FLORESTAL SANTA MARIA PROJECT (FSM-REDD PROJECT)

Document Prepared by Systemica Ltda.

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The world has a forest area of 4.06 billion hectares (ha), which is 31% of the total land area. More than half (54%) of the world's forests is in just five countries and Brazil is in second place among nations with the most forest area worldwide. On the other hand, Brazil is one of the countries with the highest rates of forest loss (Tyukavina et al., 2017). Beef and soybean production, timber collection, and illegal occupation have contributed to this historically high deforestation rate concentrated in the country's northern portion.

According to Instituto Nacional de Pesquisas Espaciais (INPE) , 729,781.76 km² of the Amazon Biome area was deforested until 2020. Currently, only 12.4% of the original forest remains. Among the regions that suffer the most deforestation is the following states Pará (34.6%), Mato Grosso (31.9%), and Rondônia (13.7%). The region in the Amazon biome denominates the "arc of deforestation" which is the highest rate of forest deforestation, extending from southeast of the Maranhão to southeast of the Acre. This area has approximately 7,000 km² which 80% is occupied by extensive livestock farming. The principal agency of this deforestation is family farming due to the distance from the consumer market and the lack of availability of labor/infrastructure (Láu, 2006). Mato Grosso has around 1,000 km² of average deforestation in the forest area from 2009 to 2014. Unfortunately, between 2009 and 2018 the deforestation rate increased by 67%, and which average rate has increased significantly to 1,600 km² per year. The Colniza municipality stands out for having the largest area of deforested forest in Mato Grosso in 2018, exploring 273 km² this year (A. Valdiones et al., 2018).

The Florestal Santa Maria is a rural property solely dedicated to the sustainable management of natural forests located in the Municipality of Colniza, in the northwestern region of the State of Mato Grosso. According to the certificate issued by the National Institute for Rural Settlement and Agrarian Reform (INCRA), through subsequent geo-referencing, the total area of the FSM farm was established at 71,713.98 ha. This project is developed and registered under the Verified Carbon Standard (VCS) to prevent unplanned deforestation (AUD) and increase carbon stock in the Brazilian Legal Amazon. In this property, the extraction of raw material from the forest takes place based on a sustainable management plan, which enhances the possibilities of non-predatory use of the forest. FSM preserves its natural forest area, reduces deforestation in the Amazon rainforest, reduces the risk of fires, and generates employment for the local population, which benefits the Amazon ecosystem and surrounding communities.

The crediting period of the project is 30 years. The project started on April 13, 2009 and is expected to end on April 13, 2039. The first baseline of the project was from April 13, 2009, to April 12, 2019. According to VCS requirements, the first baseline must be reassessed every 10 years. This Joint Project Description Monitoring Report covers the second baseline period of the FSM REDD Project, from 13th April 2019 to 12th April 2025. During the first baseline period, the following objectives have been successfully achieved: (i) environmental benefits through a successful monitoring system with 7 bases that keep the conservation of around 70,000 hectares of the Amazon biome; (ii) social benefits, through the promotion of courses and training for families living in the region on Sustainable Forest Management;

(iii) economic benefits with the generation of employment for the local community to perform forest management plan activities and monitoring of the project area, resulting in regional development employing of the investments and financial resources in this region.

It is also important to mention that during the last monitoring period the project underwent a change of proponents as allowed by Verra's rules. On 09.22.2020, Florestal Santa Maria Ltda (previous project proponent) and Caraguá Ltda (new project proponent) signed a Public Deed of Purchase and Sale with Resolutive Clause, drawn up in Book 204, pages 335 to 354 of the Civil Registry of Individuals and Notaries of the District of Santana do Parnaíba, through which Florestal Santa Maria Ltda sold 62,482.6126 hectares of the Project Area to Caraguá (Registration No. 4765 of the Property Registry of Colniza/MT). It is important to mention that such a change in the proponents does not imply any impact in relation to the project activities, as well as its additionality and baseline scenario, since the farm remains exclusively dedicated to the sustainable exploitation of the forest, and the implementation of surveillance and patrol activities, leakage control and other activities described in this document.

Despite the absence of FSC (Forest Stewardship Council) certification on the FSM farm between April 13, 2009, to December 31, 2011, and from April 2017 to April 12, 2022, all calculations of VCUS benefits in these periods were done conservatively, excluding explored areas (UPAs) without certification. And due to the efforts of the new farm and project management, the FSC certification was renewed after a series of adjustments and training carried out recently in alignment with the project objectives and FSC principles.

The new baseline modeling showed that the REDD FSM REDD project was crucial in reducing the risk of deforestation in the project area, in fact, during the modeling the project area presented a weight in avoiding unplanned deforestation, similar to the weight of conservation units and preserved indigenous lands. Evidence that the presence of the project and its activities in the region is vital for the maintenance of ecosystems since it forms a large ecological corridor with other conservation units in the region.

Although the risk in the project area has decreased significantly, the region around the project still has a high rate of deforestation, making the edges of the project area still exposed to high-risk zones of unplanned deforestation, since Colniza is the municipality in the state of Mato Grosso with the highest rate of deforestation. And for the next 6 years, the project will still avoid 5,783.5 hectares of unplanned deforestation and will reduce 3,399,595.82 tCO_{2e} of GHG emissions, compared to the first baseline that avoided unplanned deforestation of 18,391.2 hectares and generated an accumulated emission reduction of 8,001,838.6 tCO_{2e} in 10 years.

The current Joint REDD project claims total net GHG emission reductions of 1,256,256.55 tCO_{2e}, which corresponds to an average of 418,752.18 tCO_{2e} per year in emissions reductions across the current monitoring period (April 13, 2019, to April 12, 2022). These emission reductions are associated with the deforestation avoidance of 1,670.22 ha during the verification period.

1.2 Sectoral Scope and Project Type

The Florestal Santa Maria – FSM project is within the sectorial scope number 14 – Agriculture Forestry and Other Land Use (AFOLU). The project category is Avoiding Unplanned Deforestation (AUD project activity). It is also important to explicit that this is not a grouped project.

1.3 Project Eligibility

As described in the Sectoral Scope section, the Fazenda Santa Maria Project configurations as a REED – AUDD project, is eligible under the VCS Program Version 4.1. This condition can be attested once:

- The project meets all the applicable rules and requirements set out under the VCS Program.
- The project applies a methodology eligible under the VCS Program (detailed through the entire section 3).
- The project does not lead to the violation of any applicable law (described in section 1.14. Compliance with Laws, Statutes, and Other Regulatory Frameworks).
- The project reduced emissions from deforestation and degradation (REDD).
- The project is not located within a jurisdiction covered by a jurisdictional REDD+ program.
- Implementation partners are identified in the project activity (sections 1.5 and 1.6).
- This project does not convert any native ecosystems to generate GHG. The project area only contains native forested land for a minimum of 10 years before the project start date (which means at least from April 13th, 1999).
- The project does not occur on wetlands and does not drain native ecosystems or degrade hydrological functions.
- Non-permanence risk submitted together with this PD renewal was analyzed in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool.

Going a little further on why the project is eligible, the first fact that needs to be pointed out is that the project is in the Amazon rainforest region in the north portion of Mato Grosso state. There, deforestation activities are much more common than forest degradation, once cattle raising is the main economic activity that takes place. By reducing deforestation in this mature forest, consequently, the amount of GHG emissions is reduced.

It is also important to comment that unfortunately, deforestation in Brazil is far to be under control. The Amazon Forest region is very large and despite the public policies implemented over the last decade having a great reduction in deforestation, it is still needed improvement to reduce them even more. Also, the Brazilian government's Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) Phase IV was interrupted (Figure 1.1). This is evidence that government transitions and political factors have a major impact on deforestation combat, Brazil doesn't have a solid structured program and policy implemented that can guarantee deforestation mitigation. In this context, the VCS alternative for the FSM is one of the best ways to provide the necessary resources and governance for avoiding illegal deforestation, responsible for 94% of the total deforestation in the Legal Amazon (A. P. Valdiones et al., 2021).

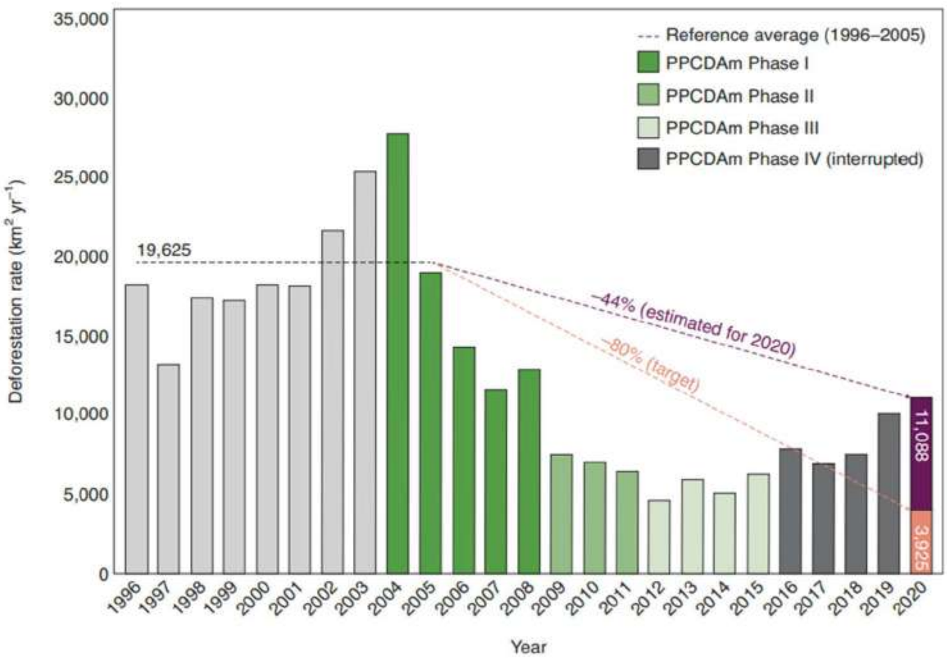

Figure 1.1. Official deforestation rates for the Brazilian Amazon (Silva Junior et al., 2021).

1.4 Project Design

This is not a grouped project, FSM configures it as a single location. The map in Section 1.12 (Project Location) shows the project boundaries that configure only one single property.

☒ The project includes a single location or installation only

☐ The project includes multiple locations or project activity instances, but is not being developed as a grouped project

☐ The project is a grouped project

Eligibility Criteria

Not applicable. This is not a grouped project

1.5 Project Proponent

Organization name	Caraguá Agronegócios LTDA
Contact person	Thiago G. de O. Ricci
Title	Legal representative

Address	Av. Eng. Luis Carlos Berrini, nº 1748, cj. 101/103 – Brooklin, SP, Brasil – CEP 04571-000.
Telephone	+55 (11) 98490-9830
Email	tgor@lawrs.com.br

Organization name	Systemica (MYS E JLFL TREINAMENTO GERENCIAL LTDA)
Contact person	Munir Soares
Title	Director
Address	Rua São Vicente de Paulo, nº 501, Apartamento 201, Jardim Paulista, São Paulo, Brasil, CEP 01229-010.
Telephone	+55 (11) 99394-1980
Email	munir@systemica.digital

1.6 Other Entities Involved in the Project

Organization name	Ricci e Santos Advogados
Role in the project	Legal Advisory
Contact person	Thiago G. de O. Ricci
Title	Director
Address	Av. Eng. Luis Carlos Berrini, nº 1748, cj. 101/103 – Brooklin, SP, Brasil – CEP 04571-000.
Telephone	+55 (11) 98490-9830
Email	tgor@lawrs.com.br

Organization name	Junp Industria e Comércio de Madeiras e Exportações LTDA.
Role in the project	Minority Landowner
Contact person	Thiago G. de O. Ricci
Title	Legal representative
Address	Av. Eng. Luis Carlos Berrini, nº 1748, cj. 101/103 – Brooklin, SP, Brasil – CEP 04571-000.

Telephone	+55 (11) 98490-9830
Email	tgor@lawrs.com.br

1.7 Ownership

From the beginning of the project until 2019, the project was owned by the Fazenda Santa Maria company. Then the property was sold and now the project area is owned by other two entities: Caraguá Agronegócios LTDA and Junp Industria e Comércio de Madeiras e Exportações LTDA.

Junp owns the minority part of the land equals 12,7% of the total property area, equivalent to 9,087.9178 hectares[1,2]. On the other hand, Caraguá owns the majority part with 87,3% of the property, equivalent to 62,482.6126 hectares[3]. Recently, an agreement between Caraguá Agronegócios LTDA and Junp Industria e Comércio de Madeiras e Exportações LTDA was signed attesting that Caraguá will be the only company able to manage and execute forest management activities, previously executed by Fazenda Santa Maria company in order to continue with the project described through this PD: Florestal Santa Maria REDD Project. In exchange, Junp will receive part of the VCUs originated by this project[4].

In the annex of this section, there are the most important documents to prove property ownership. The complete documentation required to guarantee the complete due diligence of the land is presented in section 1.14. Compliance with Law, Statues, and Other Regulatory Frameworks.

1.8 Project Start Date

Project start date: April 13th, 2009. According to the previous Validated Project Description approved by Verra and proposed by Florestal Santa Maria S.A., the date corresponds to the first money transfer made to K2C consultancy and when the participants at that time started to work on the project development. Also, the date represents the first day of the monitoring period, being the effective date of the beginning of the GHG emissions reductions.

1.9 Project Crediting Period

The project start date of crediting period is the 13th of April 2009. Its end date is the 12th of April of 2039, configuration 30 years of crediting period.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

[1] Annex:202208_FSM_PD_DomainCertificate Junp pt.1.pdf

[2] Annex: 202208_FSM_PD_Domain Certificate Junp pt.2.pdf

[3] Annex: 202208_FSM_PD_Domain Certificate Caraguá.pdf

[4] Annex: 202208_FSM_PD_Caraguá(Systemica)-Junp Accordance.pdf

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

☐ <20,000 tCO_2e/year

☐ 20,000 – 100,000 tCO_2e/year

☒ 100,001 – 1,000,000 tCO_2e/year

☐ >1,000,000 tCO_2e/year

Ex-ante baseline projections beyond the defined baseline reassessment period have not been estimated as they are not required. So, just a six-year estimation, the second baseline period, was represented in this section.

Project Scale	
Project	X
Large project	-

Year	Period	Estimated GHG emission reductions or removals (tCO_2e)
2019	13/04/2019 - 12/04/2020	42,361.75
2020	13/04/2020 - 12/04/2021	521,343.58
2021	13/04/2021 - 12/04/2022	581,420.36
2022	13/04/2022 - 12/04/2023	593,173.38
2023	13/04/2023 - 12/04/2024	741,578.30
2024	13/04/2024 - 12/04/2025	919,718.47
	Total estimated ERs	3,399,595.82
	Total number of crediting years	6
	Average annual ERs	566,599.30

1.11 Description of the Project Activity

The main objective of the FSM project is to prevent unplanned deforestation through the implementation of conservation activities, such as training in fire brigades, patrolling and surveillance of the property, remote mapping of deforested areas, maintenance of sustainable forest management activities, and leakage control.

1. **Patrolling and surveillance:**

   The protection of the forest area on the property is the project's main activity and objective, in order to avoid illegal deforestation, given that the project area is located in a region with high deforestation rates. The FSM-REDD PROJECT will reduce GHG emissions by stopping deforestation of degraded to mature forests at the frontier that has been expanding historically and will continue to expand in the future, as a result of improved access to forests, while regional development continues. The project, which has a lifetime of 30 years, has allocated resources since its inception to avoid illegal deforestation through patrolling and surveillance of the area. These activities are carried out from 7 monitoring bases strategically placed on the edges of the property, which have the necessary infrastructure (solar energy, motorcycles, mobile phones, etc) to carry out patrolling and surveillance activities and maintain 24-hour communication. A detailed description of this activity and its form of operation can be found within the monitoring plan (Section 5.3). It is relevant to mention that one of the most recurrent positive impacts perceived by the people from the adjacent community was tenure security as a result of the farm operations as can be observed in the socio-environmental assessment[5] in the annex (pg 15).

2. **Satellite monitoring:**

   Another fundamental point to ensure the success of this project is the monitoring strategy to control deforestation and forest invasion. The approach adopted by the project involves a system combining satellite images with field visits. The monitoring plan uses Mapbiomas Alert data, which is a system that validates and refines deforestation alerts with high-resolution images by integrating and analyzing multiple alert systems, such as DETER, PRODES, SAD, Sirad-X, and so on. This platform data is widely used because it integrates and validates the alerts of several products increasing the reliability of the data and can be acquired on a daily frequency.

3. **Fire brigades:**

   Fire brigades will be organized from local labor. FSM has three types of neighbors: 1) The Igarapés do Juruena State Park (Parque Estadual Igarapés do Juruena), which makes an ecological corridor with the project area; 2) Landowners with lands greater than 100 hectares; 3) INCRA settlement neighbors that live in farms and are steady in terms of the relationship. The fire brigades are responsible for containing the expansion of fires that affect the areas inside and outside the project.

   Firefighting training courses for farm employees are already performed[6] and for the upcoming courses, all types of neighbors will be invited to participate in these training sessions promoted and funded by FSM.

4. **Sustainable Forest management:**

[5] Annex: Avaliacao_Socioambiental_Caragua_2022.pdf

[6] Annex: Treinamento_brigada_incêndio_2022.pdf

The FSM farm is certificated by FSC (Forest Stewardship Council)[7], which provides several benefits to the region, as it stimulates improvements in social and environmental aspects. The FSC practices can be taken as a benchmark for other landowners/investors, also creating awareness for all categories of stakeholders in the region, by means of meetings, training, etc. As the Project will be implemented in a single sustainable management Farm (and not in a spread management area), the generation of incomes will be sustainable and permanent, creating new jobs in the whole supply chain and fixating people in the area influenced by the Project, thus decreasing the need for deforestation in new areas.

Peace and social development will only be possible by means of the creation of formal employment and the legal benefits related to them. This is exactly one of the purposes of Florestal Santa Maria S/A's Sustainable Forest Management Plan[8], which is to create consistency in the wood supply. Technical qualification, training in forest management, and community development in the form of participative workshops may increase the collective understanding of climate change and the importance of the forest. This understanding is essential for each individual in the process of a collective transformation of cultural relations and the lifestyle of the local community.

5. Leakage control:

Project proponents clearly comprehend the conceptual complexity and difficulties of implementing a policy for preventing potential leakage. Therefore, the Project proponents will adopt a proactive initiative for fighting leakage sources. This adoption will be based on a cooperative effort with local stakeholders to promote a new approach to forest use and land use in the region. In order to mitigate leakage, the Project proponents foresee continuous monitoring and interventions in areas surrounding the Project (Leakage Belt), which were mapped by satellite.

Although there is a risk of leakage, the proponents believe that the Project will have positive impacts on surrounding areas. This Project might be a well-succeeded example of the following technical and economic aspects: (i) Management of forest resources with success and profit; (ii) Additional return to forest management, due to REDD incentives, which can compensate for avoiding deforestation for other activities; (iii) Maintenance of real estate (land acquisition and grabbing dynamics), in addition to profits with sustainable management plus REDD.

6. Potential Roll-out to Other Areas:

The Project might probably stimulate other landowners to adhere to his concept. Communication with landowners might be performed using associative actions and environmental education. Other areas with the potential to be included in REDD projects have already been identified around the project site, which will favor and encourage forest conservation by means of financial incentives obtained from reduced emission sales and provide social and environmental benefits to neighboring communities.

[7] Annex: Certificado_CoC_FSC_119901_07_2022.pdf

[8] Annex: PMFS Santa Maria

By means of Project monitoring activities; we believe that the well-succeeded example of this business plan will generate an increased number of sustainably managed areas, which will create ancillary benefits around the Project boundary.

1.12 Project Location

The project is in the country of Brazil, the state of Mato Grosso, Municipality of Colniza. The project area has a size of 71,317.98 hectares[9]. The boundaries are also defined by the following geodesic coordinates referenced in datum WGS84, UTM 21:

- O 59º 23’ 12.754’’ S 9º 17’ 21.051’’
- O 59º 25’ 37.819’’ S 8º 59’ 58.947’’
- O 59º 15’ 14.817’’ S 9º 08’ 56.337’’
- O 59º 04’ 57.420’’ S 9º 08’ 43.532’’

1.13 Conditions Prior to Project Initiation

This REDD project was proposed to be implemented in a region with a previous history of deforestation pressure. The landowner requested carbon incentives to monitor the project area and avoid unplanned deforestation. As seen in Figure 1.2, the Project Area was entirely covered by native forest 27 years ago (10 years before the project start date), and this forest cover is still virtually intact.

[9] The project area boundaries are also available in the annex: 202208_FSM_PD_Project Area.kml

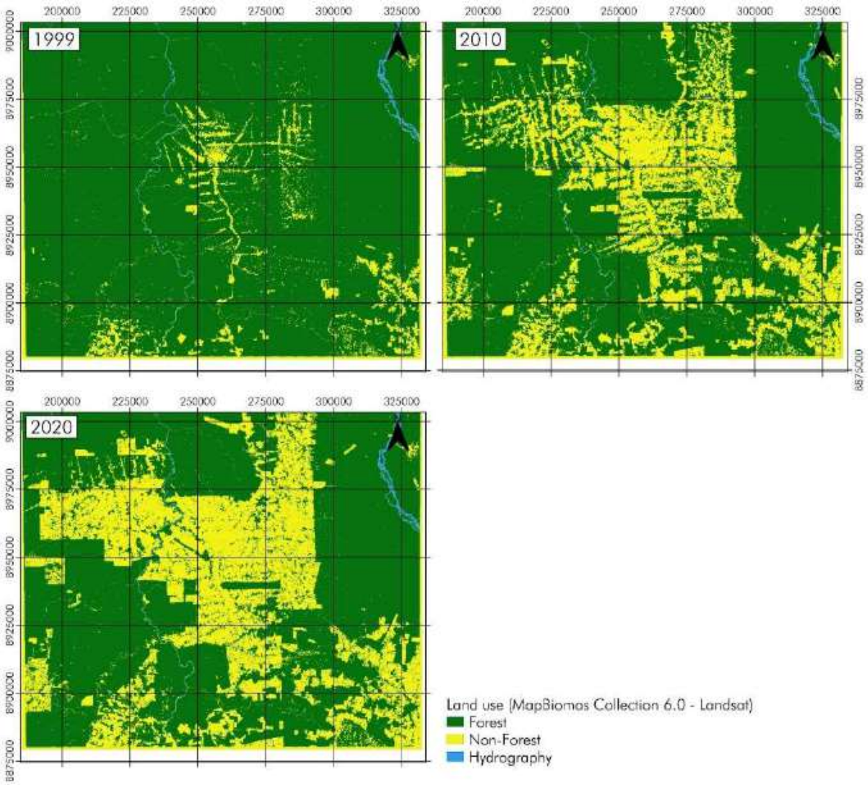

Figure 1.2. Forest coverage in 1999 (ten years before the project started), 2010, and 2020.

