, M., Steen, E., Kätterer, T., Ribeiro, C., & Araújo, C. (1995). Development of root biomass in an Eucalyptus globulus plantation under different water and nutrient regimes. Plant and Soil, 168(1), 215-223.

³³ Barton, C. V., & Montagu, K. D. (2006). Effect of spacing and water availability on root: shoot ratio in Eucalyptus camaldulensis. Forest Ecology and Management, 221(1-3), 52-62.

Table 39. Summary calculation B_{TREE} and C_{TREE}

Stratum	Area (ha)	w _i	b _{TREE} ,t t d.m. ha ⁻¹	B _{TREE} ,t t d.m.	C _{TREE} ,t t CO ₂ -e
2015	867	0.57	69.2	105,013	180,973
2016	173	0.11			
2017	457	0.30			
2018	0	0.00			
2019	22	0.01			
TOTAL	1,518	1.00			

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

Table 40. Calculation of uncertainty

Stratum	S _i t.d.m. ha ⁻¹	n _i	U _c %	U _c mean (t CO ₂ -e)	u _c Discount (t CO ₂ -e)
2015	30,1	216	3.1%	5,690	0
2016	28,1	38			
2017	11,3	111			
2018	0	0			
2019	0,9	6			
Total	33,9	371			

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

Estimation of changes in soil organic carbon stocks

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

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

For this monitoring period, for each new planting area included in a certain year, only six months are assumed for that planting year with the dSOC value.

Table 41. Calculation of SOC change for this monitoring period

Year	SOC area (ha)	Cumulative SOC area (ha)	Total ΔSOC strata 1-4 (t CO ₂ -e)
2015	867	867	1,297
2016	173	1,039	2,482
2017	457	1,496	3,350
2018	0	1,496	3,838
2019	22	1,518	3,871
2020	0	1,518	3,895
Total			18,735

Change in carbon stocks of trees

According to the tool AR-TOOL14 A/R Methodological tool 'Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities' (Version 04.1) at the first verification C_{TREE}, t2 is set equal to the carbon stock in the first verification. Based on this, the following table shows the change in carbon stock during the period between two points of time t1 (pre-existing baseline tree biomass) and t2. The Excel sheet '2020-10-05 San Pedro

Carbon Inventory M1' details the full calculation of emission reductions for this monitoring period and is available upon request.

Table 42. Change in carbon stocks during the period between two points of time t1 (pre-existing tree and shrub biomass) and t2

Year of inclusion of project areas	Area strata included in year t (ha)	$C_{TREE,t1} = C_{TREE_BSL,t1}$	$C_{DW_BSL,t1}$	$C_{SHRUB_BSL,t1}$ (t CO ₂ -e)	$C_{TREE_PROJ_DISCOUNT,t2}$	$C_{DW_PROJ,t2}$	$\Delta C_{TREE+DW_PROJ,t2-t1}$
2015	867	271	5	104.47	103,337	0	102,956
2016	173	3	0	1.20	20,572	0	20,568
2017	457	142	3	54.99	54,441	0	54,242
2018	0	0	0	-	0	0	0
2019	22	7	0	2.65	2,624	0	2,614
2020	0	0	0	-	0	0	0
Total	1,518	422	8	163.32	180,973	0	180,379

Actual net greenhouse gas removals by sinks

Table 43. Actual net greenhouse gas removals by sinks for the different years of the monitoring period

Year	Project implementation (cum. months)	Cumulative tree net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual tree net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual SOC net GHG removals by sinks, in year t; (t CO ₂ -e)	Actual total net GHG removals by sinks, in year t; (t CO ₂ -e)
2015.- 9 months	8	12,112	12,112	1,297	13,410

2016	20	36,330	24,218	2,482	26,700
2017	32	83,654	47,324	3,350	50,674
2018	44	115,024	31,370	3,838	35,209
2019	56	148,548	33,523	3,871	37,394
2020	68	180,379	31,832	3,895	35,727
Total	68	180,379	180,379	18,735	199,114

6.4 Leakage

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

Table 44. GHG emissions due to leakage, in year †

Year	Leakage (t CO ₂ -e)
2015.	0
2016	0
2017	0
2018	0
2019	0
Total	0

6.5 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)	Buffer pool allocation	VCUs eligible for Issuance
2015	381	13,410	0	13,029	2,606	10,423

2016	4	26,700	0	26,696	5,339	21,357
2017	199	50,674	0	50,475	10,095	40,380
2018	0	35,209	0	35,209	7,042	28,167
2019	10	37,394	0	37,385	7,477	29,908
2020	0	35,727	0	35,727	7,145	28,581
Total	594	199,114	0	198,520	39,704	158,816

The total GHG emission reductions of the first project instances for the 1st monitoring period 05-04-2015 to 31-12-2020 are 198,520 tCO₂e. The non-permanence risk rating is 20% (as determined in the AFOLU non-permanence risk report attached as a separate document). Therefore the total number of buffer credits that need to be deposited into the AFOLU pooled buffer account is 39,704 tCO₂e. The number of GHG credits eligible to be issued as VCUs for the first project instances of this monitoring period is 158,816 tCO₂e.