Atlantic Forest Biodiversity Conservation Limeira Project REDD

Document Prepared by Neo Green Consultoria Ambiental

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The Atlantic Forest Biodiversity Conservation Limeira Project REDD is located in the state of Paraná, southern Brazil. Its area is part of the Atlantic Forest Biome, which is recognized for harboring a vast diversity of fauna and flora, including several endemic and endangered species, such as the largest terrestrial mammal, the tapir (*Tapirus terrestrial*), described as threatened with extinction due to loss of its environment[1]. However, as a result of population growth and economic development, the Atlantic Forest was the biome that presents the highest rates of deforestation, losing almost 90% of its original area. Today, only 12,4% of the original forest remains. These numbers demonstrate that a great impact has been caused in this forest for more than 500 continuous years, mainly by human and agricultural development.

Because it is today one of the most threatened biomes on the planet and due to its wide biodiversity, the Atlantic Forest is considered a global hotspot, as it is a natural region whose preservation is a priority at world levels[2]. This causes a great risk of being converted to non-ecological uses, since it is one of the main Brazilian biomes, concentrating 70% of the Brazilian GDP, being inserted in 17 states. In most countries, the population is concentrated on the coasts and it is no different in Brazil, since every 10 Brazilians, 7 live in the biome, quantifying 72% of the Brazilian population[3].

This project avoids GHG emissions from changing the use of forest land for planting bananas and planting palm heart, degradation by cutting Juçara palm (*Euterpe edulis*) and Guaricana leaves (*Genoma gamiova*) and the deforestation carried out by squatters to open irregular lots. It still contributes to carbon sequestration due to increase in the forest biomass, along with natural regeneration and the presence of an older forest in the ecosystem.

Additionally, it achieves an exceptional level of protection and improvement of biodiversity through the protection and management of the property and the protection of ecological corridors, since the property connects two state conservation units, the Guaricana National Park and the Saint-Marc National Park. Hilaire/Lange, two environments rich in fauna and flora species that harbor endangered species. For this reason, its protection, management and monitoring is essential for the maintenance of wildlife, flora, climate change mitigation, in addition to helping to reduce greenhouse gas emissions and increase

[1] Medici et.al. Avaliação do Risco de Extinção da Anta brasileira. 2011.
[2] Hotspopts. Available at: https://www.conservation.org/docs/default-source/brasil/capa_hotspots.pdf
[3] Fundação SOS Mata Atlântica. Available at: https://www.sosma.org.br/conheca/mata-atlantica/

carbon stock. forest. Furthermore, this project improves quality and protects water resources, as it has an area of 1.023 hectares of permanent preservation area, where its main function is to protect rivers, streams and springs from erosion and degradation. As such, the project also assists in improving the quality, quantity and timing of water flows, as well as effecting important improvements in aquatic habitat over baseline conditions.

The preserved forest is an important generator of ecosystem services, such as water supply, climate regulation, tourism, energy, convenience, in addition to it unique natural beauties. The project area has no within or dependent communities, but achieves net socio-economic benefits to nearby local communities through limited-use forest environment, conservation management, research activities, provision of ecosystem services and recreation opportunities.

The project also ensures actions linked to the Sustainable Development Goals, of which it has a special connection with SDGs 6, 13, 15 and 17 (Figure 1).

Figure 1: Sustainable Development Goals related to the project.

The development and registration of this project is being carried out under the Verified Carbon Standard (VCS) and operates in activities that prevent unplanned deforestation and forest degradation (AUDD). Involving research and work with the local community, the dynamics and agents of deforestation in the region were identified, such as illegal extractors of Juçara palm and Guaricana leaves, subsistence farmers and perennial crops, mainly banana and palm heart, in addition to ranchers and people who use the lands for allotments.

Over the years, before the implementation of this project, the Fazenda Limeira property developed agricultural activities with the production of bananas, exploitation of products such as wood and Guaricana leaves, as well as by-products such as palm heart for the food industry.

In 2015, the area began to be protected by the owner, with the property being perpetually managed through long-term conservation and improvement of the ecological and forestry function, based on the formation of carbon sinks through the planting of 15 thousand palm heart seedlings, restriction of removal of wood and firewood from the forest, in addition by reducing the implementation of new areas for banana cultivation, basing forest and territorial management on conservation and reduction of deforestation and degradation. However, even with the legislation in force, deforestation and forest

degradation continue in the region, mainly due to the lack of inspection and environmental education of the population.

The project area is owned by the company Limeira Indústria e Comércio S/A, has 4.340,23 hectares of forest, where local monitoring has been carried out since 2015 and via satellite since 01/01/2017 to prevent illegal deforestation. The private company intends to reverse these efforts in carbon credits whose value will be used in the costs of monitoring activities, implantation of information boards, development of lectures together with government agencies of agricultural extension, which will contribute not only to the maintenance of the preserved area as well as avoiding deforestation in the surroundings. With monitoring, it is expected to avoid deforestation of 270,13 ha, equivalent to about 112.664 t CO_2e in the first baseline period of the project (2017-2026). The estimated annual average of GHG emission reductions and removals from the implementation of project activities for the first baseline period is 11.224 tCO_2e/year.

1.2 Sectoral Scope and Project Type

Project Scope 14: Agriculture, Forestry and Other Land Uses (AFOLU)

Project Category: Reducing Emissions from Deforestation and Degradation (REDD)

Type of Activity: Avoided Unplanned Deforestation (AUDD)

This is not a grouped project and is being registered with the Verified Carbon Standard (VCS) as a Reducing Emissions from Deforestation and Degradation (REDD) project and has been developed in compliance with the Verified Carbon Standard, Version 4.2[4] and the VCS AFOLU Requirements[5].

The methodology used was VM0007, version 1.6 of September 8, 2020.

1.3 Project Eligibility

To demonstrate the eligibility of the AUDD activity, decision trees were used to determine the type of REDD project activity provided by the VM0007, v 1.6 methodology itself[6]. Based on the project activity decision questions, it is understood that:

[4] VCS Version 4.2 was released on January 20th, 2022. Available at: https://verra.org/wp-content/uploads/2022/02/VCS-Standard_v4.2.pdf
[5] Requisitos VCS AFOLU. Available at: https://verra.org/wp-content/uploads/2020/11/PREVIOUS-VERSION-AFOLU-Requirements-v3.6.pdf
[6] VM0007 REDD+ Methodology Framework (REDD-MF), v1.6

- Forest area must be converted to non-forest area in the case of baseline;
- The land is not legally authorized and documented to be converted to a non-forest or managed tree plantation;
- 99% of the areas are forested.

It was concluded that the Atlantic Forest Biodiversity Conservation Limeira Project REDD is eligible for the AUDD activity, as forest land is expected to be converted to non-forest land in the baseline case, where the land is not legally authorized and documented to be converted into arable land. In the reference region used to compose the baseline scenario, deforestation was mainly identified to establish pasture areas, cultivation of banana or palm heart and forest degradation by the illegal extraction of Juçara palm in the Atlantic Forest biome by agents residing both within and outside the Reference Region. These agents do not have the uncontested legal right to deforest the land for these purposes due to the Atlantic Forest Law (law nº 11.428/2006), which does not allow the cutting and suppression of primary and secondary vegetation in an advanced stage of regeneration of the Biome. Atlantic forest. They are only authorized on an exceptional basis, when necessary to carry out works, projects or activities of public utility, scientific research and preservationist practices (Art. 20 and 21). In the baseline scenario, reforestation of deforested lands is also not common.

The project area is entirely composed of land qualified as forest (following the definition used by VCS) with at least 10 years before the start date of the project, therefore, there is no more place for afforestation, reforestation and revegetation activities.

In addition, the project is eligible under the VCS Version 4.2 Program scopes because:

- It meets all applicable rules and requirements set forth in the VCS Program;
- It applies the eligible methodology within the scope of the VCS Program;
- The implementation of this project does not imply any violation of applicable law;
- It does not convert native ecosystems to GHG generation, as the project area contains only native forest lands for 10 years before the minimum start date.

1.4 Project Design

The project carries out activities for the conservation and protection of forest lands, avoiding unplanned deforestation and forest degradation, protection of water resources, protection of fauna mainly threatened by extinction. It also includes only one location and it is not a grouped project.

1.5 Project Proponent

Organization name	Limeira Indústria e Comércio S/A
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Role in the project	Proponent
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1.6 Other Entities Involved in the Project

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Role in the project	Development Project
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1.7 Ownership

Limeira Indústria e Comércio S/A is the owner of the project's land according to the registration documents and the social contract of the project proponent, which will only be made available during the audit, as it is personal information.

Neo Green is responsible for the administration, management and sale of the VCUs entirely, in accordance with the agreement between the parties.

1.8 Project Start Date

The land that today forms the project area was acquired in the 1970s and 1980s. At that time logging was intense and moved the real estate market and the economy with leasing and sales of areas to companies that carried out this activity. And it was initially with this intention that the company Limeira Indústria e Comércio S/A acquired more than 5 thousand hectares of forests. Still in the 1970s, a small part of the land was sold to logging companies and at the time, the current federal legislation already guaranteed the preservation of a good part of the forests, and this condition improved over the years. So much so that in 1992, the Environmental Protection Area (APA) of Guaratuba was created through Paraná State Decree No. 1.234, covering the municipalities of Guaratuba, São José dos Pinhais, Tijucas do Sul, Morretes, Paranaguá and Matinhos.

In 2006, the Atlantic Forest Law was created (law nº 11.428/2006), a law that protects the biome that houses the lands in question and later was created the Federal Decree 6.660/08, which provides for the use and protection of vegetation. SEMA Resolution nº 019/2010 establishes norms and procedures for the protection and use of Juçara palm (*Euterpe edulis*) in the State of Paraná and, according to its article 3rd, its exploitation from natural populations is prohibited and, in addition, as provided in article 2nd of Federal Decree nº 6.660/08, the Juçara palm cannot be exploited because it is a species included in the Official List of Endangered Species of Brazilian Flora.

The project area is located, for the most part, in the municipality of Guaratuba and after so many legal milestones, it was essential to change the paradigm of landowners in the region, especially with regard to the sustainable use of land, which is imposed by rules of the Guaratuba APA itself. Two Federal Conservation Units were also created close to the project area, the Saint-Hilaire/Langue National Park and the Guaricana National Park. protect 100% of the forests on the acquired lands, as the preservation of this area forms an ecological corridor between the parks that guarantees the gene flow of Atlantic Forest species in the Brazilian region with the largest area in this preserved biome, the State of Paraná.

These facts alone demonstrate the great importance of conserving the forests in the project area and add value to keeping the forest standing, also mentioning the ecosystem services provided to the population, such as maintenance of springs and the climate regulation. However, even with all these

benefits and legal requirements, the region suffers from sport hunting and the illegal extraction of palm hearts, which are carried out by individuals from different regions who invade private properties and degrade the forest. In addition, there is the agriculture, which its production is increasing every year and also the squatters who try to invade the lands for demarcation of property.

In this scenario, despite the existence of environmental inspection carried out by the environmental police, the daily presence of the attempts of invasion or degradation of the forest mentioned above make the police activities inefficient, making it necessary to have a particular monitoring system to guarantee the forest conservation and wildlife protection.

According to this scenario, the owner decided to avoid the invasion of his lands through private patrolling, starting this activity on 01/01/2017, together with the decision to register the project in the Verified Carbon Standard (VCS) to obtain carbon credits that can initially cover the costs of protecting forests and, later, of additional activities that will indirectly help in this objective.

1.9 Project Crediting Period

The Atlantic Forest Biodiversity Conservation Limeira Project REDD has a crediting period of 30 years, from 01/01/2017 to 31/12/2046.

1st baseline period: 01/01/2017 to 31/12/2026

2nd baseline period: 01/01/2027 to 31/12/2036

3rd baseline period: 01/01/2037 to 31/12/2046

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☒ <20.000 tCO_2e/year

The scale of the project and the estimated greenhouse gas emission reduction of the project are presented in Tables 1 and 2 below.

Project Scale	
Project	X
Large Project	

Table 1: Project Scale.

The Table 2 below presents the total annual estimate ($^{NER}_{REDD\_anual}$) of the project's net emission reductions, excluding buffer and leakage discounts.

Year	$^{NER}_{REDD\_anual}$ (tCO_2e)
2017	4.004
2018	4.083
2019	2.694
2020	39.484
2021	9.555
2022	5.218
2023	5.298
2024	13.430
2025	16.528
2026	11.949
Estimated total emissions removed in the first baseline period	**112.244**
Annual average of reduced emissions in the first baseline period (10 years)	**11.224**
Total number of years in the crediting period	**30**

Table 2: Total and average annual emission reduction estimate.

1.11 Description of the Project Activity

The main objective of the Atlantic Forest Biodiversity Conservation Limeira Project REDD is the conservation of 4.340,23 hectares of forest area within the properties of Limeira Indústria e Comércio S/A as previously described, using its own resources. This will be achieved through the prevention of unplanned deforestation, with an *ex-ante* estimate of 270,13 hectares of avoided deforestation in the first 10 years and 810,39 hectares of avoided deforestation over the 30-year duration of the project. The emission of 398.748 tonnes of CO_2e is expected to be avoided during this period, including buffer, leakage and project efficiency reductions. The total crediting period for the project is 30 years (01/01/2017 - 31/12/2046).

The project is not registered under any other GHG programs or forms of credit, therefore, for its maintenance, the income from the credits is essential, due to the pressures exerted by the baseline

activities described in section 3.5 (Additionality). Such activities compete with the preservation of native forest in terms of profitability from land use and extractivism.

The Management Plan for the Guaratuba Environmental Preservation Area, where part of the project area is located, allowed the sustainable use of land in accordance with the Forest Code until the creation of the Atlantic Forest Law (described in section 1.14). However, deforestation and degradation are actions that strongly affect this biome, even with the various legislations applied in Brazil, this fact is mainly due to the lack of effective policing on properties that form corridors between remnants of vegetation that protect the surroundings of conservation units. Therefore, it is clear that inspection by government authorities to prevent deforestation is not enough and for this reason, voluntary initiatives by rural landowners for environmental protection are important.

Forest conservation is the main objective of this project, involving the banning of the following purposes: logging, extraction of Juçara palm and Guaricana leaves, agriculture and invasion for illegal squatters. To achieve this goal, the following activities are being developed:

- Surveillance and monitoring of deforestation: employing members of the local community to patrol areas most vulnerable to deforestation, with the generation of weekly reports. The patrol has been carried out since January 1st, 2017, the project's start date and the reports started being filled out from 2021, according the Model 1 presented below:

Monitoring Sheet for the Atlantic Forest Biodiversity Conservation Project at Fazenda Limeira REDD

Date: ____/____/_____.

Patrol Hours: Start: _____:_____. End: _____:_____.

Monitor's Name: _____

Patrol Mode:

□ Car □ Motorbike □ On foot

Route Covered:

□ Limeira Road: □ Total □ Partial

□ Forest:

(Location and distance done: _____)

Comments:

□ Deforestation □ Degradation

Responsible for deforestation/degradation: _____

Deforestation location: _____

Fauna found: _____

Other relevant comments: _____

_____

Signature:_____

Model 1: Limeira REDD Project Monitoring Sheet.

- Monitoring of deforestation using software to monitor via satellite;

- Signage with signs at the beginning, at the end and along the Limeira Road, informing the passing population about the presence of the project and the monitoring for the protection of the forest.

Figure 2: Information board present in the project area.

In addition to these activities, the following are planned for the second and/or third period for obtaining carbon credits:

- Support for government programs to improve technical skills for local farmers;

- The creation of a support and reception point for researchers, students and tourists who pass through Estrada Limeira;

- Environmental education, with ecological tourism carried out on trails, rivers and waterfalls in the project area, with the objective of making participants aware of the importance of conserving the Atlantic Forest.

The project is also not located within a jurisdiction covered by a jurisdictional REDD+ program.

1.12 Project Location

Atlantic Forest Biodiversity Conservation Limeira Project REDD is located in the state of Paraná, in southern Brazil, about 60 km southeast of the capital Curitiba. The project's forest area has a transition configuration, as it does not fit into the boundary or mosaic definitions. It is located along Estrada Limeira with the largest portion of land within the municipality of Guaratuba and the smallest portion within the

municipality of Morretes. Estrada Limeira divides the project area into an eastern portion and a western portion, connecting the two rural municipalities. The total area of the project (forest area at the start date of the project) is 4.340,23 hectares. The registrations where the project is inserted are in the Registro de Imóveis of São José dos Pinhais/Paraná, under registrations nº 4.543, 5.281, 31.997 and transcription nº 2.254. In the Registro de Imóveis of Morretes/Paraná, there is the registration nº 120.

A location map of the project area, along with Saint Hilaire Langue National Park and Guaricana National Park is presented in Figure 3.

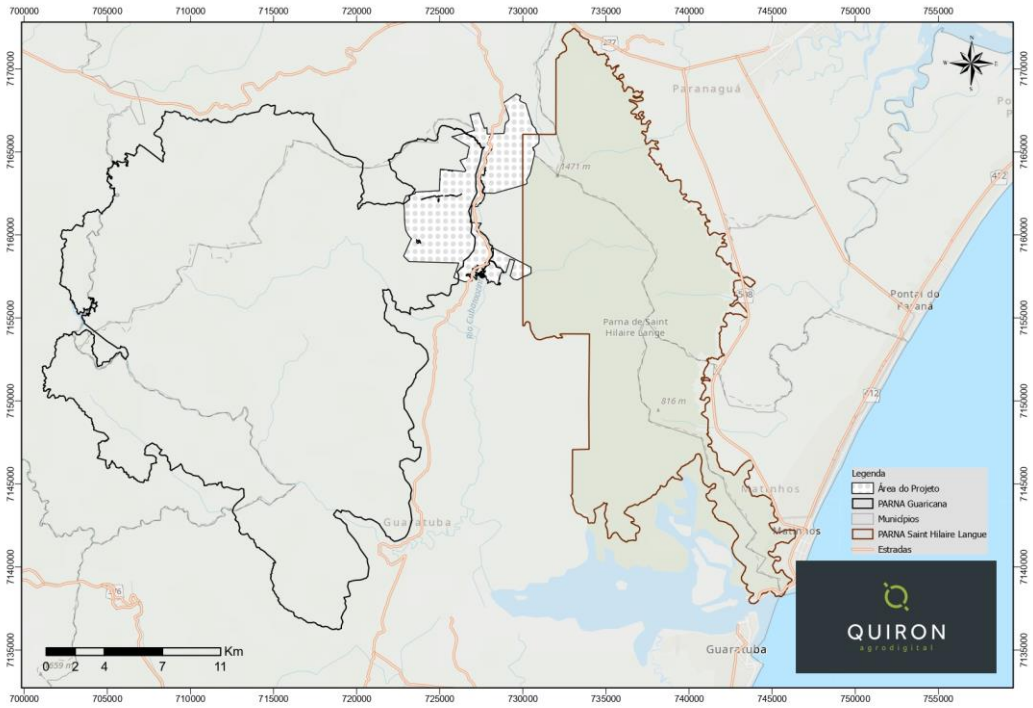

Figure 3: Location map of the area of Atlantic Forest Biodiversity Conservation Limeira Project REDD (center), Saint Hilaire Langue National Park (right) and Guaricana National Park (left).

1.13 Conditions Prior to Project Initiation

Before starting the project, some activities were identified that lead to unplanned deforestation/degradation in the region. These activities represent the baseline scenario for the project, pressures exerted by the identified agents of deforestation (Section 2.4), Baseline Scenario. The characteristics and environmental conditions of the project area are presented below:

1.13.1 Climate

According to the Brazilian Institute of Geography and Statistics (IBGE), the project area is in the Brazilian temperate climate zone[7]. According to the Institute of Water and Land (IAT)[8] in Paraná the project area has an Af and Cfb/Cfa climate[9]:

- Af - Tropical humid or super humid climate, without a dry season, with the average temperature of the hottest month above 18ºC. The total rainfall in the driest month is over 60 mm, with higher rainfall from March to August, exceeding the total of 1.500 mm per year. In the warmer months (January and February) the temperature is between 24 ºC and 25ºC;
- Cfb - Temperate climate, with mild summer. Evenly distributed rains, no dry season and the average temperature of the hottest month does not reach 22ºC. Precipitation from 1.100 to 2.000 mm. Severe and frequent frosts, with an average period of occurrence of ten to 25 days annually;
- Cfa - Subtropical climate, with hot summer. Temperatures are above 22ºC in the summer and with more than 30 mm of rain in the driest month.

The geographic position, relief and presence of the Atlantic Ocean close play a very important role in climate conditioning. In the Guaratuba city, where most of the project area is located, the average temperature is 21,1 °C, varying from 15 °C to 29 °C and it is rarely below 11 °C or above 32 °C. The warm season lasts for 3,6 months, from December 15th to April 2nd, with daily average maximum temperature above 27 °C. The cool season lasts for 3,7 months, from June 3rd to September 25th, with maximum daily temperature averaging below 22 °C. The highest rainfall season lasts 5,9 months, from October 2nd to March 31st, with over 46% probability that a given day it will rain.

The dry season lasts 6,1 months, from March 31st to October 2nd. However, it rains throughout the year in Guaratuba. The maximum rainfall occurs during 31 days around 26th of January, with an average total accumulation of 343 millimeters. And the minimum rainfall occurs around 13th of August, with an average total accumulation of 97 millimeters[10].

[7] IBGE, Climate Map of Brazil, 2002. Available at: https://geoftp.ibge.gov.br/informacoes_ambientais/climatology/maps/brazil/Map_BR_clima_2002.pdf
[8] Climate - State of Paraná, 2008. Available at: http://www.iat.pr.gov.br/sites/agua-terra/arquivos_restritos/ files/document/2020-07/mapa_climas_a3.pdf
[9] Clima. Available at: https://www.cnpf.embrapa.br/pesquisa/efb/clima.htm
[10] Weather Spark. Available at: https://pt.weatherspark.com

In the State of Paraná, the region with the highest annual precipitation is the Litorânea Hydrographic Basin. The Figure 4 below presents graphically the variation in the monthly average precipitation of this basin, which the project is located.

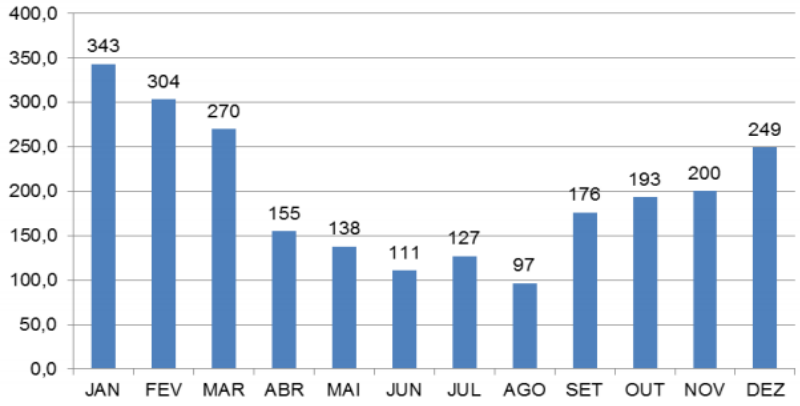

Figure 4: Variation in the monthly average precipitation of the Littoral River Basin[11].

The climatic characteristics in the project area directly influence banana production in the region, according to Volpe[12], as the optimum temperature for growing banana trees is between 25°C and 30°C, with the extreme limits of temperatures between 15°C and 35°C. Regarding precipitation, the best productions occur when these are around 1.900 mm/year, preferably evenly distributed throughout the year, between 100 – 180 mm/month.

And as for its altitude, it is considered optimal for banana cultivation, the range between 0 – 300 m. In summary, the ideal conditions for a good banana development are high temperatures with little variation during the year, high water availability and well-distributed rainfall. Therefore, the climate can indirectly influence deforestation in the region because of the increase of the agricultural area.

1.13.2 Hydrography

Both the reference region and the project area belong to the Litorânea Hydrographic Basin (BHL) which is completely inserted in the South Atlantic Hydrographic Region one of the national hydrographic divisions established by the National Water Resources Council (CNRH)[13] through Resolution No. 32/2003.

[11] Plan of the Coastal Hydrographic Basin. Paraná Water Institute, 2017.
[12] VOLPE, C. Climate factors and elements related to banana crop. Practical Course in Banana Farming, FCAVJ/UNESP, 1993
[13] Resolution No. 32/2003. Available at: https://cnrh.mdr.gov.br/divisao-hidrografica-nacional/74-resolucao-n-32-de-15-de-outubro-de-2003/file

The rivers that make up the BHL are originated on the slopes of Serra do Mar and they head towards the ocean, being the main rivers in the basin the Guaraqueçaba River, the Tagaçaba River, the Cachoeira River, the Nhundiaquara River, the Marumbi River, the Cubatão River and the Guaraguaçu River. The Cubatão River starts in the municipality of São José dos Pinhais with the name of São João River, it serves in part as the boundary between São José and Guaratuba, it receives the Arraial River and from there receives the name Cubatão River until it flows into the Bay. Its tributareis are Castelhano River, River River, Ribeirão Grande River, Zoada River, Navio Arraial River, Cubatãozinho River and Rio Preto. It has about 80 km, being navigable by shallow draft boats to Três Barras.

Cubatãozinho River crosses the project area from north to south, as it starts in Serra das Canavieiras between Guaratuba and Morretes. It has about 60 km, being navigable by canoes to Porto Limeira. Its tributaries are Ribeirão da Prata River, Rio dos Henriques, Guarajuva River, Canavieiras River, Parado River, Furta Maré River and Rasgado River[14]. A map of the water resources is presented in Figure 5.