Forest land is expected to be converted to non-forest land in the baseline case. The landowner couldn't afford all efforts and costs to keep the long-term vigilance of frontiers to avoid unplanned deforestation from uncontrolled invasions. In this context, the project was characterized and still is within the category AFOLU – REDD - Avoiding unplanned deforestation and degradation (AUDD).

1.13.1 Context of deforestation in the State of Mato Grosso

In the Mato Grosso state, areas with consolidated anthropic use (deforested before 22 July 2008) correspond to 32% of the state's area. Of that 32%, 61% are destinated in cattle-raising, and 28% in agriculture (ICV, 2017).

The Brazilian Legal Amazon region is under deforestation pressure. An estimated 20% of its original forest has already been lost[10]. From 2015 to 2019, over 61,000.0 km² of forests have been destroyed in the region[11], equivalent to 0.77% of its total territory. This configuration as an increase in deforestation when compared to the previous five years period (data shown in Figure 1.3). Even though the decade of 2010-

[10] Journal report available at https://www.cnnbrasil.com.br/nacional/em-2021-amazonia-legal-registra-pior-acumulado-de-desmatamento-em-5-anos/, accessed at 29 of July, 2022.

[11] Data extracted from Terabrasilis, a INPE initiative, information available at: http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/increments.

2019 has the lowest historic deforestation taxes, the recent increase shows that the situation still will far be under control.

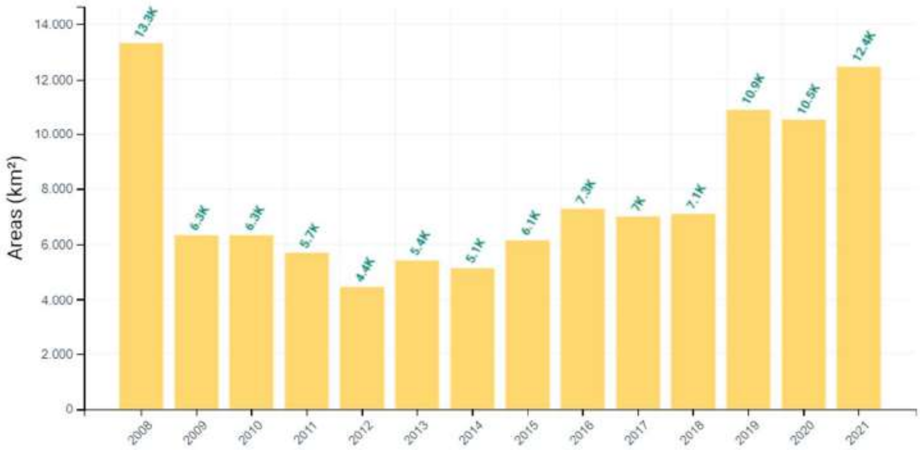

Figure 1.3. Deforestation areas in Brazilian Legal Amazon

At least since the beginning of the 2000 decade, the State of Mato Grosso has shown high deforestation rates. This state has for approximately 30% of the total deforestation within the Brazilian Amazon. This deforestation has generated total emissions of approximately 6,47 billion tons of equivalent CO_2, an average of 308 million tons per year[12].

In the process of deforestation, the first step is forest clear-cutting and logging. It is estimated that 30% of this timber is subsequently converted into long-term wood products, the non-merchantable timber that remains in the field is usually accumulated and burnt (Figure 1.4) prior to the installation of pasture or agricultural activities. Most carbon emissions from baseline activities occur during this operation. After burning the remnant forest biomass, the land is virtually clear and ready for other activities.

[12] Data extracted from the Global Forest Watch report, available at: http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/increments.

Figure 1.4. Fire in the background is outside the project boundary.

According to IBGE (2009), the municipality of Colniza, where the project is located, has 12,120 hectares occupied with coffee cultivation, which represents about 4% of the total municipality area. For calculation purposes, it is conservatively assumed that 10% of the Reference Area is covered with coffee crops. The remaining 90% of land use is conservatively considered as pasture for cattle-raising.

The IPCC (2006) mentions a conservative carbon pool in pasture lands of 15 tCO_2/ha. For coffee crops, one of the most conservative carbon pool estimates registered in the literature is mentioned by DOSSA et al. (2008), which reported 84 tCO_2/ha. These post-deforestation carbon pools were considered for calculating the difference in carbon stocks between Project Scenario and Baseline Scenario in this VCS-PD.

For conservativeness purposes, it is considered that pasture and coffee crops are cultivated using the natural fertility of recently forested soils, without the application of nitrogen fertilizers. Thus, the calculation of baseline emissions in the Reference Area does not account for N_2O emissions from nitrogen fertilization of soils. Moreover, for conservativeness purposes, project proponents decided not to account for soil carbon pool and litter carbon pool in the FSM-REDD Project benefits.

1.13.2 Ecosystem type

The Project region is situated in Brazil's Amazon ecosystem. According to IBGE (2012a) classification, the region covered by this project includes four phyto physiognomies found in the Amazon rainforest. Most of the territory (> 74%) is covered by Open and Dense-canopy rainforest submontane, being very common to find areas with vines and palm trees (SEPLAN, 2002).

The areas with dense-canopy rainforests are characterized by dense vegetation in all strata (tree, shrub, herbaceous, and lianas) (SFB, 2019). The vegetation can vary in terms of size, species presence, and composition of the strata, due to the characteristics of soil, relief features, and hydrography, but also due to human interventions, mainly the selective removal of trees with economic value (SEMA, 2009). The forest areas

In the most preserved areas of Dense-canopy rainforest, where physical conditions allow, the height of vegetation increases, and there is the presence of epiphytes. In these areas, natural disturbances can be observed, which occur due to the natural death of trees or events such as lightning, strong winds, and other reasons. The community presents itself with three strata, the arboreal composed of individuals from 5 to 50 m in height, the dense shrub layer with species from 1 to 5 m in height, and the herbaceous layer less than 1.5 m high and very open (SEMA, 2009).

The Open-canopy rainforest is a variation of the Dense-canopy Forest, being a more open forest formation, where combinations of particular species in associations are commonly observed (SFB, 2019). What characterizes and differentiates the Phyto physiognomy of this forest, is the spaced arrangement of trees, which allows the passage of light, favoring the development of vines, palm trees, and, sometimes bamboo (ARPA, 2011).

The Santa Maria Forest Farm shares a border to the north with the Igarapés do Juruena State Park and is 25 km from the Juruena National Park. These two conservation units (protected areas), along with SM forest, have a land configuration that has the potential to create an extensive ecological corridor that allows the free movement of animals, an increase in plant cover, the dispersal of seeds, and the flow of genetic material. Studies published by many authors such as Irigaray et al. (2013), Dorval et al. (2013), de Freitas Encinas Dardengo et al. (2018) stress the importance of extensive forest cover in the Mato Grosso scenario against ecosystem fragmentation and its contribution to gene flow between species.

The Project Area's region is very rich and diverse in fauna since it was classified as of extreme biological importance for birds, aquatic biota, botany, mammals, reptiles, and amphibian fauna species (ARPA, 2011). In terms of avifauna, the region is located in an area with a high concentration of bird species, 412 native bird species were registered. The mammal community contains 101 species. The total number of species inventoried in the Juruena National Park represents about 25% of the total 399 mammal species recorded for the Brazilian Amazon (Azevedo Ramos et al., 2006). 87 species were recorded for herpetofauna: 47 of which were amphibians and 40 were reptiles. Regarding the region's ichthyofauna 134 fish species belonging to seven orders and 30 families were collected.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

1.14.1 Federal Laws and Regulatory Frameworks

At a federal level, one most important piece of legislation is Law Nº 12.651 of 25/05/2012 which created the newest Brazilian Forest Code. There are some important articles and chapters to be considered that are replicated below.

"CHAPTER I: General Provisions

Article 3. For the effects of this law, the following definitions apply:

I – Legal Amazon: the States of Acre, Pará, Amazonas, Roraima, Rondônia, Amapá and Mato Grosso, and the regions located to the North of parallel 13° S, in States of Tocantins and Goiás, and to the West of meridian 44° W, of the State of Maranhão (Figure 1).

II - Permanent preservation area (APP): protected areas covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, biodiversity, gene flow of plants and animals, protecting the soil, and ensuring the well-being of human populations.

III - Legal Reserve area located within a rural property or ownership, demarcated according to article 12, with the function of ensuring sustainable economic use of natural resources of rural property, assisting the conservation and rehabilitation of ecological processes, and promoting the conservation of biodiversity, as well as shelter and protection of wildlife and native flora.

CHAPTER IV: AREAL LEGAL RESERVE

Section I: Delimitation of the Legal Reserve Area

Article 12. All property must maintain a rural area with native vegetation cover, as a legal reserve, without prejudice to the application of the rules on the Permanent Preservation Areas, subject to the following minimum percentages in relation to the area of the property, except as specified in art. 68 of this Act.:

I – Located in the Legal Amazon:

a) 80% (eighty percent), in the property situated in a forest area;
b) 35% (thirty-five percent), in the property situated in cerrado;
c) 20% (twenty percent), in the property situated in the area of general fields

II – Located in other regions of the country: 20% (twenty percent).

CHAPTER VI: THE RURAL ENVIRONMENTAL REGISTRY

Article 29. Creates the Rural Environmental Registry – CAR within the scope of the National System Information on the Environment – SINIMA as a public electronic record on a national level, mandatory for all rural properties, to integrate environmental information of rural properties and possessions, composing a database for control, monitoring, environmental and economic planning and combating deforestation."

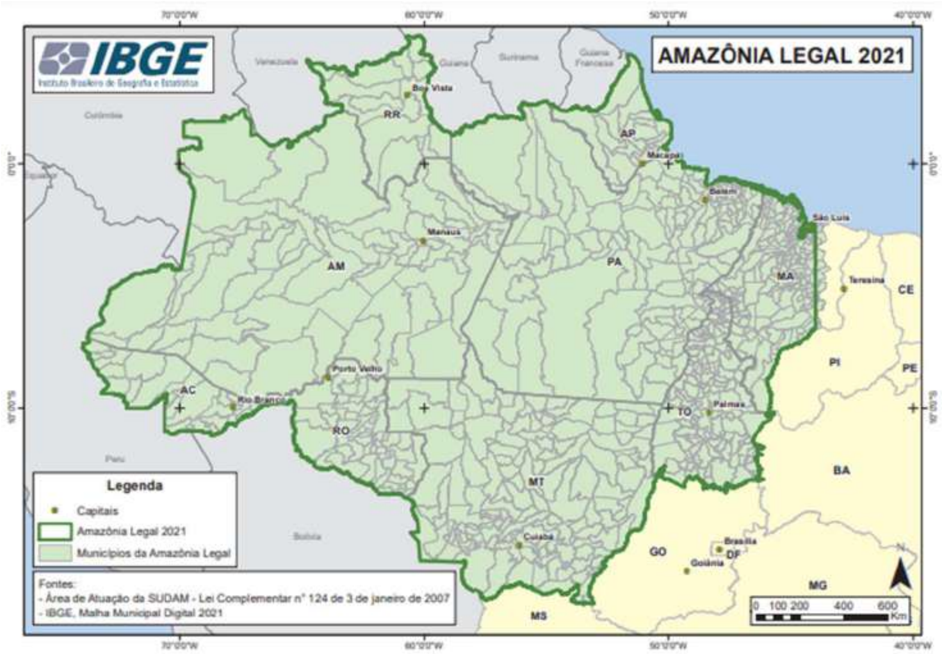

Figure 1.5 Brazilian Legal Amazon States.

The Legal Reserve (LR) must be registered in the property deed in the Real Estate Registry Office: its location must be publicly known, and future landowners must know where it is located, its boundaries, and its frontiers. The LR can be located anywhere inside a rural estate. Brazilian Forest Code also determines that once allocated, LR may not be changed even in cases of real estate transfer, land dismembering, or area rectification.

The LR allocation is a prerequisite to obtaining permission for the exploitation of the native vegetation existing inside the rural estate. To obtain this Permit for Forestry Stewardship, the landowner must previously register the location of the LR in land property documents through the Real Estate Registry. In compliance with Brazilian Forest Code, the farms have officially allocated even more than 80% of their total area as LR, the only economic activity that takes place on the property is forest management, which conservates the vegetation characteristics in the region.

In the Reference Area, although 80% of native vegetation in land properties must be preserved as LR, there is a general non-compliance with Brazilian Forest Code, as 42.7% of native vegetation has already been suppressed (i.e. there is a deficit of 22.7% of native forest that should not have been suppressed in the Reference Area). Despite the legal provisions intended to preserve at least 80% of the Amazon Forest coverage, the lack of law enforcement by local authorities along with public policies seeking to increase commodities production and encourage land use for agricultural, bio energy and cattle breeding purposes created a scenario of almost complete disregard of the mandatory provisions of the Forest Code. High rates of criminality associated with land disputes usually jeopardize efforts concerning law enforcement improvement. In addition to that, covering vast distances of areas with low demographic density makes tracking illegal activities and land surveillance very difficult for the authorities.

Even though the Brazilian Forest Code is the more specific environmental legislation at a national level regarding the use of land in the legal Amazon, other legislations are also necessary. Rural activities have several perspectives that are not resumed only by the environmental one. Here are all other legislations consulted that guided and are assisted by the due diligence process of this project:

- Brazilian Federal Constitution of 1988.
- Brazilian Civil Code, Law 10,406/2002.
- Law of Public Records, Law 6,015/1973
- Brazilian Imperial Law, Law 601/1850
- Rural Land Statute, Law 4,504/1964
- Law of Rural Property Tax, Law 9,393/1996
- Federal Environmental Crimes Law, Law 9,605/1998
- Law of Civil Action, Law 7,347/1985

Together, all those laws have can be complex for those who are not familiar with them. But the main objective of them, in a simpler way, is to demand from the landowner: (i) proof of their legal right to have and possess their land for different government agencies, (ii) guarantee that financially all taxes are being paid, (iii) there are no legal or civil lawsuits that could compromise the landowner.

1.14.2 State Laws and Regulatory Frameworks

In the state of Mato Grosso, the Secretariat for the Environment (Sema/MT) is the body responsible for environmental licensing. At the collegiate decision level, there is the State Environment Council (Consema/MT) and the State Water Resources Council (Cehidro). Among the Licensing Instruments and authorizations for environmental intervention in the state of Mato Grosso, the “Exploration Authorization” (Autex) applies to sustainable forest management activities, which is the document issued by the competent agency that authorizes the exploration of the “Annual Production Unit” (UPA) and specifies the maximum volume per species allowed for exploration, valid for 12 months, and may be extended for another 12 months, as long as duly justified in a technical exploration report. Each “Annual Production Unit” (UPA) corresponds to a subdivision of the “Forest Management Area” (AMF), destined to be explored each year. The “Forest Management Area” (AMF), in turn, is the area of the rural property to be used through forest management.

To this project, Autex is important once the activity of forest management is executed in the FSM. The instructions to obtain an Autex are explained by Decree Nº 2,152/2014, here is an excerpt of it:

> “Section II: Forest License
>
> Article 3. The Forest License will be issued with the approval of the Sustainable Forest Management Plan (PMFS), valid according to the cutting cycle.

Article 4. The technical procedures for the elaborations, presentation, execution, analysis, and technical evaluation of the Forest License in the native forests of the State of Mato Grosso and their forms of succession, shall observe the provisions of this decree and the following requirements:

I – The documentary and technical pieces are listed in the Normative Instructions.

II – Rural Environmental Registry – CAR.

III – The georeferenced location of the area covered by the license.

Single paragraph: A Forest License will be issued by the Rural Environmental Registry, with only one PMFS being allowed, regardless of the number of annual production units."

1.14.3 List of documentation in annex

The help with the identification of necessary juridic documents for the project and the legislation that requires them Table 1.1 was created with all these correlations.

Table 1.1. List all documents presented in the annex to guarantee compliance with the present legislation.

Annex	Laws/Regulations	Comments
202208_FSM_PD_Domain Certificate Caraguá.pdf 202208_FSM_PD_Domain Certificate Junp pt1.pdf 202208_FSM_PD_Domain Certificate Junp pt2.pdf	Brazilian Civil Code, Law 10,406/2002. Law of Public Records, Law 6,015/1973.	Updated Real Estate Records indicating liens, debt, or court lawsuits to the property regarding the past 20 years. It proves the regularity of the property and if it is free and clear of any liens and encumbrances.
202208_FSM_PD_Ownership Chain Caraguá.pdf 202208_FSM_PD_Ownership Chain Junp.pdf	Brazilian Civil Code, Law 10,406/2002. Law of Public Records, Law 6,015/1973. Brazilian Federal Constitution of 1988. Brazilian Imperial Law, Law 601/1850	Certificate issued by the Real Estate Registry Office with the complete chain of domain and ins transfers from the public domain to the private domain. Since all the rural land in Brazil was a state-owned asset and must fulfill the specific requirement to be transferred to the private domain, the chain of the domain is necessary to verify the regularity of the land.
202208_FSM_PD_INCRA CCIR 2020.pdf	Rural Land Statute, Law 4,504/1964	The Rural Property Registry (CCIR) is important to attest that the property is regular to the National Institute of Colonization and Agrarian Reform (INCRA).

Annex	Laws/Regulations	Comments
202208_FSM_PD_SIGEF Caraguá.pdf 202208_FSM_PD_SIGEF Junp.pdf 202208_FSM_PD_SIGEF Map Caraguá.pdf 202208_FSM_PD_SIGEF Map Junp.pdf	Law of Public Records, Law 6,015/1973	According to the Law of Public Records, to validate the property transfer, rural properties with more than 100 hectares must have a geodesic survey approved by INCRA.
202208_FSM_PD_DITR Junp.pdf	Law of Rural Property Tax, Law 9,393/1996	The Rural Property Tax Filings (DITR) must be delivered annually by every rural property owner. It is important to verify the regularity before tax authorities.
202208_FSM_PD_CAR Receipt by SEMA-MT.pdf 202208_FSM_PD_CAR.pdf	Brazilian Forest Code, Law 12,651/2012	The Rural Environmental Registry (CAR) is a legal obligation that provides properties' environmental information related to the existence of environmental protected areas, the place of the legal reserve, as well as the existence of native vegetation that exceeds the minimum required for legal reserve purposes. The document 202208_FSM_PD_CAR Receipt by SEMA-MT.pdf is just the proof that the CAR document was received by the state public environmental agency of the Mato Grosso State.
202208_FSM_PD_IBAMA Debts Caraguá.pdf 202208_FSM_PD_IBAMA Debts Junp.pdf 202208_FSM_PD_IBAMA Embargo Caraguá.pdf 202208_FSM_PD_IBAMA Embargo Junp.pdf 202208_FSM_PD_IBAMA Florestal Liscence.pdf 202208_FSM_PD_IBAMA Operational Liscence.pdf	Federal Environmental Crimes Law, Law 9,605/1998. Decree Nº 2,152/2014.	Following the Federal Environmental Crimes Law, certificates issued by the competent state and federal Environmental Authority, which in this case are SEMA-MT and IBAMA, respectively, are necessary to provide information on existing environmental assessment, penalties and procedures.

Annex	Laws/Regulations	Comments
202208_FSM_PD_SEMA-MT Debts Caraguá.pdf 202208_FSM_PD_SEMA-MT Debts Junp.pdf		
202208_FSM_PD_Certidão MPE-MT Caraguá.pdf 202208_FSM_PD_Certidão MPE-MT Junp.pdf 202208_FSM_PD_Certidão MPF Caraguá.pdf 202208_FSM_PD_Certidão MPF Junp.pdf 202208_FSM_PD_State Court Caraguá.pdf 202208_FSM_PD_State Court Junp.pdf	Law of Civil Action, Law 7,347/1985. Brazilian Civil Code, Law 10,406/2002.	To the Law of Civil Action, it is important to verify the existence of civil action related to the property issued by the Federal and State Prosecutors Office. By its time, the Brazilian Civil Code demands certificates issued by the State Court of Justice of the property(s) and the domicile of the owner(s), covering 10 years.

1.15 Participation under Other GHG Programs

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

The project is not engaged with other emissions trading programs and the host country has no binding limits on GHG emissions. The project neither has nor intends to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program. The VCS Program has a central project database, which lists each approved project. The VCS Project Database is the central storehouse of information on all projects validated to VCS criteria and all Verified Carbon Units issued under the program. Every VCU can be tracked from issuance to retirement in the database, allowing buyers to ensure every credit is real, additional, permanent, independently verified, uniquely numbered, and fully traceable online. This project has not been registered in any other credited activity, and no VCUs have been assigned to the project area so far. Thus, any possibility of double counting credits is eliminated.

Also, the project has not been registered, and it is not seeking registration under any other GHG programs.

1.15.2 Projects Rejected by Other GHG Programs

This project has not been rejected under any other GHG program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project does not reduce GHG emissions from activities included in an emissions trading program or any other mechanism that includes GHG allowance trading.

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

1.16.2 Other Forms of Environmental Credit

The project and its activities for the reduction of GHG emissions did not seek or received another form of GHG-related credit, including renewable energy certificates.

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

This project activity might be a successful benchmark for the following technical and economic aspects:

1. Sustainable management of forest resources configuring and example on how to land activities can be done differently.
2. Additional return to forest management, thanks to REDD incentives, can compensate for avoiding deforestation for other activities.
3. A positive example of sustainable real estate maintenance, in addition to profits with sustainable management plus REDD revenues.

Federal Administration, which, in the course of COP 14 Conference held in Poznan, Poland, in December 2008, declared a deforestation reduction goal of 70% by the year 2018, and following that, further goals of achieving zero illegal deforestation by 2030, and greenhouse gas emissions offsetting originating from legal removal of vegetation. The latter are elements of the Brazilian Nationally Determined Contribution (NDC), which the country aims to adopt within the framework of the Paris Climate Agreement (COP-21)[13]. To attain this goal, it will be necessary to join government initiatives with independent actions (such as that proposed under the present project).

The map of Figure 1.6 below shows the economic and ecologic strategic zones named in accordance with the main function they should attend to. The project's municipality of Colniza is located in the region for "Containment of the expansion fronts with protected areas and alternative uses", which was established

[13] Available at http://redd.mma.gov.br/pt/redd-e-a-indc-brasileira. Accessed in 25/08/2022.

by the Ecological and Economic Macro-zoning of Amazon (Macrozoneamento Ecológico-Econômico da Amazônia Legal - Macro ZEE/AL), created by the Brazilian Ministry of Environment. The Macro ZEE/AL aims to establish strategic indications of occupation and use of land on a sustainable basis to guide, at the regional scale, the development and spatial distribution of public development policies, territorial and environmental planning, as well as the decisions of private agents. Due to its shield function for the heart forest protection, this territorial unit deserves strengthening policies. In this context, this project activity aligns with the strategies set up by the Macro ZEE/AL of the Brazilian Ministry of Environment.