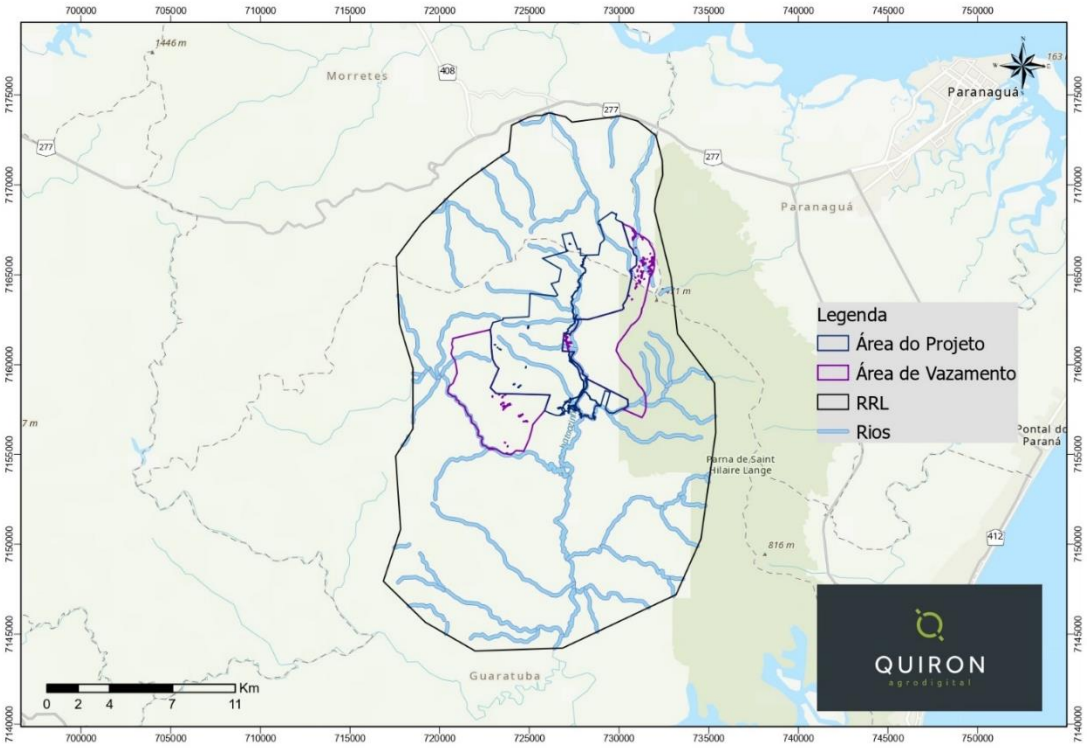

Figure 5: Rivers inside the RRL.

[14] Panorama do Litoral. Rios, Riachos e Córregos de Guaratuba, Matinhos e Caiobá. Available at: http://www.litoral.inf.br/guaratuba/rios/index.htm

1.13.3 Vegetation

The Ombrophilous Dense Forest (ODF) is expressive in the Guaratuba EPA and occupies the entire project area, predominantly the Submontane type. This is an evergreen forest and it occurs in ombrophilous environments where the main tropical climatic factors are an average temperature of 25° C and high rainfall well distributed throughout the year. It plays a very important role in the conservation of local water resources, maintenance of fauna and ecological balance for the quality of life of the entire community. To discriminate the Phyto physiognomies (forest types) existing in the project area, the classification proposed by Roderjan[15] was used. It is estimated that the arboreal flora of the ODF is represented by more than 700 species, the majority being exclusive, not occurring in other vegetation units. The Ombrophiles Dense Forest can be subdivided into the following categories, as shown in the Table 3.

Dense Ombrophilous Forest Class	Altitude (m)
Lowland Ombrophilous Dense Forest	0 to 20 meters
Submontane Ombrophilous Dense Forest	20 to 600 meters
Montane Ombrophilous Dense Forest	600 to 1200 meters
Highmontane Ombrophilous Dense Forest	> that 1200 meters

Table 3: Classes of Ombrophiles Dense Forest (ODF).

The 3 classes of Ombrophilous Dense Forest (ODF) were found in the project area, such as Lowland (1.89%), Submontane (85.97%) and Montane (12.14%). In reference regions for projection of deforestation rate (RRD) and for location of deforestation (RRL), subsequently delimited according to the BL-UP tool, the presence of Ombrophilous Dense Forest vegetation in High montane was also verified, at altitudes above 1,200 meters. In the areas delimited for this project, the Submontane ODF predominates. A vegetation map inside the RRD is presented below, in the Figure 6.

[15] RODERJAN, CV; GALVÃO, F.; KUNIYOSHI, YS; HATSCHBACH, GG Phytogeographic units of the state of Paraná, Brazil. Science & Environment, v. 24, p. 75-92, 2002

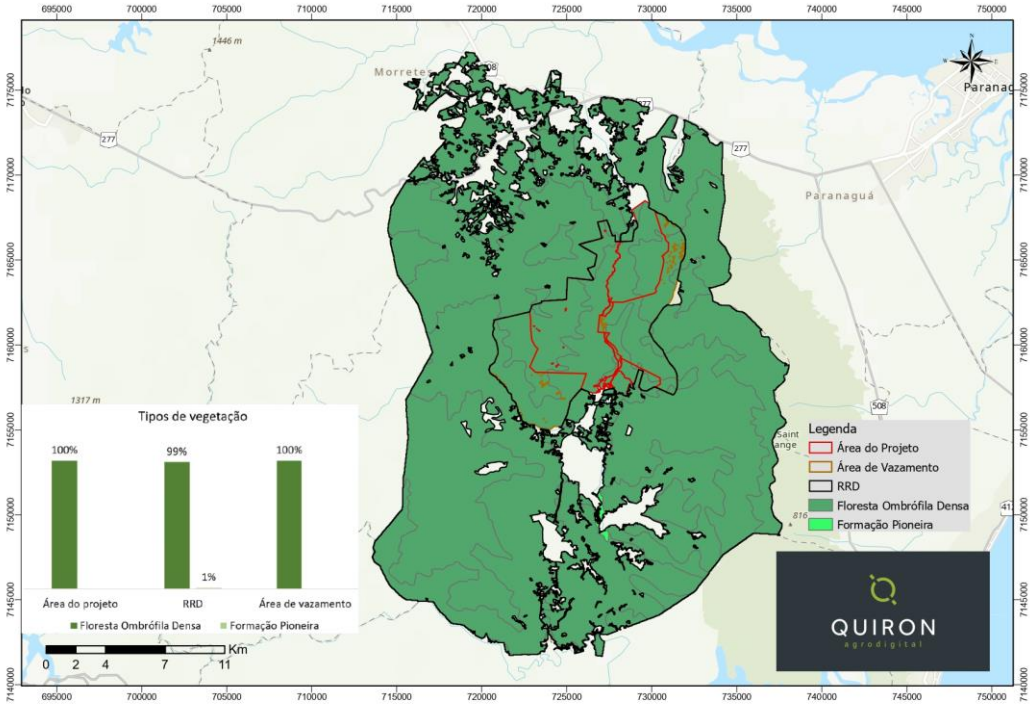

Figure 6: Vegetation Map inside the RRD.

According to Roderjan, the following tree species are common to each class of Submontane Dense Ombrophylous Forest: *Ocotea catharinensis*, *Sloanea guianensis, Schizolobium parahyba*, *Virola bicuhyba*, *Alchornea triplinervia*, *Hyeronima alchorneoides, Cariniana estrellensis, Pseudopiptadenia warmingii*, *Cabralea canjerana, Cedrela fissilis, Vochysia bifalcata*, *Garcinia gardneriana, Guapira opposit, Bathysa meridionalis, Euterpe edulis, Geonoma schottiana* and *Cyathea hirsuta.* In just two inventoried plots with an area of 900 m² each, 45 tree species were found (Table 4), considering Diameter at Breast Height (DBH) above 15 cm.

Scientific Name	Popular Brasilian Name
Actinostemon concolor	Imbuia (Laranjeira do mato)
Alchornea sidifolia	Maria Mole
Cabralea canjerana	Canjerana
Calyptranthes lucida	Guamirim
Cariniana estrellensis	Estopeira
Casearia decandra	Guaçatunga
Cedrela fissilis	Cedro

Scientific Name	Popular Brasilian Name
Hyeronima alchorneoides	Licurana
Inga edulis	Ingá Macaco
Inga luschnatiana	Ingá
Lithrea brasiliensis	Pau de Bugre
Manilkara subsericea	Maçaranduba
Marlieria obscura	Jaguapiroca
Matayba elaeagnoides	Miguel pintado

Chrysophyllum inornatum	Murtinha	*Miconia ligustroides*	Imbiuva
Coccocypselum condalia	Caburi	*Myrcia rostrata*	Guamirim
Copaifera trapezifolia	Pau de Óleo	*Nectandra megapotamica*	Canelinha
Croton celtidifolius	Pau Sangue	*Newtonia glaziovii*	Caovi
Croton urucurana	Urucurana	*Ocotea odorifera*	Canela Sassafras
Cryptocarya mandioccana	Nhotinga	*Oxandra reticulata*	Atinha
Cyathea phalerata	Xaxim Espinhento	*Piptocarpha macropoda*	Pau de Fumo
Dicksonia sellowiana	Xaxim	*Piptocarpha regnellii*	Vassourão
Eugenia multicostata	Pau-alazão	*Pterocarpus rohrii*	Sangueiro
Eugenia vattimoana	Vapurunga	*Psychotria carthagenensis*	Juruvarana
Euterpe edulis	Palmito Juçara	*Psychotria spp*	Erva de Anta
Ficus guaranitica	Figueira-branca	*Solanum granulosoleprosum*	Fumeiro
Garcinia gardneriana	Bacopari	*Talauma ovata*	Baguaçu
Genoma gamiova	Guaricana	*Trichilia pallens*	Guacá
Gomidesia spectabilis	Guamirim Vermelho	*Virola bicuhyba*	Bocuva
Hennecartia omphalandra	Canema	*Vitex megapotamica*	Tarumã

Table 4: Tree species found in the project area.

The Figure 7 shows Guaricana palm tree leaves (*Geonoma gamiova*), which its broad leaves are used to form floral arrangements and it is collected by extractivism.

Figure 7: Guaricana leaves (*Genoma gamiova)*.

1.13.4 Soil, Altimetry and Slope

The project area, the leakage area and the reference region for projecting the deforestation rate have the following types of soils, according to Brazilian Institute of Geography and Statistics (IBGE) [16]: argisol, cambisol and neosol. The soil map inside the RRD is shown in Figure 8.

Brazilian Agricultural Research Corporation (Embrapa)[17] defines these soil types as follows:

- Argissoles - Identified by the higher clay content in the subsurface horizons in relation to the surface horizons, which characterizes a textural gradient along the profile, subject to erosion;
- Cambisols - shallow soils on slopes (50 cm to 1 m) and well drained (water infiltrates easily), which characteristically occur in steeper landscapes;
- Neosols - soils on steep slopes, shallow or deep (up to 1 m) and well-drained (water infiltrates easily), subject to erosion, therefore they must be used for preservation.

[16] Solos. Available at: https://bdiaweb.ibge.gov.br/
[17] Classificação dos Solos. Available at: https://www.embrapa.br/solos/sibcs/classificacao-de-solos/

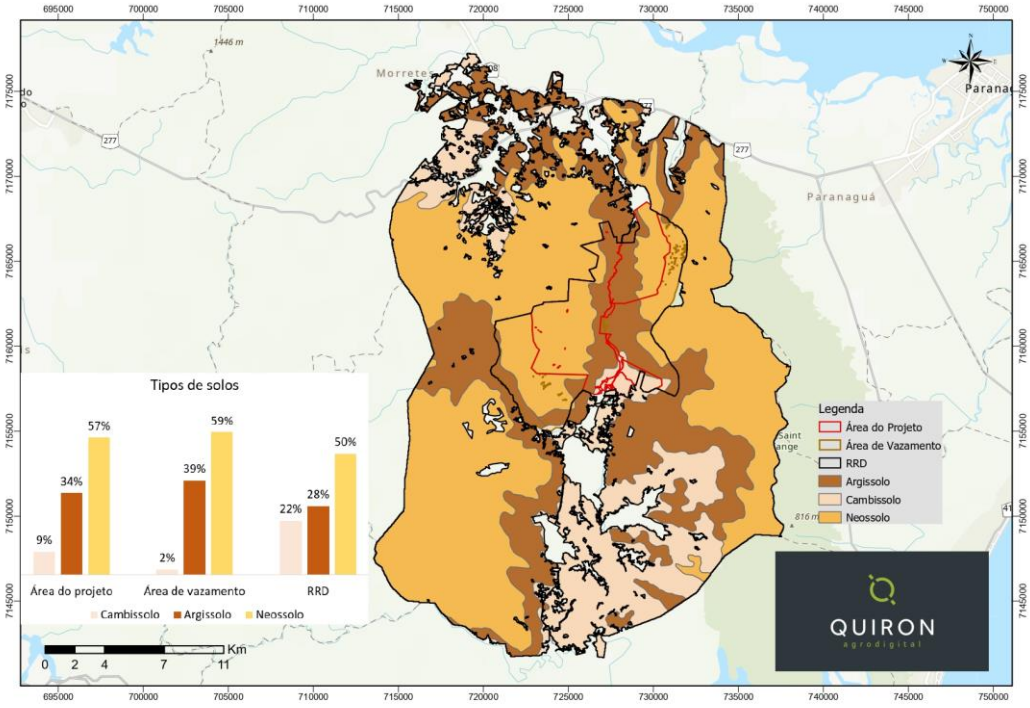

Figure 8: Soil Map inside the RRD.

Data referring to soil types and vegetation types in the RRD were obtained from the Environmental Information Bank of the Brazilian Institute of Geography and Statistics (IBGE). Topographic characteristics (altimetry and slope) were derived from TOPODATA from the National Institute for Space Research. Figures 9 and 10 shows the Altimetry Map and the Slope Map, respectively, inside the RRD.

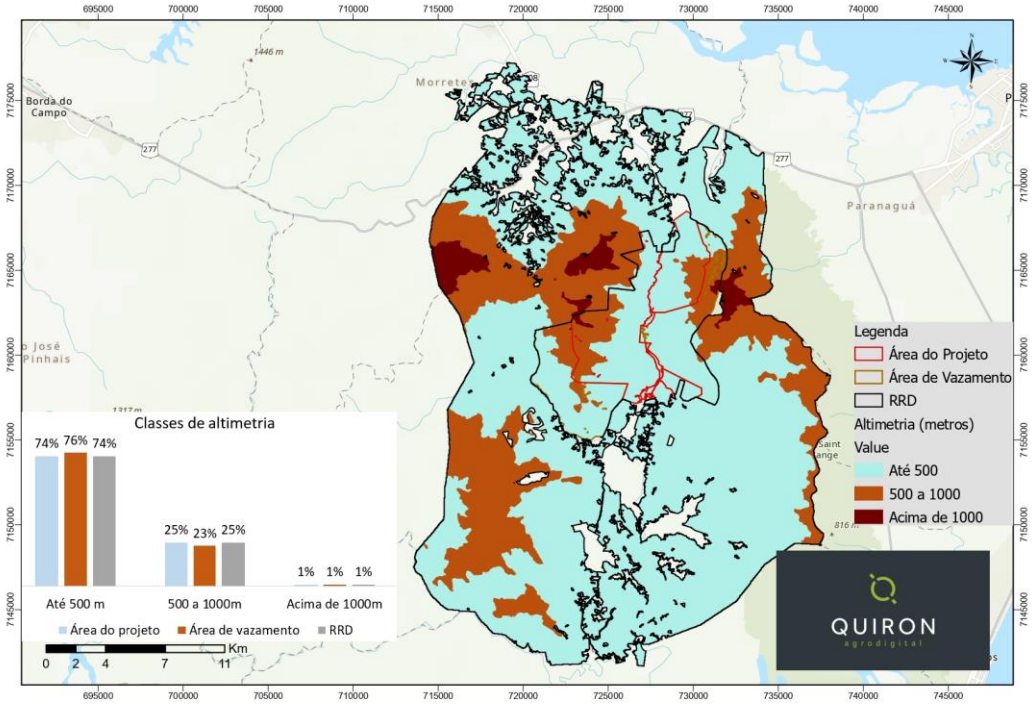

Figure 9: Altimetry Map inside the RRD.

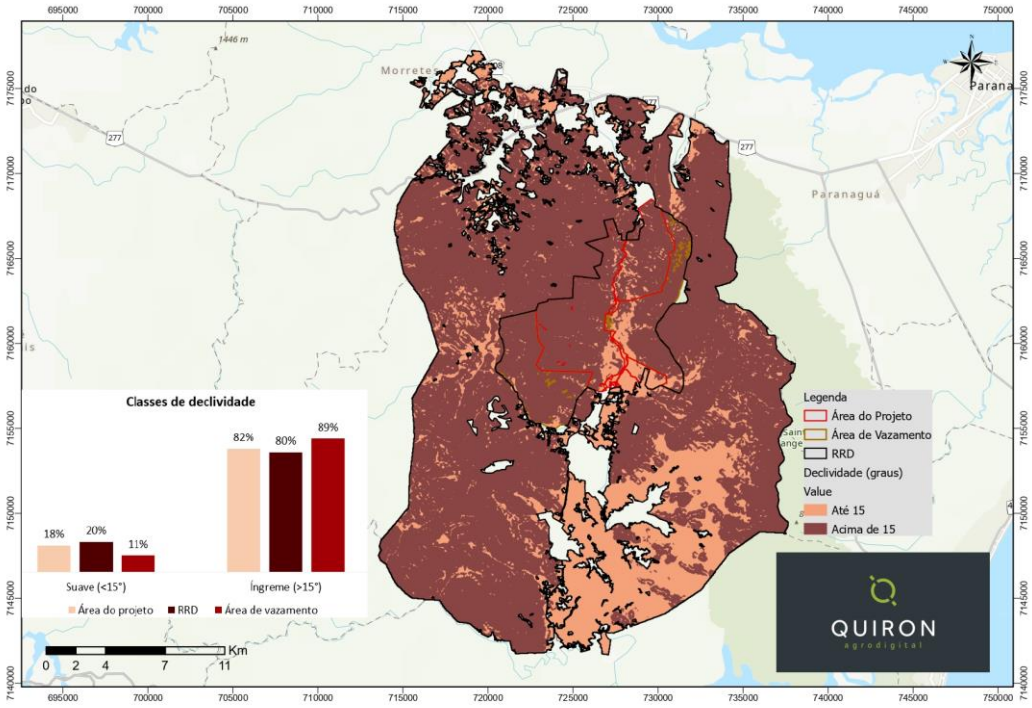

Figure 10: Slope Map inside the RRD.

The Table 5 shows the description of the data, scale, source and reference used in the validation of RRD factors.

Data	Scale	Source	Reference
Soils	1:250.000	BDiA - IBGE	https://bdiaweb.ibge.gov.br/
Vegetation	1:250.000	BDiA - IBGE	https://bdiaweb.ibge.gov.br/
Altimetry	1:250.000	TOPODATA	http://www.dsr.inpe.br/topodata/
Slope	1:250.000	TOPODATA	http://www.dsr.inpe.br/topodata/

Table 5: Data for the validation of RRD factors.

1.13.5 Fauna

The Atlantic Forest is one of the biomes with the greatest biodiversity in the world, so much so that of the estimated 1,6 million species of animals, 261 cataloged species are mammals and of these, 73 are endemic, that is, they occur only within this biome. Comparing with the Amazon, which has 353 mammals, the Atlantic Forest is proportionately richer in biodiversity given the fact that the Amazon is 4 times larger in territory. The Atlantic Forest also has 620 species of birds (181 endemic), 280 species of amphibians (253 endemic) and 200 species of reptiles (60 endemic). These numbers were enough for the non-governmental organization Conservation International (CI)[18] to place the biome on the list of Biodiversity Hotspots among the top five most threatened places on the planet[19].

The State of Paraná has the largest remnant of the Atlantic Forest in Brazil. The forests of the Guaratuba's EPA, as well as the forests of the Atlantic Forest Biodiversity Conservation Limeira Project REDD, have a heterogeneity of ecosystems that shelter diverse fauna, with significant richness of species and diversity of taxonomic groups, justifying, therefore, its importance within the global context of conservation of these forest ecosystems. Forests are constantly invaded by hunters and palm trees in conservation areas, contributing to the scenario of environmental degradation. The illegal exploitation of fauna and flora is correlated in ways that endanger the lives of animals, since the removal of plant resources from tropical forests reduces the environment's carrying capacity for animal species. The risk is even greater for endangered species.

The Guaratuba EPA Management Plan provides information on threatened species that inhabit forests in the protected area: the species *Sphiggurus villosus* (hedgehog) and *Monodelphis scalops* (catita) are

[18] Hotspots. Available at em: https://www.conservation.org/docs/default-source/brasil/HotspotsRevisitados.pdf
[19] Biodiversidade. Available at: https://apremavi.org.br/mata-atlantica/biodiversidade/

endemic to the Atlantic Forest; the species *Lontra longicaudis* (otter), *Leopardus pardalis* (ocelot), *L. tigrinus* (small wildcat), *L. wiedii* (maracajá cat), *Puma concolor* (puma), *Tayassu pecari* (wild pig), *Agouti paca* (paca), *Alouatta fusca* (howler monkey) and *Sylvilagus brasiliensis* (tapiti) are vulnerable; and the species *Speothos venaticus* (vinegar dog) and *Panthera onca* (jaguar) are in danger of extinction.

According to Panorama of the Reptiles Threatened in Brazil[20], reptiles occur in practically all Brazilian ecosystems and, because they are ectothermic, that is, their body temperature varies according to the temperature of the environment, they are especially diverse and abundant in warmer regions. from the country. A great diversity of reptiles can be found in the Atlantic Forest, with almost 200 species.

Deforestation ends up fragmenting the remaining forests, putting at risk species of ecological niches that demand large areas, such as feline species, for example. In addition to deforestation, which already has serious consequences for the species, biopiracy, especially of birds, is widely practiced not only in the project region, but throughout the country. It is understood that in order to protect the fauna, it is first necessary to conserve its habitat, that is, the forest. And secondly, carrying out monitoring by inhibiting the action of hunters helps in the conservation of this habitat.

According to the monitors, the animals that are frequently found on patrols along forest trails are: deer, coatis, graxains, armadillos, tapirs, wild pigs, monkeys, in addition to a wide variety of birds. Pumas have also been sighted several times and even with puma cubs.

The population of howler monkeys decreased dramatically with the yellow fever epidemic that occurred in 2019 and currently these animals have been more observed in monitoring. Below, Table 6 presents a list of species seen in the project area.

Reptiles and Amphibians (Herpetofauna)		Birdlife		Mammals	
Scientific Name	Popular Name	Scientific Name	Popular Name	Scientific Name	Popular Name
Bothrops jararaca	Jararaca-da-mata	*Amazona brasiliensis*	Papagaio-de-cara-roxa	*Agouti paca*	Paca
Cnemidophorus vacariensis	Lagartixa-pintada	*Brotogeris tirica*	Periquito-Rico	*Chironectes minimus*	Cuíca d'água
Ditaxodon taeniatus	Cobra de Hensel	*Hemitriccus kaempferi*	Maria-catarinense	*Dasyprocta*	Cutia
Phrynops williamsi	Cágado-de-pescoço-lateral	*Hirundo rustica*	Andorinha-de-bando	*Delomys dorsalis*	Rato-do-mato

[20] Répteis. Available at: https://www.icmbio.gov.br/portal/images/stories/biodiversidade/fauna-brasileira/livro-vermelho/volumeII/Repteis.pdf

		Leucopternis lacernulata	Gavião-pombo-pequeno	*Didelphis*	Gambá
		Pipile jacutinga	Jacutinga	*Eira barbara*	Irara
		Podiceps rolland	Mergulhão-de-cara-branca	*Kannabateomys amblyonyx*	Rato-da-taquara, rato-do-bambu
		Reinarda squamata	Andorinhão-do-buriti	*Leopardus pardalis*	Jaguatirica
		Stymphalornis acutirostris	Bicudinho-do-brejo	*Leopardus tigrinus*	Gato-do-mato-pequeno
		Triclaria malachitacea	Sabiá-cica	*Leopardus wiedii*	Gato-maracajá
		Tringa flavipes	Maçarico-de-perna-amarela	*Lontra longicaudis*	Lontra
		Tringa solitaria	Maçarico-solitário	*Lycalopex gymnocercus*	Graxaim
				Mazama americana	Veado
				Monodelphis scalops	Catita
				Nasua nasua	Quati
				Oxymycterus Quaestor	Rato-do-brejo
				Panthera onca	Onça, onça-pintada
				Puma concolor	Puma, suçuarana, onça-parda
				Sylvilagus brasiliensis	Coelho, tapiti
				Sphiggurus villosus	Ouriço-cacheiro
				Tapirus terrestris	Anta, tapir
				Tayassu pecari	Queixada, porco-do-mato

Table 6: Animal species which can be found in the project area.

In the years 2015, 2021 and 2022, camera traps were installed in the project area so that the animals could be photographed in nature with the least possible interference, not causing discomfort to the

monitored animals. Figures 11 and 12 show a mosaic of animal life found in the project region during monitoring.

Figure 11: Animals found in the project area in 2015 and 2021.

Figure 12: Animals found in the project area in 2022.

1.13.6 Other information

Since the beginning of the Project (January 1st, 2017), its area already had the following components, in addition to the forest area:

- 0,6 hectares of anthropized area, where a family's house that lives in the project area is built. The family has been lived there since 2000, when a caretaker was hired to maintain the area;
- 16 hectares of banana plantation. The same family that lives on the site maintains the cultivation, guaranteeing them an extra income;
- Lake with 0,2 hectares near the house. In the lake, fish are kept just for the sustenance and recreation of the family;
- Swamp with 9,6 hectares, vegetation different from dense rainforest.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Federal Constitution of 1988, the ecologically balanced environment is attributed as a right to all and its protection a duty of all, considering the environment as a common good for people, aimed not only at economic development, but also to promote the well-being of the living ones. The excerpt that represents this is the Art. No. 225, which says that: "everyone has the right to an ecologically balanced environment, a good for common use by the people and essential to a healthy quality of life, imposing on the public authorities and the community the duty to defend and preserve it for present and future generations". And in the 4th paragraph: "The Brazilian Amazon Forest, the Atlantic Forest, the Serra do Mar, the Pantanal Mato-Grossense and the Coastal Zone are national heritage and their use will be made, in accordance to the law, under conditions that ensure the preservation of the environment, including the use of natural resources".

The list of laws and other documents that deal with the preservation of native forests of the Atlantic Forest biome in the State of Paraná are presented below.

1.14.1 Federal Law No. 11.428/2006 (Law of the Atlantic Forest)

Abstract: Due to the large extension of the Brazilian territory and having different biomes, it is up to the states to issue norms and procedures specific to their reality. With regard to the Atlantic Forest Biome, Federal Law No. 11.428/2006 (Law of the Atlantic Forest) which establishes guidelines for the conservation, protection, regeneration and use of the biome. The law prohibits the suppression of primary and secondary vegetation in the advanced stage of regeneration and of native species that are part of the Official List of Brazilian Flora Species Endangered with Extinction.

Compliance: The purpose of the project is precisely to prevent the deforestation of the forests present in the project area, therefore the project respects the aforementioned law.

1.14.2 Federal Law No. 12.651/2012 (New Forest Code)

Abstract: this Law establishes general rules on the protection of vegetation, Permanent Preservation areas and Legal Reserve areas; forest exploitation, the supply of forest raw materials, control of the origin of forest products and the control and prevention of forest fires, and provides for economic and financial instruments to achieve its objectives. The Brazilian Forest Code has existed since 1965 with the aim of limiting land use by landowners. Since then, it has undergone seven amendments, and the New Forest Code is in effect today, which continues to provide for the use and protection of native vegetation on private land in Brazil, but with some flexibilities for the restoration of degraded areas. It is one of the most important environmental laws, with great potential to promote efficient land use in Brazil, it is a valuable tool for mitigating climate change. It relies on two instruments of fundamental importance for environmental conservation on private lands: the Permanent Preservation Areas (APP) and the Legal Reserve. In addition to creating the Rural Environmental Registry (CAR), an electronic database that assists in the environmental management of rural properties and possessions, as well as monitoring and combating deforestation.

Compliance: Before seeking registration with the VCS, the regularity of all areas that make up the project was verified. All are duly registered under a registration number in the competent body, in addition to being registered with the Rural Environmental Registry (RER). It presents all the Permanent Preservation Areas and Legal Reserve protected.

1.14.3 Federal Decree No. 6.660/2008

Abstract: It regulates provisions of Law No. 11.428/2006, which provides for the use and protection of native vegetation in the Atlantic Forest Biome.

Compliance: The project did not and will not cultivate, exploit or suppress individuals of any native species.

1.14.4 Ordinance of the Ministry of the Environment No. 443/2014

Abstract: This ordinance recognizes as endangered species of the Brazilian flora those listed in the "Official National List of Endangered Flora Species". The species *Euterpe edulis* (Juçara palm) presented in this list was already determined in 2008 as a vulnerable species by the Normative Instruction of the Ministry of the Environment No. 6 of 2008 (revoked by this ordinance). Cutting it is prohibited in a native forest, when it is not cultivated in properly licensed plantations.

Compliance: The project did not and will not cut any individual of the *Euterpe edulis* species or cultivate for this purpose without proper environmental authorization.

1.14.5 SEMA Resolution No. 019/2010

Summary: Establishes norms and procedures for the protection and use of palm heart extracted from *Euterpe edulis* in the state of Paraná.

Compliance: The project has not and will not cut any individual of the *Euterpe edulis* species, not even cultivate it for this purpose.

1.14.6 Guaratuba Environmental Protection Area Management Plan

Abstract: Planning instrument that aims to guide participatory management in order to ensure the conservation of natural resources and the improvement of quality of life, in line with the interests of present and future generations. It seeks to establish guidelines and guide programs, projects and actions that may be carried out in the region by different interest groups, working directly or indirectly in the EPA. The Plan makes a general characterization, comprising aspects related to its physical and legal context, methodological guidelines, as well as sectorial diagnoses and recommendations. It determines the ecological-economic zoning with the description of each zone with its respective peculiarities and proposed norms and introduces the management system.

Aiming to conserve the biodiversity of the Guaratuba EPA, the plan recommends as strategies the definition of potential ecological corridors and the determination of priority areas for conservation.

Compliance: The project area is located exactly where the management plan recommended the creation of the Central Corridor aiming at the connection between the Saint-Hilaire/Lange National Park and the Serras da Prata, Canasvieiras and Igreja (current Guaricana National Park). The Atlantic Forest Biodiversity Conservation Limeira Project REDD completes the creation of this corridor. However, the plan also highlights that, due to the existence of the Limeira road, the ecological zoning indicated for this region should include restrictions or regulations for vehicles access and for land occupation. Until the beginning of the project, no restrictions or regulations were determined by the competent authorities, but the monitoring of the road by Limeira Farm employees and the identification plates installed along the road which were described in section 1.11 can be considered useful to have a control and record of accidents that may occur on the road.

1.14.7 SEMA/IAP Clustered Resolution No. 005/2009

Abstract: Establishes and defines the mapping of Strategic Areas for the Conservation and Recovery of Biodiversity in the State of Paraná. Considers as priorities and strategic for the conservation of

biodiversity, all the remnants of native vegetation in the primary stage and in the medium and advanced secondary stages of regeneration. In addition, it states that economic incentives must be defined and implemented by owners located in strategic areas for the biodiversity's conservation, whose remnants of native vegetation exceed current legal requirements, through payment for environmental services provided.

Compliance: The knowledge of this resolution is an additional incentive for the conservation in the forests of the present project, especially because a large part of the project area consists of primary forest or in an advanced state of regeneration. The project is entirely committed within the priority and strategic area for conservation defined by the resolution.

1.14.8 Decree No. 10.144/2019

Abstract: Establishes the Commission for the Reduction of Greenhouse Gas Emissions from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks – REDD+.

Compliance: The present project is in line with the objectives of the National Commission established by this decree. Through this commission, Brazil recognizes the elaboration of this type of project in the national territory as a way of contributing with the reduction of GHG and the conservation of forest carbon stock. It also recognizes the legitimacy of payments from multiple sources for REDD projects as deliberated by the United Nations Framework Convention on Climate Change.

1.14.9 Ordinance No. 288/2020

Abstract: Establishes the National Program for Payments for Environmental Services – Floresta+, within the scope of the Ministry of the Environment.

Compliance: This is another initiative by the Brazilian government to support public or private projects in the search for national and international partnerships to encourage payment for environmental services in forested areas. The project seeks as a form of payment the carbon credits generated from forest protection as a way to subsidize this activity.

1.14.10 Law No. 14.119/2021

Abstract: Establishes the National Policy for Payment for Environmental Services (PNPSA).

Compliance: It is within the PNPSA's objectives to encourage the development and execution of voluntary private projects for the provision and payment of environmental services, which involve initiatives by companies, Civil Society Organizations of Public Interest (Oscip) and other non-governmental organizations. The law also states that full protection conservation units or any areas with native

vegetation cover, landscapes of great scenic beauty, primarily in special areas of tourist interest and areas defined by the government as priorities for the biodiversity conservation may be a subject to payment for environmental services. Atlantic Forest Biodiversity Conservation Limeira Project REDD fits all of these definitions.

1.14.11 Law No. 9.985/2000

Abstract: Establishes the National System of Nature Conservation Units (SNUC), providing criterias and norms for the creation, implementation and management of conservation units.

Compliance: Conservation Units in Brazil are divided into two groups: integral protection and sustainable use. The project area is entirely in the Guaratuba APA, a sustainable use unit, with part of the area also belonging to the integral protection units Guaricana and Saint-Hilaire/Langue National Parks. The law determines that landowners who own land in a conservation unit must obey the unit's management plan. None of the activities carried out or intended to be done in the project go against the Management Plan of APA de Guaratuba or the uses allowed in an Integral Conservation Unit, which is the preservation of natural ecosystems, scientific research and the development of environmental education, ecological recreation and tourism.

1.14.12 Decree No. 4.339/2002

Abstract: Establishes principles and guidelines for the implementation of the National Biodiversity Policy.

Compliance: The decree refers to the contribution of additional financial resources from developed countries that can be used to meet the needs of developing countries with regard to the conservation of biodiversity, which is a common concern for humanity. And national actions related to biodiversity management must be integrated with international conventions, treaties and agreements. In this case, the present project complies with the law because the carbon market was created from an international agrement. And as a trade can be carried out between developed and developing countries that the latter can finance forest protection activities that will reduce GHG emissions, but also protect their biodiversity.

1.14.13 Law No. 9.433/1997

Abstract: Establishes the National Water Resources Policy.

Compliance: The National Water Resources Policy is based on the principle that water is a limited natural resource that has economic value and that its management must involve the participation of users and communities. One of the policy's objectives is to ensure that current and future generations are going to have water availability at appropriate standards according to use. Clearly, the project collaborates with the conservation of water sources given the number of springs, streams and rivers present in the project

area. The conservation of the forest in this area is crucial for the maintenance of this natural resource for the surrounding rural communities that use it mainly in agriculture.

1.14.14 Law No. 9.795/1999

Abstract: Provides for environmental education and institutes the National Environmental Education Policy.

Compliance: The project provides for environmental education combined with ecological tourism, which is in line with the law's objective of developing an integrated understanding of the environment in its multiple and complex relationships.

1.14.15 Law No. 12.187/2009

Abstract: Establishes the National Policy on Climate Change (PNMC).

Compliance: The project is a way of contributing to the mitigation of climate change through the conservation of natural resources, which is one of the objectives of the PNMC. It also seeks to use the financial and economic mechanisms that exist within the scope of the United Nations Framework Convention on Climate Change and the Kyoto Protocol mentioned in Article 5th of the Law. The financial mechanism in the case of this project is the generation of carbon credits from the it.

1.15 Participation under Other GHG Programs

This project does not participate in other GHG programs.

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

This project does not participate in other programs that may generate carbon credits.

1.15.2 Projects Rejected by Other GHG Programs

This project has never been submitted to any other GHG program and has never been rejected.

1.16 Other Forms of Credit

This project does not have other forms of credit.

1.16.1 Emissions Trading Programs and Other Binding Limits

This project does not participate in emissions trading programs and other binding limits.

1.16.2 Other Forms of Environmental Credit

This project does not participate in other forms of environmental credit.

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

The project activities are closely connected with SDGs 6, 13, 15 and 17 and aim according to each item:

- SDG 6: Protect and restore water-related ecosystems, such as forests, mountains and rivers, as we want to mitigate their scarcity;
- SDG 13: Protect forests, because by removing carbon from the atmosphere and keeping its stocks in the forest, we help to mitigate climate change;
- SDG 15: Stopping deforestation is vital, as reducing the loss of biodiversity and preventing the extinction of species also help to mitigate climate change;
- SDG 17: Forming partnerships with institutions linked to agriculture, universities and research presents new possibilities for community agriculture, aiming at carrying out research and supporting sustainable development.

1.17.2 Monitoring Contributions to Sustainable Development Activities

The Ministry of Planning, Development and Management through the Institute for Applied Economic Research (IPEA)[21], adapted the goals of Agenda 30 from the UN Sustainable Development Goals to the Brazilian reality, with a document available on the website www.ipea.gov.br. As previously mentioned, this project has a special link with SDGs 6, 13, 15 and 17 and an explanation of how project activities result in contributions to the project can be found in Table 7 below.

[21] Agenda SDG. Available at: https://www.ipea.gov.br/portal/images/stories/PDFs/livros/livros/191122_livro_2030_agenda_sdg_national_targets_of_sustainable_development_goals.pdf

SDG Target	SDG Indicador	Net Impact on the SDG Indicator	Current Project Contributions	Project Lifetime Contributions
6	6.6 (Brazil): By 2020, protect and restore water-related ecosystems, including mountains, forests, swamps, rivers, aquifers and lakes, reducing the impacts of human action.	The protection of forests in the project area has been monitored since 2017 and is extremely necessary, as they play an important role in maintaining the area's water resources.	Atlantic Forest Biodiversity Conservation Limeira Project REDD has an area of 1.023 hectares of protected permanent preservation areas (APPs).	The main function of these APPs is to protect rivers, streams and springs from erosion and degradation, keeping the region's water resources preserved, increasing the quality and availability of water and reducing the risk of natural disasters.
13	Target 13.1 (Brazil): Increase resilience and capacity to adapt to hazards and impacts resulting from climate change and natural disasters.	The project aims to collaborate with the reduction of greenhouse gas emissions, monitoring the increase in its forest carbon stock.	By conserving 4.340,23 ha of forest, Atlantic Forest Biodiversity Conservation Limeira Project REDD expects to avoid deforestation of 270,13 ha in the first baseline period of the project (2017-2026).	The project expects to avoid about 112.664 t CO_2e in the atmosphere in the first baseline period of the project (2017-2026), which can be reported in monitoring reports.
13	13.3 (Brazil): Improve education, awareness and human and institutional capacity on the dangers of climate change, mitigation, adaptation, impacts and early warning.	The project aims to develop education and awareness of the importance of forests in combating climate change through ecological tourism as one of the project's activities.	By holding meetings, it is possible to measure mitigation activities, which include community awareness activities.	Better understanding and knowledge so that emissions and activities that contribute to carbon emissions are avoided, reporting the community's incentive to protect the forest from agents of deforestation and degradation.

15	15.2 (Brazil): By 2030, eliminate illegal deforestation in all Brazilian biomes, expand the area of forests under sustainable environmental management and recover 12 million hectares of degraded forests and other forms of native vegetation, in all biomes and preferably in Permanent Preservation Areas and Legal Reserve and, in areas of alternative land use, expand the area of planted forests by 1.4 million hectares.	By monitoring deforestation and patrolling the project area, it contributes to reducing deforestation in the Atlantic Forest biome.	Through monitoring through Forest Watch, in the years 2017 to 2020 it was possible to count an area of 0.0695 ha deforested within the project.	It was estimated that deforestation of 270.13 ha would be avoided in the first baseline period of the project (2017-2026). The value of 0.0695 corresponds to 0.025% of this value. Citing that this deforestation is solely associated with the natural disaster that occurred in 2020 and the illegal deforestation that may have occurred along the highway that passes through the project area.
15	15.b (Brazil): Mobilize significant resources from all sources and at all levels to finance and provide adequate incentives for sustainable forest management, including for conservation and reforestation.	The project aims to access financial resources from the carbon market through registration in the VCS Program to generate carbon credits.	There are no further changes in this monitoring period.	There are no further changes in this monitoring period.
17	17.17 (Brazil): Encourage and promote effective partnerships in the public, private, public-private and civil society spheres, based on the experience of the resource mobilization strategies of these partnerships.	Forming partnerships with institutions linked to agriculture, universities, research and presenting new possibilities for community agriculture, monitoring the conduct of research and supporting sustainable development.	There are no further changes in this monitoring period.	There are no further changes in this monitoring period.

17	17.18 (Brazil): Strengthen support for data disaggregation, integration, availability and sharing of administrative records and statistical and geoscientific databases relevant to the achievement of goals and to measure sustainable development indicators, respecting the legislation on information security .	Monitoring of the project area is done through Remote Sensing systems, such as Global Forest Watch, combined with armed surveillance, signaling and periodic audits. The monitoring of the leakage area is done only by Global Forest Watch.	The project area map can be accessed via: www.globalforestwatch.org/dashboards/aoi/623893d67a228f001bb3e07e The leak area map can be accessed via: https://gfw.global/3ulvYee	There are no further changes in this monitoring period.

Table 7: Project Contributions to Sustainable Development.

1.18 Additional Information Relevant to the Project

1.18.1 Leakage Management

Atlantic Forest Biodiversity Conservation Limeira Project REDD will contribute to leakage management by supporting municipal or state government projects for the technical training of farmers in the region, searching for more sustainable practices. The properties surrounding the project area, that is, the spill area, are private and their owners must follow the Guaratuba EPA Management Plan where they are located. Therefore, for leak management, the guidelines and programs developed by the management plan must also be taken into account. Here are some examples:

- Economic Ecological Zoning: part of the project area and adjacent areas belong to the Limeira-Cubatão management unit, Agricultural Use Zone A1 and Protection Zone, where polluting industries are prohibited; reforestation with invasive exotic species; high-impact sports activities; implementation of farming activities, housing and rural infrastructure on sambaquis; tourism infrastructure with a high environmental impact; use of aircraft for spraying;
- Recovery of Degraded Areas: encourage the recovery of areas degraded by mining or other impacting activities; the restoration of permanent preservation areas;
- Biodiversity Conservation: encourage the creation of RPPNs, in order to increase the level of conservation and environmental quality in the unit; prioritize the surroundings of full protection UCs and potential areas for connectivity between forest fragments;
- Sustainable Tourism and Recreation: Training technicians and local residents in the operation of sustainable tourism in order to minimize negative impacts (environmental, social and cultural) and maximize the quality of tourism products.

1.18.2 Commercially Sensitive Information

There is no commercially confidential information in this project description document. Supporting documents that include commercially confidential information that will not be publicly available include agreements, contracts with buyers and service providers, and documents related to project finances used in risk assessment, including bank statements.

1.18.3 Further Information

Further informations can be requested under demand.

2 SAFEGUARDS

2.1 No Net Harm

This project does not generate any negative environmental or socio-economic impact. The main activity of the project is the integral protection of the forest, therefore the benefits to the environment are essential. When you keep a forest standing, you maintain a large carbon reservoir. In addition, preventing the emission of GHG into the atmosphere by avoiding the cutting of trees, the forest can still increase its carbon stock from its development. According to the IPCC[22], a subtropical forest in America can have an average increase in aboveground biomass of 2 to 7 tons/hectare/year, depending on its regeneration's stage.

The forest is the habitat of thousands of living beings forming a balanced ecosystem. Abiotic factors such as water, soil and temperature are also kept in balance, regulating the climate and guaranteeing essential ecosystem services for the surrounding communities. Protected water resources support springs that supply communities, agriculture and livestock, bringing socio-economic benefits to the region, in addition to generating employment by the necessity of people to carry out ecotourism activities, monitoring and patroling the protected the area.

There is no negative socio-economic impact as there are not communities living within the projected area and there are not communities that depend on the forest for their sustenance.

2.2 Local Stakeholder Consultation

[22] IPCC Good Practice Guidance for LULUCF.

First, organizations that could be related in some way to the project in terms of interest or location were identified. Contact was made by telephone and by email with representatives of these organizations to invite them to participate in an online meeting.

1st Meeting

Date: 20/04/2021

Objective: To present the creation of the Limeira REDD Project to the representatives of the relevant bodies for the project.

Participating institutions:

- Neo Green Consultoria Ambiental (the company which is developing the project);
- ICMBio (Chico Mendes Institute for Biodiversity Conservation), which manages protected areas in Brazil;
- IDR (Institute of Rural Development of Paraná);
- Environment Departments of the Municipalities of Morretes and Guaratuba.

At the meeting, Neo Green Consultoria Ambiental introduced itself as the developer of the project, explained some general concepts about REDD projects and presented the project itself. The location and limits of the project, the deforestation and degradation found in the region and the activities which are developed to avoid unplanned deforestation since the beginning of the project were demonstrated. The interest in collaborating in some way with the sustainability of agriculture in the region surrounding the project was also discussedd. Some doubts were raised by the participants, such as where the resources for the development of the project come from, how the monitoring is done, if any fauna and flora survey has already been carried out, if there is any accommodation on site, if the entire project area has regular documentation. All enquiries have been answered.

On the part of the IDR, the comment was about the culture of rural producers who do not easily accept changes in their production systems for sustainable production. Mr. Sebastião commented that after so many changes and restrictions created by environmental legislation in his 40 years of work, there was a considerable rural exodus. He reported that with the creation of environmental protection areas and regulations for the sustainable use of the land, there was a drop in banana production, for example, and a general dissatisfaction on the part of the producers who remained in the place. And he warned that any kind of interaction with producers should be done with great caution when dealing with matters of environmental protection. Managers of the Guaricana National Park (ICMBio) commented on the overlap of part of the project area in the park and the importance of the initiatives being consonant and a joint work.

To these comments, it was stated that any activity carried out within the project area will always have accessible information to the agencies represented at this meeting and to the interested community, in addition of being compatible with current legislation and regulations of the Guaratuba's APA. As for the performance outside the project area, it will be analyzed and it will have the intention of being collaborative in the actions carried out by the IDR.

It is concluded that the project does not present risks to the interested parties, on the contrary, it helps to protect the forest, adding to the monitoring in the buffer zone of national parks and within the environmental protection area. This meeting was recorded and can be consulted in the project files.

The Figure 13 shows some of the participants of the first online meeting.

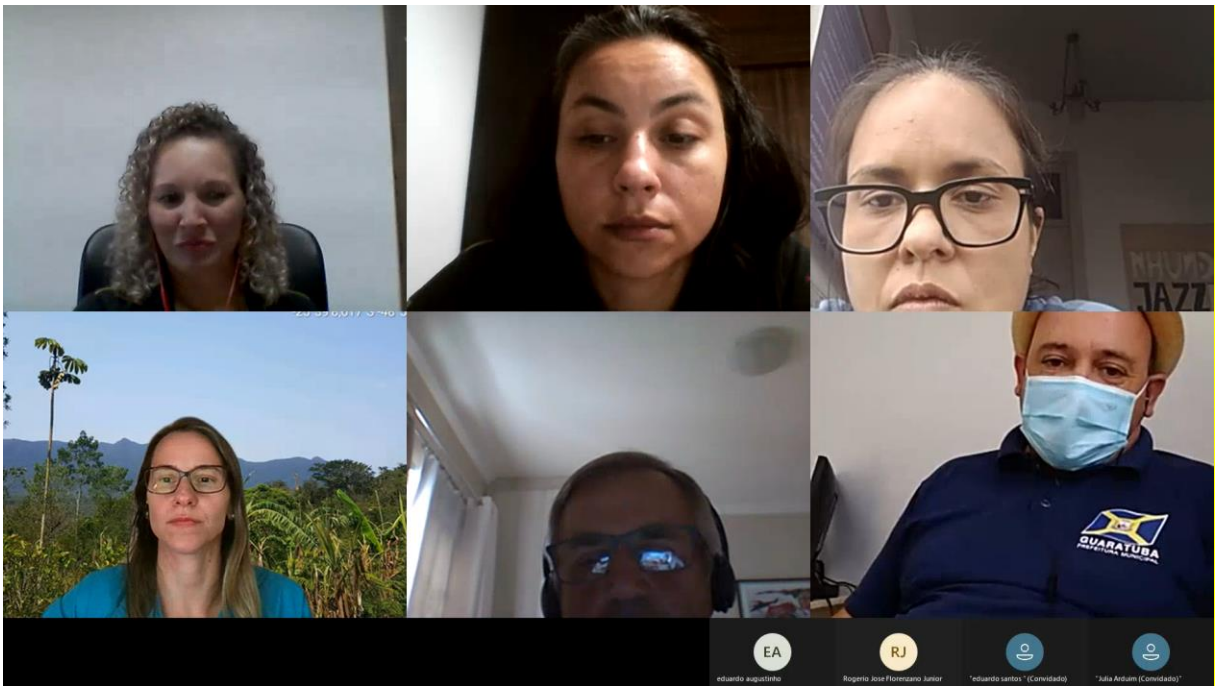

Figure 13: Participants of the first online meeting.

2nd Meeting

Date: 02/07/2021

Objective: To present the creation of the Limeira REDD Project to the representatives of the relevant bodies for the Project, demonstrate the project's evolution and understand the actions developed by the IDR together with the local farmers.

Participating institutions:

- Neo Green Consultoria Ambiental (the company which is developing the project);
- ICMBio (Chico Mendes Institute for Biodiversity Conservation), which manages protected areas in Brazil;
- IDR (Institute of Rural Development of Paraná);
- IAT (Paraná Water and Land Institute).

The meeting started with the presentation of the participants and once more with the presentation of the company Neo Green Consultoria Ambiental and the project. There was a change in the name of the Project, which was previously called "Projeto Limeira REDD" to "Atlantic Forest Biodiversity Conservation Limeira Project REDD". "Biodiversity Conservation" was added, due to the lack of familiarity of the meeting participants and the community in general with the term REDD. It was noticed that most participants still had many doubts about the REDD projects and how the voluntary carbon Market would occur. There were questions like:

How and by whom is the project validated?

How is it the amount of carbon credits calculated and how are they generated?

How will the value of the sale of the credits be invested?

What are the benefits to the community from carrying out this project?
In spite of the attempt to answer the questions, the lack of specific prior knowledge on the subject still left the participants insecure about understanding the idea of the project.

It was commented on the fact that the project lands have forests that by law can not be deforested and that is for this reason the proponent has the obligation to protect them. But in Brazil in general, protection is onerous for forest landowners, who in many cases can not afford to pay for effective protection. And one of the ways found to conserve the forests and their natural resources was the execution of the project in which the sale of the generated credits will be used mainly to improve monitoring. Other alternatives would be the Payment for Environmental Services (PSA) and Legal Reserve Compensation, but both do not yet have defined legal procedures.

It was also stated by several participants that in order to carry out this project, authorization must first be obtained from the IAT (Instituto Água e Terra do Paraná). The land owner is aware that the project area is located within the Guaratuba APA under its own use and zoning rules and that part of the land is within the Guaricana and Saint-Hilaire/Langue National Parks. However, he believes that monitoring through hired guards is not something that requires authorization, since it is carried out only within his lands, which have legal documentation. The protection/conservation activity through monitoring is consistent with the uses defined by the APA de Guaratuba management plan and with the uses allowed in national

parks according to Law No. 9985/2000, since the mentioned national parks do not have their own management plan.

According to the 1st paragraph of article 11 of this law, the lands of national parks are in the public domain and the private áreas, including in their boundaries, will be expropriated. This was one of the points raised at the meeting by ICMBio. The Atlantic Forest Biodiversity Conservation Limeira Project REDD proponent has all the legal documentation of the area's ownership, which is required at the time of project validation to later register it in the VCS Program. Therefore, there is no impediment on carrying out the project and naturally from the moment when the lands within the national parks are expropriated, the monitoring report will show the occurrence to the verification. The bidder will no longer be entitled to forest carbon in that area and will no longer carry out monitoring there.

On behalf of the IDR (Institute for Rural Development of Paraná), the participants were interested in the project and in the benefits that forest conservation can bring to the community. And they were empathetic with the idea of valuing the standing forest, quoting the expression "Carbon Farms". It was alerted to some problems that occur in the community such as poverty in many families, lack of access to electricity and internet. Also, it was indicated some actions that are being planned to train farmers, such as teaching organic farming techniques and agroecology. Actions in which the Atlantic Forest Biodiversity Conservation Limeira Project REDD could collaborate with technical knowledge.

It was concluded that the project should be presented once more in a much more detailed and didactic perspective to the IAT Council, as advised by the manager of the APA of Guaratuba and to other participants if they are interested in being present again.

3rd Meeting

Date: 23/02/2022

Objective: To present the Guaricana National Park Management Plan and talk to stakeholders and the community to understand the demands for carrying out the Plan.

Participating institutions:

- Neo Green Consultoria Ambiental (the company which is developing the project);
- ICMBio (Chico Mendes Institute for Biodiversity Conservation), which manages protected areas in Brazil;
- IDR (Institute of Rural Development of Paraná);
- Environment Department of the Municipality of Guaratuba;
- Guaratuba community.