The REDD+ mechanism works as a barrier to containing deforestation. Thus, the development of the present REDD+ project and other carbon credit projects in the region can not only contribute to reducing predatory deforestation in the Amazon biome but also expand the official containment area. This project represents the potential to continue the work started by other REDD+ projects in the region: assisting the Federal Administration and State agencies to attain these goals and leverage further pilot REDD projects in the municipalities, which are facing critical deforestation levels.

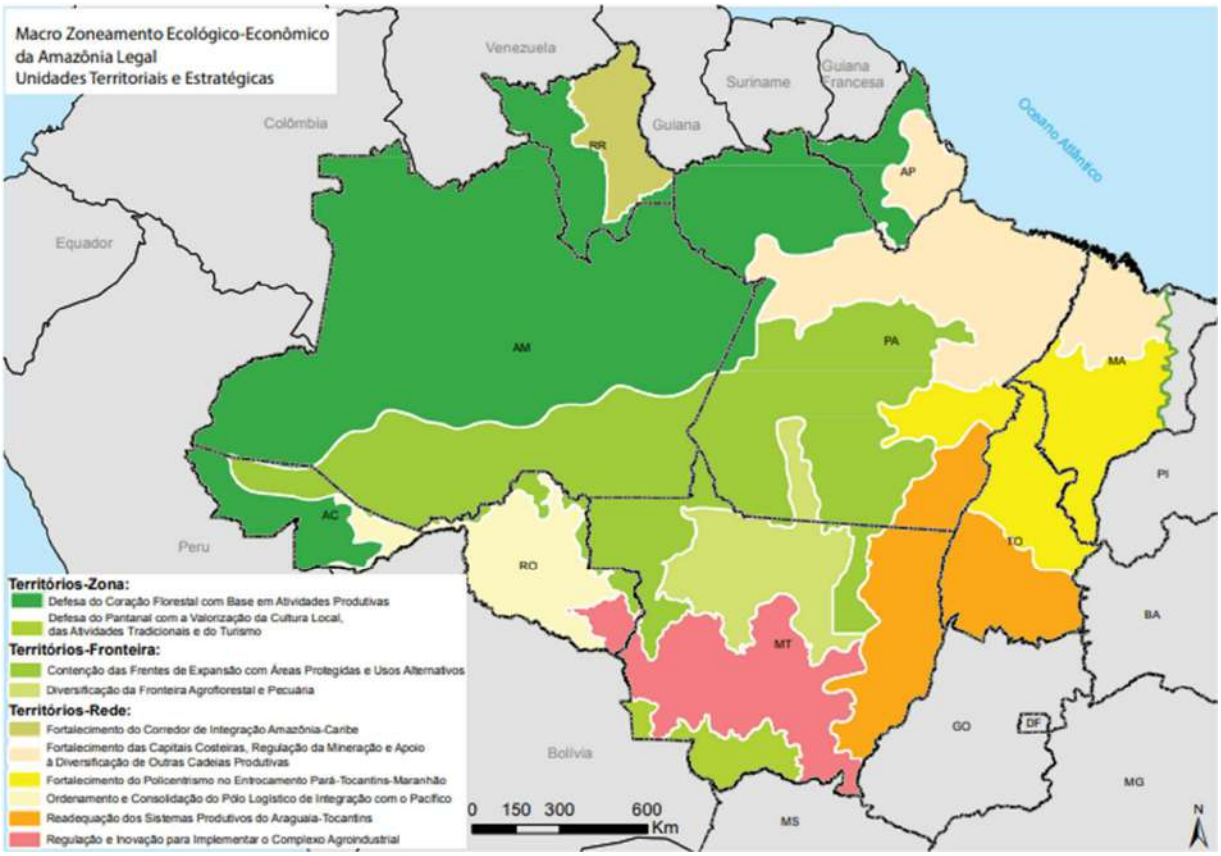

Figure 1.6. Economic and ecological zones of the Legal Amazon (MATTEO, 2007).

The REDD+ mechanism works as a barrier to containing deforestation. Thus, the development of the present REDD+ project and other carbon credit projects in the region can not only contribute to reducing

predatory deforestation in the Amazon biome but also expand the official containment area. This project represents the potential to continue the work started by other REDD+ projects in the region: assisting the Federal Administration and State agencies to attain these goals and leverage further pilot REDD projects in the municipalities, which are facing critical deforestation levels.

1.17.2 Sustainable Development Contributions Activity Monitoring

The Florestal Santa Maria REDD Project had, in the years that composed this Monitoring Report, contributed mainly with actions to increase: the healthy conditions of the Caraguá forest management workers, gender equity, the conservation of natural resources and the amazon rainforest and to contribute with the global warming mitigation by reducing carbon emissions.

The complete description of actions taken in the last few years is presented in Table 1.2 below.

Table 1.2: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	3.8.	3.8.1. Coverage of essential health services.	Implemented activities to increase.	Developed a program for the medic and healthy control of the forest management workers[14].	Improvement of the workers' health quality.
2)	5	5.a.1(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex;	Implemented activities to increase.	The farm's management follows the collective agreement regarding workers' best interests for the years 2021 to 2023 prepared by the labor unions associated with logging activities[15].	The activities developed seek to effectively involve all possible stakeholders, especially the inclusion of women and minority groups, ensuring equal treatment in the development of activities.
3)	8.8.	8.8.1. Level of national compliance with labor rights (freedom of association and collective bargaining) based on International Labour Organization (ILO) textual sources and national legislation, by sex and migrant status	Implemented activities to increase	Local workers are persuaded by third local agents to believe that unregistered labor is better for them. Then, it is part of the hiring operational procedure done by Caraguá to carefully explain and educate new workers about the benefits of being a duly registered employee. This matter is addressed recurrently during the training following employee registration. The risks to workers who carry out forest management can be found in the Risk Management Program (RMP) [16]	Lowered the number of unregistered labor in the municipality of Colniza.

[14] Annex: 202208_FSM_PD_Modical and health program.pdf

[15] Annex: 202208_FSM_PD_Colective Convention.pdf

[16] Annex: 202208_FSM_PD_PGR Caraguá.pdf

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
4)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By conserving more than 71 thousand ha of tropical rainforest, Project Fazenda Santa Maria has prevented the release of 1.2 million tonnes of carbon into the atmosphere during the monitoring period.	Prevented the release of 1.2 million tonnes of carbon into the atmosphere. (Calculation of avoided emissions through section 4. Quantification of GHG Emissions Reductions and Removals of the PD).
5)	15.2	15.2.1. Progress toward sustainable forest management.	Implemented activities to increase	Trained the Caragua employees with the best practices of forest management[17] executed in accordance with Brazilian legislation. At the beginning of 2022 reacquired the FSC seal.	Developed activities to train Caraguá employees and local households with the best forest management practices. Every year presents the AUTEX document (legal document permitting forest management by the regional environmental agency SEMA-MT)[18].
6)	15.1	15.1.1. Forest area as a proportion of the total land area.	Implemented activities to increase	No further changes during this monitoring period	By maintaining only forest management as an economic activity in the property, almost all land is occupied by the amazon rainforest, excluding the infrastructure to transport, pre-process and storage of the wood managed[19].
7)	15.1	15.1.2. Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type.	Implemented activities to increase	No further changes during this monitoring period	The property area and its vegetation work as an ecological corridor with Igarapés do Juruena State Park[20], which contributes to the existence and maintenance of rich fauna and flora biodiversity, land fragmentation control, the connection between stands, and biodiversity refuge, being home to various endangered and vulnerable fauna and flora species.[21]

[17] Annex: 202208_FSM_PD_Reduced Impact Forest Management Training.pdf

[18] Annex: 202208_FSM_PD_AUTEX 2021.pdf

[19] Annex: 202208_FSM_PD_Map with Land Cover.jpg

[20] Annex: 202208_FSM_PD_Decree Nº 5,438.pdf

[21] Annex: 202208_FSM_PD_Map with Ecological Parks.jpg

1.18 Additional Information Relevant to the Project

Leakage Management

The main leakage management activities are described in Section 1.11 Description of the Project Activity, especially in the items on Sustainable Forest Management activities and Leakage Control.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the Project Description.

Further Information

No further information to disclose.

2 SAFEGUARDS

2.1 No Net Harm

Between 2000 and 2005, illegal occupation in the region, led by “professional” land-grabbers (mainly over private lands), generated uncontrollable pressure on local landowners, becoming extremely threatening, given the lack of governmental infrastructure and law enforcement to preserve privately owned lands. The deforestation pressure in the State of Mato Grosso is mostly the result of land-grabbing by the invasion of private lands, using objective logging, slash-and-burning, and cattle-ranching. However, other factors contributed to deforestation in the State of Mato Grosso. According to the Amazon Institute for Environmental Research (Galvão et al., 2011), the causes of tropical deforestation are apparently the same in different regions of the planet and can directly be accounted for: (a) conversion of forest areas into areas for agriculture and cattle breeding for the purpose of land possession or not; (b) timber extraction; and (c) land-clearance by fire. There are also indirect causes such as (d) governmental subsidies and incentives for agriculture and cattle breeding; (e) investment policies in infrastructure projects; (f) illegality of land possession and ownership; (g) lack of state governance and law enforcement; and (h) market drivers, such as rising commodities prices. All these patterns can be found in the Brazilian Amazon and specifically in the State of Mato Grosso.

The settlement projects, called PA, began in the 1970s when the creation of INCRA and the establishment of a more comprehensive policy for the settlement of vacant land. The Settlement Projects consist of a set of planned actions, in an area intended for agrarian reform, of an interdisciplinary nature integrated into territorial and regional development (Ávila et al., 2019). In the meantime, the settlements composed the main axis of population expansion and territorial integration of the state. "A dynamic observed among the studied settlements is the trend of substitution of the original vegetation by cultivated pastures. In the beginning, the settlers tend to work with agricultural activity, then there is the impoverishment of the soil, and they opt for pastures and dairy cattle" (Alves et al., 2009). The initiative of colonization of the territory that is now located in the municipality of Colniza began in 1986, with the arrival of the first families of southern Brazil, arising from a process of compensation for land expropriation. These migrants occupied the northern region of the state with interests focused on extensive farming and logging.

"The expansion of the agricultural frontier in the northern region of the state of MT was perceived in the advance on the areas of forests, through deforestation and fire, followed by the cultivation of temporary crops for the formation of pastures. For family farmers, deforestation of the area and the replacement of vegetation with pasture were presented as the fastest alternative for the valuation of their lands. For the large rural owner, deforestation and the implementation of extensive livestock was the way found to ensure the legal legitimacy of the property" (Ávila et al., 2019). This process paved the way and created the condition for the beginning of the invasion process by land-grabbers and a total lack of governmental control of the region, which resulted in the current environmental situation.

The FSM farm is one of the sites in the state that still conserves native forests through sustainable forest management. Several illegal occupations in the FSM farm were eradicated and registered by local authorities and by the farm self-vigilance system. These invasions originated judicial prosecutions for repossession of land tenure. Thanks to an extensive self-vigilance system and landowner's investments and efforts, these invasions have not caused significant damage to the original vegetation.

To control deforestation and invasion, the FSM farm has 7 fixed vigilance points distributed all along the property, which control all entrances and boundaries of the farm. The southeast portion of the farm is the most critical in terms of invasion risks, as several roads and trails have been made to access farm boundaries passing through INCRA settlement. In this portion exists the Perserverança Pacutinga INCRA Settlement that shares boundaries with FSM, is one of the first settlements in the region that brought about the Colniza municipality, and has most of its today residents made up of Rondônia state migrants. The Perserverança Pacutinga settlement is directly impacted by the farm activities because they share the same road to the highway that is used by the farm timber trucks.

One of the pillars of project risk management consists of building a good relationship with the community surrounding the farm. That will be led through the active communication channel between stakeholders and the farm team by using WhatsApp and telephone numbers and using affixed posters in the community meeting places such as churches and small local stores.

One of the farm's activities is sustainable forest management, and the Caraguá team has sought to be FSC-certified since the beginning of the project. In 2022, the new farm management acquired certification, updating the Risk Management Program (PGR), a document that contains an action plan to mitigate possible risks to workers associated with forest management, and can be found in the annex[22]. For the safety of workers, the farm follows the collective agreement regarding workers' best interests for

[22] Annex: PGR Caragua Agronegocios Ltda.pdf

the years 2021 to 2023 prepared by the labor unions associated with logging activities and developed the Occupational Health Medical Control Program for the years 2022 and 2023, both attached [23],[24].

The mapped potential negative impacts for local stakeholders are listed below:

Although in the project area fires are unlikely to occur on account of the natural amazon forest humidity, alongside areas where local people raise cattle, natural and/or man-made fires could spread uncontrollably, putting people, livestock, and assets at risk:

Mitigation to be adopted: effective operational procedure and staff training to assure that FSM employees are able to promptly respond to any fire emergency, being part and/or being able to quickly trigger the municipal fire brigade.

To mitigate fire outbreaks and spread, Caraguá farm provides training, material, and planning for fire prevention and control, which is stated in the Operational Plan[25]. Some of the activities that are carried out before, during, or after a fire outbreak are the following:

- Communication of fire outbreaks to the administrative sector, registration in the fire occurrence form, and communication with competent bodies. In the event of a fire, call the region's fire brigade team.
- Provision of materials and equipment for Fire Fighting and Control activities.
- Availability and qualified team ready to act and interfere in the early stages of fire outbreak.
- Mandatory use of protection
- Use off-fire spread control techniques with natural firebreaks and artificial firebreaks.
- Guidance to the neighborhood in the prevention, measures, and good practices to avoid the beginning of fires.

There is periodic fire brigade training with farm employees, through a fire-fighting course planned for May 2022[26].

Since the timber-loaded trucks must cross the Perseverança Pacutinga settlement, there is a risk of road accidents and/or accidents related to loading fall:

Mitigation to be adopted: an effective operational procedure to assure that the timber-loaded truck drivers will be in full compliance with all safety best practices, regulations, and traffic laws, ensuring that this operation is carried out in the most possibly safe way to the farm employees and the local community.

[23] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf

[24] Annex: Programa de controle médico de saúde ocupacional 2022.pdf

[25] Annex: PO_PCI_13_ PREVENCAO_COMBATE_INCENDIO.pdf

[26] Annex: Evidência do treinamento de brigada de incêndio.pdf

Mitigation measures for transport-related risks are described in the attached PGR (p.30). In addition, monitoring of forest management procedures is being adopted by the farm in order to minimize risks and improve procedures[27].

<u>Possible conflicts arising from the illegal occupation of the project area by land-grabbers or property trespassing by people hunting and/or fishing:</u>

Mitigation to be adopted: careful and systematic vigilance aiming to guarantee property security and inform any potential trespasser about the hunting and fishing prohibition in the area as well as about its private status of it.

According to the monitoring plan, 7 bases are part of the surveillance of the property, in which the management created a patrol method, which is based on a periodic visit to the bases. The agent visits the bases and fills in a short questionnaire regarding property surveillance and security (model of the monitoring document attached[28]). One of the most recurrent positive community impacts perceived by the people from the adjacent was tenure security as a result of the farm operations, in addition, most stakeholders claim to have a good relationship with the farm, as can be observed in the socio-environmental assessment [29]

<u>Local roads erosion as a result of the timber-loaded trucks traffic:</u>

Mitigation to be adopted: periodical road maintenance twice a year before the timber extraction operation period and after it.

The periodic maintenance of the roads is part of an operation carried out by the farm management.[30] Furthermore, 96% of those interviewed in the socio-environmental assessment (p.15) claim that one of the positive impacts of the company's activities in the region is the maintenance of roads and bridges.

<u>The people living in the community nearby the farm might have doubts and/or requests to make to the farm and feel that they might not be heard:</u>

Mitigation to be adopted: implementation of an active channel of communication between the farm and the local community, consisting in having and informing people about a phone and WhatsApp number used to share information about the farm operations and to clarify any possible doubt or lack of information that the local community might have.

During the monitoring period, a socio-environmental diagnosis was carried out with the local community to assess the impacts of the farm, and their perception of it. At this time, communication channels were

[27] Annex: monitoramento_operacoes.pdf

[28] Annex: MONITORAMENTO PATRIMONIAL.docx

[29] Annex: Avaliacao Socioambiental Caragua 2022.pdf

[30] Annex: evidencias manutencao estradas.docx

reinforced and information on the activities carried out in the project was made available[31]The mobile numbers of the local stakeholders were also collected to create an invitation list for the WhatsApp group, in order to create a more direct communication channel with the farm management[32].

To be in compliance with VCS Standards as well as to inform about an important project related activity, a careful stakeholders' communication about the audit process was carried out within the period outlined in the methodology (at least a month before the in loco field audit). During meetings with the stakeholders, it was explained how the process works and they were notified that an auditor could ask to interview them. To meet this objective, meetings with secretariats and the Perseverança Pacutinga community were carried out, as well as posters were affixed in secretariats, community church and given to community leaders for them to affix in community meeting places[33]. SEMA, specifically, was made aware of the auditing process by means of telephone calls and emails (annex).

2.2 Local Stakeholder Consultation

The consultation of stakeholders was made through direct communication with the community surrounding the project area, during January and February 2022. The families of Perseverança Pacutinga settlement were visited by FSM workers, who explained the project and provided the farm contact phone and WhatsApp number as can be seen in the poster given to the interviewed settlers and affixed in community meeting places such as churches and small local stores[34]. On this visit, a questionnaire was applied in order to conduct a socio-environmental diagnosis of residents in order to assess the impacts of the project on their lives and their opinion on the activities developed by the farm. In addition, an email was sent to other stakeholders, such as public and private institutions, with a project summary and a form assessing their opinion on the project.

This form provides continuous and permanent communication[35] with stakeholders throughout the project, as one of the channels of consultation and feedback, considering that it will be applied recurrently during the project time, also allowing to raise information regarding the well-being and impact of the project actions. Other forms of communication were implemented, such as communication through the phone, and email, which is open to questions and complaints about the project. In addition, a WhatsApp group will be created with the residents of the surrounding community to create a more agile and easy communication for the community.

So far there have been no comments or suggestions about the project in the online communication channels, or in the online form. From the results of the last applied research, it was possible to identify that the potentially negative impact of FSM operations perceived by the local community results from the

[31] Annex: 04_FSM_Community assessment report.pdf and 04_FSM_Interview files.pdf

[32] Annex: 03_FSM_Whatsapp group invite and group evidence.pdf

[33] Annex: 04_FSM_Audit communication.pdf

[34] Annex: 03_FSM_Informative Poster_1.pdf

[35] Link: https://forms.gle/Zf9koYTqx4NXyAsr9

traffic of trucks that transport the wood at the time of harvest, which causes damage to road infrastructure. In this way, the project considered this impact and suggested mitigation for it demonstrated in item "2.1 No net Harm". For more information about the consultation see the annexes: evidence of visits to local stakeholders[36]; report of socio-environmental diagnosis[37]; and the project summary[38] sent to the other stakeholders.

To carry out a continuous consultation throughout the project, an email will be sent to the stakeholders presenting the PD ("Project Description") and the results of the monitoring reports, emphasizing the part of risks, costs, and benefits associated with the project. The other online communication channels will be updated with information on the completion of these steps and the provision of the link to access the documents through the VERRA website. In addition, meetings with stakeholders are planned to present the PD and listen to its opinion on the final version. The project owner often holds meetings with farm employees, where the carbon project and its benefits are discussed. Finally, posters will be placed in strategic locations in the areas adjacent to the project, informing about the date of the audit for validation and verification in the community. This same information will be made available through online communication channels and WhatsApp.

Relevant to note that SEMA MT has a mandatory bureaucratic relation with Fazenda Santa Maria since the Sustainable Forest Management Plan and its activities must be approved and audited by this government agency, that is aware of the activities carried out in the project domains.

All the company workers are duly registered and have their contracts in total compliance with the Consolidation of Labor Laws (CLT)[39], Decree-Law Nº 5.452, of 1º May of 1943, assuring their rights as well as safety and security, attached. Since unregistered labor and being in non-compliance with labor laws and regulations are common practices in Colniza municipality, and because local workers are persuaded to believe that unregistered labor is better for them, it is part of the hiring operational procedure to carefully explain and educate new workers about benefits of being a duly registered employee. This matter is addressed recurrently during the training following employee registration.

In addition, the farm's management follows the collective agreement regarding workers' best interests for the years 2021 to 2023 prepared by the labor unions associated with logging activities and developed the Occupational Health Medical Control Program for the years 2022 and 2023, both attached [40],[41]. The

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[36] Annex: evidências das visitas aos stakeholders locais.pdf

[37] Annex: Avaliacao Socioambiental Caragua 2022.pdf

[38] Annex: Resumo Projeto REDD Florestal Santa Maria.pdf

[39] Annex: decreto_5452_CLT.pdf

[40] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf

[41] Annex: Programa de controle médico de saúde ocupacional 2022.pdf

risks to workers who carry out forest management can be found in the Risk Management Program (RMP), a document that presents an action plan for the mitigation of possible risks identified. [42]

The activities carried out do not incur financial costs, as proposed by the project, and are funded by the farm's management. Also, it is understood that there are no risks to local stakeholders associated with the project activities, as there are no communities within the project area that depend on forest resources that are present there. However, the benefits of the project are related to ecosystem services, like support and regulating services such as air quality regulation, climate regulation, water regulation, erosion protection, the process of degradation, soil formation and regeneration, pollination, biological regulation, nutrient and life-cycle maintenance, gene-pool protection (Lee & Diop, 2009; Loft, 2011). It is relevant to mention that one perceived benefit by the people from the adjacent community was tenure security because of the farm operations as can be observed in the socio-environmental assessment (p. 15).

2.3 Environmental Impact

The Fazenda Santa Maria project improves and contributes to various ecological services, such as the conservation of ecological corridors, the existence and maintenance of rich fauna and flora biodiversity, land fragmentation control, the connection between stands, and biodiversity refuge. Environmental impact assessments are not required by applicable legislation or regulation. The Caraguá property has a Sustainable Forest Stewardship Plan previously approved by SEMA (Environment Secretariat of the State of Mato Grosso). This management plan was conceived in compliance with Brazilian Forest Code and local regulations.

The Project Area is near two important conservation units (UCs), Igarapés do Juruena State Park (PES, 2008) and Juruena National Park (PERNA, 2008), and so plays an important role in the preservation of larger areas and creates an ecological corridor linking forested stands within the landscape.

The data gathered during the inventory at the Caraguá farm and region show that the natural environment is in good condition and is home to various endangered and vulnerable fauna and flora species (Table 2.1, Table 2.2). It should be highlighted as well that the project is located near an Important Bird and Biodiversity Area (BirdLife International, 2022) and provides a habitat for endangered bird species such as the Choca-de-garganta-preta (*Clytoctantes atrogularis*) (PORTARIA Nº 44, 2011; PORTARIA Nº. 016, 2009).

Table 2.1-Vulnerable and endangered fauna species

BIRDS		
IUCN Threat Categories	Popular Name	Scientific name
Vulnerable (VU)	Choca-de-garganta-preta	*Clytoctantes atrogularis*

[42] Annex: PGR Caragua Agronegocios Ltda.pdf

MAMMALS		
Vulnerable (VU)	Tamanduá-bandeira	*Myrmecophaga tridactyla*
	Cachorro-do-mato-vinagre	*Speothos venaticus*
	Gato-maracajá	*Leopardus wiedii*
	Jaguatirica	*Leopardus pardalis*
	Onça-pintada	*Panthera onca*
	Ariranha	*Pteronura brasiliensis*
	Lontra	*Lontra longicaudis*
	Anta-brasileira	*Tapirus terrestris*
Endangered (EN)	Gato-do-mato-pequeno	*Leopardus tigrinus*
	Rato-candango	*Kunzia tomentosus*
	Pacarana	*Dinomys branickii*
AMPHIBIANS		
Vulnerable (VU)	Jabuti-Tinga	*Chelonoidis denticulata*

Table 2.2-Vulnerable flora species

IUCN and IBAMA Threat Category	Popular Name	Scientific Name
Vulnerable (VU)	Castanha do Pará	*Bertholletia excelsa* H. & B.
	Serigueira	*Hevea brasiliensis* L.

2.4 Public Comments

Procedures for listing projects in the pipeline were released on May 1, 2012[43], from an update to VCS version 3, and the addition of sections for receiving public comments was implemented to the standard only on October 19, 2012. 2016[44].

[43] Annex: VCS-Program-Update-Catalogue-1-May-2012_1.pdf

[44] Annex: VCS-Program-Update-Catalogue-1-May-2012_1.pdf

Considering this, public comments requirements do not apply to the Florestal Santa Maria REDD Project, as it had its validation completed on May 4, 2012 (date of completion of the validation report[45]). And at that time, the listing in the pipeline was not a requirement, so the project did not go through the process of a public comment period of 30 days, and as a result, it did not receive any comments.

Despite this, the project maintains an online communication channel[46] to receive public comments from stakeholders and the communities involved, and so far, no comments received have generated changes in the project design[47]. Regardless of that, the project will keep the channel open and will take action to make sure that communities and stakeholders are aware of the existence of the communication channel to make comments, suggestions, and evaluations about the project.

In addition to this, it is important to mention that the project has an internal policy[48] of commitment to the safety, health, and life of its employees. and repudiates any discrimination based on race, color, national origin, age, religion, sexual, physical, or mental orientation inability. In addition to not allowing moral or sexual harassment in their work environments.

2.5 AFOLU-Specific Safeguards

2.5.1 Local Stakeholder Identification and Background

Identification of local stakeholders likely impacted by the project

Understanding that local stakeholders are the actors directly impacted by the project, they were identified through research and previous social activities developed by Florestal Santa Maria in the project area, resulting in the report of socio-environmental diagnosis[49]. This analysis was based on secondary geographic data, identifying the communities surrounding the project. Then, field work was carried out, identifying the possible impacts of the project activities on the stakeholders, through the understanding of their relationship with the project area and with the managers. The main stakeholders include Governmental agents, Environmental and Agricultural Agencies, private sector representatives, universities, and importantly, people from the community that shares boundaries with the project area. The possible communities impacted by the project were identified at a distance of 20km from the boundary of the project area, being: (a) Kawahiva Indigenous Land of the Pardo River (b) Settlement Project Perseverança do Pacutinga, Colniza I, Colniza II, Nova Cotriguaçu (geographic database is attached[50]).

[45] Annex: VALID_REP_875_04MAY2012.pdf

[46] Link: https://forms.gle/Zf9koYTqx4NXyAsr9

[47] Annex: FSM-Public-Consult-Responses.pdf

[48] Annex: Autoavaliacao_PoliticaTrabalhista_CARAGUA_Assinado.pdf

[49] Annex: Avaliacao Socioambiental Caragua 2022.pdf

[50] Annex: GIS_comunidades.zip

According to these analyses, there are no traditional or indigenous people directly or indirectly affected by the project. The Kawahiva Indigenous Land of the Pardo River is a territory occupied by the last isolated group of the Kawahiva people (Fiocruz, 2022) and so was not consulted. The Perserverança Pacutinga settlement is the only community directly impacted by the farm activities because they share the same road to the highway that is used by the farm timber trucks. Santa Maria farm team conducted a careful identification of the people of the community of the adjacent area, focusing on the households located on the roads used by the farm. For more information on the identification of stakeholders, consult the report on socio-environmental diagnosis (p. 10 and 11). The list below concerns the stakeholders that are impacted by the project activities.

- Small Farmers Association of Perseverança Pacutinga Empresa Mato-grossense de Pesquisa (EMPAER-MT)
- (Mato Grosso Research Bureau)Federal University of Mato Grosso (UFMT) and State University of Mato Grosso (UNEMAT)
- Leaders of the Settlement Perseverança Pacutinga
- Parque Estadual Igarapé do Jurena (Igarapé do Jurena State Park) Rural Union of Colniza
- City Hall of Colniza, Department of Environment and Department of Agriculture Brazilian Agricultural Research Corporation (EMBRAPA – MT)
- Caraguá farm workers
- Federal University of Mato Grosso (UFMT) and State University of Mato Grosso (UNEMAT)
- Technical Assistance and Rural Extension - SENAR
- Rural Union of Colniza
- Brazilian Agricultural Research Corporation (EMBRAPA – MT)
- State Environment Secretariat - SEMA MT

Identification of any legal or customary tenure/access rights to territories and resources, including collective and/or conflicting rights, held by local stakeholders:

The region has a history of invasions and irregular land occupations. However, since the beginning of Florestal Santa Maria's operations in the region, the property has had a single owner and has been monitored carefully, and has no reports of any kind of problem-related to land invasion whatsoever in recent years. It is relevant to mention that one of the most recurrent positive impacts perceived by the people from the adjacent community was tenure security as a result of the farm operations as can be observed in the socio-environmental assessment (p. 15). Historically and nowadays, there is no seed collecting or any extractivism of non-timber products of any kind in the project area.

A description of the social, economic and cultural diversity within local stakeholder groups and the differences and interactions between the stakeholders' groups:

As stated in item 1, project stakeholders range from government agencies to the community near the project area. Thus, by applying different forms of consultation, it is considered that the project covers the social, economic, and cultural diversity of the different stakeholders.

The total population of Colniza is estimated at 41.117 inhabitants, 46.6% women and 53.4% men, and has a resident population of 26.381 people, with most of them in rural areas (IBGE, 2022b). As mentioned in item "2.1 No Net Harm", the colonization of the municipality took place from the settlement projects, in which most of the population were, and still are, migrants from other states in the country. Consultation with local stakeholders was carried out through interviews with residents of PA Perseverança Pacutinga, a settlement adjacent to the project area. This interview aimed to make a socio-environmental diagnosis and assess the impacts of the farm's activities on the local community, in addition, to providing clarification on the project's activities.

In this interview, it was found that 40% of respondents arrived at the property after 2010, and 100% of them declared that they carry out (or intend to) beef cattle activities on their properties. In addition, 98% of those interviewed declared that they do not collect non-timber forest products for subsistence or commercial purposes, and so far, no initiative to collect and/or process non-timber forest products has been identified in the region.

Communication with the project team is informal and carried out through direct communication with the employees. For government agencies, private agencies, and NGOs, the contact method for suggestions and complaints is concentrated on the communications online channel by e-mail and a formulary[51]. Nonetheless, direct consultation was also carried out, with secretariats and labor unions being consulted.

Any significant changes in the makeup of local stakeholders over time:

No changes were identified among the stakeholders involved with the project. Any future significant changes will be informed in this section.

The expected changes in well-being and other stakeholder characteristics under the baseline scenario, including changes to ecosystem services identified as important to local stakeholders.

Considering that the surrounding community does not carry out any type of use of any kind of resource (non-timber forest products or others) within the project area, it is of common understanding that the business operation or the project activities per se will not have any negative impact on the ecosystem's services associated to extractivism that could be important to local stakeholders.

The maintenance of the forest structure, as well as all related biodiversity, feasible because of the project's existence, is responsible for some not so easy to perceive ecosystem services, like support and

[51] Link: https://forms.gle/Zf9koYTqx4NXyAsr9

regulating services such as air quality regulation, climate regulation, water regulation, erosion protection, the process of degradation, soil formation and regeneration, pollination, biological regulation, nutrient and life-cycle maintenance, gene-pool protection (Lee & Diop, 2009; Loft, 2011). Although these ecosystem services might not always be perceived by the local community as important ecosystem services, they have great relevance in their lives, and having such a healthy and extensive forest fragment nearby their households does certainly have an impact on their environmental and ecological perception.

It is relevant to note that the project activities that do not necessarily clearly relate to ecosystem services are expected to generate a positive impact, namely:

- The careful and systematic vigilance and monitoring of the project area and its surroundings inevitably have a positive impact on the security all over the surrounding area, since it ends up acting as a suppressing mechanism to land grabbers and or hunters way beyond the controlled area, as perceived by the local community in the socio-environmental assessment
- The periodical road maintenance twice a year, before the timber extraction operation and after will contribute to the maintenance of access to the community nearby the project since during the rainy season, the intense rainfall almost always causes serious problems to the roads and make some of the community properties very difficult to reach.
- The good relatioship between the community and FSM. WIn a community assesment carried out by the FSM team, 98% of the interviewed settlers informed that has a good or excellent relationship with FSM. They also informed their understand that the farm activities have a positive impact, naming the roads maintenance carried out by FSM, environmental conservation, job creation, better legal and land security, and more security when it comes to a possible need of help in an emergency[52] Those who informed negative impacts related with the FSM activities mentioned the road maintenance that could be better, and the risk posed by the heavy timber loaded trucks traffic. The project team were aware of these issues and considered them when, as well as other potential risks, were thoroughly examined and addressed in section “risk to stakeholders”.

The location of communities, local stakeholders and areas outside the project area that are predicted to be impacted by the project

The map below (Figure 2.1) shows the location of all communities (not only those impacted by the project) within a maximum distance of 20km from the project area. Impacted communities are listed above.

[52] Annexes: 04_FSM_Community assessment report and 04_FSM_Interview files

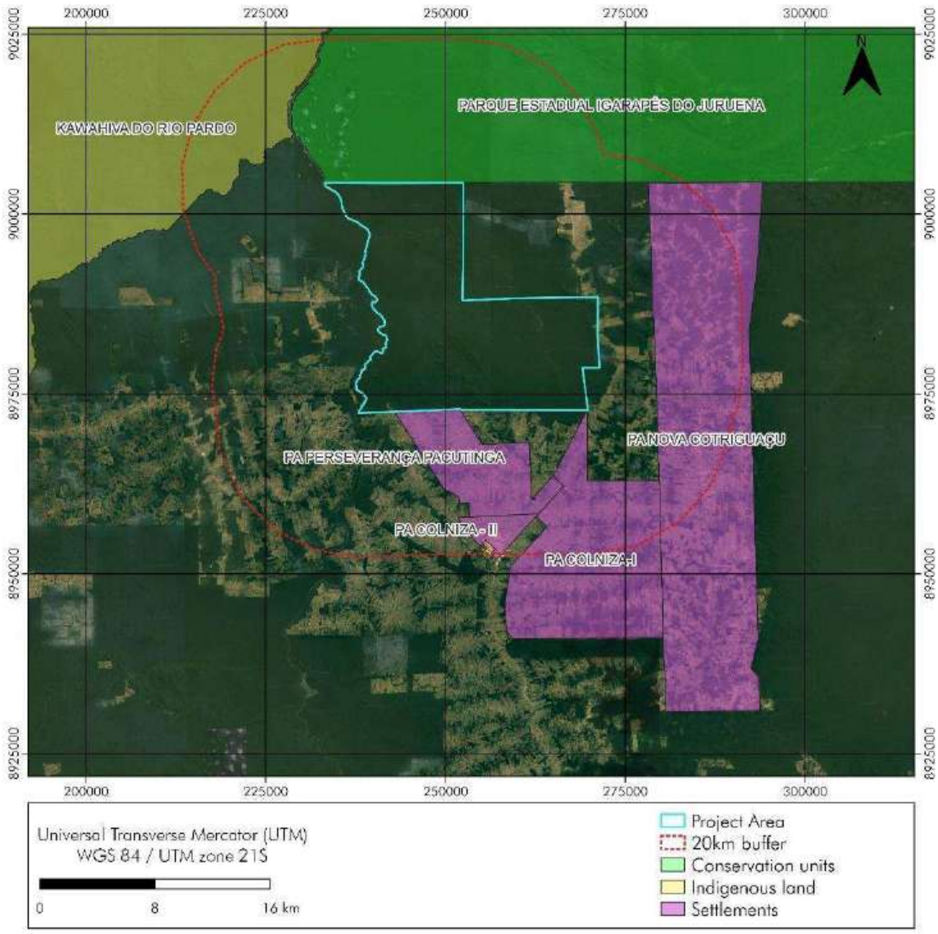

Figure 2.1. Stakeholders location.

The location of territories and resources which local stakeholders own or to which they have customary access

There are no local stakeholders who profit from the farm resources as informed in item 3.

Risks to Local Stakeholders

Four main groups of stakeholders were identified, namely: FSM employees, Perseverança Pacutinga Settlement householders, Colniza city hall and secretariats, local associations, and unions. The identified potential natural and human-induced impacts on local stakeholder well-being are listed below:

1. Although in the project area fires are unlikely to occur on account of the natural amazon forest humidity, alongside areas where local people raise cattle, natural and/or man-made fires could spread uncontrollably, putting people, livestock, and assets at risk.

Mitigation to be adopted: effective operational procedure and staff training to assure that FSM employees can promptly respond to any fire emergency, being part and/or being able to quickly trigger the municipal fire brigade.

To mitigate fire outbreaks and spread, Caraguá farm provides training, material, and planning for fire prevention and control, which is stated in the Operational Plan[53]. There is periodic fire brigade training with farm employees, through a fire-fighting course planned for May 2022[54]

2. Since the timber-loaded trucks must cross the Perseverança Pacutinga settlement, there is a risk of road accidents and/or accidents related to loading falls.

Mitigation to be adopted: effective operational procedure to guarantee that the timber-loaded truck drivers will be in full compliance with all safety best practices, regulations, and traffic laws, ensuring that this operation is carried out in the most possibly safe way to the farm employees and the local community.

Mitigation measures for transport-related risks are described in the attached PGR[55] (p.30). In addition, monitoring of forest management procedures is being adopted by the farm in order to minimize risks and improve procedures[56]

3. Possible conflicts arise from the illegal occupation of the project area by land-grabbers or property trespassing by people hunting and/or fishing.

Mitigation to be adopted: careful and systematic vigilance aiming to secure the property and inform any potential trespasser about the hunting and fishing prohibition in the area as well as about its private status of it.

According to the monitoring plan, 7 bases are part of the surveillance of the property, in which the management created a patrol method, which is based on a periodic visit to the bases. The agent visits the bases and fills in a short questionnaire regarding property surveillance and security (model of the monitoring document attached). [57] One of the most recurrent positive community impacts perceived by the people from the adjacent was tenure security as a result of the farm operations, in addition, most stakeholders claim to have a good relationship with the farm, as can be observed in the socio-environmental assessment [58]

4. Local road erosion as a result of the timber-loaded truck traffic.

Mitigation to be adopted: periodical road maintenance twice a year before the timber extraction operation period and after it.

[53] Annex: PO_PCI_13_ PREVENCAO_COMBATE_INCENDIO.pdf

[54] Annex: Evidência do treinamento de brigada de incêndio.pdf

[55] Annex: PGR Caragua Agronegocios Ltda.pdf

[56] Annex: monitoramento_operacoes.pdf

[57] Annex: MONITORAMENTO PATRIMONIAL.pdf

[58] Annex: Avaliacao Socioambiental Caragua 2022.pdf

The periodic maintenance of the roads is part of an operation carried out by the farm management.[59] Furthermore, 96% of those interviewed in the socio-environmental assessment (p.15) claim that one of the positive impacts of the company's activities in the region is the maintenance of roads and bridges.

5. The people living in the community nearby the farm might have doubts and/or requests to make to the farm and feel that they might not be heard.

Mitigation to be adopted: implementation of an active channel of communication between the farm and the local community, consisting in having and informing people about a phone and WhatsApp number used to share information about the farm operations and to clarify any possible doubt or lack of information that the local community might have.

During the monitoring period, a socio-environmental diagnosis was carried out with the local community in order to assess the impacts of the farm, and their perception of it. At this time, communication channels were reinforced and information on the activities carried out in the project was made available. The mobile numbers of the local stakeholders were also collected to create an invitation list for the WhatsApp group, to create a more direct communication channel with the farm management.

The activities carried out do not incur financial costs, as they are proposed by the project and are funded by the farm's management. In addition, it is understood that there are no risks to local stakeholders associated with the project activities, as there are no communities within the project area that depend on forest resources that are present there. The risks to workers who carry out forest management can be found in the Risk Management Program (RMP), a document that presents an action plan for the mitigation of possible risks identified.

Considering that there is no direct or indirect use of the project area by any of the stakeholders, the project activities do not imply any risk related to food security, land loss, loss of yields, or climate change adaptation, and being so, there are no trade-off implications whatsoever resulting from the project activities. Nonetheless, all four groups were informed and consulted about the project and, it is interesting to note, that the stakeholders have in general a very positive understanding of the FSM activities and of the project.

One of the most important values in the FSM project and among team members is praising for respect regarding culture, gender, and sexual orientation, and not being involved in any form of sexual harassment, as demonstrated in the collective agreement regarding workers' best interests for the years 2021 to 2023 (p.11) [60]. The activities developed seek to effectively involve all possible stakeholders, especially the inclusion of women and minority groups, ensuring equal treatment in the development of activities. Also, it is important to mention that the project has an internal policy[61] of commitment to the safety, health, and life of its employees and repudiates any discrimination based on race, color, national origin, age, religion, sexual, physical, or mental orientation inability not allowing any kind of moral or

[59] Annex: evidencias manutencao estradas.pdf

[60] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf

[61] Annex: Autoavaliacao_PoliticaTrabalhista_CARAGUA_Assinado.pdf

sexual harassment in their work environments. In addition, the farm's management follows the collective agreement regarding workers' best interests for the years 2021 to 2023 prepared by the labor unions associated with logging activities and developed the Occupational Health Medical Control Program for the years 2022 and 2023, both attached[62].

The project management team has the expertise and prior experience in implementing projects with community engagement within the project region, and being involved, in past activities of VCS and FSC. The FSM REDD project began in 2009, completing more than 10 years of existence, and throughout its history, it has monitored its activities for project verification, in which all project history documents are available on the VERRA website [63]. In addition, between 2012 and 2019 the project was verified with the Social Carbon certification, in which it promoted social activities with the surrounding community, bringing benefits to the well-being of the population, the project and validation report are attached[64,65].

Systemica, which was founded in 2012, supports the FSM project and has experience in projects related to ecosystem services; incorporation of sustainability into governance strategies to generate value; public policies; and the most relevant for this analysis, the voluntary carbon market forest projects[66].

When it comes to the FSM project, all the technical activities are supported by a professional team with extensive experience in sustainable business development and processes related to the generation and trading of carbon credits and the neutralization of emissions.[67]

Respect for Local Stakeholder Resources

The project owner recognizes, respects, and supports local stakeholders' customary tenure/access rights to territories and resources. According to the socio-environmental diagnosis, the local community does not depend on the project area for subsistence and does not make use of non-timber forest resources or any other type. Other than that, there is no community living within the project area. The project will never encroach on private property or relocate people off their lands, and there is no activity with this pretense. No community member has been or will be removed from their land because of any FSM or project activity.

If for any reason, an ongoing or unresolved event over property rights among local households, usage or resources takes place, the project will undertake no activity that could exacerbate the conflict or influence the outcome of the unresolved dispute. Nevertheless, there was no record of conflicts of this nature from the project start date until now. An important project activity that is supposed to have a positive externality on this matter consists of building a good relationship with the community surrounding the farm that is

[62] Annex: Programa de controle médico de saúde ocupacional 2022.pdf

[63] Link: https://registry.verra.org/app/projectDetail/VCS/875

[64] Annex: SCR_Florestal Santa Maria_ Point_0_v2.pdf

[65] Annex: 2020_VCS_SCR_validation.pdf

[66] Annex: Systemica_Company_Portfolio.pdf

[67] Annex: Systemica_Project Development Team_Santa Maria.pdf

supported by the active communication channel between stakeholders and the farm team by using WhatsApp and telephone numbers.

In addition, the project did not introduce any invasive species or allow an invasive species to thrive through project implementation. If the project implements any reforestation project that will be with native species in the future. Besides that, there is no use of fertilizers, chemical pesticides, biological control agents, and other inputs in the activities.

Communication and Consultation

The communication and engagement of stakeholders were made through direct contact with the community surrounding the project area, during January and February 2022. The families of Perseverança Pacutinga settlement were visited by FSM workers, who explained the project and provided the farm contact phone and WhatsApp number. On this visit, a questionnaire was applied in order to conduct a socio-environmental diagnosis of residents in order to assess the impacts of the project on their lives and their opinion on the activities developed by the farm. In addition, an e-mail[68] was sent to other stakeholders[69], such as public and private institutions, with a project summary and a form assessing their opinion on the project.

This form provides continuous and permanent communication[70] with stakeholders throughout the project, as one of the channels of consultation and feedback, considering that it will be applied recurrently during the project time, also allowing to raise information regarding the well-being and impact of the project actions. Other forms of communication were implemented, such as the distribution of flyers [71], communication through the phone, and e-mail, which is open to questions and complaints about the project. In addition, a WhatsApp group will be created with the residents of the surrounding community to create more agile and easy communication for the community. This way the project design and implementation, as well as the costs and benefits, were communicated and the stakeholders were consulted. The results of the monitoring will be communicated by communication channels and meetings with the Perseverança Pacutinga settlement households. For more information about the consultation see the annexes: evidence of visits to local stakeholders[72]; report of socio-environmental diagnosis[73]; and the project summary[74] sent to the other stakeholders.

Regarding laws and regulations covering workers' rights, as mentioned, it is part of the hiring operational procedure to carefully explain to every new worker the benefits and implications of being a duly registered

[68] Annex: email_stakeholders_MRV.pdf

[69]Annex: stakeholders_FSM.xlsx

[70] Link: https://forms.gle/Zf9koYTqx4NXyAsr9

[71] Annex: Cartaz-FSM-auditoria-VCS-2022.pdf

[72] Annex: evidências das visitas aos stakeholders locais.pdf

[73] Annex: Avaliacao Socioambiental Caragua 2022.pdf

[74] Annex: Resumo Projeto REDD Florestal Santa Maria.pdf

employee. In addition to this operational procedure, the matter is addressed recurrently in training moments with the employees.

The process of VCS Program validation and verification was also informed, as well as the validation/verification body's site visit, which will be recalled at least a month before each visit.

The project, as already mentioned, has active different communication channels to actively listen to the stakeholder's demands and provide proper information about the activities held by FSM. Regarding the local households living nearby the project area, WhatsApp and phone number function, among other things, as a grievance redress mechanism.