The meeting began with a speech by Luiz (ICMBio), presenting the Project for the Guaricana National Park Management Plan. The general lines of work (preservation, tourism, recreation and research) and the specific objectives of the unit were mentioned, which is to guarantee the preservation of remnants of dense rainforest and mixed rainforest, including flora, fauna, water and geological resources, geomorphology and associated natural landscapes.

The question of whether or not to sell the land within PARNA Guaricana was presented, explaining the need for documentation of the lot for the regulation of the sale to the government, being well stressed the question that each property may have specific issues that can be discussed individually.

One concern raised was that many plots were owned by squatters who had lived in the area for many years. A proposed solution was the effectuation of adverse possession, but this issue would have to be better discussed among the interested parties, as it is a mechanism that can take a considerable time to be effective. PARNA's plan also needs to describe this reality.

There was also talk about the participation of the 2019 council, where IAT, Paraná Turismo, COPEL, the association of Rio Cubatão and the association of Rio Sagrado were inserted.

Another concern was the use of the territory within the park for extractivism. The law guarantees the use of the park in cases where a family uses the area for extraction (guaricana leaves and vines), but this is also an item that must be analyzed individually and that the plan needs to describe the diagnoses, agreements and registrations. So much so that illegal deforestation, in addition to trampling and hunting wildlife, are considered pressures of conflict in the area.

An overview was presented, in a pyramid, of the management plan and how the workshop would work so that this plan could be structured. Essential items for the workshop are: 1 – purpose, 2 – significance, 3 – resources and core values, 4 – management zones and 5 – legal, administrative and regulatory acts. This workshop is scheduled for August and its didactic needs 5 days in a row to be applied. In this way, the speakers requested the possibility of appointing people who can participate every day in a row, without any interference.

The issue of buffer zones was also discussed. The community wants to continue with its productions normally, without being affected by the delimitation of such zone. The speaker informed that the management plan is different from the buffer zones. The community feels apprehensive about the buffer zone due to the process that took place for the implementation of the current APA that is located on the site.

The question was asked that the community values the most in the region and people were unanimous in terms of bananas, since Guaratuba is the largest banana producer in the state of Paraná, especially

as it is a region with fertile and flat land. The cultivation of palm hearts is also relevant, but it is not as strong as that of bananas.

Thus, a paved road ends up being of great interest to the community, especially for the flow of production. For this reason, the city's secretary of works mentioned that there is a project for the asphalt and the creation of a highway to be made.

The preservation of rivers, tapirs and guaricana leaves were also mentioned.

The borders of PARNA Guaricana were also requested, for better visualization of the community, as many farmers are not sure if their lots are inside or outside the community.

The little structure for receiving tourists attracts many people with low environmental awareness, who end up polluting and leaving garbage along the points visited. The community is also afraid of being judged by tourists at times when an agricultural pesticide is passed through the banana plantations, because tourists do not have an effective knowledge of what can and cannot be done on the landowners' lots.

The Figure 14 shows some of the participants of the meeting which took place on February 23rd, 2022.

Figure 14: Participants of the presencial meeting.

2.3 Environmental Impact

As said before, this project does not generate any negative environmental or socio-economic impact, because the main activity of it is the integral protection of the forest and this is why the benefits to the environment are essential.

2.4 Public Comments

Public comment period is going to run from the day of this project submission, for a period of 30 days.

2.5 AFOLU-Specific Safeguards

Stakeholders were identified in 2.2 and they are: Institutional stakeholders (Neo Green Consultoria Ambiental, ICMBio, IDR, IAT and the Environment Departments of the Municipalities of Morretes and Guaratuba) and Community stakeholders (Guaratuba community).

Atlantic Forest Biodiversity Conservation Limeira Project REDD does not represent any risk to stakeholders as the Project did not take community stakeholders's work away.

The communication and consultation with local stakeholders will be active for all the duration of the Project and claims or complaints should be attended within 15 working days of receipt of the request. Suggestions should be attended within 30 working days of receipt of the request.

However, when it is not possible to provide an answer within the established frame time, the claimant must be formally informed and the reasons for the delay and the new date for reply must be given. The proposed mechanism will be in constant evaluation and adjustment, according to the recorded dynamics and evaluation of effectiveness. So far, none of the stakeholders has been expressed any kind of grievance.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Atlantic Forest Biodiversity Conservation Limeira Project REDD uses the VCS REDD Methodology, entitled “VM0007: REDD Methodology Modules (REDD-MF)”. The only activity eligible as part of this project is to avoid unplanned deforestation and degradation, therefore only modules related to unplanned deforestation are required.

This project is eligible as an unplanned deforestation prevention project, because the forest area must be converted to non-forest land in the baseline case and the land is not legally authorized and documented to be converted to non-forest or managed tree plantation. The specific modules applied to the Atlantic Forest Biodiversity Conservation Limeira Project REDD are listed below.

3.1.1 Carbon pool modules

CP-AB, "VMD0001 Estimation of carbon stocks in above and below ground biomass in pools of living trees and non-trees", Version 1.1.

3.1.2 Baseline modules

BL-UP, "VMD0007 Estimation of Baseline Carbon Stock Changes and Greenhouse Gas Emissions from Unplanned Deforestation", Version 3.3.

3.1.3 Leakage modules

LK-ASU, "VMD0010 Emissions Estimate from Activity Change to Avoided Unplanned Deforestation", Version 1.2.

3.1.4 Emissions modules

E-BPB, “Estimate greenhouse gas emissions from biomass burning and peat burning”, Version 1.2.

E-NA, “Estimation of the direct emission of nitrous oxide from nitrogen fertilization”, Version 01.

3.1.5 Monitoring module

M-REDD, “VMD0015 Methods for Monitoring Greenhouse Gas Emissions and Removals”, Version 2.2.

3.1.6 Miscellaneous Modules

X –STR, “VMD0016 Methods for project area stratification”, Version 1.2.

X-UNC, “VMD0017 Estimation of uncertainty for REDD project activities”, Version 2.2.

3.1.7 Tools

T-SIG, CDM tool "Tool to test the significance of GHG emissions in A/R CDM project activities", Version 1.0.

T-ADD, “Tool VT0001 for the demonstration and assessment of additionality in agriculture, forestry and other land use (AFOLU) VCS project activities”, Version 3.0.

T-BAR, "Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination", Version 3.2.

The use of modules, REDD-MF, M-MON, T-ADD, T-BAR, X-UNC and X-STR is always mandatory when using the VM0007 methodology. Subsequent use of the modules, BL-UP and LK-ASU is mandatory in the case of projects focusing on unplanned deforestation.

The E-BPB and E-NA modules were used to calculate the project's GHG emissions, the use of the T-SIG module determines whether GHG emissions by sources and/or reductions in carbon pools are significant and finally, the use CP-AB is mandatory in all cases, while CP-D is optional and has not been used.

3.2 Applicability of Methodology

The modules mentioned above are used because the project meets the applicability conditions of each one as justified below.

3.2.1 VM0007 Methodology (REDD-MF), REDD Methodology Framework

a) For all activities, every land area registered under the CDM or any other GHG program, it must be transparently reported and excluded from the project area.

Justification: there are not land areas registered in any other GHG program in this project, thus guaranteeing that there will be no double counting of carbon credits.

b) Land in the project area was qualified as forest (following the definition used by the VCS) for at least 10 years prior to the project start date.

Justification: The project area complies with this condition, as mentioned in Section 1.12, with full forest cover.

c) Baseline deforestation and forest degradation in the project area fall into one or more of the following categories: unplanned deforestation (category VCS AUDD), planned deforestation/ degradation (category VCS APD) or degradation through logging for fuel (firewood and charcoal production) (category VCS AUDD).

Justification: The project is eligible for AUDD activity as forest land is expected to be converted to non-forest land, in the case of the baseline, where land is not legally authorized and documented to be converted to arable land, as described in section 1.3.

d) Leakage prevention activities should not include agricultural land that is flooded to increase production or intensify livestock production with feedlots and/or manure ponds.

Justification: the leakage prevention activities are not specific to this project, as they are carried out at the Guaratuba EPA according to its Management Plan, where no activity involving flooding of agricultural land or use of feedlots and/or ponds is mentioned manure.

e) Baseline deforestation agents must: (i) clear land for tree harvesting, settlements, agricultural or livestock or aquaculture production, where such clearing for agricultural or livestock production or aquaculture does not correspond to industrial agriculture activities or large-scale aquaculture; (ii) have no documented and uncontested legal right to clear land for these purposes; and (iii) being residents in the reference region for deforestation or immigrants.

Justification: Deforestation agents in the baseline are residents in the reference region or immigrants who cleaned the land, especially for small-scale agricultural production or to take possession of land to later implement agricultural production. It is a place where they do not have the legal right to do so since the end of 2006, according to the Atlantic Forest Law (Federal Law No. 11.428/2006).

f) If, in the baseline scenario, post-deforestation land use constitutes reforestation, this methodology cannot be used.

Justification: in the baseline scenario, the deforested lands are mainly destined to the cultivation of banana and palm heart, beyond that the Guaratuba EPA management plan itself prohibits reforestation with exotic and invasive species.

3.2.2 Module BL-UP (VM0007), Estimation of baseline carbon stock changes and GHG emissions from unplanned deforestation and unplanned wetland degradation

a) Baseline deforestation agents must: (i) clear land for tree harvesting, settlements, agricultural or livestock or aquaculture production, where such clearing for agricultural or livestock production or aquaculture does not correspond to industrial agriculture activities or large-scale aquaculture; (ii) have no documented and uncontested legal right to clear land for these purposes; and (iii) being residents in the reference region for deforestation or immigrants.

Justification: Deforestation agents in the baseline are residents in the reference region or immigrants who cleaned the land, especially for small-scale agricultural production or to take possession of land to later implement agricultural production. It is a place where they do not have the legal right to do so since the end of 2006, according to the Atlantic Forest Law (Federal Law No. 11.428/2006).

b) When, prior to the project, the collection of unsustainable firewood is taking place within the project boundary, the BL-DFW and LK-DFW modules should be used to determine the potential leak. When a project claims that no firewood has been collected, this must be proven through a PRA process.

Justification: in the project area there is only one family, as previously mentioned, which does not use the forest (project area) to collect firewood. The only necessity that the family has to use firewood is supplied by the anthropized area where they live.

3.2.3 Module CP-AB (VMD0001), Estimation of carbon stocks in aboveground and belowground biomass in live tree and non-tree pools

a) This module is applicable to all forest types and age classes.

Justification: there is no need to justify it.

b) The inclusion of the aboveground tree biomass reservoir as part of the project is mandatory as per the REDD-MF framework module.

Justification: this reservoir is included in the project.

c) Aboveground non-tree biomass should be included in the project if the following applicability criteria are met (per REDD-MF framework module): aboveground non-tree biomass stocks are higher in the baseline than in the scenario of project and aboveground non-tree biomass is considered significant (using the T-SIG module).

Justification: Non-tree aboveground biomass stocks are higher in the baseline than in the project scenario, as the project aims to conserve the forest that is present in 100% of its area at the beginning of the project. Consequently, the forest will not be converted to other land uses as identified as baseline scenarios. Moreover, non-tree biomass was considered insignificant applying the T-SIG tool.

d) Belowground biomass (tree and non-tree) is not required for inclusion in the project boundary because the omission is conservative.

Rationale: Belowground biomass is conservatively omitted.

3.2.4 Module LK-ASU (VMD0010), Estimation of emissions from activity shifting for avoiding unplanned deforestation and avoiding unplanned wetland degradation

a) This module is applicable for estimating changes in carbon stock and greenhouse gas emissions related to displacement of activities that cause deforestation or land degradation outside the Project Area due to avoiding unplanned deforestation and degradation in the Project Area.

Justification: the module is applicable as the project activity is AUDD.

b) Activities subject to potential displacement are the conversion of forest areas to pastures, cropland and other land uses, or the conversion of intact or partially degraded wetlands to drained or degraded wetlands.

Justification: In the baseline scenario, forestlands are converted to cultivated areas.

c) The module is mandatory if the BL-UP module has been used to define the baseline and the applicability conditions in the BL-UP module must be fulfilled.

Justification: the BL-UP module was used to define the baseline according to its applicability conditions.

3.2.5 E-BPB, Estimate of greenhouse gas emissions from biomass burning and peat burning

a) This module is applicable to REDD project activities with emissions from biomass burning.

Justification: The project's baseline scenario presents emissions from biomass burning, as presented in the identification of alternative use scenarios in section 3.5 (Additionality).

3.2.6 E-NA, Estimate of direct nitrous oxide emission from nitrogen fertilization

a) The tool is not applicable when project activities are implemented in wetlands or has been flooded within a period of 3 months from the date of fertilization.

Justification: The project area is not a wetland and baseline agricultural practices do not practice flood irrigation.

3.3 Project Boundary

The project boundaries were defined in accordance with the BL-UP module of the modular methodology REDD VCS VM0007. The project meets the applicability conditions of this module, as established in Section 2.2.

Baseline development includes the spatial and temporal boundaries from which information about the historical rate of deforestation is extracted and projected into the future. The deforestation rate is derived from the reference region to rate (RRD), while the reference region to location (RRL) is used in the baseline spatial modeling component. Finally, the leakage area is the area around the project area where activity leakage (where deforestation that is displaced from the project area due to the implementation of project activities) is most likely to occur.

3.3.1 Spatial Limits

The spatial boundaries are RRD, RRL, Project Area (PA) and Leakage Area (LA) are shown in Figure 15.

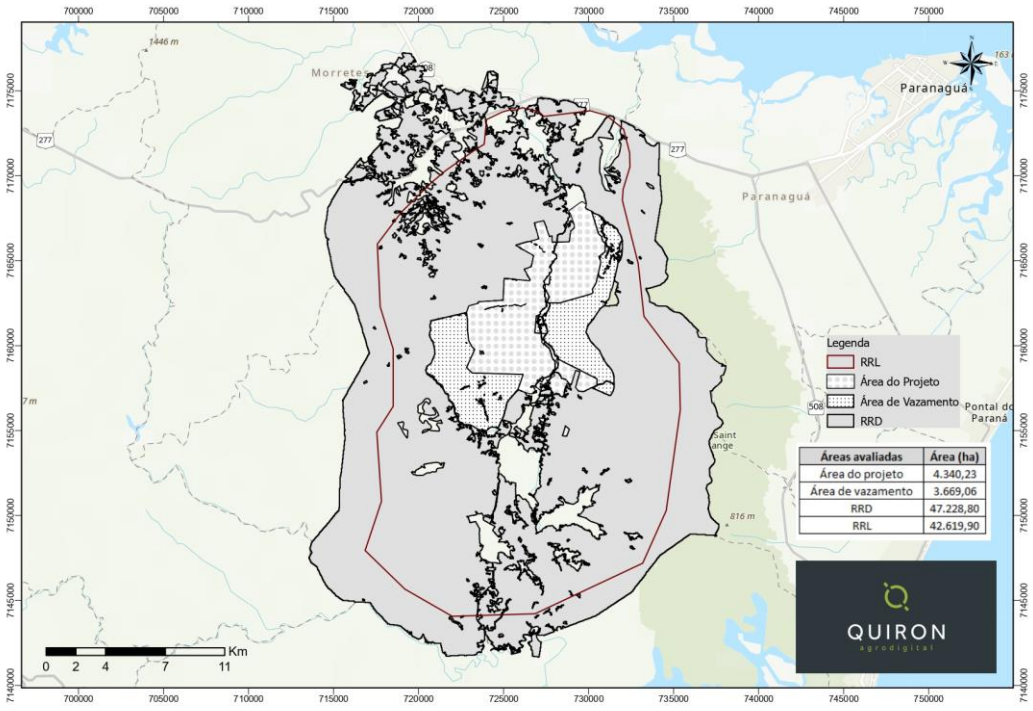

Figure 15: Spatial boundaries of the RRD, RRL, Project Area (AP) and Leakage Area (LA).

3.3.2 Reference region for the projection of the deforestation rate (RRD)

The reference region for the projection of the deforestation rate (RRD) has a total area of 47.228,80 hectares, excluding the project area, leakage area and all non-forested areas at the beginning of the historical reference period in 2007. The main deforestation agents in the RRD are small farmers who intend to establish or expand areas of banana or palm heart cultivation by converting the forest into agricultural land.

The landscape mapping, including phytophysiognomy, soil type, slope and elevation were used on helping to define the reference region and ensure similarity to the project area. The incorporation of these landscape factors was important to define the RRD, as the lands close to the project area are diversified in relation to these factors, mainly for phytophysiognomy and elevation. Therefore, it was considered to define the size of the RRD, the relaxation of the requirements by 30% for a RRD at least equal to ½ MREF (minimum RRD size). Factor maps were used to define the most suitable lands for conversion to agriculture, also taking into account the mobility of the deforestation agent through side roads used to transport agricultural products.

A survey with the local community and the government agencies was carried out to verify that the deforestation agents and social factors coincide in RRD and in the project area. Policies and regulations are the same for both, considering that they must follow the rules of the Guaratuba EPA, as both areas are within the mentioned EPA.

3.3.3 Reference region to locate deforestation projection (RRL)

The reference region to locate the deforestation projection (RRL) has an area of 42.619,90 hectares, 10% smaller than the RRD. According to the methodology, the RRL is a single parcel, contiguous and including the project area and the leakage area. It comprises 30% non-forest land and 70% forestland; therefore, it complies with the methodological requirements of a minimum of 5% non-forest and a minimum of 50% forest.

As the main cause of deforestation is agriculture, access to and availability of land suitable for growing bananas and palm heart are the most important factors in determining whether the land is suitable for conversion. No protected forests were removed from the RRL, because as deforestation was observed within the conservation units, it was considered that the protection status is not fulfilled.

3.3.4 Project Area (PA)

The project area consists of an area of 4.340,23 hectares of forest (100% afforested at the start of the project) along the Limeira road between the national parks of Guaricana and Saint-Hilaire/Langue, which according to the baseline scenario, is under threat of deforestation. The project proponent carries out the project activities, described in Section 1.8, within the project area to mitigate deforestation pressures and halt deforestation. The property boundaries were delineated and georeferenced through a topographic survey to regularize the rural property for registration and title of the property.

3.3.5 Leakage Area (LA)

The leakage area is the part of the forest at the beginning of the project, with two areas in the immediate vicinity of the project area where the leakage caused by the displacement of the activity is expected, as they are areas accessible to agents of deforestation. It has 3.669,06 hectares, representing 84,5% of the project area, where ±50% of the requirements related to landscape and transport were met, because there was not a forest area with at least 90% of the project area which met all the methodological criteria.

In order to define the LA limits, some factors that are characteristic of the project's location area and the dynamics of deforestation and degradation in the region were considered. The Limeira Road works as a driver of deforestation, as do the roads throughout the RRD. But because monitoring patrols are carried out mainly by road, deforestation/degradation agents prefer to enter the forest by trails or open paths when looking for Juçara palm, Guaricana leaves or animals to hunt. There are also squatters who use this strategy to take possession of small areas. There are no limits for these agents to cross mountains or great distances, as they usually camp in the woods to avoid traveling along the road within the project area. Therefore, preference was given on seeking the forest areas closest to the project area that meet this characteristic. It was decided to exclude the areas adjacent to Estrada Limeira to the south of the project area, as it would not fit the landscape requirements, and there is also the fact that both to the north and south the lands along the road are private property, where no there is a way to ensure that the owners do not deforest it. Even with laws that prohibit deforestation, it is possible for farmers to gradually increase their cultivated areas.

The leakage area is not spatially polarized in terms of the distance from the edge of the leakage area to the edge of the project area. However, it is concentrated in the north, south and east of the project area. In addition, the closest national parks areas were excluded from the leakage area, as administrative policies and regulations in these areas differ from privately owned areas. The proponent owns parts of the leakage area boundaries, as the leakage area shares a boundary with the project area. The Table 8 shows a comparison of criteria to define the limits of DRR and the leakage area.

Factors evaluated	Category	RRD	Project Area	Leakage Area
Vegetation (%)				
	Mixed Ombrophilous Forest	99%	100%	100%
	Pioneer Training	1%	0%	0%

Elevation (%)				
	0-500 m	74%	74%	76%
	500-1000 m	25%	25%	23%
	> 1000 m	1%	1%	1%
Slope (%)				
	Gentle (<15%)	20%	18%	11%
	Steep (> 15%)	80%	82%	89%
Ground (%)				
	Argissol	28%	34%	39%
	Cambisol	22%	9%	2%
	Neosol	50%	57%	59%
Roads (m/km2)				
		130,12	219,73	85,04

Table 8: Comparison of criteria to define the limits of DRR and the leakage area.

3.3.6 Time Limits

The time limits of the Limeira REED+ Project are listed below:

- January 1st, 2006 to December 31st, 2016 - Starting and ending date of the historical reference period;
- January 1st, 2017 to December 31st, 2026 - Starting date and ending date of the first baseline period of the project;
- January 1st, 2023 - Date when the project baseline will be revised. The baseline must be reassessed every six years from the project starting date.

3.3.7 Emission sources

The sources of GHG emissions associated with the baseline, for the project and leakage areas, are listed in the Table 9 with justifications and if they are included or excluded.

Source	Gas	Included	Justification/Explanation
Biomass burning	CO_2	No	CO_2 emissions are already considered in changes in carbon stock.
	CH_4	Yes	They are included due to the occurrence of fires to clear areas for agriculture.
	N_2O	Yes	
Fossil fuel burning	CO_2	No	Carbon dioxide was omitted as carbon dioxide emissions are calculated in the BL-UP module through stock change (deforestation).
	CH_4	No	Emissions are small and insignificant.
	N_2O	No	
Fertilizer use	CO_2	No	Emissions are small and insignificant.
	CH_4	No	
	N_2O	Yes	Direct N_2O emission was included due to the use of fertilizers in agriculture.

Table 9: GHG emission sources.

3.3.8 Carbon reservoirs

The chosen carbon pools are discussed in the Table 10.

Reservoirs of carbon	Included	Justification of Choice
Aboveground	Yes	The inclusion of the reservoir is mandatory. Only tree biomass is included, which is the most significant reservoir. Non-tree woody biomass (e.g. shrubs) is lower at baseline (pasture and cropland) than the project case (forest) and is conservatively excluded.
Underground	Yes	Included and treated along with aboveground biomass to complete inclusion of whole tree biomass (above and below ground).

Dead wood	No	Conservatively omitted as permitted by the methodology.
Harvested Wood Products	No	Excluded as no commercial harvesting for wood products occurs at baseline (as part of forest conversion process) or with project scenarios.
Burlap	No	Conservatively omitted as permitted by the methodology.
Soil organic carbon	No	Conservatively omitted as permitted by the methodology.

Table 10: Carbon reservoirs.

3.4 Baseline Scenario

Tool T-ADD, "Tool for the demonstration and assessment of additionality in agriculture, forestry and other land uses (AFOLU) project activities" is applied to identify the most likely baseline scenario of the project.

Because of sub-step 1a of the tool, the following alternative land use scenarios were identified:

- Degradation by illegal extraction of Juçara palm and Guaricana leaves;
- Deforestation for the cultivation of banana and palm heart;
- Deforestation carried out by squatters to open irregular lots.

Because of Substep 1b, all identified land use scenarios do not comply with applicable legal and regulatory requirements. Deforestation for agriculture can be legalized in certain cases where there is no primary or secondary forest in an advanced state of regeneration. These scenarios are discussed and justified below.

3.4.1 Continued Pre-Project Land Use with Unshakeable Threat of Illegal Deforestation

Although the project area before the start of the project was fully forested by Atlantic Forest, this condition is unlikely to be continuing in the future, given the patterns of land use which have changed and deforestation pressures which may happen in the area.

Considering deforestation and degradation that occurred over the historical reference period in other areas close to the project area and in the region in general, portions of the project area are increasingly likely to be deforested and converted to crops by small farmers.

According to a study by Fernandes[23], in 2017 there were 270 rural farming families in the Caovi-Limeira management unit of the Guaratuba EPA, in this unit is the project area. Seventy rural farmers from across the Guaratuba EPA were interviewed. These farmers live in a total area of 2.023,13 hectares, of which 82% has been declared as forest area. Agricultural production is present in more than 81,40% of the properties, with bananas being the main crop in the region (37,86%).

About forest production, 2 families that living in the Caovi-Limeira unit extract Juçara palm illegally, in addition to another 14 families that extract lianas and Guaricana leaves, 9 families that cultivate royal and imperial palm trees and another 8 families that cultivate palm heart.

Even when the agent of deforestation is a small farmer and legal owner of his lands, deforestation is defined as unplanned, as it is technically illegal to clear areas of primary and secondary forests in an advanced stage of the Atlantic Forest. However, this deforestation is hardly prosecuted by the authorities.

The most likely baseline scenario is the continuous conversion of forest areas into banana and palm heart cultivation, in order to gradually increase existing cultivated areas, in addition to boosting the opening of irregular lots and forest degradation through extraction. of Juçara palm and Guaricana leaves. Degraded areas tend to be more easily deforested in the future and there is no knowledge of any institution that systematically tracks these cases.

Brazil generally has insufficient levels of government enforcement of property rights to prevent or remove illegal land invasions and stop deforestation in accessible areas.

3.5 Additionality

The analysis of additionality was carried out using the T-ADD tool, which is a tool for the demonstration and assessment of additionality in AFOLU project activities, version 3.0, approved by the VCS. The applicability conditions of the tool are met as follows:

- The Atlantic Forest Biodiversity Conservation Limeira Project REDD is the only one in the project area to be registered in the VCS. The proposed activity is to avoid unplanned deforestation and degradation (AUDD). The activity does not violate any applicable law to the project area.

[23] Sociocultural and economic aspects in the environmental protection area (APA) of Guaratuba, Paraná, 2017. Available at: https://online.unisc.br/seer/index.php/cadpesquisa/article/view/9654/7104

- The BL-UP module of the VM0007 methodology, approved by the VCS, was used to estimate changes in carbon stock and GHG emissions related to unplanned deforestation. The methodology provides strategies for determining the most likely baseline scenario.

The tool application procedure is defined in four steps:

- Step 1: Identification of alternative land use scenarios for the AFOLU project activity;
- Step 2: Investment analysis to determine that the proposed project activity is not the most economically or financially attractive of the identified land use scenarios;
- Step 3: Analysis of barriers; or
- Step 4: Analysis of common practices.

3.5.1 Step 1 - Identification of alternative land use scenarios to the proposed VCS AFOLU project activity

Substep 1a. Identify credible alternative land use scenarios for the proposed VCS AFOLU project activity.

a) Identify realistic and credible land use scenarios that would have occurred on land within the proposed project boundary in the absence of the AFOLU project activity under the VCS.