The FSM workers have a channel specifically designed for this audience to meet possible demands and answer any questions they may have, whether about management or the project activities, which consists of a suggestion box that all workers have access to.

In the case of a grievance, FSM will do its utmost efforts to amicably resolve it and will provide a written response to the grievances in a culturally appropriate manner. In case there is not possible to promptly resolve the issue, it will be referred to mediation by a neutral party. Any grievances that are not resolved through mediation shall be referred either to arbitration, to the extent allowed by the laws of the relevant jurisdiction, or to the competent courts in the relevant jurisdiction, without prejudice to a party's ability to submit the grievance to a competent supranational adjudicatory body, if any.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

This project is based on VCS Methodology VM0007, Version 1.6, approved on 08 September 2020, entitled "REDD Methodology Framework (REDD-MF)"[75].

This REDD+ Methodology Framework document is the basic structure of a modular REDD+ methodology. It provides the generic functionality of the method, which frames pre-defined modules and tools that perform a specific function. It constitutes, together with the modules and tools it calls upon, a complete REDD+ baseline and monitoring methodology.

The modules and tools called upon in the VM0007 methodology are applicable to project activities that reduce emissions from unplanned (AUDD) deforestation.

Furthermore, the specific modules and tools applied to the Florestal Santa Maria REDD project are listed below:

[75] Annex: VM0007-REDDMF_v1.6.pdf

Carbon Pool Modules:

CP-AB, "VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools", Version 1.1[76].

CP-W, "VMD0005 Estimation of carbon stocks in the long-term wood products pool", Version 1.1[77].

Baseline Modules:

BL-UP, "VMD0007 Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation and unplanned wetland degradation", Version 3.3[78].

Leakage Modules:

LK-ASU, "VMD0010 Estimation of emissions from activity shifting for avoided unplanned deforestation", Version 1.2[79].

LK-ME, "VMD0011 Estimation of emissions from market-effects", Version 1.1[80].

Emissions Modules:

E-BPB, "VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning", Version 1.2[81].

Monitoring Module:

M-REDD, "VMD0015 Methods for monitoring of greenhouse gas emissions and removals", Version 2.2[82].

Miscellaneous Modules:

X-STR, "VMD0016 Methods for stratification of the project area", Version 1.2[83].

X-UNC, "VMD0017 Estimation of uncertainty for REDD project activities", Version 2.2[84].

Tools:

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[76] Annex: VMD0001-CP-AB-v1.1.pdf

[77] Annex: VMD0005-CP-W-v1.1.pdf

[78] Annex: VMD0007-BL-UP-v3.3.pdf

[79] Annex: VMD0010-LK-ASU-v1.2.pdf

[80] Annex: VMD0011-LK-ME-v1.1.pdf

[81] Annex: VMD0013-E-BPB-v1.2.pdf

[82] Annex: VMD0015-M-REDD-v2.2.pdf

[83] Annex: VMD0016-X-STR-v1.2.pdf

[84] Annex: VMD0017-X-UNC-v2.2.pdf

T-ADD, "VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities", Version 3.0[85].

T-BAR, "VCS AFOLU Non-Permanence Risk Tool", Version 4.0[86].

T-SIG, "CDM Tool for testing significance of GHG emissions in A/R CDM project activities", Version 1.0[87].

3.2 Applicability of Methodology

This REDD Methodology Framework applies to project activities within the AFOLU project category "REDD" as defined in the VCS AFOLU Guidance document. By choosing the appropriate modules based on the applicability conditions mentioned in each of the modules, a project-specific methodology was constructed. According with the Standard VCS 4.3 in Section 3.19.2 "Where the deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario, and the project remains in compliance with the applied methodology, the deviation shall be described and justified in the monitoring report. This shall include a description of when the changes occurred and the reasons for the changes. The deviation shall also be described in all subsequent monitoring reports"

On September 22nd, 2020, FLORESTAL SANTA MARIA LTDA. and CARAGUÁ AGRONEGÓCIOS LTDA. signed a Public Deed containing a Purchase and Sale Agreement registered in Book 204, pages 335 to 354 of the Civil Registry of Natural Persons and Notary Public of the District of Santana do Parnaíba, through which Caraguá acquired the Florestal Santa Maria farm (Registration No. 4765 of the Real Estate Registry of Colniza/MT). The change in ownership of the project area has no impact on the applicability of the methodology, additionality or appropriateness of the baseline scenario, since the parties involved have an agreement of rights and obligations related to the maintenance and continuation of the REDD Project Florestal Santa Maria[88,89] . In addition, Caraguá is a company that intends to maintain sustainable forest management activities, and soon after acquiring the farm, it began investments to readjust the activity within FSC standards, and has no intention of performing other economic activities other than forest management and conservation of the area through the carbon project.

The justification for the choice of modules and why they apply to the proposed project activity is explained below:

<u>Carbon Pool Modules:</u>

VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools (CP-AB), v1.1[90]. This module allows for ex-ante estimation of carbon stocks in above- and

[85] Annex: VT0001-T-ADD-v1.0.pdf

[86] Annex: AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

[87] Annex: T-SIG-v1.pdf

[88] Annex: CONTRATO-final-300321.pdf

[89] Annex: Florestal-Caraguá-Aditivo.pdf

[90] Annex: VMD0001-CP-AB-v1.1.pdf

belowground tree and non-tree woody biomass in the baseline case (for both pre- and post-deforestation stocks) and project case and for ex-post estimation of change in carbon stocks in above- and belowground tree biomass in the project case. Uncertainty of estimates is treated in module X-UNC. Identification of baseline (post-deforestation) land-uses and stocks are treated in modules BL-UP and BL-PL. This module is applicable to all forest types and age classes. The inclusion of the aboveground tree biomass pool as part of the project boundary is mandatory as per the framework module REDDMF. Non-tree aboveground biomass must be included as part of the project boundary if the following applicability criteria are met (per framework module REDD-MF):

- Stocks of non-tree aboveground biomass are greater in the baseline than in the project scenario, and
- Non-tree aboveground biomass is determined to be significant (using the T-SIG module). Belowground (tree and non-tree) biomass is not required for inclusion in the project boundary because omission is conservative.

VMD0005 Estimation of carbon stocks in the long-term wood products pool (CP-W), v1.1 [91]. This module allows for ex-ante estimation of carbon stocks in the long-term wood products pool in the baseline case. Carbon stocks treated here are those stocks entering the wood products pool at the time of deforestation. This module is applicable to all cases where wood is harvested for conversion to wood products for commercial markets, for all forest types and age classes. This module is applicable in the baseline if the wood products pool is included as part of the project boundary as per applicability criteria in the framework module REDD-MF, specifically:

- Timber harvest occurs prior to or in the process of deforestation, and where timber is destined for commercial markets.
- The wood products pool is determined to be significant (using T-SIG).

Baseline Modules:

VMD0007 Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation and unplanned wetland degradation (BL-UP), v3.3 [92]. This module allows for estimating carbon stock changes and GHG emissions related to unplanned deforestation and wetland degradation in the baseline scenario (VCS eligible categories AUDD and AUWD, respectively) as well as RWE-AUDD project activities. The module is applicable for estimating baseline emissions from unplanned deforestation (conversion of forest land to non-forest land in the baseline case). The following conditions must be met to apply this module. The forest landscape configuration can be mosaic, transition or frontier.

- The module must be applied to all project activities where the baseline agents of deforestation: (i) clear the land for settlements, crop production (agriculturalist), ranching or aquaculture, where

[91] Annex: VMD0005-CP-W-v1.1.pdf

[92] Annex: VMD0007-BL-UP-v3.3.pdf

such clearing for crop production, ranching or aquaculture does not amount to large scale industrial agri/aquaculture activities; (ii) have no documented and uncontested legal right to deforest the land for these purposes; and (iii) are either resident in the region or immigrants.

• Where pre-project, unsustainable fuelwood collection is occurring within the project boundaries, Modules BL-DFW and LK-DFW must be used to determine potential leakage.

Leakage Modules:

VMD0010 Estimation of emissions from activity shifting for avoiding unplanned deforestation and avoiding unplanned wetland degradation (LK-ASU), v1.2 [93]. This module provides methods for estimating emissions from displacement of unplanned deforestation and unplanned wetland degradation (leakage due to activity shifting). This module provides methods to determine the net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation ($\Delta C_{LK\text{-}AS,unplanned}$) and/or unplanned wetland degradation ($GHG_{LK\text{-}WRC\text{-}AS,unplanned}$). This module was originally developed for AUDD project activities. It is also mandatory for use in stand-alone AUWD project activities. This module is applicable for estimating carbon stock changes and greenhouse gas emissions related to the displacement of activities that cause deforestation of lands or wetland degradation outside the project area due to avoiding unplanned deforestation or avoiding unplanned wetland degradation in the project area. Activities subject to potential displacement are the conversion of forest land to grazing lands, crop lands, and other land uses, or the conversion of intact or partially degraded wetlands to drained or degraded wetlands. The module is mandatory if module BL-UP has been used to define the baseline and the applicability conditions in module BL-UP must be complied with in full.

VMD0011 Estimation of emissions from market-effects (LK-ME), v1.1 [94]. This module allows for estimating GHG emissions caused by the market-effects leakage related to the extraction of wood for timber, fuelwood, or charcoal in the baseline for carbon projects. As per the VCS AFOLU Requirements consideration of international market leakage is not required. This module provides procedures to determine the net greenhouse gas emissions due to market effects leakage ($\Delta C_{LK\text{-}ME}$). This module is applicable for calculating market-effects leakage from REDD projects that are anticipated to reduce levels of wood harvest substantially and permanently. When REDD project activities result in reductions in wood harvest, it is likely that production could shift to other areas of the country to compensate for the reduction, including activity shifting to forested peatland that is drained because of project implementation. This tool shall be used in countries where wood harvest happens on forested peatland regardless of the absence of peatland within the project boundary. As referenced in REDD-MF, this module is mandatory (within the context of such methodology) where:

[93] Annex: VMD0010-LK-ASU-v1.2.pdf

[94] Annex: VMD0011-LK-ME-v1.1.pdf

- The process of deforestation involves timber harvesting for commercial markets.
- The baseline is calculated using module BL-DFW and fuel wood or charcoal is harvested for commercial markets.

This module should not otherwise be used in the context of REDD-MF.

Emissions Modules:

VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning (E–BPB), v1.2 [95]. This module provides a step-wise approach for estimating GHG emissions from biomass burning ($E_{biomassburn,i,t}$) and peat burning ($GHG_{peatburn,i,t}$). This module is applicable to REDD project activities with emissions from biomass burning and REDD-WRC project activities with emissions from biomass and/or peat burning. This module is also applicable to RWE and ARR-RWE project activities with emissions from peat burning.

Monitoring Module:

VMD0015 Methods for monitoring of greenhouse gas emissions and removals (M-REDD), v2.2 [96]. This module provides methods for monitoring ex-post emissions and removals of GHGs due to avoiding deforestation and forest degradation, and carbon stock enhancement that has been induced because of REDD project implementation within the project area and leakage belt and as a result of natural disturbances. This module also provides methods for monitoring ex-post emissions and removals of GHGs due to standalone CIW, CIW-REDD and RWE-REDD project activities. This module was originally developed for REDD project activities. It is also mandatory for use in CIW project activities and for this purpose the following translation table must be used. Socio-economic processes causing the degradation of wetlands are like those causing deforestation or forest degradation. Therefore, for stand-alone CIW project activities (e.g., conservation of salt marshes without a tree biomass component), similar methods for baseline determination can be used for REDD project activities (see Modules BL-UP and BL-PL). Likewise, monitoring methods for areas of wetland degradation are similar to those for deforestation and forest degradation. Strata as defined in the relevant baseline modules are fixed and may not be changed without baseline revision. The module is mandatory for REDD, CIW-REDD, RWE-REDD and stand-alone CIW project activities. Where selective logging is taking place in the project case:

- Emissions from logging may be omitted if it can be demonstrated the emissions are de minimis using Tool T-SIG.
- If emissions from logging are not omitted as de minimis, logging may only take place within forest management areas that possess and maintain a Forest Stewardship Council (FSC) certificate for the years when the selective logging occurs.
- Logging operations may only conduct selective logging that maintains a land cover that meets the definition of forest within the project boundary.

[95] Annex: VMD0013-E-BPB-v1.2.pdf

[96] Annex: VMD0015-M-REDD-v2.2.pdf

· All trees cut for timber extraction during logging operations must have a DBH greater than 30 cm.

• During logging operations, only the bole/log of the felled tree may be removed. The top/crown of the tree must remain within the forested area.

• The logging practices cannot include the piling and/or burning of logging slash.

• Volume of timber harvested must be measured and monitored.

<u>Miscellaneous Modules:</u>

VMD0016 Methods for stratification of the project area (X-STR), v1.2 [97]. This module provides guidance on stratifying the project area into discrete, relatively homogeneous units to improve the accuracy and precision of carbon stock, carbon stock change, and GHG emission estimates. Different stratifications may be required for the baseline and project scenarios to achieve optimal accuracy of the estimates of net GHG emissions or removals. In the equations used in the accompanying modules, the suffix “”" is used to represent a stratum, and the suffix “M” for the total number of strata (M_{WPS} for the project scenario and M_{BSL} for the baseline scenario). Any module referencing strata “”" must be used in combination with this module. In the case of REDD, aboveground biomass stratification is only used for pre-deforestation forest classes, and strata are the same in the baseline and the project scenario. Post-deforestation land uses are not stratified. Instead, average post-deforestation stock values (e.g., simple or historical area-weighted approaches are used, as per Module BL-UP). For peatland rewetting and conservation project activities this module must be used to delineate nonpeat versus peat and to stratify the peat according to peat depth and soil emission characteristics, unless it can be demonstrated that the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario are de minimis, In the case of WRC project activities, the project boundary must be designed such that the negative effect of drainage activities that occur outside the project area on the project GHG benefits are minimized.

VMD0017 Estimation of uncertainty for REDD project activities (X-UNC), v2.2 [98]. This module allows for estimating uncertainty in the estimation of emissions and removals in REDD and WRC project activities. Uncertainty in the estimation of emissions and removals from ARR project activities is treated in the CDM tool Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities. The module may also be used for project planning purposes. The use of the module while planning the project can assure the monitoring is of sufficient intensity to minimize uncertainty deductions. The purpose of the methodology is for calculating ex-ante and ex-post a precision level and any deduction in credits for lack of precision following project implementation and monitoring. The module assesses uncertainty in baseline estimations and in estimations of project sequestration, emissions, and leakage. This module is mandatory when using the methodology REDD+ MF. It is

[97] Annex: VMD0016-X-STR-v1.2.pdf

[98] Annex: VMD0017-X-UNC-v2.2.pdf

applicable for estimating the uncertainty of estimates of emissions and removals of CO_{2-e} generated from REDD and WRC project activities. The module focuses on the following sources of uncertainty:

- Determination of rates of deforestation and degradation.
- Uncertainty associated with the estimation of stocks in carbon pools and changes in carbon stocks.
- Uncertainty associated with the estimation of peat emissions.
- Uncertainty in assessment of project emissions.

Where an uncertainty value is not known or cannot be simply calculated, a project must justify that it is using an indisputably conservative number and an uncertainty of 0% may be used for this component.

Guidance on uncertainty – a precision target of a 95% confidence interval half-width equal to or less than 15% of the recorded value must be targeted. This is especially important in terms of project planning for the measurement of carbon stocks; sufficient measurement plots should be included to achieve this precision level across the measured stocks.

Tools:

VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities (T-ADD), v3.0[99]. This tool provides a step-wise approach to demonstrate additionality in VCS AFOLU projects. Project proponents proposing new baseline methodologies may incorporate this tool in their proposal. Project proponents may also propose other approaches for the demonstration of additionality as set out in the most recent version of the VCS for consideration under the VCS methodology approval process. In validating the application of this tool to a proposed project activity, validation/verification bodies should assess credibility of all data, rationales, assumptions, justifications, and documentation provided by project proponent(s) to support the selection of the baseline and demonstration of additionality. The tool is applicable under the following conditions:

a) AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced.

b) The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario. Project proponent(s) proposing new baseline methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.

[99] Annex: VT0001-T-ADD-v3.0.pdf

VCS AFOLU Non-Permanence Risk Tool (T-BAR), v4.0 [100]. This tool is fully mandatory for the given project activity and must be used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.

CDM Tool for testing significance of GHG emissions in A/R CDM project activities (T-SIG) [101], **v1.0.** This tool is not mandatory and may be used to justify the omission of carbon pools and emission sources is significant.

3.3 Project Boundary

The geographic project boundary is defined by the geographic limits of the FSM farm, as mentioned in "1.12. Project Location". The map containing the project boundary including locations of the project area, reference region, and leakage belt is represented in Figure 3.1.

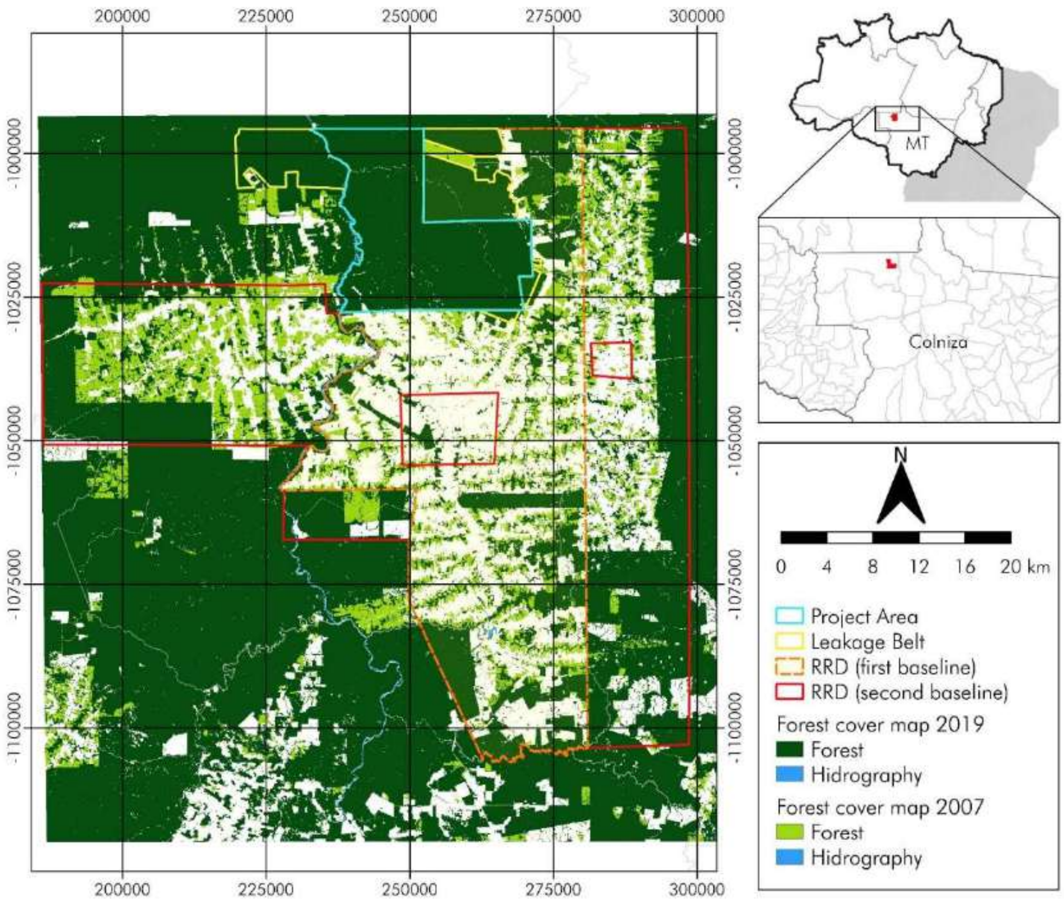

Figure 3.1. Geospatial map representing the new baseline.

[100] Annex: AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

[101] Annex: T-SIG-v1.pdf

The total area of each region is the following: RRD with ha, Leakage belt with 37,887.39 ha, and the project area having 71,317.98 ha. The temporal period adopted to compare the new baseline with the FSM project starts on January 01, 2007 to December 31, 2019. The sources of GHG emissions are in Table 3.1.

Table 3.1. Sources and GHG included within the boundary of the proposed AUD project activity.

<table>
<tr><th colspan="2">Source</th><th>Gas</th><th>Included?</th><th>Justification/Explanation</th></tr>
<tr><td rowspan="8">Baseline</td><td rowspan="4">Unplanned Deforestation</td><td>CO_2</td><td>Yes</td><td>Included as non-CO2 emissions from unplanned deforestation in the baseline scenario, according to the methodology.</td></tr>
<tr><td>CH_4</td><td>No</td><td>Excluded for simplification. This is conservative.</td></tr>
<tr><td>N_2O</td><td>No</td><td>Excluded for simplification. This is conservative.</td></tr>
<tr><td>Other</td><td>No</td><td>No other GHG gases were considered in this project activity.</td></tr>
<tr><td rowspan="4">Biomass Burning</td><td>CO_2</td><td>No</td><td>Excluded as recommended by the applied methodology. Counted as carbon stock change.</td></tr>
<tr><td>CH_4</td><td>Yes</td><td>Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.</td></tr>
<tr><td>N_2O</td><td>Yes</td><td>Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.</td></tr>
<tr><td>Other</td><td>No</td><td>No other GHG gases were considered in this project activity.</td></tr>
<tr><td rowspan="4">Project</td><td rowspan="4">Forest Management</td><td>CO_2</td><td>Yes</td><td>Included as non-CO2 emissions from forest management in the project scenario, according to the methodology.</td></tr>
<tr><td>CH_4</td><td>No</td><td>Excluded for simplification. This is conservative.</td></tr>
<tr><td>N_2O</td><td>No</td><td>Excluded for simplification. This is conservative.</td></tr>
<tr><td>Other</td><td>No</td><td>No other GHG gases were considered in this project activity.</td></tr>
</table>

Carbon pools were elected conservatively. According to module X-UNC "Estimation of uncertainty for REDD project activities", conservative numbers and approaches were adopted and an uncertainty of 0% may be used for this component. The following carbon pools were involved in quantifications:

- Aboveground biomass (Mandatory).
- Belowground biomass (Mandatory).

- Permanent (long-term) wood products.

Deforestation emissions were estimated for 4 forest strata, whose above and belowground carbon pools were previously determined by means of a systematic-sampling forest inventory in the Project Area. It is considered that a certain portion of logged wood is converted into long-term wood products, which serve as carbon pools after deforestation. This content of carbon fixed into long-term wood products was considered in the calculation of net deforestation emissions.