From the point of view of the continuation of the pre-project land use (*ante post*), it was first identified what was the common land use in the project area before the start of the AUDD activity. Before the start date of the project (2017), the land was degraded due to the illegal extraction of Juçara palm and Guaricana leaves and deforestation for the cultivation of banana and palm heart and the opening of irregular lots.

In a visit carried out in March, 2021 by the project's development team, there was sighted the opening and sale of plots of land on the edge of Limeira road outside the project area. The Limeira road crosses the project area and ends up being used by illegal loggers and hunters who enter the forests and it is widely used to transport agricultural production from the region.

The information mentioned above was collected from testimonies of residents in the project area, news published in the media and field visits.

b) All identified land use scenarios must be credible.

Degradation and deforestation scenarios are considered credible because they represent the reality of what happens in the project's reference region. Some news, published by the local media, were found reporting cases of deforestation and are presented below:

News 1

Source: Agora Litoral - http://agoralitoral.com.br

Date: 25/07/2018

Title: Illegal deforestation area found after anonymous report in Guaratuba

Excerpts from the news:

“The imprisoned man was deforesting an area of 1840m² of secondary vegetation in an advanced stage of regeneration in the Atlantic Forest Biome, in Balneário Nereidas. He was hired to work at the site and was caught using a chainsaw to cut the vegetation, aiming to open up streets and plots of land”.

“The area was prepared to carry out an irregular project. Machines - a mechanical excavator and a motor grader - and a dump truck were seized at the site”.

"The area is located in the protective surroundings of the Boguaçu State Park, composed by a vegetation with maximum expression of regeneration".

News 2

Source: Correio do Litoral - https://www.correiodolitoral.com.br

Date: 20/05/2021

Title: Guaratuba City Hall Removes Buildings from Environmental Protection Area

Excerpts from the news:

“Five wooden houses and one brick house with no signs of housing were dismantled – some newly built, others still under construction. The land is within the boundaries of the Guaratuba EPA (Environmental Protection Area), in the Boguaçu State Park buffer zone, close to the Nereidas neighborhood. According to the city hall, agents of the Instituto Água e Terra (IAT) had already fined and seized the site”.

"According to the city hall, a real estate sales industry has been operating for some time in Guaratuba, offering apparently abandoned land, private, public areas and in an environmental preservation area."

News 3

Source: Correio do Litoral - https://www.correiodolitoral.com.br

Source: Correio do Litoral - https://www.correiodolitoral.com.br

Date: 22/02/2018

Title: Military Police (PM) catches juçara palm heart extraction in Guaraqueçaba EPA

Excerpts from the news:

“The Environmental Police and the Metropolitan Tactical Ostensible Rounds (ROTAM) caught the extraction of native hearts of palm in the EPA de Guaraqueçaba, close to the border of Paraná and São Paulo. A man was arrested. The action took place this week, in the region of Manecão, in the municipality of Barra do Turvo. The teams were on patrol to deter aggression at EPA, when they spotted a man near a watercourse. He was extracting juçara palm heart, a native species protected by law. The man, whose identity was not revealed, was maintaining a makeshift camp. He was arrested and the hearts of palm seized”.

News 4

Source: Folha do Litoral - https://folhadolitoral.com.br/

Date: 03/03/2018

Title: Military Police of Paraná (PMPR) catches illegal extraction of palm heart in an environmental protection area between Guaratuba and Morretes.

Excerpts from the news:

“During the action, the team caught two individuals illegally extracting heart of juçara palm heart in the region, even carrying a shotgun that could be used to hunt wild animals in the region. According to the press office of the Environmental Police, the action began in the region known as Limeira and entered the dense forest and after six hours of patrolling, it spotted traces of possible crime in the locality of Garajuva, an area of national environmental protection. The police came across two individuals cutting down juçara palm (Euterpe edulis species) and illegally extracting the palm, each carrying an amount of cut palm. Each of them carried 18 units “in nature” palm hearts and a Tramontina’s machete used in the cut, explains Força Verde”. The Figure 16 shows the items seized.

Figure 16: Illegal palm heart extraction and items seized.

News 5

Source: JB Litoral - https://jblitoral.com.br/queimadas-devastam-areas-de-protecao-ambiental-em-guaratuba-para-venda-ilegal-de-terrenos/

Date: 21/04/2020

Title: Fires devastate Environmental Protection Areas in Guaratuba for illegal sale of land

Excerpts from the news:

“According to the Municipal Secretary for the Environment, Adriana Correa Fontes, several people are taking advantage of the dry weather to carry out criminal fires.”

“It defines criminal action as an 'intrusion industry'. ‘They arrive cutting down and burning native vegetation. They demarcate areas and divide them into lots. They don't care about the laws, animals, and even less about springs and springs, always with the same excuses: nobody has a place to live, I can't pay rent. But the truth is that this criminal industry is there to profit from the sale of illegally acquired space. We are talking about land invaders, who are gradually degrading Environmental Protection Areas”. Figure 17 shows a criminal invasion and burning.

Figure 17: Criminal invasion and burning.

c) Outcome of Sub-step 1a: List of credible alternative land use scenarios that could have occurred in the field within the boundaries of the VCS AFOLU project.

- illegal extraction of Juçara palm and Guaricana leaves;
- deforestation for the cultivation of banana and palm heart;
- deforestation carried out by squatters to open irregular lots.

Substep 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations.

Not all land use scenarios identified in the previous step comply with the legal and regulatory requirements applicable to the project area. As mentioned, the extraction of Juçara palm from Atlantic Forest areas is prohibited by law. However, the cultivation of banana or palm heart is allowed in accordance to the ecological zoning of the Guaratuba EPA and respecting the rules of its management plan.

The Juçara palm is on the Official List of Species of the Brazilian Flora Threatened of Extinction, as described in the Annex I of Normative Instruction No. 6/2008 of the Ministry of the Environment. Every year, there are several records of the local Environmental Police for arrests in the act of people who commit this type of environmental crime. It is noticed that the number of flagrant from this type of crime results from the systematic lack of compliance with applicable laws and regulations, as it was demonstrated through community testimonies, newspaper and media reports and through the Management Plan itself, which mentions the problem of illegal extraction, mainly from the Juçara palm.

Because of sub-step 1b, the following plausible alternative land use scenarios for the VCS AFOLU project activity are presented by:

- degradation by illegal extraction of Juçara palm and Guaricana leaves;
- deforestation for the cultivation of banana and palm heart;
- deforestation carried out by squatters to open irregular lots.

Substep 1c. Selection of the baseline scenario.

The selected baseline scenario includes all alternative scenarios cited because of substep 1b.

3.5.2 Step 2 - Investment analysis

This step should demonstrate that the proposed project activity is financially less attractive than at least one of the alternative land use scenarios.

Substep 2a. Determine appropriate analysis method.

Atlantic Forest Biodiversity Conservation Limeira Project REDD does not generate financial or economic benefits beyond the income related to the VCS from the generated carbon credits. Therefore, simple cost analysis is applied, option I defined by the T-ADD tool.

Substep 2b. Simple cost analysis.

The costs associated with the project come from the following activities:

- patrolling carried out by employees living in the project area;
- placement of nameplates and information in the project area;
- satellite monitoring of deforestation;
- environmental education based on guided ecological tourism;
- project design, monitoring and reviews;
- support to local government projects in technical improvement of farmers;
- project validation and verifications.

These activities do not produce financial benefits, on the contrary, they generate costs. The source of financial benefit is restricted to VCS related income. Thus, according to this tool, the Common Practice Analysis must be carried out.

Note: When it is concluded that the proposed VCS AFOLU project produces no financial benefits other than VCS-related income, proceed directly to Step 4 (Common Practice Analysis).

3.5.3 Step 3 - Barrier Analysis

This step was not used, as the step 2 was described on 3.5.2.

3.5.4 Step 4 - Common Practice Analysis

The conservation of privately owned forest areas that belong to the Atlantic Forest biome is generally limited to designated permanent protection areas and legal reserve (requirement of the Brazilian Forest Code) and areas of primary or secondary forest in the medium and advanced stages of regeneration (requirement of the Atlantic Forest Law). It must also be considered that the project area is located in an Environmental Preservation Area, which, like any other private property within the EPA, must respect its

ecological-economic zoning. Regardless of this designation or the intention of the property owner to comply with the law, these areas remain subject to pressure from illegal deforestation.

It is perceived that government assistance programs for small farmers and even inspection actions are not enough to prevent deforestation in and around the project area. It is only through the implementation of significant social and environmental programs, as well as the implementation of forest protection measures, such as those documented in Section 1.11, that illegal deforestation could be reduced or avoided in the project area.

Although, there are two protected areas adjacent to the project, the essential distinction between this land and the project area is that the project area is privately owned and it has no access to government resources to hold pressures from unplanned deforestation on its land. It has been carrying out the activity of preventing deforestation so far with its own resources and with several actions as presented in the previous step, it was implemented only from the project start date, January 1st, 2017. This demonstrates that the project activity is additional as there are not activities similar to the project.

3.6 Methodology Deviations

This project does not have methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The BL-UP methodological module was used to estimate changes in carbon stock and GHG emissions related to unplanned deforestation and degradation in the baseline scenario.

4.1.1 Setting limits

Based on the location and size of the area available to carry out the REDD project, the limits of all areas necessary for the development of the project were defined:

a) Reference region to project deforestation rate (RRD);

b) Reference region for locating the projection of future deforestation (RRL);

c) Project Area (PA);

d) Leakage Area (LA).

To define the RRD size, the MREF value was calculated:

$$MREF = RAF * PA \quad (1)$$

$$RAF = 7500 * PA^{-0.7} \quad (2)$$

Where:
MREF: Minimum size of the reference region to project deforestation rate; ha
PA: Unplanned deforestation project area; ha
RAF: Reference area factor. Factor to multiply by the project area to obtain the minimum reference area; dimensionless

If the RAF calculated using Equation 2 is less than 1, the RAF must be equal to 1.

In an area mapping, the project area (PA) of 4.340,23 ha was determined using the entire forest area within the limits of the property. For this area, a RAF of 21,32 was obtained and the MREF is equal to 92.536,93 ha.

However, for the conditions of this project, which is located in the Atlantic Forest biome, there is no availability of forest areas outside the PA that meets the MREF value and the PA landscape characteristics at the same time. Therefore, it was considered to use as a minimum size just over half of MREF (46.268,46 ha), as the minimum size, to delimit the reference region to project deforestation rate (RRD).

The RRD was defined as 47.228,80 ha. The RRL has a total area of 42.619,90 ha, 37.884,97 ha of forest (20% smaller than RRD) and 4.734,93 ha of non-forest area. And the leakage area (LA) has 3.669,06 ha, 84.5% of the size of PA. The summary of the areas and their respective sizes is presented in the Table 11.

Area Type	Area (ha)
RRD	47.228,80
RRL	42.619,90
PA	4.340,23
LA	3.669,06

Table 11: Summary of delimited areas for the REDD project.

4.1.2 Estimate of annual deforestation areas

a) Estimation of the annual areas of unplanned baseline deforestation in the RRD

Deforestation in RRD was analyzed by satellite imagery over a period of 10 years before the start of the project (historical reference period) to define the deforested area using the standard "simple historical" approach. The Table 12 presents the annual areas of deforestation in the RRD.

Year	Deforested Area (ha)
2007	86,22
2008	31,56
2009	117,24
2010	15,53
2011	278,57
2012	111,49
2013	77,01
2014	360,34
2015	5,04
2016	107,51
Total	**1.190,51**

Table 12: Annual areas of deforestation in RRD.

This deforestation rate in the RRD may be associated with some population factors, such as population distribution and density; agriculture-related factors such as expansion of agricultural areas and increased domestic demand for agricultural products; logging (increased demand for timber resources, forest concessions and illegal logging, needs of energy in the cities (firewood and charcoal); and governmental factors such as insufficient monitoring and inspection of forest resources and the presence of Conservation Units (UC) and other protected areas (Parque Nacional Guaricana and Parque de Saint Hilaire Lange). To model the average annual deforested area, the methodology provides three regression approaches: linear, exponential nonlinear and logarithmic nonlinear. Each was tested with the data in the table 12, but no regression obtained (r2) ≥ 0,75. Therefore, the average deforested area, in hectares per year, over the historical reference period, (ABSL, RRD, unplanned, t) was calculated using the standard approach "simple history", using equation 3.

$$A_{BSL,\,RRD,\,unplanned,\,t} = A_{RRD,\,unplanned,\,hrp} \,/\, T_{hrp} \quad (3)$$

Where:

$A_{BSL,\,RRD,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in RRD in year t; ha

$A_{RRD,\,unplanned,\,hrp}$: Total area deforested during the historical reference period in the RRD; ha

T_{hrp}: Duration of the historical reference period in years; year

t: 1, 2, 3, ... *t* * years which passed by since the projected start of the project activity

It was obtained an $A_{BSL,\ RRD,\ unplanned,\ t}$ equal to 119,05 ha. This average deforestation value will be used for each year of the baseline period, which results in a deforestation rate of 0,3% per year.

It is assumed here that there is zero uncertainty in the baseline rate of deforestation, because according to the methodological module X-UNC (Estimation of uncertainty for REDD+ project activities), where a term average is used, it can be assumed an uncertainty rate equal to to zero.

For deforestation projections, the methodology based on historical deforestation occurred between the years of 2006 to 2016 was used, using the following weights for each item:

- Vegetation: 30%;
- Roads: 25%;
- Slope: 20%;
- Altimetry: 15%;
- Hydrography: 8%;
- Conservation Unit: 2%.

Figure 18 presents a compilation of maps within the RRD, with the items and weights mentioned above.

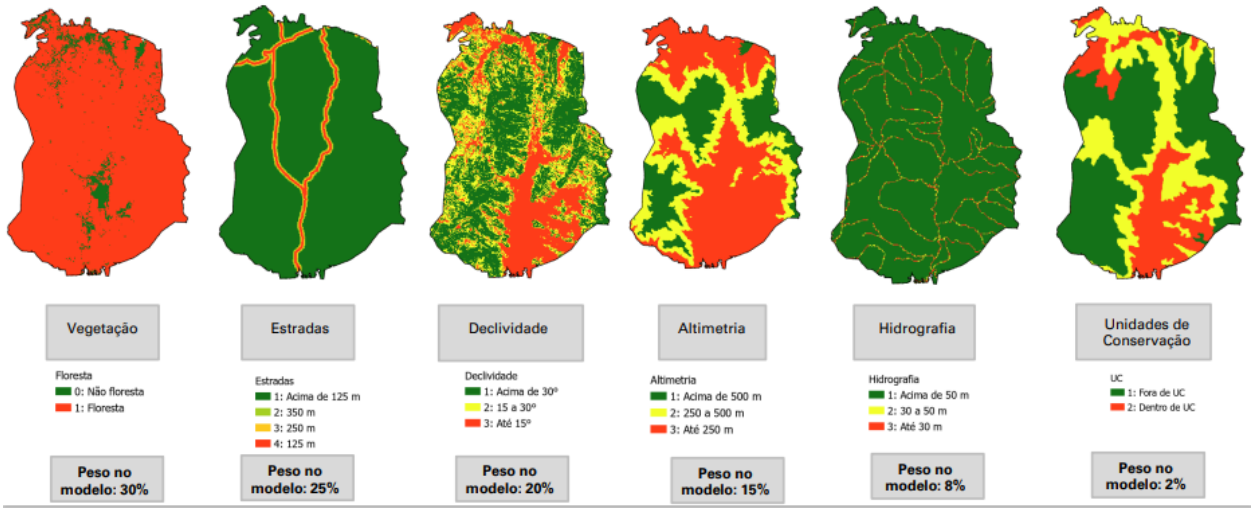

Figure 18: Items that influence the projection of deforestation within the RRD.

b) Estimation of annual areas of unplanned baseline deforestation in the project area.

First, the unplanned baseline deforestation projected in the RRL was calculated as follows:

$$A_{BSL,\,RR,\,unplanned,\,t} = A_{BSL,\,RRD,\,unplaned,\,t} * P_{RRL} \quad (4)$$

Where:

$A_{BSL,\,RR,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in the reference region for location (RRL) in year t; ha

$A_{BSL,\,RRD,\,unplaned,\,t}$: Projected area of unplanned baseline deforestation in RRD in year t; ha

P_{RRL}: Ratio of forest area in the RRL at the beginning of the baseline period to the total area of the RRD; dimensionless

t: 1, 2, 3,... *t* * years elapsed since the projected start of the project activity

Then, the projected baseline deforestation in the project area:

$$A_{BSL,\,PA,\,unplanned,\,t} = A_{BSL,\,RRD,\,unplanned,\,t} * P_{PA} \quad (5)$$

Where:

$A_{BSL,\,PA,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in the project area in year t; ha

$A_{BSL,\,RRD,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in RRD in year t; ha

P_{PA}: Ratio between the project area and the total area of the RRD; dimensionless

t: 1, 2, 3, ... *t* * years elapsed since the projected start of the project activity

The modeling process did not define deforested areas in the leakage area due to the risk of this area classified as moderate in all forecast years. Therefore, for this area, the baseline annual deforestation area calculation provided by the methodology (which was used because the spatial modeling was not applied):

$$A_{BSL,\,LB,\,unplanned,\,t} = A_{BSL,\,RRD,\,unplanned,\,t} * P_{LK} \quad (6)$$

Where:

$A_{BSL,\,LB,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in the leakage belt area in year t; ha

$A_{BSL,\,RRD,\,unplanned,\,t}$: Projected area of unplanned baseline deforestation in RRD in year t; ha

P_{LK}: Ratio between the leakage belt area and the total area of the RRD; dimensionless

t: 1, 2, 3, ... *t* * years elapsed since the projected start of the project activity

Table 13 describes the projected area of unplanned deforestation from the baseline in the first 10 years of the project for RRL, PA and LA, according to equations 4, 5 and 6.

Parameter	Area Type	Area (ha)
$A_{BSL, RR, unplanned, t}$	RRL	107,43
$A_{BSL, PA, unplanned, t}$	PA	10,94
$A_{BSL, LB, unplanned, t}$	LA	9,24

Table 13: Projected area of unplanned baseline deforestation in the first 10 years of the project for RRL, PA and LA.

For mapping the locations of future deforestation, were considered the pixels with the highest values and consequently the highest risks obtained for each year that were located in areas with the presence vegetation.

For the determination and quantification of the threat of future deforestation, the pixels of each risk map (from 2018 to 2027) obtained by the modeling were classified in: 0 to 1,78 (low risk); 1,79 to 2,22 (intermediate risk) and 2,23 to 2,45 (high risk). For each year analyzed, the pixels with the highest values (2,23 to 2,45) were quantified, generating the projected future deforestation. In the leakage area, only moderate risk pixels were found and for this reason, this area was not quantified, because according to the methodology, only the pixels with the highest value should be considered as projected future deforestation.

With the classification described above, the spatial modeling indicated that 1.067,03 ha has a higher risk of deforestation in the RRL, with 270,12 ha being in the project area and 0 (zero) ha in the leakage area for the future series (2017 to 2027), as shown in Table 14, 15 and 16.

Year	Predicted Deforestation (RRL-ha)	Projected Deforestation (ha)	Difference (ha)
2017	0	0	-
2018	107,43	112,39	-4,96
2019	107,43	152,31	-44,88
2020	107,43	78,07	23,36
2021	107,43	149,90	-42,47
2022	107,43	35,34	72,09
2023	107,43	67,20	40,23
2024	107,43	129,55	-22,12
2025	107,43	105,22	2,21

2026	107,43	127,13	-19,70
2027	107,43		
Total	**1.074,43**	**1.067,23**	**7,27**

Table 14: Comparison of estimated future deforestation in the RLL area.

Year	Predicted Deforestation (PA-ha)	Projected Deforestation (ha)	Difference (ha)
2017	0	0	-
2018	10,94	21,18	-10,24
2019	10,94	6,81	4,13
2020	10,94	101,41	-90,47
2021	10,94	22,39	-11,45
2022	10,94	0,00	10,94
2023	10,94	21,57	40,23
2024	10,94	31,52	-22,12
2025	10,94	38,89	2,21
2026	10,94	26,35	-19,70
2027	10,94	0,00	-2,49
Total	**109,40**	**270,12**	**-160,72**

Table 15: Comparison of estimated future deforestation in the PA area.

Year	Predicted Deforestation (LA-ha)	Projected Deforestation (ha)	Difference (ha)
2017	0	0	-
2018	9,25	0,00	9,25
2019	9,25	0,00	9,25
2020	9,25	0,00	9,25
2021	9,25	0,00	9,25
2022	9,25	0,00	9,25
2023	9,25	0,00	9,25
2024	9,25	0,00	9,25
2025	9,25	0,01	9,24
2026	9,25	0,00	9,25

2027	9,25	0,00	9,25
Total	**92,50**	**0,01**	**92,50**

Table 16: Comparison of estimated future deforestation in the LA area.

When checking Tables 14, 15 and 16, it can be seen that there were differences in the results that point to future deforestation in the RLL, PA and LA. These differences are due to the procedure applied for each method. The predicted deforestation estimated an annual deforestation value based on historical deforestation data in the reference region, without indicating the location of future deforestation, as the projected deforestation was obtained from the static and dynamic variables, highlighting areas with greater probability of future deforestation that were reclassified and quantified annually. Another important difference in the methods is reflected in the variation of future deforestation derived from the modeling and the uniform average value derived from the historical average, by the first method.

4.1.3 Location and quantification of the threat of unplanned deforestation

The location analysis was carried out according to the need foreseen in the methodology, when the project presents the configuration of transitional deforestation and less than 25% of the project's geographic boundary is within 50 m of land that has been anthropogenically deforested in the 10 years prior to the project start date.

For the execution of the factor maps, the following factors were used within each class:

- Landscape: Presence of vegetation, type of soil; altimetry of the area; slope of the area and hydrography;
- Accessibility: Distance of the roads; distances of the rivers and if there are not railways in the área;
- Anthropic: Areas protected as conservation units; sustainable use units;
- Land tenure and management: Areas deforested in the historical period and forest edges.

The factors were classified as static and dynamic variables, to which values were assigned. They were weighted and tested according to the level of influence that each one has on transformation such as land and plant use. The generated risk maps were compared with reference maps from 2017 to 2021 for validation and calibration of a model built in a GIS environment, using ArcGIS Pro 2.8 for the assessment of critical areas and/or susceptible to deforestation in the RRL.

The values were tested and the generated risk maps were compared with the reference maps from (2017 to 2021), for validation and calibration. After several rounds of tests, the weighting of the values that best represented reality were chosen. Another criterion used in the weighting was the evaluation of the 1.067,03 ha deforested in the projected area of unplanned baseline deforestation in the reference region for location (RRL) in year, aiming to analyze which characteristics influenced deforestation.

Risk maps were generated for each of the first 10 years of the project. For mapping the future deforestation sites, the pixels with the highest values and consequently the highest risks obtained for each year that were located in areas with the presence of vegetation were considered.

This stage of the project resulted in annual deforestation for the project áreas, which are presented in the Table 17, 18 and 19.

Year	Projected Deforestation (RRL-ha)	Accumulated Projected Deforestation (ha)
2017	0	0
2018	112,39	112,39
2019	152,31	264,70
2020	78,07	342,77
2021	149,90	942,67
2022	35,34	528,01
2023	67,20	595,21
2024	129,55	724,77
2025	105,22	829,98
2026	127,13	957,11
2027	109,92	1.067,03
Total	**1.067,23**	

Table 17: Projected deforestation areas modeled for the RLL.

Year	Projected Deforestation (PA-ha)	Accumulated Projected Deforestation (ha)
2017	0	0
2018	21,18	21,18
2019	6,81	27,99
2020	101,41	129,40
2021	22,39	151,79

2022	0,00	151,79
2023	21,57	173,36
2024	31,52	204,88
2025	38,89	243,77
2026	26,35	270,12
2027	0	270,12
Total	**270,12**	

Table 18: Future deforestation areas modeled for the PA.

Year	Projected Deforestation (LA-ha)	Accumulated future deforestation (ha)
2017	0	0
2018	0,00	0,00
2019	0,00	0,00
2020	0,00	0,00
2021	0,00	0,00
2022	0,00	0,00
2023	0,00	0,00
2024	0,00	0,00
2025	0,01	0,01
2026	0,00	0,01
2027	0,00	0,01
Total	**0,01**	

Table 19: Areas of future deforestation calculated for the LA.

The maps of future deforestation for 2018, 2020, 2023, 2026 are presented in Figures 19, 20, 21 and 22, respectively.

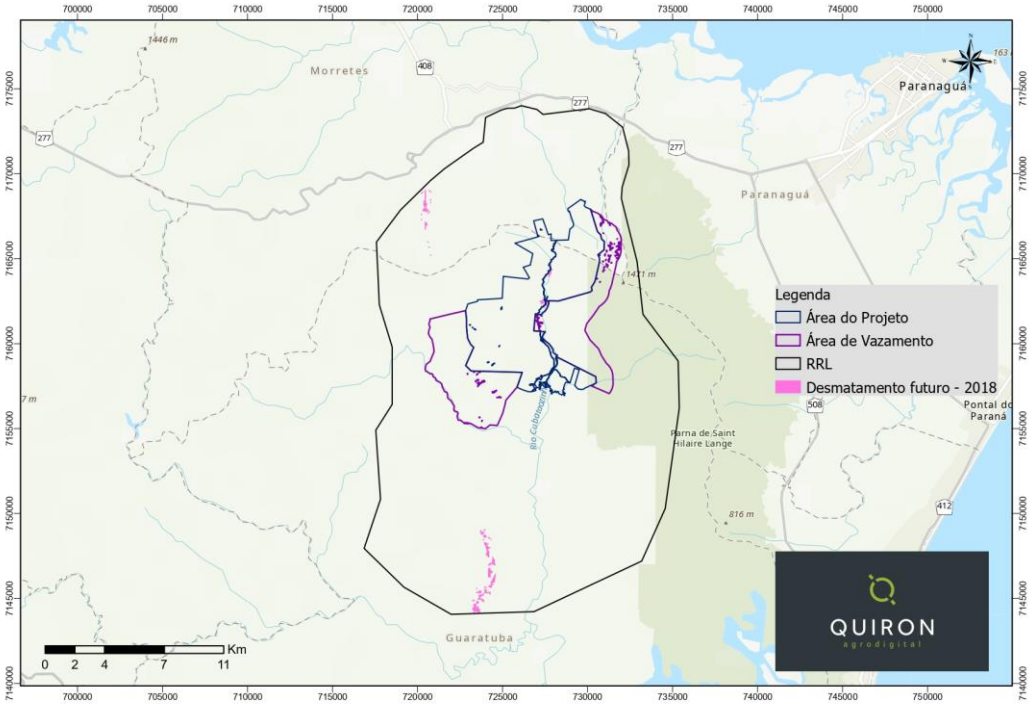

Figure 19: Future Deforestation Map (2018).