Table 3.2 indicates the recommendations for carbon pool inclusion, as mentioned in REDD Methodology Framework (REDD-MF) Version 1.1. In the VCS recommendation column, the options are:

- M: Modules marked with an M are fully mandatory, their tools and methodology must be used.
- O: Modules marked with an O are fully optional. The indicated pools and sources can be included or excluded as decided by the project. If the decision is to their inclusion, must be considered both in the baseline and project scenarios.
- (m)[1]: Mandatory where the process of deforestation involves timber harvesting for commercial markets.
- (m)[3]: Mandatory modules if the carbon pool is greater in baseline (post-deforestation/degradation) than the project scenario and significant.

Table 3.2. Included carbon pools according to the REED-MF and their recommendations.

Module	Carbon Pool	VCS Recommendation
CP-AB	Above and below ground biomass	M
CP-D	Dead wood	(m)[3]
CP-L	Litter	O
CP-S	Soil organic carbon	O
CP-W	Long-term wood products	(m)[1]

3.3.1 Justification for not including soil organic carbon and litter pools

It is assumed that the Project Activity preserves soil organic carbon pool if compared with BAU activities. Although good pasture management might increase carbon stocks on the soil surface (until 30-cm depth), in comparison with the original forest (Fearnside & Barbosa, 1998), carbon stocks in deeper soil layers will certainly decrease due to pasture activities (Fearnside & Barbosa, 1998). Isotopic assessments (Fearnside & Barbosa, 1998) indicate that soil carbon stocks occurring in depths below 60 cm are reduced after conversion of forest to pasture, owing to the occurrence of increased oxidation in this depth. Similarly, a reduction in soil carbon pool is also reported in the conversion of forest to coffee crops, as indicated in Figure 3.2 (red bars). The reduction in carbon stock due to deforestation is even more pronounced in the litter, as seen in Figure 3.2 (yellow bars). In this context, for conservativeness purposes, project proponents decided not to account soil carbon pool and litter carbon pool in FSM-REDD Project benefits. Thus, in conformity with module X-UNC "Estimation of uncertainty for REDD project activities", a conservative approach was adopted and an uncertainty of 0% may be used for the carbon pool component.

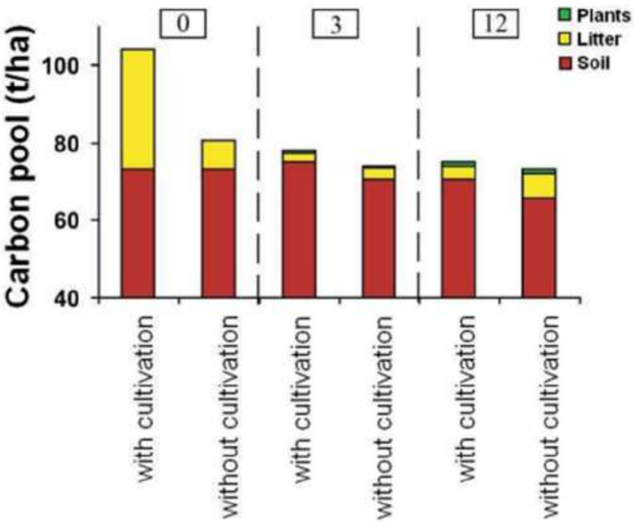

Figure 3.2. Carbon pool in coffee crops.

3.3.2 Justification for not including dead wood carbon pool

The omission of the dead wood carbon pool was determined as a matter of conservativeness, given that in the deforested baseline scenario this carbon pool is likely to be much less than in the project scenario. Even if the dead wood carbon pool is significantly lower in the baseline than in the project scenario, the project proponent opted not to include this carbon pool in the accounting of VCU benefits, according to "REDD Methodology Framework" (REDD-MF) Version 1.6 statement: "Harvested wood products and dead wood must be included when they increase more or decrease less in the baseline than in the project scenario."

3.4 Baseline Scenario

The VCS "Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities" was applied to identify the baseline scenario of the project, as required by the approved VM0007 REDD+ Methodology Framework (REDD+ MF).

Forest land is expected to be converted to non-forest land in the baseline case, deforestation would occur in the project area and the leakage belt, as described below. The landowner cannot afford efforts and costs to keep long-term vigilance of frontiers to avoid unplanned deforestation from uncontrolled invasions. In this context, the project would fall within the category AFOLU – REDD - Avoiding unplanned deforestation and degradation (AUDD).

Degradation was not considered in the present REDD project, in accordance with methodology requirements, which define "forest" and "non-forest" as the minimum land-use and land-cover classes.

3.4.1 Selection of the most reasonable baseline scenario for the project

The FSM farm wouldn't be able to afford large long-term costs and efforts for the vigilance of land property. The company had registered a series of denouncements in the local Police Station (B.O.) and filed lawsuits against land-grabbers and criminal organizations that issued adulterated land documents.

Moreover, the sustainable forest management conducted at the property is under great pressure from other economic activities conducted in the area bordering the property, related to land-grabbing and to extensive cattle-raising, in addition to the difficulties inherent to the development of the forestry stewardship council seal, that undergone through a crisis in Brazil in the final of 2000 decade.

Considering difficulties faced with sustainable forest management and land tenure, land selling can also be an alternative way to alleviate FSM's expenses on land vigilance and juridical assistance. In this latter case, it is highly probable that new landowners will prioritize activities involving deforestation and the installation of the most common land uses in the region (i.e. pasture and coffee cultivation).

In this context, the FSM farm baseline may involve the following non-excluding baseline scenarios:

Scenario 1 – Deforestation and logging

Deforestation and logging are permitted by Law[102] (i.e. out of the Legal Reserve), to generate supplementary incomes to financially support a long-term vigilance system. This scenario would hence involve the total clear-cut deforestation of areas out of Legal Reserve, which is operationally feasible in a period of three years. This scenario is not the most plausible, given that landowners have licensed the area for the forest stewardship purposes before the environmental agency. However, the licensing proceeding is reversible and FSM could request permits for other activities, so this scenario might become possible if landowners officially change the status of forest preservation for lands out of Legal Reserve.

Scenario 2 – Business as usual (BAU) activities

Adoption of common land-use practices in the region (business as usual - BAU), including deforestation beyond limits established by Brazilian Forest Code (generalized non-compliance, typically observed in the farm region). This scenario would involve the deforestation inside FSM farm (Project Area) at a deforestation rate similar to that observed in the Reference Area. This scenario is not the most plausible, as landowners have officially approved a Sustainable Forest Stewardship Plan, which foresees sustainable exploitation of wood and non-wood products in FSM property.

Scenario 3 – Unplanned deforestation

Unplanned deforestation caused by uncontrolled invasions for wood logging and implementation of BAU activities. As described in item "1.13 Conditions Prior to Project Initiation" of this VCS-PD, coffee crops represent about 10% of land use in BAU, while pasture accounts for virtually all the remaining land occupation. The implementation of these BAU activities is usually financed by means of initial capital

[102] Annex: Lei_12.651_Forest_Code.pdf

obtained in wood logging. It is believed that the same rate of deforestation and proportion of land uses observed in the Reference Area might be fairly replicated into the Project Area in the absence of this REDD Project. Moreover, there is strong evidence that unplanned deforestation would transgress the limits imposed by the Brazilian Forest Code, by exceeding the 20% of clear-cut deforestation permitted by Law (general non-compliance observed in the Reference Area). The rate of deforestation calculated for the Reference Area is 1.35%/year. It is assumed that this same rate might be replicated into the FSM property in the absence of the REDD Project.

Description of the baseline scenario adopted

According to the descriptions above, it is expected that unplanned deforestation is most likely to occur in the Project Area in case of absence of the REDD Project. In this context, a rate of deforestation of 1.35%/year is adopted for calculation of FSM-REDD Project benefits. This rate can vary between 0.09 to 2.26%/year considering the new baseline (13.04.2019 – 12.04.2025). Deforestation is considered to occur through clear-cutting of forest logging followed by pasture installation (~90%) or coffee cultivation (~10%).

In absence of REDD project, it is assumed that FSM property would certainly undergo the same deforestation intensity as other neighboring lands, which exhibit deforested areas far above the limits stipulated by Brazilian Forest Code.

As indicated in the VCS Program Guidelines, above- and belowground carbon pools (mandatory) were previously determined by means of a systematic-sampling forest inventory in the Project Area. Considering that the baseline process of deforestation involves timber harvesting for commercial markets, the content of carbon fixed into long-term wood products was also considered in the calculation of net deforestation emissions.

It is assumed that the Project Activity preserves soil organic carbon and litter pools, if compared with BAU activities, as demonstrated in item “3.3 Project Boundary” of this VCS-PD. In this context, for conservativeness purposes, project proponents decided not to account for soil carbon pool and litter carbon pool in FSM-REDD Project benefits.

Fossil fuel emissions were not accounted for the Reference (Baseline) Area or for the Project Activity. It is assumed that the Project Activity also reduces emissions from fossil fuel burning, in comparison with BAU activities. However, this factor was not accounted for conservativeness purposes and difficulties in monitoring during the project period. In conformity with module X-UNC “Estimation of uncertainty for REDD project activities”, a conservative approach was adopted and an uncertainty of 0% may be used for the Project Emissions component.

3.5 Additionality

According to the Verra Standard methodology Section 3.8.9, regarding the renewal of the project crediting period:

> "1) A full reassessment of additionality is not required when renewing the project crediting period. However, the regulatory surplus shall be demonstrated in accordance with the requirements set out in the VCS Program rules and the project description shall be updated accordingly."

Considering this orientation, some adjustments were made to the Additionality section first approved in 2012. The amended text follows below.

3.5.1 STEP 1: Identification of alternative land use scenarios to the AFOLU project activity

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

Unplanned deforestation is caused by uncontrolled invasions for wood logging and implementation of BAU (Businedd as Usual) activities. As described in item "1.13 Conditions Prior to Project Initiation" of this VCS-PD, coffee crops represent about 10% of land use in BAU, while pasture accounts for virtually all the remaining land occupation. The implementation of these BAU activities is usually financed by means of initial capital obtained in wood logging. It is believed that the same rate of deforestation and proportion of land uses observed in the Reference Area might be fairly replicated in the Project Area in the absence of this REDD Project. In this context, comparative investment analysis was mainly focused on these BAU activities.

Sub-step 1b: Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

Pasture

Pasture activities for cattle raising are authorized in the Mato Grosso state. The requirement is attendance to the Brazilian Federal Law 12,651/2012. For properties in the Amazon Biome, the law classifies at least 80% of the property area as Legal Reserve, restricting the activities that could be developed to the remaining only 20% of the property's area. In addition, there are other mandatory regulations that futher limit the legal exploring area, excluding the Permanent Preservation Areas, for example. The landowner must also obtain authorization for clearing the area for pasture.

Since 2014, the Brazilian Central Bank, through the resolution Nº4.327 demands from banks an assessment of socio-environmental risks to approve public financing and the existence of credit and restricts the financing to producers in compliance with environmental laws. However, the fact is that in 2009, when the project started, this type of criteria didn't exist. Also, cattle raising activities increased by 165% between 1985 and 2019 in the Mato Grosso state, from approximately 7.75 to 12.8 million hectares (do Canto et al. 2020). Meanwhile, the native vegetation in the state suffered a reduction of 28%, from 79 million hectares to 57 million (do Canto et al. 2020). This practice is still used mainly due to its low implementation costs and maintenance, along with non-intensive use of labor, and as long as it's held in legal areas. In 2017 the forest deficit in the municipality of Colniza was 37.5%, showing a general non-compliance with the Law, resulting from a systematic lack of enforcement of applicable laws and regulations in the region.

Coffee Crops

Coffee plantations in the Amazon Forest are legal provided landowners abide to 80% Legal Reserve and Permanent Preservation Areas restriction described in the Brazilian legislation, as explained above. The agricultural activities in the State of Mato Grosso increased by 349% from 1985 to 2019, from 2 million hectares to 9 million hectares (do Canto et al. 2020). In the municipality of Colniza, according to the Agricultural and Cattle Raising census done by IBGE in 2006, the agricultural activity carried out by the largest number of properties was coffee crops, with more than 800 properties. In 2017 this number increased by 50%, reaching more than 1230 properties, which is more than double than the second activity executed by the largest number of properties: coin crops with less than 500 properties.

Sub-step 1c Selection of the baseline scenario

As provided in sub-steps 1a and 1b, the most plausible baseline scenario is logging followed by pasture and/or coffee crops, beyond the limits of deforestation stipulated by the Brazilian Forest Code. This is discussed in more details in Section 5.4.

3.5.2 STEP 2: Investment Analysis

This Step determines that the proposed project activity, without the revenue from the sale of GHG credits, is economically and financially less attractive than at least one of the other land use scenarios.

Sub-step 2a: Determine appropriate analysis method

As the FSM-REDD Project generates financial or economic benefits other than VCS related income (i.e. from Sustainable Forest Management), the investment comparison analysis (Option II) was applied.

Sub-step 2b: Investment comparison analysis

Financial analysis on coffee cultivation

Table 3.3 shows a compilation of IRRs (Internal Return Rates) found in Brazilian literature on coffee cultivation, for several regions and activity conditions. According to the literature survey, the return rate from coffee cultivation can be conservatively considered as 10.4% in the worst scenario.

Table 3.3. IRRs (%) for coffee cultivation, compiled from Brazilian literature.

State/Region	IRR (%)	Source
State of Paraná	23.2	(A. J. d. Santos et al., 2000)
Formoso (State of Minas Gerais)	15.6	(Pierdoná, 2009)

State/Region	IRR (%)	Source
Viçosa (State of Minas Gerais)	10.4	(A. d. Arêdes & Pereira, 2008)
State of Espírito Santo	11.8	(Siqueira et al., 2011)
São Sebastião do Paraíso (State of Minas Gerais)	11.5	(Aredes et al., 2008; A. F. d. Arêdes et al., 2008)
Brazilian average	18.3	(Torres et al., 2000)
Coimbra State of Minas Gerais	19.9	(da Fonseca Pereira et al., 2008)
State of Rondônia	20.5	(Kester, 2019)
State of Amazonas	22.7	(Espindula et al., 2022)
State of Paraná	25.4	(Zapparoli et al., 2012)
State of Espírito Santo	20.1	(Souza et al., 2019)
State of Minas Gerais	18.0	(D. F. Santos & Campos, 2019)

Financial analysis on pasture

The displacement of cattle-raising to the Legal Amazon has been stimulated by factors related to financial returns of this activity in that region, considering, for instance, that its Internal Return Rate (IRR) in some regions of the Legal Amazon can be twice as profitable as in the Southeast of the country. According to studies from the University of São Paulo (USP), the profitability of livestock in the Central-West region, as in Alta Floresta (State of Mato Grosso, MT), is twice-fold that observed in traditional regions, compared with the State of São Paulo, for example, in relation to typical lands and production schemes. In Alta Floresta, the activity yields a 14.5% IRR, which is the highest in the region, and 30% higher than the average of the State of Pará (IRRs calculated in local currency). In Tupã, West of the State of São Paulo, for example, the IRR is estimated at 6.43% (J. Silva, 2009). Livestock is the main land use in deforested areas in the Amazon, accounting for 77% of the area converted into economic uses (Schneider et al., 2000).

Table 3.4 shows a compilation of IRRs found in Brazilian literature on cattle-raising, for several regions and activity conditions. According to the survey, we may consider 4.2% as a worst-case scenario (Table 3.4).

Table 3.4. IRRs (%) for pasture and cattle-raising, complied from Brazilian literature.

State/Region	IRR (%)	Source
Legal Amazon	11.5	(Barreto, 2005).
Alta Floresta (State of Mato Grosso)	14.5	(Florestal, 2021; Margulis, 2003; J. Silva, 2009)
Triângulo Mineiro (State of Minas Gerais)	5.1	(MARTHA JÚNIOR et al., 2010)
Legal Amazon	4.2	(Schneider et al., 2000)
Legal Amazon	12.4	(Centro de sesoriamento remoto, 2022)
Pampa biome, southern Brazil	4.6	(Ruviaro et al., 2018)
State of Pará	11.0	(D. C. d. Silva, 2021)
State of Mato Grosso do Sul	13.1	(Araújo et al., 2012)

Sub-step 2c: Calculation and comparison of financial indicators and 2d: Sensitivity analysis

Financial analysis of FSM activities

The current IRRs for FSM activities are presented in Table 3.5 (see Annex for calculations[103]). The WACC (weighted average cost of capital) was set to 12% in all cases. The table demonstrates the estimated return rate of FSM farm with sustainable management (SFM) for timber logging (Scenario 1, CURRENT). The analysis shows that the current return rate from FSM farm activities (sustainable management; 5.94%) is comparable with that observed for the worst scenario of the less profitable alternative activity (pasture; 4.2%; Table 4). Moreover, the IRR from FSM farm activities (excluding REDD revenues) is far below that obtained in coffee cultivation (10.4%, in the worst scenario Table 3.3.

The inclusion of REDD benefits into the FSM revenues would considerably increase (57.8%) the current IRR to 9.37%. A sensitivity analysis of potential IRRs, as a function of different scenarios of exchange rates and VCU prices, is also presented in Table 5. The estimated return rate of 9.41% is comparable with that observed for the worst scenario of the led profitable alternative activity, pasture, with IRR of the 4.2%. Moreover, the IRR from FSM farm activities (excluding REDD revenues) is far below that obtained in coffee cultivation (10.4%, in the worst scenario in Table 3.3. According to the estimates, the inclusion of REDD benefits into the FSM revenues considerably increases the IRR to 36.78% (Scenario 2A).

[103] Annex: FSM-Annex-Additionality.xlsx

Table 3.5. Summary of financial analysis for the FSM activities.

Sensitivity analysis	IRR Project
Financial indicators in different scenarios	**(% yearly)**
Scenario 1A - SFM without VCS benefits	9.41%
Scenario 1B - SFM with VCS benefits	36.78%
Scenario 2A - SFM with VCS benefits and +10% in VCU value	48.74%
Scenario 2B - SFM with VCS benefits and -10% VCU value	24.08%

Note: SFM is the sustainable forest management

To establish the robustness of this conclusion, a sensitivity analysis of potential IRRs as a function of different VCU prices is also presented in Table 3.5. For Scenarios 2A and 2B the VCU price was set to a value 10% higher or 10% lower than that used in Scenarios 1A and 1B, respectively. It is concluded that the IRR could vary between 24.08% and 48.74% in these cases. Comparison with typical BAU return rates reveals that, even in the worst case, the VCS benefits are sufficient to make the sustainable alternative a viable option.

The IRR resume of the values of the literature represented in Table 3.3 and Table 3.4 with the sensitivity analysis values are represented in Figure 3.3. It is even more evident that REDD revenues are crucial to elevate the FSM activity to an attractive economic level thus reinforcing the conclusion obtained in the original PD.

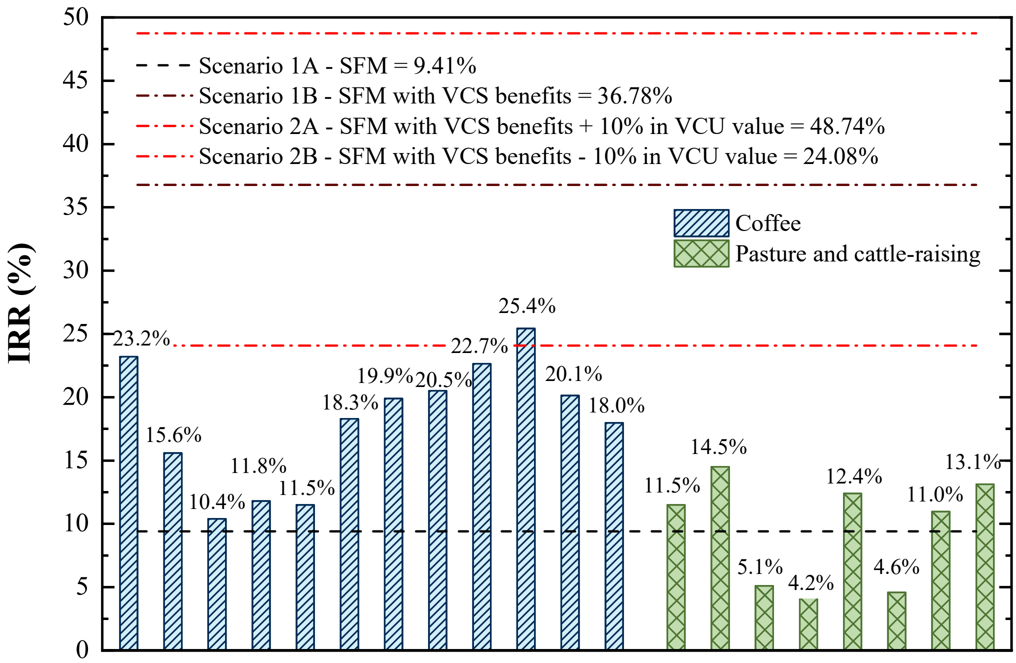

Figure 3.3. Resume of the IRR values. Note: SFM is the sustainable forest management

Since without VCS benefits the IRR from SFM activity is comparable to some other reference values from the BAU activities, it is necessary to discuss the barriers related to the implementation of SFM activity.

3.5.3 STEP 3: Barriers analysis

This Step demonstrates that the proposed project activity faces barriers that prevent it to be implemented without the revenue from the sale of GHG credits.

Complementary considerations

Thanks to the financial benefits explained above, unplanned deforestation pressures are continuously perceived in the Reference Area, and would certainly affect the Project Area in the absence of an effective vigilance system. Colniza municipality is among the 4 municipalities in the state of Mato Grosso with the highest deforestation, with 90% unplanned deforestation with illegal practices (G1, 2022). According to UNISINOS (2017), the current situation in Colniza continues with violent conflicts that operate in illegal logging. The Reference Area and Project Area are subject to serious risks of land-grabbing promoted by illegal organizations (i e. family-scale land-grabber associations, land-property documentation forgers), mostly supported by unscrupulous sawmills and political interests.

In fact, the FSM estate has been invaded several times, which is evidenced by a series of denouncements (B.O.) against land-grabbers and criminal organizations that issued adulterated land documents. Thus, according to VT001 v3.0, the project activity faces the following barriers:

- Lack of enforcement of forest or land-use-related legislation. The Brazilian federal police and environmental agencies did not have enough power or resources to ensure the correct legislation application and monitoring.
- Barriers related to local traditional practices. The local culture and people are very simple, the enforcement to conserve forests aiming to reduce GHG emissions needs a macro-environmental awareness different from what they used to have.
- The project activity is the “first of its kind”: no project activity of this type was operational in the year of 2009 in the host country or region.
- Demographic pressure on the land (e.g. increased demand for land due to population growth).
- Social conflict among interest groups in the region where the project takes place.
- Widespread illegal practices (e.g. illegal grazing, non-timber product extraction, and tree felling).

Therefore, the project maintenance in this region remains of paramount importance to maintain environmental integrity in and around the project area.

3.5.4 STEP 4: Common practice analysis

The practice of the conservation of privately-owned forest areas in the Colniza municipality is extremely rare. In the Mato Grosso state, this practice is not common. In this case, in the FSM project region, there are no areas that are not REDD+ projects were found. There is a conservation unit localized above the project area denominated Parque Estadual Igarapes do Juruena. However, illegal activities are putting pressure on this conservation unit, and in 2021, activities like illegal mining were discovered there (MT, 2021). Thus, unplanned deforestation, pasture, wood management, and coffee cultivation are the dominant practices in the region.