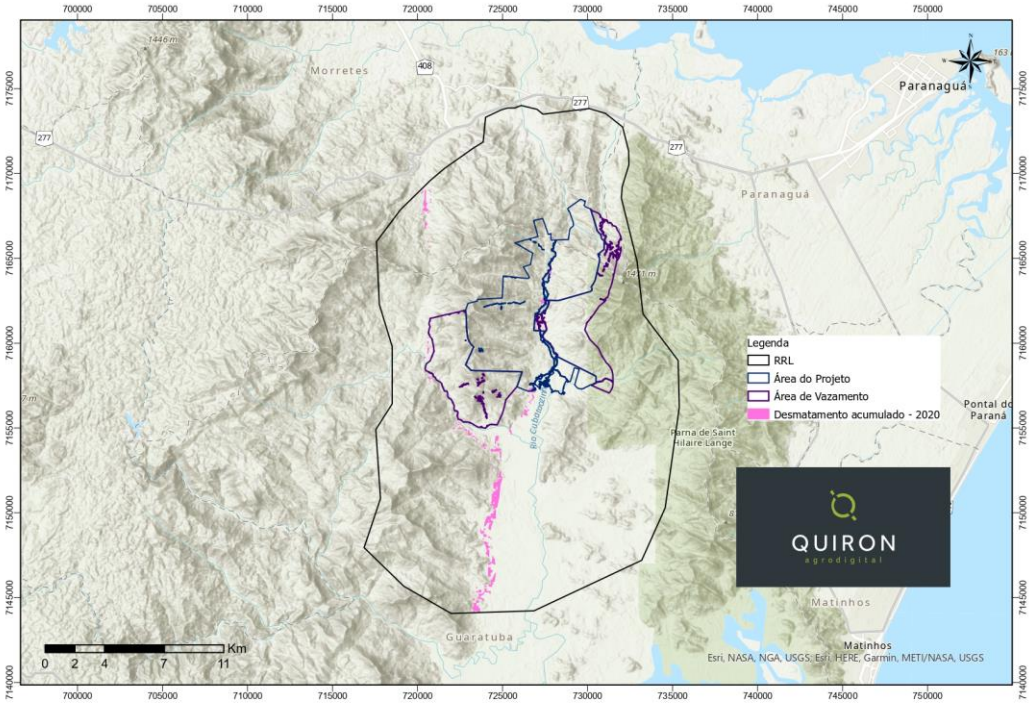

Figure 20: Future Deforestation Map (2020).

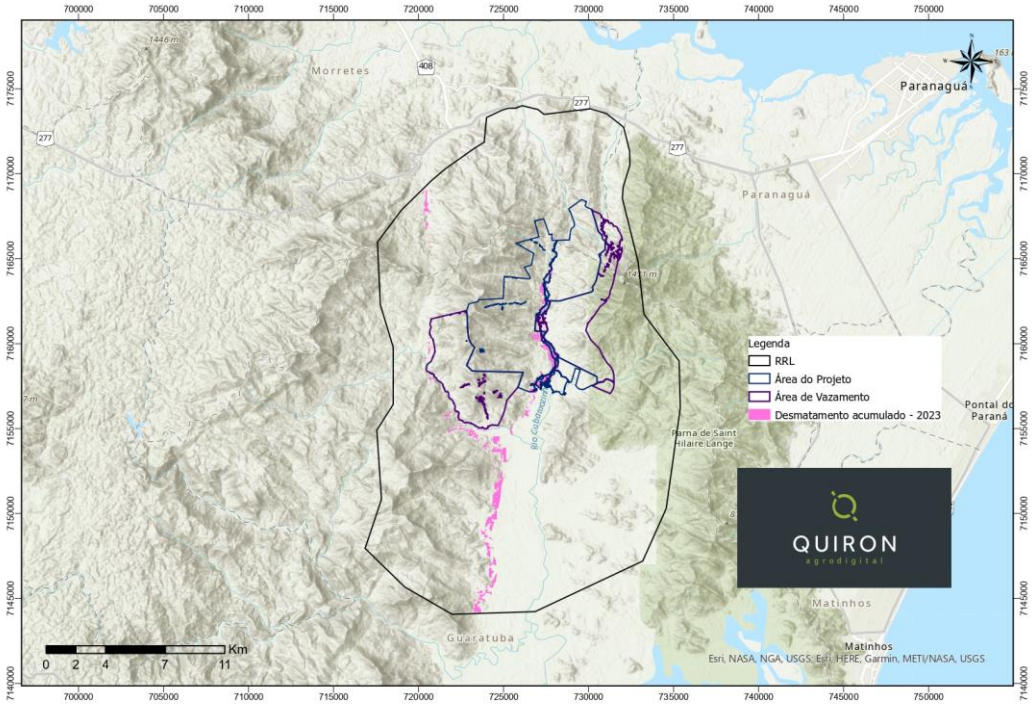

Figure 21: Future Deforestation Map (2023).

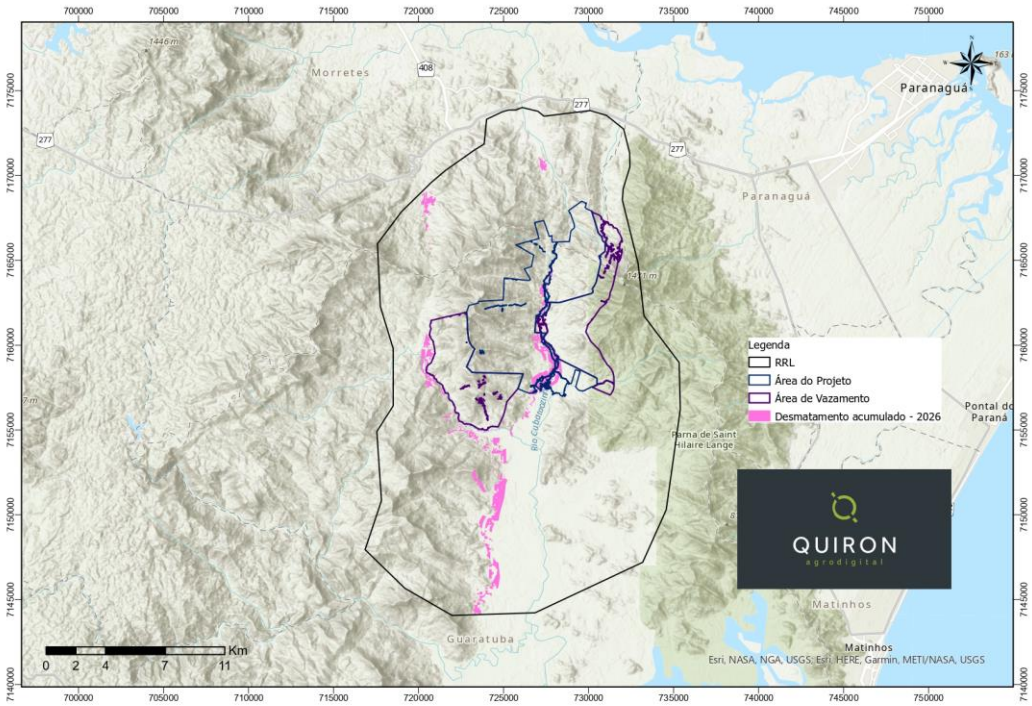

Figure 22: Future Deforestation Map (2026).

Note: A detailed technical report on the process of locating and quantifying the threat of unplanned deforestation is presented along with other commercially sensitive documents to VVB and VERRA.

4.1.4 Estimate of carbon stock changes and greenhouse gas (GHG) emissions

At this stage, the same stratification presented in the phytophysiognomies map of the project area was used for the area subject to deforestation, according to the X-STR module. After the stratification of the project's forests, the methodology recommends using the CP-AB module to estimate carbon stocks in each forest stratum. Although the module was applied to quantify the carbon stock of the project's forests after a forest inventory of the area[24], the values of the Third Brazilian Inventory of Anthropogenic GHG Emissions and Removals (2015)[25] were used conservatively, where was found for Submontane Ombrophilous Dense Forest (Ds) the following values of aboveground and belowground biomass, respectively: 243,6 t ha^{-1} and 22,54 t C ha^{-1}.

These values have been converted into tonnes of CO_2 equivalent. For aboveground biomass, which is in the unit of t ha^{-1}, the value of 243,6 was first multiplied by the carbon fraction of dry matter in t C t^{-1} dm, where the default value defined was 0.47[26]. Therefore, the aboveground biomass value resulted in 114,49 t C ha^{-1}. Thus, the biomass values in tons of carbon per hectare were multiplied by the ratio between the molecular weights of CO_2 and C (44/12) resulting in 419,8 t CO_2e ha^{-1} (above ground) and 82,65 t CO_2e ha^{-1} (below ground), resulting in 502,45 t CO_2e ha^{-1}.

To calculate the post-deforestation carbon stock, the most likely land uses were assumed, based on a simple approach, which are banana and palm heart crops. Local studies were not found to quantify the carbon stocks of palm heart cultivation. So, a study done by ÁVILA et. al.[27], which estimated the plant biomass productivity of a banana plantation at 9,18 t ha^{-1} at the end of the vegetative growth cycle. Converting this value, as done before, the result 15,82 t CO_2e ha^{-1} was found.

For terrestrial carbon pools, stock change was calculated by subtracting post-deforestation carbon stocks from forest carbon stocks, as shown in equation 7. Considering only aboveground biomass as forest

[24] Inventário Florestal Nacional. Available at: https://www.florestal.gov.br/documentos/informacoes-florestais/inventario-florestal-nacional-ifn/resultados-ifn/3966-relatorio-ifn-pr-2018/file
[25] Mudança de Uso e Floresta. Available at: http://redd.mma.gov.br/images/FREL/RR_LULUCF_Mudana-de-Uso-e-Floresta.pdf
[26] IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3
[27] ÁVILA, João Eduardo; LOPES ASSAD, Maria Leonor; LIMA, Abdeel Silva. Evaluation of plant biomass in a production system in agroecological transition. Brazilian Journal of Agroecology, [SI], v. 7, n. 3, Dec. 2012. ISSN 1980-9735. Available at: http://revistas.aba-agroecologia.org.br/index.php/rbagroecologia/article/view/12858.

carbon stock (419,8 t CO_2e ha^{-1}) and as a post-deforestation carbon stock the biomass of banana cultivation (15,82 t CO_2e ha^{-1}).

$$\Delta C_{ABtree,i} = C_{ABtreebsl,\,i} - C_{ABtreepost,i} \quad (7)$$

Where:

$\Delta C_{AB\_tree,i}$: Baseline carbon stock change in aboveground tree biomass in stratum $_i$; t CO_2e ha^{-1}

$C_{AB\_treebsl,\,i}$: Forest carbon stock in aboveground tree biomass in stratum $_i$; t CO_2e ha^{-1}

$C_{AB\_treepost,i}$: Post-deforestation carbon stock in aboveground tree biomass in stratum $_i$; t CO_2e ha^{-1}

$_i$: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

The result found for $\Delta C_{ABtree,i}$ was 403,98 t CO2e ha^{-1}. Moreover, to estimate the change in the baseline carbon stock, equation 8 is used.

$$\Delta C_{BSL,i,t} = A_{unplanned,i,t} \times \Delta C_{ABtree,i} + \left(\sum_{t-10}^{t} A_{unplanned,i,t}\right) \times \Delta C_{BBtree,i} \times \frac{1}{10} \quad (8)$$

Where:

$\Delta C_{BSL,i,t}$: Sum of baseline carbon stock change in all terrestrial pools in stratum $_i$ in year *t*, t CO_2e (calculated separately for project area [PA] and leakage belt [LB])

$A_{Unplanned,i,t}$: Area of unplanned deforestation in forest stratum $_i$ in year *t*; ha

$\Delta C_{AB\_tree,i}$: Baseline carbon stock change in aboveground tree biomass in stratum $_i$; t CO_2e ha^{-1}

$\Delta C_{BB\_tree,i}$: Baseline carbon stock change in belowground tree biomass in stratum $_i$; t CO_2e ha^{-1}

$_i$: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

For this calculation it was considered that changes in aboveground biomass stocks are emitted at the time of deforestation. After deforestation, emissions from belowground biomass occur gradually over time at an annual rate of 1/10 of the 10-year stock change. Thus, for a given year *t*, emissions are summed between the deforested areas from time *t*-10 to time *t*. The calculation was made for the project area and the leakage area using instead of $A_{unplanned,\,i,\,t}$, the average annual area of projected deforestation for each, as shown previously on Tables 18 and 19.

The results of estimating changes in the baseline carbon stock, both for the project area and for the leakage area, in the first ten years of the project are presented in the Table 20.

Project year	PA		LA	
	$\Delta C_{BSL,I,t}$ (t CO_2e)	$\Delta C_{BSL,I,t}$ accumulated (t CO_2e)	$\Delta C_{BSL,I,t}$ (t CO_2e)	$\Delta C_{BSL,I,t}$ accumulated (t CO_2e)
2017	4.365,71	4.365,71	0,00	0,00
2018	4.453,23	8.818,95	0,00	0,00
2019	2.982,46	11.801,40	0,00	0,00
2020	4.2037,45	53.838,85	0,87	0,87
2021	10.299,69	64.138,54	0,02	0,89
2022	5.702,65	69.841,19	0,02	0,91
2023	5.791,83	75.633,02	0,02	0,92
2024	14.426,92	90.059,94	0,02	0,94
2025	17.725,69	107.785,63	5,12	6,06
2026	12.877,51	120.663,14	1,45	7,51

Table 20: Estimated change in carbon stock from baseline to project area and leakage area.

Considering the baseline scenario, i.e., change from forest to banana plantations, other GHG emissions can be estimated as a result of this activity, both in the project area and in the leakage area using equation 9.

$$GHG_{BSL,\,E} = E_{FC,\,i,\,t} + E_{BiomassBurn,\,i,\,t} + N_2O_{direct\text{-}N,\,i,\,t} \quad (9)$$

Where:

$GHG_{BSL,\,E}$: Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline up to year t*; t CO_2e

$E_{FC,\,i,\,t}$: Net CO_2e emission from fossil fuel combustion in stratum i in year t; t CO_2e

$E_{BiomassBurn,i,t}$: Non-CO_2 emissions due to biomass burning as part of deforestation activities in stratum i in year t; t CO_2e

$N_2O_{direct\text{-}N,i,t}$: Direct N_2O emission as a result of nitrogen application in alternative land use within the project boundary in stratum i in year t; t CO_2e

i: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

The net emission of CO_2e from burning fossil fuel ($E_{FC, i, t}$) was excluded from the equation as it does not affect the present project. And to calculate $E_{BiomassBurn,i,t}$ e $N_2O_{direct\text{-}N,i,t}$ modules E-BPB (Estimation of greenhouse gas emissions from biomass and peat burning) and E-NA (Estimation of direct nitrous oxide emission from nitrogen fertilization) were used, respectively, as recommended by the VM0007 methodology, from the following equations:

$$E_{BiomassBurn,i,t} = (((A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i}) \times 10^{-3}) \times GWP_g) \quad (10)$$

Where:

$E_{BiomassBurn, i, t}$: Greenhouse gas emissions due to biomass burning in stratum *i* in year t of each GHG (CO_2, CH_4, N_2O); t CO_2e

$A_{burn, i, t}$: Area burnt for stratum *i* in year *t*; ha

$B_{i, t}$: Average aboveground biomass stock before burning stratum *i*, year; t d.m. ha^{-1}

$COMF_i$: Combustion factor for stratum *i*; dimensionless

$G_{g, i}$: Emission factor for stratum *i* for gas *g*; kg t^{-1} dm burned

GWP_g: Global warming potential for gas *g*; t CO_2 / t gas g

g: 1, 2, 3 ... G greenhouse gases, including carbon dioxide, methane and nitrous oxide; dimensionless

i: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

$$B_{i, t} = (C_{AB\_tree, i, t} + C_{DWi, t} + C_{LI, i, t}) \times 12/44 \times (1 / CF) \quad (11)$$

Where:

$B_{i, t}$: Average aboveground biomass stock before burning for stratum *i*, year *t*; tons dm ha^{-1}

$C_{AB\_tree, i, t}$: Carbon stock in aboveground biomass in trees in stratum *i* in year *t*; t CO_2e ha^{-1}

$C_{DWi, t}$: Carbon stock in dead wood for stratum *i* in year *t*; t CO_2e ha^{-1}

$C_{LI, i, t}$: Carbon stock in litter for stratum *i* in year *t*; t CO_2e ha^{-1}

12/44: *Inverse* ratio of molecular weight of CO_2 to carbon; t CO_2e t C^{-1}

CF: Carbon fraction of biomass; t C t^{-1} d.m

i: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

The average aboveground biomass stock before burning for stratum (*Bi, t*) was calculated according to Equation 11 and resulted in the value of 243.6 t/ha.

The Equation 12 was provided from E-NA.

$$N_2O_{direct\ N,\ t} = (F_{SN,\ t} + F_{ON,\ t}) \times EF_1 \times MW_{N2} \times GWP_{N2O} \quad (12)$$

Where:

$N_2O_{direct\ N,\ t}$: Direct N_2O emission as a result of nitrogen application within the project boundary; t CO_2e in year *t*

$F_{SN,\ t}$: Mass of synthetic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NO_X, t-N in year t

$F_{ON,\ t}$: Mass of organic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NO_X, t-N in year t

EF_1: Emission factor for emissions of N inputs, ton-N_2O-N (t N input)$^{-1}$

MW_{N2O}: Ratio of molecular weight of N_2O and N (44/28), ton-N_2O (t N)$^{-1}$

GWP_{N2O}: Global Warming Potential for N_2O, kg CO_2e (kg-N_2O)$^{-1}$

i: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

The result of equation 12 was 0,4684t/ha.

According to the IPCC guide (1996), the amounts of nitrogen as fertilizers applied to the soil must be adjusted as a function of the volatilized amounts of NH_3 and Nox to obtain F_{SN} from the following equation 13:

$$F_{SN,t} = N_{FERT} \times (1 - Frac_{GASF}) \quad (13)$$

Where:

N_{FERT}: Amount of N applied in the form of synthetic fertilizer; kg N/year

$Frac_{GASF}$: Nitrogen fraction of applied synthetic fertilizer that volatilizes as NH_3 and NOx; kg NH_3-N and Nox-N (input of kg N_2O-N)$^{-1}$, 0.1 (IPCC, 1996)

For the $F_{NS,t}$ calculation, the amount of synthetic fertilizer nitrogen applied was acquired from the study of López and Espinosa[28] (1995) with a high yield banana crops (70 t ha^{-1} year^{-1}). In the study it was found that under the conditions of Central America, the amount of nitrogen exported with the fruits is about 125 kg ha^{-1} year^{-1}. The authors highlighted that the maintenance of high yields over time depends on the replacement of exported nutrients through fertilization. In other words, 0,125 t of nitrogen must be applied to each hectare of cultivation. Therefore, from equation 13, $F_{NS,t}$ was obtained equal to 0,1125 t N and this value represents the annual amount applied per hectare. The mass of organic fertilizer nitrogen ($F_{ON,t}$) was not considered.

The data used in equations 10, 11 and 12 were acquired from the IPCC (2014) and are presented in the Table 21 below.

[28] LÓPEZ, A., ESPINOSA, J. Manual de nutricion y fertilizacion del banana. Quito: CORBANA/INPOFOS, 1995. 82p.

Parameter	Value	Information
$COMF_i$	0.32	Tropical forest (burning and cutting)
$G_{g,i}$ (CH_4)	6.8	Tropical forest
Gg,i(N_2O)	0.2	
GWP_g (CH_4)	28	Standard
GWP_g (N_2O)	265	
CF	0.47	Standard
EF_1	0.01	Standard

Table 21: IPCC data (2014).

A summary of the results obtained through equations 9, 10 and 12, in other words, greenhouse gas emissions due to biomass burning, direct N_2O emissions as a result of nitrogen application and baseline greenhouse gas emissions for the project and leakage areas are presented in the Table 22.

Year	PA				LA			
	$E_{BiomassBurn,i,t}$ -CH_4 (eq. 10)	$E_{BiomassBurn,i,t}$ -N_2O (eq. 10)	$N_2O_{direct\ N,t}$ (eq. 12)	$GHG_{BSL,E}$ (eq. 9)	$E_{BiomassBurn,i,t}$ -CH_4 (eq. 10)	$E_{BiomassBurn,i,t}$ -N_2O (eq. 10)	$N_2O_{direct\ N,t}$ (eq. 12)	$GHG_{BSL,E}$ (eq. 9)
2017	157,18	43,75	4,96	205,89	0,00	0,00	0,00	0,00
2018	157,18	43,75	4,96	205,89	0,00	0,00	0,00	0,00
2019	101,07	28,14	3,19	132,40	0,00	0,00	0,00	0,00
2020	1505,13	418,97	47,50	1971,60	0,00	0,03	0,00	0,04
2021	332,31	92,50	10,49	435,30	0,00	0,00	0,00	0,00
2022	160,15	44,58	5,05	209,78	0,00	0,00	0,00	0,00
2023	160,15	44,58	5,05	209,78	0,00	0,00	0,00	0,00
2024	467,82	130,22	14,76	612,81	0,00	0,00	0,00	0,00
2025	577,21	160,67	18,21	756,09	0,01	0,18	0,01	0,24
2026	391,09	108,86	12,34	512,29	0,00	0,05	0,00	0,06
Total	**4.009,29**	**1.116,03**	**126,52**	**5.251,83**	**0,02**	**0,26**	**0,01**	**0,34**

Table 22: Result GHG emissions as a result of deforestation activities in the PA and the LA.

For the first 10 years of the crediting period project, greenhouse gas emissions as a result of baseline deforestation activities resulted in 5.251,83 t CO_2e (PA) and 0,34 t CO_2e (LA).

4.1.5 Net GHG emissions at baseline

To calculate the net GHG emissions ($\Delta C_{BSL,\ unplanned}$) the equation 14 was used.

$$\Delta C_{BSL,\ unplanned} = \Delta C_{BSL,\ PA,\ unplanned} + GHG_{BSL,\ E} \quad (14)$$

Where:

$\Delta C_{BSL,\ unplanned}$: Net greenhouse gas emissions in the baseline from unplanned deforestation up to year t^*; t CO_2e

$\Delta C_{BSL,\ PA,\ unplanned}$: Net CO_2 emissions in the baseline from unplanned deforestation in the project area up to year t^*; t CO_2e

$GHG_{BSL,\ E}$: Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline up to year t^*; t CO_2e

$\Delta C_{BSL,\ PA,\ unplanned}$ is calculated through the sum of $\Delta C_{BSL,i,t}$ (sum of baseline carbon stock change in all terrestrial reservoirs in stratum *i* in year t) of all considered forest strata. In the case of this project, only the Submontane Ombrophilous Dense Forest (Ds) stratum was considered, which is the one that comprises most of the project area and where it is assumed that unplanned baseline deforestation would occur. Therefore, in equation 14, $\Delta C_{BSL,PA,unplanned}$ was replaced by $\Delta C_{BSL,i,t}$ of the project area.

The result for net GHG emissions for the project area was 125.914,97 t CO_2e in 10 years. The Table 23 presents the annual net GHG emissions for the project area.

Project's Year	$\Delta C_{BSL,\ PA,\ unplanned}$
2017	4.571,60
2018	4.659,12
2019	3.114,86
2020	44.009,05
2021	10.734,99
2022	5.912,43
2023	6.001,61

2024	15.039,72
2025	18.481,78
2026	13.389,80
Total	**125.914,97**

Table 23: Annual net GHG emissions for the project area.

Note: The estimation of carbon stock changes and GHG emissions was performed from values based on verifiable literature sources. According to the methodological module X-UNC (Estimation of uncertainty for REDD+ project activities), in this case, the uncertainty is considered zero, as the estimate is conservative.

4.2 Project Emissions

Project emissions were estimated *ex-ante* by applying the M-REDD module (Methods for Monitoring GHG Emissions and Removals in REDD and CIW Projects). Equation 15 is used to calculate *ex-ante* project emissions.

$$\Delta C_{WPS-REDD} = \sum_{t=1}^{t*} \sum_{i=1}^{M} (\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + \Delta C_{P,DistPA,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t}) \quad (15)$$

Where:

$\Delta C_{WPS-REDD}$: Net GHG emissions in the REDD project scenario up to year *t**; t CO_2e

$\Delta C_{P,\ DefPA,\ i,\ t}$: Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* in year *t*; t CO_2e

$\Delta C_{P,\ Deg,\ i,\ t}$: Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* in year *t*; t CO_2e

$\Delta C_{P,\ DistPA,\ i,\ t}$: Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* in year t; t CO_2e

$GHG_{P-E,\ i,\ t}$: Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the case of the project in stratum *i* in year *t*; t CO_2e

$\Delta C_{P,\ Enh,\ i,\ t}$: Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline in stratum *i* in year *t*; t CO_2e

i: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, ... t * time elapsed since the start of the project activity; year

The net GHG emissions in the case of the project are equal to the sum of stock changes due to deforestation and forest degradation, plus total GHG emissions, minus any increase in carbon stock in the considered reservoirs.

Considerations:

- Conservatively, it is assumed that no increase in carbon stock occurs in the case of the project, defining that $\Delta C_{P, Enh, i, t}$ is equal to zero.

- Project activities such as satellite area monitoring, patrolling and area signaling will considerably reduce deforestation and degradation, where an efficiency of 98% is assumed for the project. If any deforestation occurs, it will soon be identified and banned and there is not the possibility of any plantation being installed. Therefore, the post-deforestation carbon stock and any GHG emissions from post-deforestation land use will be counted as zero. And the project activities do not generate significant GHG emissions from burning fossil fuels, so $GEE_{P-E, I, t}$ is equal to zero.

- There is not a knowledge of natural disturbances in the project area in the historical reference period nor from a literature search of occurrences in the region in previous years that may have led to significant emissions. Therefore, $\Delta C_{PDistPA, I, t} = 0$. Events of this type will be monitored and accounted for if they occur during the project period.

- Emissions resulting from degradation due to illegal extraction of juçara palm hearts and guaricana leaves, which occur in the baseline, will be quantified *ex-post* through the monitoring plan based on the M-REDD module. There is no way to predict the degradation in the case of the project, because although it was identified in the baseline, it was not estimated in the field before the beginning of the project. The family residing in the project area does not carry out any type of illegal extraction, and the amount of firewood removed only for the family's consumption is insignificant. In this way, $\Delta C_{P, Deg, I, t,}$ will be counted as zero.

Due to the simplifications made in $\Delta C_{WPS-REDD} = \Delta C_{P, DefPA,i,t}$, it resulted in a variation of 109,04 to 108,99 t CO_2e per year, in the first 10 years, with a baseline deforestation rate of 0,0025..

For the leakage belt of project activities, the net GHG emissions in the case of the project are equal to the sum of stock changes due to deforestation in the leakage belt, as per equation 16:

$$\Delta C_{WPS-REDD,LB} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \Delta C_{P,DefLB,i,t} \quad (16)$$

Where:

$\Delta C_{WPS-REDD,LB}$: Net GHG emissions in the leakage belt in the case of the REDD project up to year *t**; t CO_2e

$\Delta C_{P, DefLB, i, t}$: Change in net carbon stock as a result of deforestation in the leakage belt the case of the project in stratum *i* in year *t*; t CO_2e

$_i$: 1, 2, 3 ... strata M; dimensionless

t: 1, 2, 3, … t * time elapsed since the start of the project activity; year

The value of $\Delta C_{P, DefLB, i, t}$ was found from equation 17:

$$\Delta C_{P,DefLB,i,t} = \sum_{u=1}^{U} \left(A_{DefLB,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right) \quad (17)$$

Where:

$\Delta C_{P, DefLB, i, t}$: Change in net carbon stock as a result of deforestation in the case of the project in the leakage belt in stratum *i* in year *t*; t CO_2e

$A_{DefLB, u, i, t}$: Area of deforestation recorded in the stratum of the leakage belt *i* converted to land use *u* in year *t*; ha

$\Delta C_{pools, Def, u, i, t}$: Changes in net carbon stock in all reservoirs in case of project in land use u in stratum *i* in year *t*; $tCO_2e\ ha^{-1}$

u: 1, 2, 3,, … U post-deforestation land uses

i: 1, 2, 3 … strata M; dimensionless

t: 1, 2, 3, … t * time elapsed since the start of the project activity; year

For the project leakage area, the $\Delta C_{P, DefLB, i, t}$ values ranged from 4.608,80 to 4.506,14 t CO_2e per year in the first 10 years, with a baseline deforestation rate of 0,0025.

4.2.1 Deforestation in the case of the project

For the leakage belt of project activities, the net GHG emissions in the case of the project are equal to the sum of stock changes due to deforestation in the leakage belt, as per equation 18:

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^{U} (A_{DefPA,u,i,t} \times \Delta C_{pools,P,Def,u,i,t}) \quad (18)$$

Where:

$\Delta C_{P, DefPA, i, t}$: Change in net carbon stock as a result of deforestation in the project area in the case of the project in stratum *i* in year *t*; t CO_2e

$A_{DefPA, u, i, t}$: Area of deforestation recorded in the extract of the project area *i* converted to land use u in year *t*; ha

$\Delta C_{pools,P,Def, u, i, t}$: Changes in net carbon stock in all reservoirs in case of project in land use *u* in stratum *i* in year *t*; t CO_2-e ha^{-1}

u: 1, 2, 3, … U post-deforestation land uses

i: 1, 2, 3 … strata M; dimensionless

t: 1, 2, 3, … t * time elapsed since the start of the project activity; year

The emission per unit area is equal to the difference between stocks before and after deforestation, minus any wood products created from logging in the deforestation process, as shown in Equation 19.

$$\Delta C_{pools,P,Def,i,t} = \Delta C_{BSL,i} - \Delta C_{P,post,i} - \Delta C_{WP,i} \quad (19)$$

Where:

$\Delta C_{pools,P,Def,i,t}$: Changes in net carbon stock in all reservoirs as a result of deforestation in the case of the project in stratum *i* in year *t*; t CO_2e ha^{-1}

$C_{BSL,i}$: Carbon stock in all pools in the baseline case in stratum *i*; t CO_2e ha^{-1}

$C_{P,post,i}$: Carbon stock in all reservoirs in post-deforestation land use *u* in stratum *i*; t CO_2e ha^{-1}

$C_{WP,i}$: Carbon stock sequestered in wood products from crops in stratum *i*; t CO_2e ha^{-1}

i: 1, 2, 3 … strata M; dimensionless

t: 1, 2, 3, … t * time elapsed since the start of the project activity; year

Considerations:

- Conservatively, it is assumed that no wood products are produced ($\Delta C_{WP,i} = 0$).
- There will not be a post-deforestation carbon stock, as monitoring in the project area will not allow the installation of plantations ($\Delta C_{P,post,u,i} = 0$).
- Instead of tracking annual emissions from burning and/or decay, the methodology employs the simplifying assumption that all carbon stocks are emitted in the year deforested. So, $\Delta C_{pools,Def,u,i,t} = \Delta C_{BSL,i}$, which includes aboveground and belowground biomass stocks. The values to represent carbon stocks in this calculation are the same as those used for the calculation of baseline emissions ($\Delta C_{BSL,i}$= 502,45 t CO_2e ha^{-1}).

Year	PA (ha)	Deforestation rate project scenario	A_{DefPA} (ha)	$\Delta C_{pools,P,Def}$ (t CO_2e/ha) (eq. 19)	$\Delta C_{P,DefPA}$ (t CO_2e) (eq 18)
4.340,23	4.340,23	0,00005	0,217	502,45	109,04
4.340,23	4.340,23	0,00005	0,217	502,45	109,03
4.340,23	4.340,23	0,00005	0,217	502,45	109,03
4.340,23	4.340,23	0,00005	0,217	502,45	109,02
4.340,23	4.340,23	0,00005	0,217	502,45	109,02
4.340,23	4.340,23	0,00005	0,217	502,45	109,01
4.340,23	4.340,23	0,00005	0,217	502,45	109,00
4.340,23	4.340,23	0,00005	0,217	502,45	109,00
4.340,23	4.340,23	0,00005	0,217	502,45	108,99

4.340,23	4.340,23	0,00005	0,217	502,45	108,99

Table 24: Net change in project area carbon stock.

A_{DefPA} was calculated assuming a project efficiency of 98% over a deforestation rate of 0,0025 = 0,3% per year, resulting in an annual deforestation rate of 0,00005 in the project scenario.

Carrying out satellite monitoring and patrols in the project area and also with the signaling of the project area, it is intended to avoid deforestation and degradation, therefore, if any deforestation occurs, it will soon be identified and banned, with no possibility of being installed any plantation. For this reason, emissions due to the use of fertilizers are not considered.

4.3 Leakage

The estimate of baseline carbon stock changes and GHG emissions in the leakage area were previously presented in Table 18 together with the estimate for the project area using the deforestation rate of 0,0025 = 0,3% per year as verified in historical average of the reference period.

Emissions from the displacement of unplanned deforestation from the project area into and out of the leakage area are estimated according to the LK-ASU module of the VCS methodology VM0007.

4.3.1 Estimation of Proportions of Deforested Area by Immigrants and Local Deforestation Agents in the Baseline

The LK-ASU module (Estimation of emissions from activity shifting for avoiding unplanned deforestation and avoiding unplanned wetland degradation) provides a step to estimate proportions of area deforested by local deforestation agents ($PROP_{RES}$) and immigrants ($PROP_{IMM}$) at the baseline. Due to the socioeconomic characteristics of the project area and the leakage area and the lack of population data, it is not possible to satisfactorily estimate the area deforested by local deforestation agents and immigrants in the leakage area.

This is because the residents of the leakage area are legal owners of the land with use rights regulated by local and Federal legislation as well as the project area, which is fully owned by a single owner and with only one family residing within its boundaries. Public institutions that manage rural areas in the municipalities of Guaratuba and Morretes are linked to the Institute of Rural Development (IDR) of the State of Paraná. When IDR was contacted in the search for information, stated that it did not have any data files referring to this demand and recommended using data from the Brazilian Institute of Geography and Statistics (IBGE).

Among the possible immigrants are those who legally acquired their lands and those who occupy lands improperly. According to data from the Agricultural Census of Guaratuba, carried out by the IBGE[29] in 2006, among the 392 rural establishments in the municipality, only 1 was derived from an illegal occupation of land. In 2017, this number increased to 5 among the 376 rural establishments that existed that year. Therefore, in the year in which the Atlantic Forest Biodiversity Conservation Limeira Project REDD begins, 1,3% of the establishments were irregular occupations in the municipality of Guaratuba. The data consulted do not provide information on the location of these establishments, nor information on the origin of these inhabitants, whether they are locals or immigrants. Satellite images show that there are not buildings in the leakage area, so there are not residents in this area. The definition of the leakage area limits is justified in section 3.3.1. Because it is an unplanned deforestation, that is, illegal, a Participatory Rural Assessment would not report the deforestation that occurred either by local or immigrant agents. Due to the obstacles found in this research, it was decided to attribute 50% of deforestation in the area of leakage by local agents and 50% by immigrant agents, thus obtaining the following proportions: $PROP_{RE}$ = 0,5 and $PROP_{IMM}$ = 0,5.

4.3.2 Estimate of unplanned deforestation displaced from the project area to the leakage belt

To conservatively estimate the changes in carbon stock and greenhouse gas emissions in the leakage area, for an *ex-ante* evaluation, the default value of 15% of the estimated changes in the carbon stock of the baseline and greenhouse gas emissions for the project area ($\Delta C_{BSL,\ PA,\ unplanned}$), recommended by VCS Standard v. 4.2[30], which added to the estimated changes in baseline carbon stock and GHG emissions from the leakage area ($\Delta C_{BSL,\ LK,\ unplanned}$) result in the baseline net CO_2 emissions from unplanned deforestation in the leakage area ($\Delta C_{P,\ LB}$). Leakage is then calculated as the difference between the project and baseline carbon stock changes and greenhouse gas emissions in the leakage area, as described in equation 20.

$$\Delta C_{LK\text{-}ASU\text{-}LB} = \Delta C_{P,LB} - \Delta C_{BSL,\ LK,\ unplanned} \quad (20)$$

Where:

$\Delta C_{LK\text{-}ASU\text{-}LB}$: Net CO_2 emissions due to unplanned deforestation displaced from the project area to the leakage belt up to year t^*; t CO_2e

$\Delta C_{P,LB}$: Net greenhouse gas emissions within the leakage belt in the project case up to year t^*; t CO_2e

[29] Pesquisa. Available at: https://cidades.ibge.gov.br/brasil/pr/guaratuba/pesquisa/24/76693

[30] "3.14.13 – 1) Where the applied methodology requires the quantification of activity-shifting leakage, projects may apply the optional default activity-shifting leakage deduction of 15 percent to the gross GHG emission reductions and/or removals." (VCS Standard v. 4.2). Available at: www.verra.org.

$\Delta C_{BSL, LK, unplanned}$: Net CO_2 emissions in the baseline from unplanned deforestation in the leakage belt up to year t^*; t CO_2e

The results of this calculation will be presented together with the results of emissions from deforestation displaced outside the leakage area further on.

4.3.3 Estimated unplanned deforestation displaced from the project area outside the leakage belt

To estimate the unplanned deforestation displaced from the project area outside the leakage area, it is considered that immigrants who are prevented from migrating and deforesting the project area have the alternative of migrating either to the leakage area or to an area of forest anywhere else in the country. The proportion that migrates to the leakage area is calculated as the proportion of the area of the leakage area within the total available forest nationally.

The available national forest area is calculated from equation 21.

$$AV_{FOR} = TOT_{FOR} - PROT_{FOR} - MAN_{FOR} \quad (21)$$

Where:

AV_{FOR}: Total available national forest area for unplanned deforestation; ha

TOT_{FOR}: Total available national forest area; ha

$PROT_{FOR}$: Total area of fully protected forests nationally; ha

MAN_{FOR}: Total area of forests under active management nationally; ha

The total area of natural forest in Brazil (TOT_{FOR}) was obtained from FAO[31], with 462.100.665 hectares in 2017. Assuming that the areas of conservation units registered in Brazil, even those with integral protection, are susceptible to deforestation, they were conservatively excluded from the $PROT_{FOR}$ and MAN_{FOR} calculations. Therefore, AV_{FOR} is equal to TOT_{FOR}.

The leakage area is calculated as a proportion of the total area of national forest available as follows:

$$PROP_{LB} = LB_{FOR} / AV_{FOR} \quad (22)$$

Where:

$PROP_{LB}$: Area of forest available in the leakage belt for unplanned deforestation as a proportion of the total national forest area available for unplanned deforestation; proportion

LB_{FOR}: Total available forest area for unplanned deforestation in the leakage belt; ha (calculated from the *Leakage Belt Forest Cover Benchmark Map*)

[31] Food and Agriculture Organization of the United Nations. Available at: https://plataforma.brasil.mapbiomas.org/

AV_{FOR}: Total available national forest area for unplanned deforestation; ha

The $PROP_{LB}$ proportion resulted in 0,0000079. The same data source was used to obtain aboveground biomass from forest strata of AV_{FOR}. The Brazilian biomes, presented in the Table 25 with their respective areas and aboveground biomass, were considered as strata to calculate the weighted average that represents the CO_2e emission per hectare of Brazilian forests if they were deforested.

FAO Data		% National	Aboveground biomass (Mt)	Carbon stock (t C/ha)	Emissions (t CO_2e/ha)	Weighted average (t CO_2e/ha)
Biome	Area (ha)					
Amazon	321.218.941	0,70	77.760,98	113,78	417,19	290,00
Caatinga	36.387.925	0,08	719,53	9,29	34,08	2,68
Savanna	76.735.871	0,17	3.376,59	20,68	75,83	12,59
Atlantic Forest	19.499.592	0,04	1.307,90	31,52	115,59	4,88
Pampa	2.683.852	0,01	161,90	28,35	103,96	0,60
Pantanal - Wetland	5.574.484	0,01	393,66	33,19	121,70	1,47
Total	**462.100.665**					**312,22**

Table 25: CO_2e emissions per hectare from Brazilian forests if deforested.

The proportional difference in in stocks is calculated by dividing the stock outside the leakage belt by the stock inside the leakage belt is calculated using the equation 23.

$$PROP_{CS} = C_{OLB} / C_{LB} \quad (23)$$

Where:

$PROP_{CS}$: The proportional difference in carbon stocks between areas of forest available for unplanned deforestation both inside and outside the leakage belt; proportion

C_{OLB}: Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the leakage belt; t CO_2e ha^{-1}

C_{LB}: Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the leakage belt; t CO_2e ha^{-1}

Using aboveground biomass carbon stock data for forests available for unplanned deforestation within the leakage area (C_{LB}) equal to 419,8 t CO_2e/ha (above ground), as described in the second paragraph of section 4.1.4 and C_{OLB} = 312,22 t CO_2e/ha (total of weighted average), as presented in Table 25, the proportion for $PROP_{CS}$ = 0,744 was calculated.

Then, the proportional leakage for areas with immigrant populations was calculated using the equation 24.

$$LK_{PROP} = PROP_{IMM} \times (1 - PROP_{LB}) \times PROP_{CS} \quad (24)$$

Where:

LK_{PRO}: Proportional leakage for areas with immigrating populations; proportion

$PROP_{IMM}$: Estimated proportion of baseline deforestation caused by immigrating population; proportion

$PROP_{LB}$: Area of forest available for unplanned deforestation in the leakage belt as a proportion of the total national forest area available for unplanned deforestation; proportion

$PROP_{CS}$: The proportional difference in stocks between areas of forest available for unplanned deforestation both inside and outside the leakage belt; proportion

The proportion obtained for LK_{PROP} found was 0,372. Therefore, in an *ex-ante* assessment, leakage due to the proportion of baseline deforestation agents that are displaced outside the leakage area is calculated as follows, with the result in the Table 26:

$$\Delta C_{LK\text{-}ASU,\ OLB} = (\Delta C_{BSL,\ LK,\ unplanned} - \Delta C_{P,\ LB}) \times LK_{PROP} \quad (25)$$

Where:

$\Delta C_{LK\text{-}ASU,OLB}$: Net CO_2 emissions due to unplanned deforestation displaced outside the leakage belt up to year *t**; t CO_2e

$\Delta C_{BSL,LK,unplanned}$: Net CO_2 equivalent emissions in the baseline from unplanned deforestation in the leakage belt up to year t*; t CO_2e

$\Delta C_{P,LB}$: Net CO_2 equivalent emissions within the leakage belt in the project case up to year t*; t CO_2e

LK_{PROP}: Proportional leakage for areas with immigrating populations; proportion

Year	$\Delta C_{BSL,PA,unplanned}$	$\Delta C_{BSL,LK,unplanned}$	$\Delta C_{P,LB}$	$\Delta C_{LK\text{-}ASU,OLB}$ (eq 25)	$\Delta C_{LK\text{-}ASU\text{-}LB}$ (eq 20)
2017	4.571,60	0,00	685,74	-255,00	685,74
2018	4.659,12	0,00	698,87	-259,88	698,87
2019	3.114,86	0,00	467,23	-173,74	467,23
2020	44.009,05	0,91	6.602,27	-2.454,79	6.601,36
2021	10.734,99	0,02	1610,27	-598,79	1.610,25
2022	5.912,43	0,02	886,88	-329,79	886,86
2023	6.001,61	0,02	900,26	-334,76	900,24
2024	15.039,72	0,02	2.255,98	-838,90	2.255,96
2025	18.481,78	5,36	2.777,63	-1.030,90	2.772,27
2026	13.389,80	1,51	2.009,98	-746,87	2.008,47

Total	125.914,97	7,85	18.895,10	-7.023,43	18.887,25

Table 26: Net CO_2 emissions.

4.3.4 Emissions from leakage prevention activities

Emissions from leakage prevention activities are not counted in this project as, as mentioned in section 1.17.1, leakage management will not be carried out directly by the proponent. Therefore, the variable $GEE_{LK,\ E}$ greenhouse gas emissions as a result of leakage prevention activities, is equal to zero.

4.3.5 Estimate of total leakage due to displacement of unplanned deforestation

The estimate of total leakage due to displacement of unplanned deforestation is calculated according the equation 26 with the results presented in the Table 27.

$$\Delta C_{LK\text{-}AS,\ unplanned} = \Delta C_{LK\text{-}A\ SU\text{-}LB} + \Delta C_{LK\text{-}ASU\text{-}OLB} + GHG_{LK,\ E} \quad (26)$$

Where:

$\Delta C_{LK\text{-}AS,\ unplanned}$: Net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation Net CO_2 emissions up to year *t* *; t CO_2e

$\Delta C_{LK\text{-}ASU\text{-}OLB}$: Net CO_2 emissions due to unplanned deforestation displaced outside the leakage belt up to year t*; t CO_2e

$\Delta C_{LK\text{-}ASU\text{-}LB}$: Net CO_2 emissions due to unplanned deforestation displaced from the project area to the leakage belt up to year t*; t CO_2e

$GHG_{LK,E}$: Greenhouse gas emissions as a result of leakage prevention activities up to year t*; t CO_2-e

As said before, $GHG_{LK,E}$ was considered zero. The result of equation 26 is presented on Table 27.

Year	$\Delta C_{LK\text{-}AS,unplanned\ (eq\ 26)}$
2017	430,74
2018	438,99
2019	293,48
2020	4.146,57
2021	1.011,46
2022	557,07
2023	565,48
2024	1.417,06

2025	1.741,37
2026	1.261,60
Total	**11.863,81**

Table 27: Estimate of net greenhouse gas emissions preventing unplanned deforestation.

4.4 Estimated Net GHG Emission Reductions and Removals

Estimates of GHG credits eligible for emission as VCUs were calculated according to the VM0007 methodology instructions. The project's total net greenhouse gas emission reductions were calculated according to the equation 27.

$$NER_{REDD} = \Delta C_{BSL\text{-}REDD} - \Delta C_{WPS\text{-}REDD} - \Delta C_{LK\text{-}REDD} \quad (27)$$

Where:

NER_{REDD}: Total net GHG emission reductions of the REDD project activity up to year t^*; t CO_2e

$\Delta C_{BSL\text{-}REDD}$: Net GHG emissions in the REDD baseline scenario up to year t^*; t CO_2e

$\Delta C_{WPS\text{-}REDD}$: Net GHG emissions in the REDD project scenario until year t^*; CO_2e

$\Delta C_{LK\text{-}REDD}$: Net GHG emissions due to leakage from REDD project activity up to year t^*; t CO_2e

This project only considers unplanned deforestation, therefore $\Delta C_{BSL\text{-}REDD} = \Delta C_{BSL,\ unplanned}$, calculated in section 4.1.5 and $\Delta C_{LK\text{-}REDD} = \Delta C_{LK\text{-}AS,unplanned}$ calculated in section 4.3.5.

To calculate the contribution to the joint AFOLU account, a simplification of the equation provided by the methodology was carried out. Considering that emissions due to the use of fossil fuels are excluded in all cases and that emissions due to the use of fertilizers are excluded from the project scenario, it was calculated as the equation 28 follows:

$$Buffer_{Total} = [(\Delta C_{BSL,unplanned} - N_2O_{direct,t}) - \Delta C_{P,unplanned}] \times Buffer\ \% \quad (28)$$

Where:

$Buffer_{Total}$: Total permanence risk buffer withholding; t CO_2e

$\Delta C_{BSL,unplanned}$: Net GHG emissions in the baseline from unplanned deforestation; t CO_2e

$N_2O_{direct,t}$: Direct N_2O emission as a result of nitrogen application to alternative land use within the project boundary in stratum i in year t; t CO_2e

$\Delta C_{P,unplanned}$: Net GHG emissions within the project area in the project scenario; t CO_2e

Buffer %: Buffer withholding percentage; percent

The percentage of 10% withholding tax based on the overall project risk rating calculated came from the T-BAR tool and was used on the *Buffer %*.

And the calculation of Verified Carbon Units (VCU) was performed from the following equation 29:

$$VCU_t = (NER_{REDD,\ t2} - NER_{REDD,\ t1}) - Buffer_{Total} \quad (29)$$

Where:

VCU_t: Number of Verified Carbon Units at year t = t2 - t1 (VCU)

$NER_{REDD,\ t2}$: Total net GHG emission reductions from the REDD+ project activity up to year t_2 and adjusted to account for uncertainty; t CO_2e

$NER_{REDD,\ t1}$: Total net GHG emission reductions from the REDD+ project activity up to year t_1 and adjusted to account for uncertainty; tCO_2e

Note: As justified in previous relevant sections, it was not necessary to account for the uncertainty of parameters that led to the NER_{REDD} calculation. Therefore, to calculate VCU_t, the uncertainty adjustment was not performed.

The table 28 presents the results of equations 27, 28 and 29.

Year	$C_{BSL-REDD}$	$C_{WPS-REDD}$	$C_{LK-REDD}$	$NER_{REDD\ (eq.\ 27)}$	$Buffer_{Total\ (eq.\ 28)}$	$VCU_{t\ (eq.\ 29)}$
2017	4.571,60	109,04	430,74	4.031,82	445,76	3.586
2018	9.230,72	218,07	869,73	8.142,93	900,27	7.243
2019	12.345,58	327,10	1.163,21	10.855,27	1.200,54	9.655
2020	56.354,63	436,12	5.309,78	50.608,73	5.585,79	45.023
2021	67.089,62	545,13	6.321,24	60.223,25	6.647,34	53.576
2022	73.002,05	654,14	6.878,31	65.469,59	7.227,18	58.242
2023	79.003,66	763,15	7.443,79	70.796,72	7.815,93	62.981
2024	94.043,39	872,15	8.860,85	84.310,39	9.307,53	75.003
2025	112.525,17	981,14	10.602,22	100.941,81	11.142,99	89.799
2026	125.914,97	1.090,13	11.863,81	112.961,03	12.469,83	100.491

Total	**634.081,4**	**5.996,17**	**59.743,68**	**568.341,55**	**62.743,15**	**505.598,39**

Table 28: Estimated number of Verified Carbon Units (VCU).

Below, Table 29 shows a summary of emissions in t CO_2e.

Baseline issuance	**640.077,57**
Leakage net issuance	**59.743,68**
Reduction of net emissions from the project	**568.341,55**
Buffer	**62.743,15**
VCUs - Accumulated	**505.598,39**

Table 29: Summary of emissions in t CO_2e.

5 MONITORING

5.1 Data and Parameters Available at Validation

The documents available in the Validation will be the following:

- PDD version;
- Project activity tables and schedules;
- Spreadsheets with predicted calculations based on bibliography and calculations with on-site sampling;
- Calculation worksheets containing the baseline, project emissions and leakages;
- Documents of legal proof of land tenure and rights;
- Maps relevant to the project, such as location, hydrography, vegetation, soils, altimetry, slope and predicted deforestation);
- Others, on demand.

5.2 Data and Parameters Monitored

Data / Parameter	$\Delta C_{WPS\text{-}REDD}$
Data unit	t CO_2e
Description	Net GHG emissions in the REDD project scenario
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$\Delta C_{WPS\text{-}REDD, LB}$
Data unit	t CO_2e
Description	Net GHG emissions within the leakage belt in the REDD project scenario
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	

QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of leakage
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{RRD,\ unplanned,\ hrp}$
Data unit	ha
Description	Total area deforested (REDD) during the historical reference period in the RRD
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{RRL,\ forest,\ t}$
Data unit	ha
Description	Remaining area of forest (REDD) in RRL in year *t*
Source of data	Module M-REDD
Description of Measurement methods and procedures to be	See Module M-REDD

applied	
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{DefPA,\ i,\ t}$
Data unit	ha
Description	Area of recorded deforestation (REDD) in the project area in the project case in stratum *i* in year *t*
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{DefLB,\ i,\ t}$

Data unit	ha
Description	Area of recorded deforestation (REDD) in the leakage belt in the project case in stratum *i* in year *t*
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of leakage
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{burn,\,i,\,t}$
Data unit	ha
Description	Area burnt in stratum *i* in year *t*
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD

Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

Data / Parameter	$A_{DistPA,\ i,\ t}$
Data unit	ha
Description	Area impacted by natural disturbance in stratum *i* in year *t*
Source of data	Module M-REDD
Description of Measurement methods and procedures to be applied	See Module M-REDD
Frequency of monitoring/ recording	See Module M-REDD
Value applied	
Monitoring equipment	
QA/QC procedures to be applied	See Module M-REDD
Purpose of data	Calculation of project emissions
Calculation method	See Module M-REDD
Comments	

5.3 Monitoring Plan

This monitoring plan was developed using the M-REDD module, "Methods for monitoring greenhouse gas emissions and removals" and it is mandatory for REDD project activities. It establishes procedures to monitor deforestation, illegal degradation, natural disturbance and project emissions *ex-post* in the project and leakage areas. In addition, procedures for updating forest carbon stocks and revising the baseline are also provided by the module.