According to the REDDdatabase (2022), there are ten REDD projects and programs ongoing in Mato Grosso state (Table 3.6). Most of these projects are related to restoration, recovery of degraded areas, and indigenous land use change by preventing land conversion. In this case, only the FSM project (current project) is related to a privative area of native forest conserved. In addition, the FSM project is unique in the Colniza municipality.

For the reasons of the essential difference between the FSM Project and similar projects in the area, the proposed project VCS AFOLU activity is not the baseline scenario, and hence it is additional.

Table 3.6. Carbon projects ongoing in Mato Grosso state (REDDdatabase, 2022).

Project name	Localization (municipality, state)	Objective
Halitina RED project	Campos de Julio, MT	The project objective is to reduce GHG emissions from indigenous land use change by preventing land conversion without interrupting the flow of economic resources crucial to the Paresi economic system. The project aims to avoid unplanned mosaic deforestation and degradation and reduce emissions from mature forests under the mosaic configuration.
Carbon Project in the Emas-Taquari Biodiversity Corridor, Goiás and Mato Grosso do Sul, Brazil	Santa Rita do Araguaia, MT	The projet is part of a broader strategy of conservation and restoration of the Cerrado-Pantanal biodiversity corridor. The projects includes the recovery of degraded areas and promotion of gene flow among fauna and flora species, through the creation of biodiversity corridors connecting remaining Cerrado fragments in the area surrounding the Emas National Park, GO, and the Nascentes do Rio Taquari State Park, MS. The project includes the reforestation of 589 hectares using native Cerrado species, especially those strongly interrelated with the fauna and/or those with non-destructive economic uses (non-timber), such as fruits, seeds, fibers, oils, and honey.
Multi-Species Reforestation in Mato Grosso, Brazi	Cotriguaçu, MT	The project aims at the restoration of grasslands that were formerly deforested for the purpose of cattle grazing activities. The project was designed for the following objectives: - Greenhouse gas removals; - Pedagogic activities on carbon sequestration; - Preservation of biodiversity; - Local development
Portal Seeds Project	Nova Guarita, MT	The objective of the project is to guarantee access to natural resources and sustainable development through family agricultural practices. The activities include the diffusion of agroforestry systems which combine the sustainable use of the forest with income generation. The project also includes a component on capacity building for the indigenous communities to collect the seeds that will be used in the agroforestry systems. The project aims to recover 1,200 hectares of degraded areas (restoration of permanent preservation areas and legal reserves) and rescuing of family farming through the introduction of agroforestry systems.
Suruí Forest Carbon Project	Cacoal, Espigão D'Oeste and Rondolândia, RO and MT	The Surui Forest Carbon Project was the first indigenous-led conservation project financed through the sale of carbon offsets. The Surui Carbon Project intends to fund protection, territorial control and local capacity building activities through payments for ecosystem services, especially the marketing of carbon credits, which emerged as a promising new alternative.
Xingu Mata Viva	Santa Cruz do Xingu, MT	The project plans to introduce and to improve the following activities: equipment leasing, grain production, storage and processing, dairy and beef cattle farming, pig farming, poultry farming, aquaculture, exotic species reforestation, wood treatment, feed mills and a thermal power plant.
Teles Pires Mata Viva	Colinder, MT	The project aims to promote sustainable development and environment preservation. Activities currently in place are grain production, beef cattle farming and dairy cattle farming.

Project name	Localization (municipality, state)	Objective
		Other activities will be developed, including poultry grange, aquaculture and exotic reforestation.
FAZENDA SÃO PAULO AGROFORESTRY	Campo Grande, MT	The project consists in the the reforestation of degraded lands, which would continue to remain degraded in the absence of the project. The Project aims to produce timber for different destinations of use.The total area of the Project has an extension of 1,055.6736 hectares and it is located inside the Fazenda São Paulo, a private farm. Two species have been specifically chosen for the afforestation project: Eucalyptus (Corimbia) citriodora and Eucalyptus urograndis (hybrid of E. urophylla e. grandis species).
Carbono Nascentes do Xingu	Santa Cruz do Xingu, MT	The project comprises the restoration of native vegetation in degraded riparian areas on private farms in the basin of the Xingu River in the state of Mato Grosso. The Carbono Nascentes do Xingu Project, part of the Xingu Po and the Y'Ikatu Xingu Campaign
This project - Florestal Santa Maria project	Colniza, MT	The FSM-REDD Project was conceived to give the opportunity for this forest management company to take full advantage of the REDD regulatory system under development by means of the VCS System.

3.5.5 Final Considerations about Additionality

For the aforementioned reasons the additionality of the FSM project in updated data for this reassessment baseline reinforces the conclusion obtained in the original PD. The REDD revenues are crucial to elevating the FSM activity to an attractive economic level. Hence the FSM project is additional to the current baseline.

3.6 Methodology Deviations

According to VCS rules, methodology deviations shall be reported in all subsequent verification reports. Therefore, this section describes all methodology deviations reported in the Joint Project Description and Monitoring Report.

The deviations related only to the criteria and procedures for monitoring or measurement and did not relate to any other part of the methodology. In addition, these methodology deviations, presented from a reliable scientific basis, did not negatively impact the conservativeness of the quantification of GHG emission reductions or removals, as following the methodology VCS Standard v4.3 - section 3.18.

3.6.1 Methodology Derivation

$\mathrm{PROP_{IMM}}$ estimation

In the analysis of leakage outside the leakage belt, for calculating the estimated proportion of baseline deforestation caused by immigrating population ($\mathrm{PROP_{IMM}}$), the participatory rural appraisal (PRA) approach was replaced by local official available data from IBGE. This approach has been used and validated in the documents Project Description: VCS version 3 and Monitoring Report: VCS version 3. This methodology deviation is justified by the fact that IBGE and DataSus databases have a precise approach for accounting population locally, which allowed calculating the number of immigrants from 2015 to 2020 in the municipality of Colniza.

The number of immigrants can be estimated by subtracting the annual population growth from the difference in rates of the number of annual births and death, dividing by the total population (see database from Table 3.7). This technique also assumes that the IBGE assessment is applicable to estimate population migration between urban and rural zones (i.e., there is similar accuracy between urban and rural immigrants' estimations).

Table 3.7. Estimation through local sources in the municipality of Colniza.

Parameter in the municipality of Colniza	Time	Values	References
The total annual population growth	2015-2020	1,257.20 inhab. $year^{-1}$	(IBGE, 2020)
The number of annual births	2015-2020	513.00 inhab. $year^{-1}$	(DataSus, 2020b)
The number of annual deaths	2015-2020	121.20 inhab. $year^{-1}$	(DataSus, 2020a)
The total population in 2020	2020	39,861.00 inhab.	(IBGE, 2020)

TOTFOR, PROTFOR and MANFOR estimations

Furthermore, due to the large extension of Brazil, the determination of the total available national forest area (TOTFOR), the total area of fully protected forests nationally (PROTFOR), and the total area of forests under active management nationally (MANFOR) were estimated based on the Amazon biome.

As Brazil has many forest biome types in its large extension, the conservative approach was considered assuming only the Amazon Rainforest biome in the TOTFOR parameter. Thus, as a representation of the total area of the Amazon Rainforest in Brazilian Territory, TOTFOR consisted of the total area of 501,499,993.66 ha (IBGE, 2021) multiplied by the net preserved forest (0.97) (SEMA, 2022), resulting in 486,454,993.85 ha.

As the Amazon biome is localized in Brazilian Northern and Centre-West macro-regions, the PROTFOR and the MANFOR parameters consider these regions. In addition, the value of PROTFOR includes the Conservation Units (UCs) instituted by Federal Law Nº.9985/2000: i) integral protection units and ii) sustainable use units. Therefore, the PROTFOR and MANFOR used are 128,899,480.00 ha (Murer & Futada, 2022) and 1,400,000 ha (IBAMA, 2020), respectively.

3.6.2 Project Description Deviations

Change of company name of the Project Proponent

Considering that Verra allows that throughout the project, proponents can change, and considering the necessary legal procedure for this stipulated in section 7.2.1 of the Registration and Issuance Process Document "Where a project has one project proponent only, and the project proponent wants to leave the project in favor of another entity, this is handled by having the new entity accede to the project via an accession representation and the original project proponent released from the project via a release representation." In December 2021, the parties signed the Deed of Accession[104] and Deed of Partial

[104] Annex: Deed of Accession – December 2021.pdf

Release[105] in order transfer the project (Florestal Santa Maria Project ID 875) to Caraguá Agronegócios, and on May 17, 2022 Verra Registry approved the request to change project proponents[106], making Caraguá company the sole proponent of the REDD project Florestal Santa Maria.

FSC certification for forest management

The areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. The documents showing the management areas exploited within this period are available for consultation by auditors. These documents will be kept safely for two years after the final credit period of the FSM project. So, the baseline and project emissions in this verification period were not quantified.

Despite the lack of FSC certification in this period, from the beginning of 2022, the new proponents of the project began the process of recovering the FSC certification, based on a series of adaptations and training[107,108] in line with the principles of the FSC, culminating in the renewal of the FSC certification in July 2022[109,110]. Considering this, all UPAS that will be exploited from this date can be included in the project again, and due to these the ex-ante calculations benefits from VCUs from 2022 onwards were estimated for the entire project area without excluding any UPA. However, during the next monitoring period, the validity of the FSC certification must be confirmed again for the ex-post calculations, and in case of a new absence of certification, the same conservative procedure for excluding the UPAS exploited from the project area at the time of the calculation of the benefits of VCUs should be applied.

Leakage belt area

During the baseline review process, the leakage areas were reassessed in accordance with the requirements of the approved VCS module VMD0007. Although the leakage areas at the time of validation are similar to the project area according to landscape, transport, political and social factors (criteria "d", "e", "f" and "g" of module VMD0007). It is understood that leakage belt areas do not meet criteria "a" and "c".

According to criterion “a”, the leakage belt area must be the forest areas closest to the project area meeting the minimum area requirement. This criterion is not met because the leakage areas established are not close to the project's forest areas, since some of the polygons in the leakage belt are located at a distance of approximately 60 km from the project area. Such distancing is not expected during the

[105] Annex: Deed of Partial Release – April 2022.pdf

[106] Annex: Verra Registry Project Transfer Approved.pdf

[107] Annex: Anexo_Palestra_Segurança_Trabalho_Normas_Internas.pdf

[108] Annex: Treinamento_Impacto_Reduzido

[109] Annex: FSC certification_site information.PNG

[110] Annex: FSC certification.pdf

establishment of leakage areas, as this can create additional difficulties during the management, accounting, and mitigation of leakage.

According to criterion "c", the leakage belt must not be spatially biased in terms of distance of edge of belt from edge of project area without justification based on agent mobility or criteria for landscape and transportation. This criterion is also not covered since the leakage belt areas are spatially distant from the edges of the project areas without any justification considering the mobility criteria of deforestation agents. As mentioned above in criteria "a", it is expected that the leakage areas are located within a buffer around the project, and in the absence of a sufficient amount of forest meeting the criteria of similarity of landscape and transport, the methodology foresees a relaxation of up to ±50% on these criteria (see Minimum Leakage Belt Area requirements on VMD0007).

It is also important to mention that during the second monitoring report[111] of the project, a leakage of 1,110.0 hectares was observed and accounted for between 2018 and 2019, which resulted in a leakage emission of 628,991.4 tCO_{2e}. Considering the magnitude of this activity shifting inside the Leakage Belt, a due diligence process was initiated to identify the agents of deforestation and propose mitigation and control measures. With this, it was possible to identify that the deforestation agent related to the deforestation observed in the leakage belt at that moment differs from the expected deforestation agents to cause unplanned deforestation in the absence of the project, which are mainly the settlements and family-scale land grabbers (holding less than 150 hectares of land) located around the Project Area. The result of the investigation process showed that in fact the deforestation observed was caused by a company that owns an area of more than 40 thousand hectares, evidence will be provided to the auditor[112]. The project proponents are in contact to try to propose solutions to mitigate and control this deforestation through technical assistance, financing in the carbon market and REDD mechanisms.

Considering all these facts, during this baseline revalidation a new leakage belt was established from the application of the approved module VMD0007, and all the analyzes of similarities developed and justifications for each criterion can be found in chapter 4 "Baseline Emissions", within the item "Definition of Boundaries".

Location analysis

The approach used in the first baseline period in the documents (i) Project Description: VCS version 3 and (ii) Monitoring Report: VCS version 4.0, corresponds to the transition configuration without the location analysis. As in the second baseline, about 6.5% (less than 25%) of the project geographic boundary is within 50 m of land that has been anthropogenically deforested within the 10 years before the project start date, and the location analysis was required.

According to the methodology, a risk map in the reference region for projecting the location of deforestation (RRL) and allocating the deforestation rate to estimate the deforestation that affects the project area is required. Although this makes sense in the project's first period because the risk map

[111] Annex: FSM_REDD_MR2_04_03_2021.pdf

[112] Annex: due_diligence_observed_leakage.png

does not influence the project area, the project baseline reassessment effect coexists with the historical period. In this case, the AUD project has a positive influence resulting in almost non-existent risk in the project area. Therefore, another approach that achieves the same level of accuracy was taken in this baseline reassessment, in which the risks from the outside project area were allocated in the project area.

In this case, the project area was used as a factor both in the confirmation and baseline projection stages. However, it was treated differently when predicting confirmation-period and baseline-period deforestation. This is because the purpose of the model is different in each case: in the confirmation, stage one seeks a description of what happened during the confirmation period. In contrast, when projecting future baseline deforestation, one seeks to understand what would happen in the region in case the project ceased to exist.

To cope with this change in perspective the weight of evidence associated with the presence of the project area was altered when predicting future deforestation (otherwise the area will once more act as a major deforestation inhibitor which, we emphasize, is incorrect given the scenario that one is seeking to describe). The question then is how to introduce a sensible modification. So, different models were evaluated, and the high value of the figure of merit (FOM) was used as a criterion according to the methodology. Details of this application are described in Section 4.1.3.

LFME estimation

The deduction factor (LFME) was adopted as 0.7 instead of 0.2 (Monitoring Report) or 0.4 (VCS-PD) since the percent of merchantable biomass is greater in the Project Area than in the average Amazon Biome. It is important to consider that the Market Leakage is not calculated only for the Reference Area, but for all Amazon Biome. In addition, this factor is estimated considering the relation between the percent of merchantable biomass in the Amazon Biome and in the project area. Just in relation the biomass in the forest, as considered in the monitoring report, differs from the VMD0011-LK-ME-v1.1 methodology required.

According to the VMD0011-LK-ME-v1.1 methodology, deduction factors for LF_{ME} is defined by:

$$\mathrm{PML_{FT}} = \pm 15\%\ \mathrm{to PMP_i} \qquad \mathrm{LF_{ME}} = 0.4$$

$$\mathrm{PML_{FT}} > 15\%\ \text{less than}\ \mathrm{PMP_i} \qquad \mathrm{LF_{ME}} = 0.7$$

$$\mathrm{PML_{FT}} > 15\%\ \text{greater than}\ \mathrm{PMP_i} \qquad \mathrm{LF_{ME}} = 0.2$$

Where:

$\mathrm{PML_{FT}}$	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type (%)
$\mathrm{PMP_i}$	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary (%)
$\mathrm{LF_{ME}}$	Leakage factor for market-effects calculations; dimensionless

The deduction factor (LF_{ME}) was adopted based on the relation between mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type ($\mathrm{PML_{FT}}$) and merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary ($\mathrm{PMP_i}$).

- The $\mathrm{PML_{FT}}$ is estimated considering the literature data. According to Homma (2011) from 45 billion m^3 of Amazon wood stocks, almost 15 billion m^3 was marketable. Thus, the $\mathrm{PML_{FT}}$ adopted is 31% for legal Amazon.
- The $\mathrm{PMP_i}$ is calculated from forest inventory. In the update forest inventory, commercial biomass was estimated through the allometric equation conforming described in Section 4.1.4 Characterization of biomass in Project Area. According to the VMD0011-LK-ME-v1.1 methodology, the merchantable biomass is defined by the total gross biomass (including bark) of a tree 40 cm DBH or larger from a 30 cm stump to a minimum 10 cm top of the central stem. In this case, $\mathrm{PMP_i}$ is calculated as the ratio between marketable biomass of DBH trees higher than 40 cm (14,207,847.38 t)[113] and total biomass (25,734,621.53 t)[114], resulting in 55%.

Hence, like $\mathrm{PML_{FT}} >$ 15% less than $\mathrm{PMP_i}$ the leakage factor for market-effects calculations adopted is 0.7. In other words, it is expected that the areas to be deforested in the Amazon Biome in the presence of the project are greater than would be observed in the project region.

Field Inventory of Biomass

A new forest inventory was performed for this second baseline period. As required by the methodology, the baseline reassessment process (10 in 10 years) entails updating the biomass inventory with data collected in the field, using the same procedures defined in the first baseline and described in the Standard Operating Procedure (SOP)[115], which is available for consultation by the auditors, and the results obtained for biomass carbon stocks were described in Section 4.1.4.

However, during this new inventory, it was decided not to inventory the palm trees due to the difficulty in measuring tree heights in the field, once palms are evolutionarily, morphologically, and physiologically distinct from other trees, using the same method to measure the biomass of trees and palms may neglect substantial amount of carbon sequestered because the specific measurement of palms takes into account height and diameter (Muscarella et al., 2020).

Also, according to approved VCS module VMD0001 "Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools (CP-AB)[116]". Non-tree aboveground biomass must

[113] Annex: Forest inventory_DBH 40.xlsx

[114] Annex: Forest inventory total.xlsx

[115] Annex: SOP - Standard Operating Procedure

[116] Annex: VMD0001-CP-AB-v1.1.pdf

be included as part of the project boundary only if the following applicability criteria are met (per framework module REDD-MF):

- Stocks of non-tree aboveground biomass are greater in the baseline than in the project scenario, and;
- Non-tree aboveground biomass is determined to be significant (using the T-SIG module).

Considering the methodology requirements, non-tree aboveground biomass should only be considered if it is a significant component of the ecosystem, otherwise, they should not be measured, which is conservative, as their biomass is very reduced in the LU/LC classes adopted after deforestation in this project (mostly pasture). Thus, the exclusion of non-tree aboveground biomass at the time of this inventory is considered conservative and is supported by the approved methodology requirements.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

According to VCS requirements, the baseline must be reassessed because projections beyond the baseline reassessment period are not likely to be realistic because rates of change in land-use and/or land are subject to many factors that are difficult to predict over the long term.

Considering this, the development of the baseline reassessment for project baseline emissions from unplanned deforestation, both rate and location, was conducted in conformance with the latest approved version of the methodology VCS modular REDD+ Methodology Framework VM0007 Version 1.6, specifically the BL-UP (VMD0007 Version 3.3) module using the simple historic approach.

The objective of this baseline reassessment was to capture changes in the drivers and behavior of agents causing land use changes, as well as changes in carbon stocks, with such changes being incorporated into revised estimates of the rates and patterns of change in the land use and baseline emissions estimates. Ex-ante baseline projections beyond the defined baseline reassessment period have not been estimated as they are not required.

4.1.1 Definition of Boundaries

The analytical domain from which information on the historical deforestation rate was extracted and projected into the future is described in the sections below.

Reference Region for Projecting Deforestation Rate (RRD)

According to the module requirements, the reference region for projecting the rate of deforestation does not need to be contiguous and must not encompass the project area or the leakage belt. The RRD can be composed of several parcels that do not have to be contiguous and must meet the minimum size requirements.

Considering the project area (71,317.98 ha), the minimum size of the reference region for projecting rate of deforestation (MREF = 214,299.41 ha) was determined using Equation 1 and Reference Area Factor (RAF = 3.0) by Equation 2 from the approved methodology VMD0007 (BL-UP).

$$\mathrm{MREF} = \mathrm{RAF} * \mathrm{PA}$$ Equation 1

$$\mathrm{RAF} = 7500 * \mathrm{PA}^{-0.7}$$ Equation 2

Where:

MREF	Minimum size of reference region for projecting rate of deforestation; ha
RAF	Unplanned deforestation project area; ha
PA	Reference Area Factor. Factor to multiply times project area to get minimum reference area; dimensionless

However, the forest area on the original RRD at the start of the new historical reference period (12 years prior to the second baseline start date) was equivalent to 192,154 hectares, not meeting the minimum amount of forest to be valid for this baseline reassessment.

In this way, a new RRD was established based on the criteria of main agent(s) of deforestation, which are mainly the settlements and family-scale land grabbers (holding less than 150 hectares of land) located around the Project Area, as well as landscape, transportation, social, policies and regulations factors. Planned deforestation was also excluded from the reference region, and all the detailed analyses performed for the delimitation of the RRD can be found in the section below entitled Similarity Analysis for Spatial Boundaries.

The RRD reassessment determination was crucial for better deforestation representative in the second baseline period and the resulting RRD forest area in 2007 was 418,160.25 ha corresponding to the delineated orange area shown in Figure 4.1. Therefore, the RRD complies with the standards required by VMD0007 (BL-UP): (i) composed of discontinuous areas which 100% forest at the start historical period; (ii) it excludes the project area, the leakage belt, and all non-forested areas; and (iii) the RRD is large than the MREF.