The parameters produced in the monitoring are presented in the Table 30.

Parameter	Unit	Description
$\Delta C_{WPS\text{-}REDD}$	t CO_2e	Net GHG emissions in the project scenario

$\Delta C_{WPS\text{-}REDD,\ LB}$	t CO_2e	Net GHG emissions within the leakage area in the project scenario
$A_{RRD,\ unplanned,\ hrp}$	ha	Total area deforested during the historical reference period in the RRD
$A_{RRL,\ forest,\ t}$	ha	Remaining forest area in RRL in year t
$A_{DefPA,\ i,\ t}$	ha	Area of deforestation recorded in the project area in the case of the project in stratum i in year t
$A_{DefLB,\ i,\ t}$	ha	Area of deforestation recorded in the leakage area in the case of the project in stratum i in year t
$A_{burn,\ i,\ t}$	ha	Burnt area in stratum i in year t
$A_{DistPA,\ i,\ t}$	ha	Area impacted by natural disturbance in stratum i in year t

Table 30: Monitoring parameters.

All changes in forest cover, such as areas of deforestation, burned or impacted by natural disturbance, will be monitored from an annual dataset on the extent and spatial location of all deforestation using Landsat imagery. Deforestation and natural disturbance will be distinguished using auxiliary data which may include, but are not limited to high resolution imagery, digital elevation models (to identify steep areas subject to landslides), monthly report of deforested areas provided by Global Forest Watch[32], Mapbiomas[33] and information from field monitors. In the event that this dataset is no longer available, ex-post deforestation will be determined by classifying remote sensing images and procedures for detecting changes in land use.

The forest cover map at the beginning of the project of the project and leakage areas, as defined in the PD, will serve as a reference against which changes in forest cover will be evaluated in the interval of the first monitoring period (2017-2021). There was also demonstrated that the entire project area meets the definition of forest at the beginning of the crediting period. For subsequent monitoring periods, the change in forest cover will be assessed against the forest cover map at the end of the previous monitoring period. Because of that, the reference map will be updated with each monitoring event.

The remaining forest area in the RRL ($A_{RRL,\ forest,\ t}$) is derived by subtracting the unforested area within the RRL, as found in the forest reference map (updated at each monitoring event), from the total area of the RRL.

[32] GFW. Available at: https://www.globalforestwatch.org/my-gfw/
[33] Mapbiomas. Available at: https://plataforma.brasil.mapbiomas.org/

5.3.1 Monitoring Structure

Monitoring will be carried out jointly by two teams, each with its own role:

- Field monitors: two monitors living within the project area were hired by the project proponent to carry out on-site monitoring patrols. The Limeira Road will be covered daily along its entire length within the project area and trails through the forest will be carried out three times a week, or whenever necessary, alternating places with a history of access by deforestation's agents and places accused of deforestation by monitoring via satellite. In the event of any situation such as deforestation or degradation, tree cutting or finding an area impacted by some type of natural disturbance, photographic records will be made and the monitoring form will be completed. The monitors will also be responsible for installing and maintaining the information boards along the Limeira Road. Everything will be reported to Neo Green Consultoria Ambiental team, who are responsible for the execution of the Atlantic Forest Biodiversity Conservation Limeira Project REDD.

- Neo Green Consultoria Ambiental Team: responsible for receiving all information, analyzing and archiving to compose the monitoring report. The team will carry out monitoring via satellite through the Global Forest Watch software that signals the places where deforestation or fire have been occurring. When these locations are reported by the software, they will be passed on the information to the field monitors and they will be able to verify it *in loco*. The QA/QC procedures are going to be a responsibility of Neo Green Consultoria Ambiental team.

The Figure 23 shows how the monitoring structure is organized.

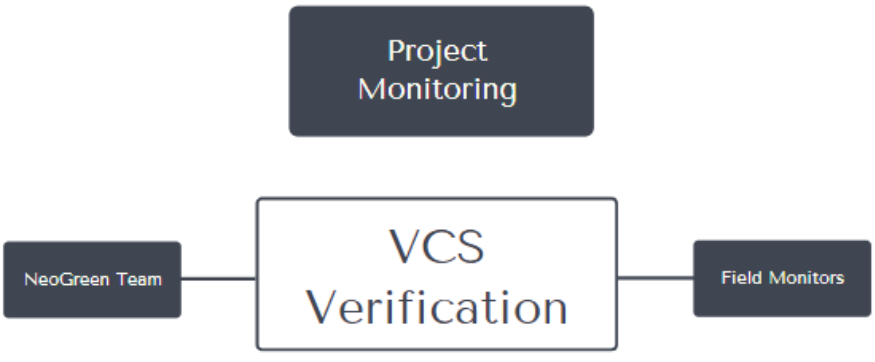

Figure 23: Overview of the monitoring structure and process.

5.3.2 Project Monitoring Schedule

For the first baseline period, the schedule of activities to be carried out per year are presented below in the Table 31.

Activities	Years									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Monitoring										
Monitoring Report										
Verification										
Baseline Review										

Table 31: Timeline of the first baseline period.

The other baseline periods (2027-2036 and 2037-2046) will follow the same model with constant monitoring, monitoring report and verification carried out always after a period of 6 years of monitoring and the baseline review whenever it starts a new baseline period. The project start date was on January 1st, 2017 and because of that, a monitoring year is equivalent to the calendar year starting on the first day and ending on the last day of a project year. Therefore, the execution of monitoring and verification reports will always be carried out in January of the year following the 6-year monitoring period. Likewise, baseline reviews will be carried out in January of the year in which a new baseline period begins. The revisions will be included in the respective monitoring reports for the same year.

5.3.3 QA/QC Procedures

Neo Green Consultoria Ambiental Ltda. is responsible for the control and quality assurance of the entire monitoring process through the Neo Green Team. One of the fundamental procedures for QA/QC is the communication between teams.

Field Monitors and Neo Green Team:

- Neo Green Team are going to train Field Monitors to act in the patrol activity of the project area;
- Field Monitors are going to carry out the monitoring with their cellphones (with GPS) to make a photographic record of occurrences, wearing personal protective equipment and appropriate clothes;

- Field Monitors are going to fill out the monitoring form when they find deforested/degraded areas, hunting traps, natural disturbances or any other type of abnormality;
- Field Monitors are going to make complaints to the local environmental police in situations of flagrant deforestation;
- All occurrences are going to be reported weekly to the Neo Green Team;
- Neo Green Team are going to receive and analyze all data and information collected by the Field Monitors;
- The Neo Green Team are going to report what is presented by the Global Forest Watch satellite monitoring to the Field Monitors for on-site confirmation;
- The Neo Green Team are going to visit the project area every three months to inspect the project area and receive the completed monitoring forms;
- All mapping to scale deforestation in the monitoring period and baselines are carried out and validated by the Neo Green Team

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

The M-REDD module was to be used to set and revisit the project baseline and monitor changes to the baseline revisit at the end of each baseline period.

The data and parameters monitored during the monitoring period are filled in below.

Data / Parameter	Project forest cover monitoring map
Description	Map showing the location of forest areas within the project area at the beginning of each monitoring period. If within the project area any forest area is deforested, the reference map must show the deforested areas in each monitoring event.
Justification of the choice of data or description of measurement methods	Minimum map accuracy should be 90% for forest/non-forest classification in remote sensing images.

and procedures applied (extra comment)	If the classification accuracy is less than 90%, the map is not acceptable for further analysis. More remote sensing data and ground verification data will be needed to produce a product that achieves the minimum 90% mapping accuracy. Frequency: Must be monitored at least every 5 years or if verification takes place less frequently than every 5 years, examination must take place before any verification event.
Comments	Where the forest contains more than one forest class, the map must be stratified into forest classes using the X-STR Module.

Data / Parameter	Forest Coverage Monitoring Map of the Leakage Area
Description	Map showing the location of forest lands within the leakage belt area at the beginning of each monitoring period. Only applicable when leakage is to be monitored on a leakage belt.
Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	Minimum map accuracy should be 90% for forest/non-forest classification in remote sensing images. If the classification accuracy is less than 90%, the map is not acceptable for further analysis. More remote sensing data and ground verification data will be needed to produce a product that achieves the minimum 90% mapping accuracy. Frequency: Must be monitored at least every 5 years or if verification takes place less frequently than every 5 years, examination must take place before any verification event.
Comments	Where the forest contains more than one forest class, the map must be stratified into forest classes using the X-STR Module.

Data / Parameter	$A_{RRD,\ unplanned,\ hrp}$
Data Unit	ha

Description	Total area deforested during the historical reference period in the RRD.
Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	Frequency: at least every ten years prior to baseline renewal.
Comments	Monitored for baseline reviews.

Data / Parameter	$A_{RRL,\ forest,\ t}$
Data Unit	ha
Description	Remaining area of forest in RRL in year t.
Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	Frequency: Must be monitored at least every 5 years or if verification takes place less than 5 years, examination must take place before any verification event.
Comments	*Ex ante,* an estimate must be made of the likely deforestation in the case with the project.

Data / Parameter	$A_{DefPA,\ i,\ t}$
Data Unit	ha
Description	Area of deforestation recorded in the project area in the case of the project in stratum i in year t.

Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	Frequency: Must be monitored at least every 5 years or if verification takes place less than 5 years, examination must take place before any verification event.
Comments	*Ex ante*, an estimate must be made of deforestation in the case with project. If the belief is that zero deforestation will occur within the project boundaries, then this parameter can be set to zero if there is infrastructure, contracting, and clear policies to prevent deforestation.

Data / Parameter	$A_{DefLB,\ i,\ t}$
Data Unit	ha
Description	Area of deforestation recorded in the leakage area in the case of the project in stratum i in year t.
Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	Frequency: Must be monitored at least every 5 years or if verification takes place less than 5 years, examination must take place before any verification event.
Comments	*Ex ante*, an estimate must be made of deforestation in the leakage belt in the case with the project.

Data / Parameter	$A_{DistPA,\ i,\ t}$
Data Unit	ha
Description	Area impacted by natural disturbance in stratum i of the project converted to natural disturbance stratum q in year t; ha

Justification of the choice of data or description of measurement methods and procedures applied (extra comment)	The minimum monitoring unit must be equal to a minimum of 11 Landsat pixels or one hectare. Frequency: Must be monitored at least every 5 years or if verification takes place less than 5 years, examination must take place before any verification event.
Comments	*Ex ante*, estimates of emissions from natural disturbances should be based on the historical incidence of such an event in the Project region.

Regarding the monitoring parameters, in order to analyze their veracity, in 2021 a forest inventory was carried out to quantify carbon stocks in above and below ground reservoirs. Recalling that according to the bibliography, 502,45 t CO_2/ha were accounted for. With the inventory, it was possible to sample two homogeneous areas and account for 1.198,10 t CO_2/ha.

The values of the total area deforested during the historical reference period in the RRD ($A_{RRD,\ unplanned,\ hrp}$) is presented from Forest Watch maps and Forest Remaining Area in RRL in year t ($A_{RRL,\ forest,\ t}$) is presented below according to the maps presented in item 6.1.1., both in Table 32. The values of $A_{DefPA,\ i,\ t}$ and $A_{DefLB,\ i,\ t}$ remained equal to the estimated values. The values of $A_{DistPA,\ i,\ t}$ was counted as zero and the value of $A_{burn,\ i,\ t}$ was not calculated because there were no fires during monitoring.

Year	$A_{RRD,\ unplanned,\ hrp}$, ha	$A_{RRL,\ forest,\ t}$, ha
2017	80	39.960,39
2018	17	-
2019	13	-
2020	54	-
2021	11	39.855,37

Table 32: Values of de $A_{RRD,\ unplanned,\ hrp}$ and $A_{RRL,\ forest,\ t}$.

Monitoring maps are presented in item 6.2.

The monitoring report was carried out according to the M-REDD tool (Methods for monitoring GHG emissions and removals in REDD and CIW projects), version 2.2, approved by the VCS. This module provides methods for monitoring ex-post GHG emissions and removals. The calculation procedure is implemented by applying the following 3 steps:

- Step 1: Selection and analysis of land use and land cover change (LU/LC) data sources;
- Step 2: Interpretation and analysis;

- Step 3: Documentation.

6.1.1 Step 1: Selection and analysis of land use and land cover change (LU/LC) data sources

The data collected and analyzed should cover:

- Entire reference region: data must be available for the year of baseline renewal or no further than the year prior to baseline renewal;

- Entire project area: data must be available for the year in which monitoring and verification is taking place;

- Entire leakage belt, when needed: Data must be available for the year in which monitoring and verification is taking place.

The function of this module for the present project is to monitor the area of forest land converted to non-forest land and associated changes in carbon stocks, the area of forest land in loss of carbon stock from degradation activities and associated changes in carbon stocks. and the area of forest in the phase of gaining carbon stock from improvement activities and associated changes in carbon stocks.

The maps of the monitoring of changes in land use and cover carried out in 2017 (beginning of the project) and 2021 (four years after the start of the project) are shown in Figures 24 and 25.

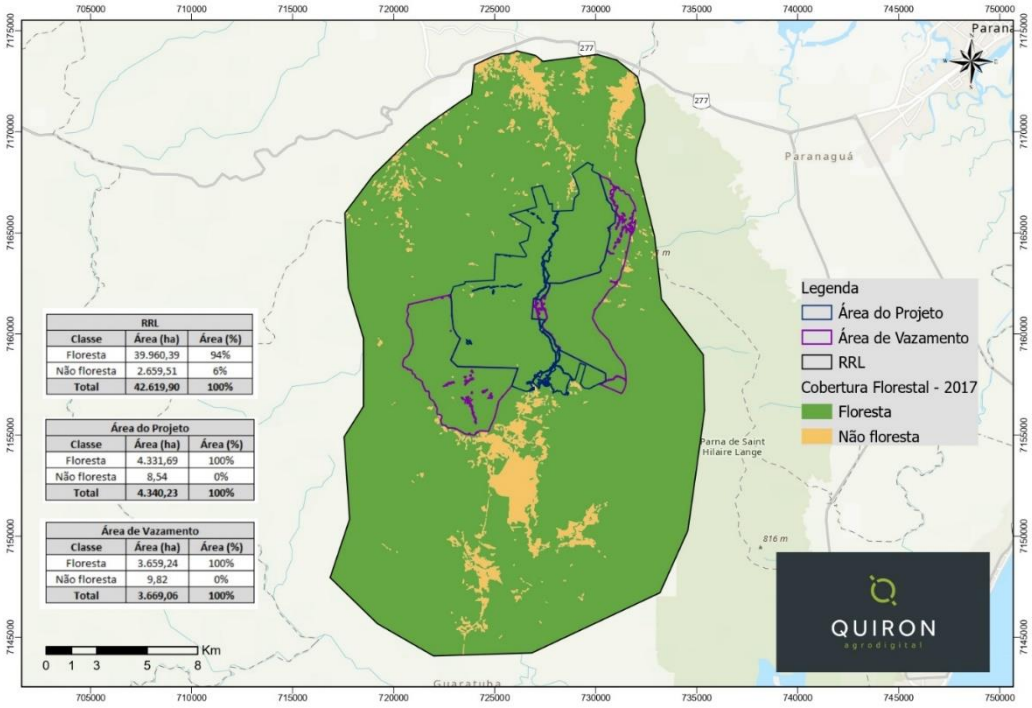

Figure 24: Forest cover monitoring map in 2017.

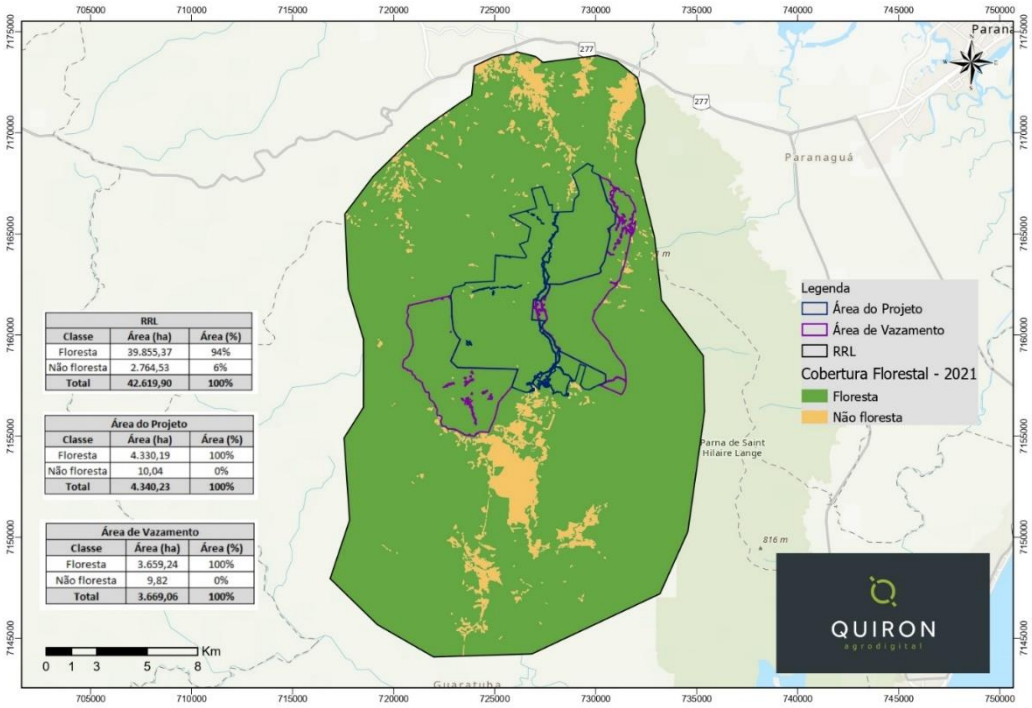

Figure 25: Forest cover monitoring map in 2021.

Post-processing and accuracy assessment is necessary to analyze changes in the map area detected in the images and calculate the area of each category of change within the project area and, when necessary, the leakage belt. In the monitoring carried out in 2017 and 2021, it can be seen that in the maps above, the regions of PA. LA and RRL did not change in their areas.

6.1.2 Step 2: Interpretation and Analysis

In the figures above it is possible to verify the decrease in non-forest areas within the project area, the leakage area and the RRL. It is worth mentioning that the percentage values in the project area, leakage area and RRL tables are erroneous, but will be discussed correctly.

In the monitoring carried out in 2017, it can be seen that the project area had 4.331,69 ha (99,8% of the total) of forest and 8,54 ha (0,2% of the total) of non-forest, in the leakage area. there were 3.659,24 ha (99,73% of the total) of forest and 9,82 ha (0,27% of the total) of non-forest and in the RRL there were 39.960,39 ha (93,76% of the total) of forest and 2.659,51 ha (6,24% of the total) of non-forest.

In the monitoring carried out in 2021, it can be seen that the project area had 4.330,19 ha (99,76% of the total) of forest and 10,04 ha (0,24% of the total) of non-forest, in the area of there were 3.659,24 ha (99,73% of the total) of forest and 9,82 ha (0,27% of the total) of non-forest and in the RRL there were 39.855,37 ha (93,51% of the total) of forest and 2.464,53 ha (6.,49% of the total) of non-forest.

In the leakage area, there was no change between forest and non-forest areas in 2017 and 2020.

Deforestation in the project area is uniquely associated with the natural disaster that occurred in 2020, when a bomb cyclone passed through the region, and illegal deforestation that may have occurred along the highway that passes through the project area. The project area is duly limited, signposted and has armed surveillance and periodic audits.

The increase in non-forest cover in the RRL may be associated with factors related to agriculture, since the production of bananas, palm hearts of palm and rice cultivation are of relevant importance for the region's economy. Another factor that helped to increase deforestation was the maintenance of the Limeira road, which crosses the project area from North to South and therefore the edges of this road are susceptible to deforestation, predatory hunting and forest degradation.

It is conservative for the project to assume that no wood products were produced.

The project conservatively assumes stable stocks and no biomass monitoring is carried out in areas under increased carbon stock as allowed in the monitoring module and therefore, $\Delta C_{P, Enh, i, t}$ is set to zero. And since project activities do not generate significant GHG emissions from burning fossil fuels, the *GEE*

$_{P\text{-}E}$ is equal to zero. Therefore, the emissions that will be monitored are due to deforestation ($\Delta C_{P,DefPA,i,t}$), to degradation ($\Delta C_{P,Deg,i,t}$) and to natural disturbances($\Delta C_{P,DistPA,i,t}$), that were previously counted as zero.

6.1.2.1 Deforestation

Changes in forest cover due to deforestation are monitored through periodic assessments of satellite images. Below is a comparative table between the estimated deforestation values of the project area and the values recorded through Forest Watch.

Year	A_{DefPA} (ha) Estimation	A_{DefPA} (ha) Forest Watch	Difference
2017	0,217	0	0,217
2018	0,217	0	0,217
2019	0,217	0	0,217
2020	0,217	0,0695	0,1475
Total	**0,868**	**0,0695**	**0,1475**

Table 33: Comparison between estimated and effective areas of deforestation between 2017 and 2020

6.1.3 Step 3: Documentation

The documents that were used for monitoring are presented in the following items.

6.2 RRD Baseline Emissions

According to Forest Watch, the habitat of the region is formed by the coastal forests of Serra do Mar and has an Intact Forest. The area has a predominantly warm and temperate climate with high humidity and hot summers, which is part of the Tropical and Subtropical Moist Broadleaf Forests biome and its location is predominantly terrestrial. The RRD area contains 47,23kha, is predominantly located in a floodplain and the area monitoring maps were made using Forest Watch from the years 2017 to 2021 and are presented below (Figure 26 and 27).

Figure 26: Primary forest cover in the RRD between 2017 and 2021.

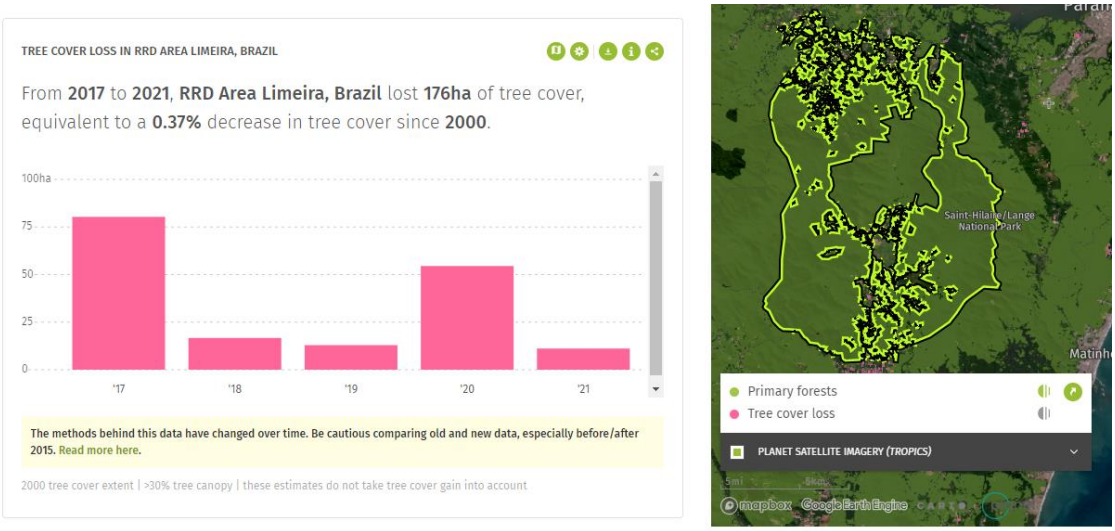

Figure 27: Lost tree cover in the RRD between 2017 and 2021.

The data mentioned above and other additional data can be found at: https://gfw.global/3NJULId

6.3 Project Emissions

The project area has 4,34kha, is located predominantly in the floodplain, its monitoring maps were made using Forest Watch from 2017 to 2021 and are presented below (Figure 28 and 29).

Figure 28: Primary forest cover in the project area between 2017 and 2021.

Figure 29: Lost tree cover in the project area between 2017 and 2020 between 2017 and 2021.

The data mentioned above and other additional data can be found at: www.globalforestwatch.org/dashboards/aoi/623893d67a228f001bb3e07e

6.4 Leakage

The leakage area has 3,67kha, is predominantly located in a floodplain, its monitoring maps were made using Forest Watch from 2017 to 2021 and are presented below (Figure 30 and 31).

Figure 30: Primary forest cover in the leakage area between 2017 and 2021.

Figure 31: Lost tree cover in the leakage area between 2017 and 2021.

The data mentioned above and other additional data can be found at: https://gfw.global/3ulvYee

6.5 Net GHG Emission Reductions and Removals

The quantification of net GHG emission reductions and removals achieved for this monitoring period (2017 – 2021), presents a summary of the main results using Table 34 below.

Year	Baseline emissions from the RRD ($ktCO_2e$)	Emissions from the leakage area ($ktCO_2e$)	Emissions from the project area ($ktCO_2e$)	Net reductions in GHG emissions (tCO_2e)	Buffer pool allocation	Eligible VCUs for issuance
2017	31,6	0	0	8.170	940,73	7.286
2018	7,01	0	0	8.488	1917,72	7.568
2019	5,29	0	0	5.797	2.585,89	5.165
2020	22,9	241	28.6	81.305	11.913,14	72.523
2021	4,64	596		21.449	14.374,02	19.109
Total	**71,44**	**837**	**28.6**	**125.209**	**31.731,50**	**111.652**

Table 34: Net emissions and removals of GHG emissions between 2017 and 2021.

The emissions specified above were collected from ForestWatch, using the amount of $ktCO_2e$ released into the atmosphere in the RRD, LA and PA areas.

For net GHG emission reductions, buffer pool allocations and VCUs eligible for emission, a forest inventory carried out on site in 2020, available separately from the project, was used.

For AFOLU projects, the quantification of the net change in carbon stocks is included and in addition, the non-permanence risk ratings are indicated and the total number of reserve credits that need to be deposited in the AFOLU pooled reserve account is calculated.

The non-permanence risk report is in a separate document of this project.