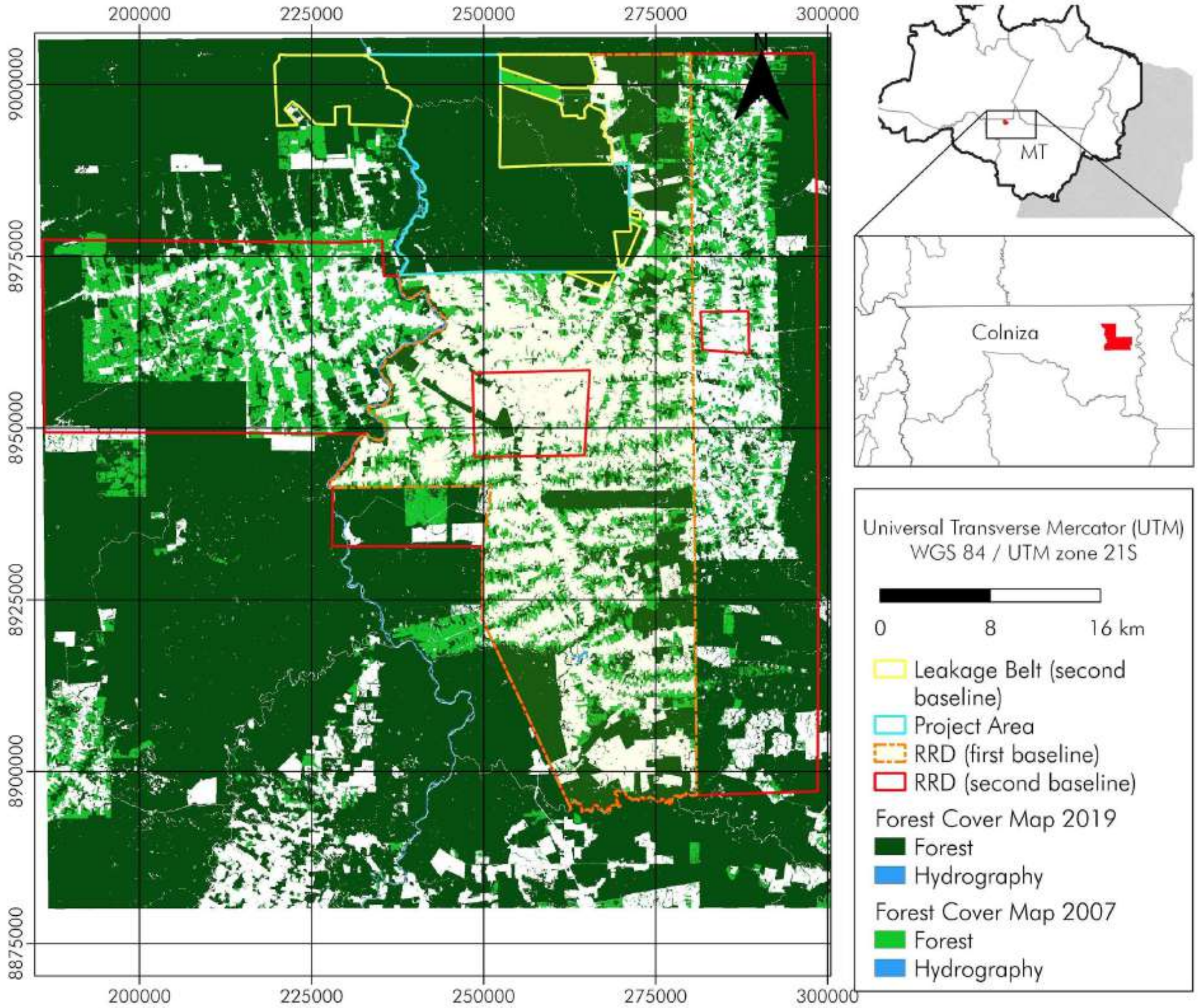

Figure 4.1. Reference Region in the first and second project baselines.

Reference region for projecting location of deforestation (RRL)

The Project Area is located in a transitional configuration and does not have ≥ 25% of its geographic boundary within a 50 m distance of land that has been anthropogenically deforested in the 10 years prior to the start date of the second project baseline. In this case, according to the methodology, the location analysis is always necessary, and with that, a reference region for projecting location of deforestation (RRL) must be established.

The area RRL delimited equivalents 789,120.63 hectares (Figure 4.2). In agreement with the methodology, it is a single parcel, contiguous with and including the Project area and the Leakage belt. Further, it is 41% non-forest and 59% forest and thus in compliance with the methodological requirements of a minimum of 5% non-forest and a minimum of 50% forest, at the start of the project. The forest area of the RRL totals 468,613.62 hectares, which is within ±25% of the size of the RRD. Therefore, the RRL complies with the standards required by VMD0007 (BL-UP).

Protected forests where protected status is enforced have been removed from the RRL as required by methodology. In addition, at the start of the baseline period, RRL has the same proportion of forests suitable for conversion to the land-use practices of the deforestation agents as the project area (±30%), as demonstrated in the similarity analysis below.

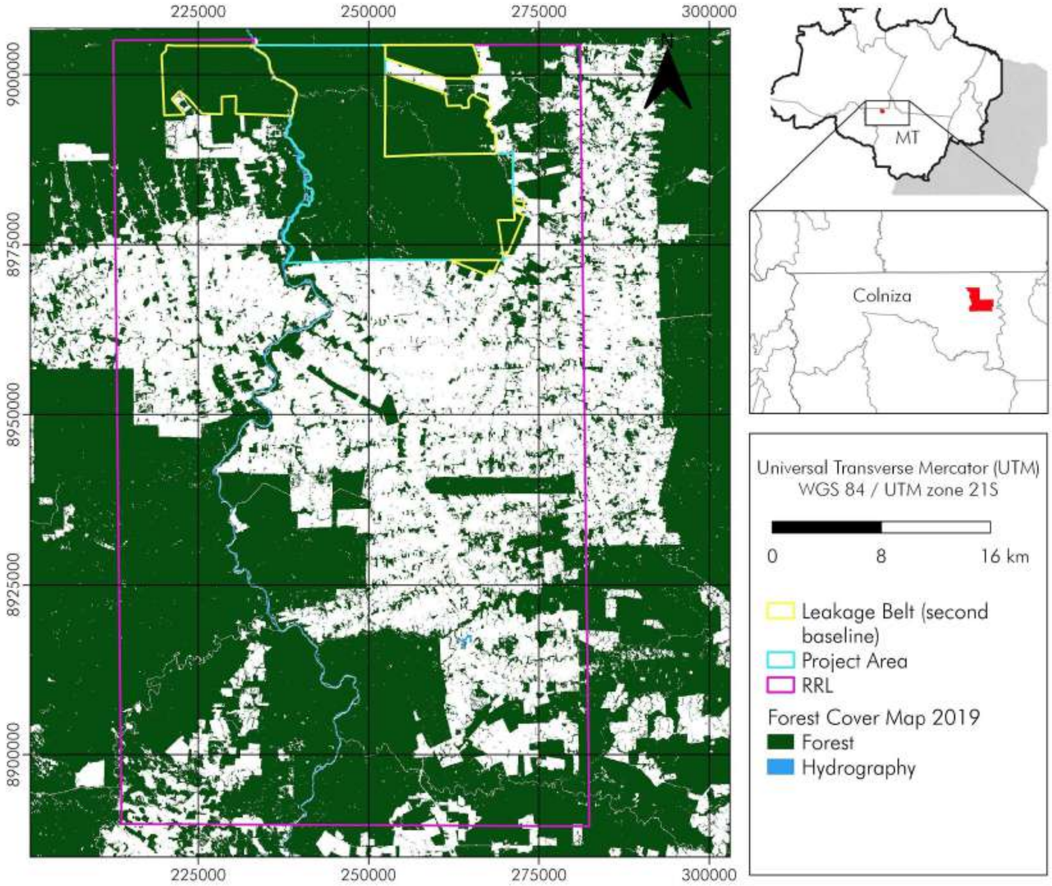

Figure 4.2. Reference region for projecting location of deforestation (RRL).

Project area

The Project Area total area is 71,317.98 ha and meets the requirements of being a discrete parcel of land which is under threat of deforestation, and on which the project developers will undertake the project activities and that is 100% forest land at the start date of the REDD project.

Leakage belt

The leakage belt area delimited in the first baseline was reassessed according to the module VMD0007 (BL-UP), to check if the original leakage belt area still meets the criteria required. However, however, and as already discussed in Section 3.6.3 (Project Description Deviations), the original leakage belt area was not located surrounding or immediate vicinity of the Project Area and was not spatially biased in terms of the distance of edge of belt from edge of project area without justification based on agent mobility or criteria for landscape and transportation.

Without meeting these criteria, the original areas of the leakage belt were located far from the project area, with some polygons located at approximately 60 km from the project area, which creates additional difficulties for any type of activity that aims to monitor, control, and mitigate potential leakage caused by project activities. Furthermore, and as already demonstrated from the investigative due diligence carried out in the original leakage belt areas of the project, it was concluded that the deforestation agent related to the observed deforestation in 2018 and 2019 differs from the deforestation agents expected to cause unplanned deforestation in the absence of the project, which are mainly the family settlements and squatters (less than 150 hectares of land) located around the Project Area. Based on these facts, it was concluded that the original leakage areas were no longer valid according to the methodology requirements.

In this way, a new leakage area was delimited to meet the methodology. The leakage belt drawn to the second baseline covers 37,887.39 hectares and was allocated surrounding the project area on forest areas spatially closest in terms of distance of edge of belt from edge on (Figure 4.3).

Therefore, all parts of the new leakage belt are accessible and reachable by project baseline deforestation agents with consideration of agent mobility or criteria for landscape and transportation. The similarity between leakage belt areas with the project area is presented in the similarity analysis below.

Although the leakage belt road density (m/km^2) and populational density (number of people/km^2) are not the same as Project Area and RRD, at the start of the historical reference period, however, it is similar because it fits into the relaxation of similarity requirements in transportation factors. The Leakage Belt's Forest area is equivalent to 37,629.45 hectares, corresponding 52.76% of the Project Area, thus is less than 75% forest area relative to Project Area, and according to the relaxation criterion (i.e., relaxation from ±20% to ±50%), it meets the methodology with similarity requirements in d and e relaxed to ±50%. and conforms to the criteria similarity of spatial databases (e.g., vegetation map, soil suitability map, DEM for slope and elevation) and transportation factors (e.g., navigable rivers, road density, and density of people) in forest area, relative to Project Area (Emmer et al., 2020).

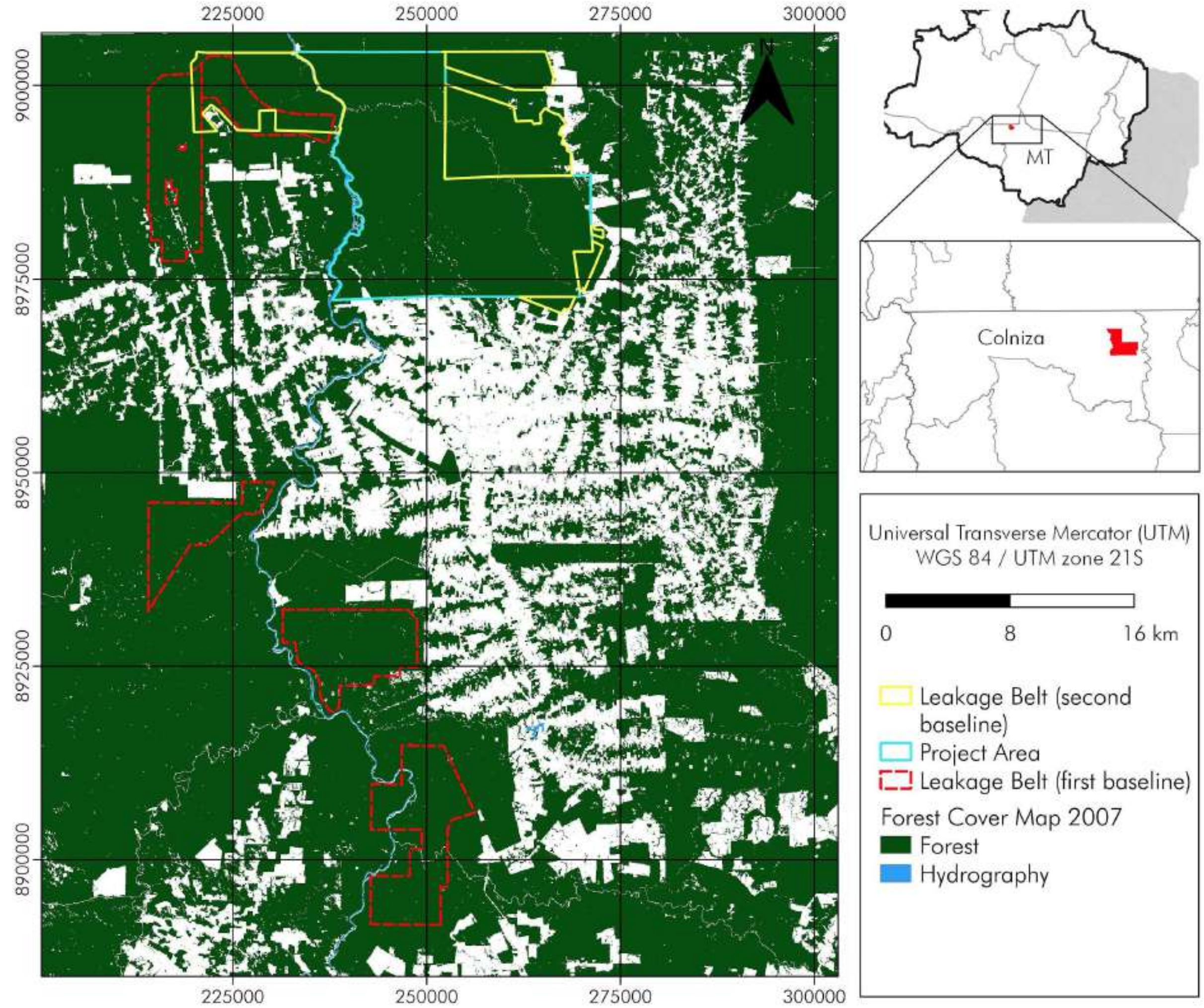

Figure 4.3. Leakage Belt comparison between the first and second project baselines.

Similarity analysis

The similarity analysis between project area (PA) and reference areas (RRD and RRL) and leakage belt (LB) were explored by the following criteria:

The main agents of deforestation

There are the same main agents of deforestation in the project area, RRD, RRL, and leakage belt, being direct or indirect agents. The main agents of direct deforestation are small-scale family farmers who want to establish or expand pastures and cropland through forest conversion. The initial settlements often made by family farmers in the region were subsequently supplanted by large ranches (Carrero & Fearnside, 2011). The indirect agents of deforestation, are defined as complex interactions of social, economic, political, cultural, and technological processes that affect the system and can cause deforestation or forest degradation. Increased demand for timber and agricultural products (primary commodity exports) are critical indirect drivers (Kessy et al., 2016).

Landscape factors and transportation networks, human infrastructure, and weather factors

The landscape, transportation factors, and weather factors used in the similarity analysis were estimated using the variables: (i) vegetation type, (ii) temperature, (iii) soil type, (iv) precipitation, (v) slope, (vi) elevation, (vii) road density, (viii) settlement density, (ix) navigable rivers (Figure 4.4).

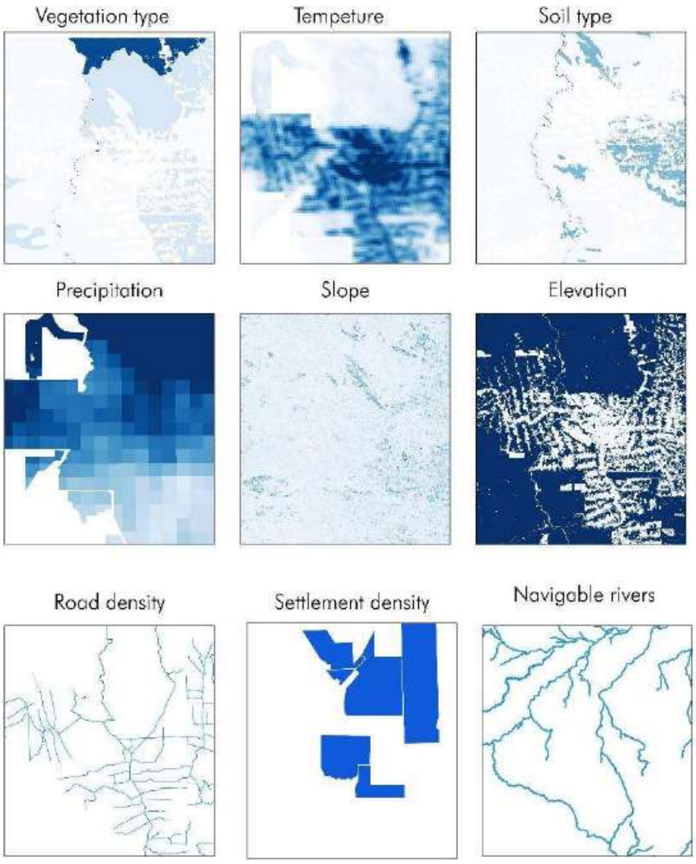

Figure 4.4. Landscape and transportation variables used in the similarity analysis.

The landscape factors criteria and transportation factors of the project area with leakage belt, RRL, and RRD areas were in Table 4.1 and Figure 4.4. All the parameters analyzed for each spatial boundary are in conformance (± 20%) with the project area at the start of the historical reference period. General climate patterns (temperature and precipitation) are considered similar in all areas, which determines the occurrence of similar vegetation types inside the PA, RRL, RRD, and LB. In all areas considered in the analysis, the vegetation types classed as "Fo" and "Fe" ("*Floresta Ombrófila* e *Floresta Estacional*", (Geoportal, 2022; IBGE, 2022a) is predominant, which demonstrates similarity among the areas studied, in conformity with methodology requirements.

Table 4.1. Landscape factors criteria and transportation factors.

	PA [a]	LB [a]	RRD [a]	RRL [b]

Landscape factors	Forest classes	%	%	%	%
	Fe - Floresta Estacional	2.0%	0.9%	2.2%	1.1%
	FeS - Contato Floresta Estacional / Savana	0.0%	0.0%	0.0%	0.0%
	Fo - Floresta Ombrofila	98.0%	99.1%	97.7%	98.8%
	Fr - Formacao Riparia	0.0%	0.0%	0.0%	0.1%
	Fs - Formacao Secundaria	0.0%	0.0%	0.0%	0.0%
		100.0%	100.0%	100.0%	100.0%
	Soil classes	%	%	%	%
	Argissolo	80.5%	71%	79%	83%
	Latossolo	2.4%	21%	2%	4%
	Neossolo	16.6%	7%	19%	13%
	Corpo d' Água	0.6%	0%	0%	0%
		100.0%	100.0%	100.0%	100.0%
	Elevation	%	%	%	%
	0 - 500 m	100.0%	100.0%	100%	100%
	> 500 m	0.0%	0.0%	0%	0%
		100.0%	100.0%	100.0%	100.0%
	Slope	%	%	%	%
	Gentle (< 15%)	87.2%	91.3%	80%	88%
	Steep (>= 15%)	12.8%	8.7%	20%	12%
		100.0%	100.0%	100.0%	100.0%
Weather factor	Precipitation	mm $year^{-1}$	mm $year^{-1}$	mm $year^{-1}$	mm $year^{-1}$
		2,311.27	2,335.22	2,270.06	2,254.80
	Temperature	ºC	ºC	ºC	ºC
		28.13	28.14	29.83	29.35
Transportation factors	Roads	m km^{-1}	m km^{-1}	m km^{-1}	m km^{-1}
		58.70	0.03	70.67	n.a.
	Population density	n of person km^{-2}	n of person km^{-2}	n of person km^{-2}	n of person km^{-2}
		3.64	0.25	4.60	n.a.

[a] The data values from project area (PA), leakage belt (LB), and reference region for projecting rate of deforestation (RRD) correspond to the start of the historical reference period (2007). [b] The data of reference region for projecting location of deforestation (RRL) correspond to the start of the baseline period (2019). In this case, PA's landscape and transportation factors are the same in 2007 and 2019. Road density and population density for RRL has not been estimated as it is not mandatory.

It is noticed that the presence of roads is a very determinant driver in explaining deforestation risks. The FSM farm has 7 fixed vigilance points distributed all along with the property, which control all entrances and boundaries of the farm. The portion southeast of the farm is the most critical in terms of invasion risks, as several roads and trails have been made to access farm boundaries. Over time, small areas, adjacent to already cut-down areas, are predominantly cleared, often with additional deforestation along road axes (Halbgewachs et al., 2022). The roads allow human occupation, but in return lead to the destruction of forests. There are two types of roads in the region: official and unofficial roads. The first ones link the Northern region to the rest of Brazil and the unofficial roads connect local sites and are not reported in the official data by the DNIT (National Infrastructure and Transport Agency) and by IBGE (GROSSO, 2009). Hence, like the RRD, RRL, and the leakage belt areas were contemplated around the project area, the influence of transport networks and human infrastructure are alike, also, LB is similar because it fits into the relaxation of similarity requirements in transportation factors. The results of the geospatial analyzes carried out for the variables are also presented in Table 4.1 and Figure 4.4.

Social and economic factors

In Colniza municipality the same social and economic factors are contemplated. According to the population, estimate carried out by the Instituto Brasileiro de Geografia e Estatística (IBGE) (2018), in 2010, the Colniza municipality had about 41,117 inhabitants with a population density of 0.94 inhabitants km^{-2}. In 2019, according to IBGE data, the economy of Colniza produced a *Produto Interno Bruto* (PIB) of R$ 14,598.35, being the first in the production of coffee and cocoa, the second in the production of cassava, the fourth in the production of Brazil nuts, the sixth in the production of orange and watermelon, and the production of bananas. In addition, the livestock in the municipality is formed by fish farming. There are 160 tons between painted, tambacu, and tambaqui. The bovine herd has 642.7 thousand heads, of which 8.4 thousand cows are milked, with 11.4 million liters of milk. Poultry farming totals 150,500 chickens, in addition to 620,000 dozen eggs. The swineherd accounts for 12,490 heads, of which 3,227 sows. Moreover, according to Survival (2018) 90% of Colniza's income comes from illegal logging. So, there are indigenous territories under a lot of pressure from invasions.

Access to markets

Market access refers to the ability of a company or country to sell goods and services across borders. Market access can be used to refer to domestic trade as well as international trade, although the latter is the most common context. As the RRL/RRD/LB are close to the project area, the access to roads and hydrous bodies are similar. Moreover, the government taxes, tariffs, duties, and quotas are the same because these areas are localized in the same municipal, state, and country. Therefore, there are similarities in the market access between the project area and RRD/RRL/LB.

Policies and regulations

Since both areas are in the same municipality of Colniza in Mato Grosso (MT) state, policies and legislation related to the environment and land ownership are the same for both areas. Furthermore, the regulatory, command, and control bodies related to Brazilian forest law are the same throughout the MT state. In this case, the same difficulties in enforcing forest legislation in the reference area will apply to the project area. Therefore, the boundary of the RRD/RRL/LB does not cross into another subnational unit that does not have equivalent policies or regulations.

Exclusion of planned deforestation

The planned deforestation areas were excluded from the reference region boundaries based on data and evidence made available to Secretaria de Estado de Meio Ambiente (2022) from Mato Grosso State sources.

Temporal Boundaries

The temporal boundaries of the FSM REDD Project are listed below:

- **Start date and end date of the historical reference period:**

- First historical reference period: July 15, 1999 to August 14, 2010.
- Second historical reference period: January 01, 2007 to December 31, 2019.

- Start date and end date of the project crediting period:
  - April 13th, 2009 to April 13th, 2039.
- Start date and end date of the project baseline periods:
  - First baseline period: April 13th, 2009 to April 12th, 2019 (10 years).
  - Second baseline period: April 13th, 2019 to April 12th, 2025 (6 years).
- Date at which the project baseline will be revisited:
  - April 13th, 2025.
  - According to VCS requirements, the new baseline reassessment period has been updated from 10 to 6 years for AUDD, APDD (where the agent is unknown), AUC, and AUWD type projects.

4.1.2 Annual Areas of Unplanned Deforestation

Collection of appropriate data sources

Annual dataset land cover maps for the historical reference period 2007, 2010, 2013, 2016 and 2019, was obtained through Collection 6's Mapbiomas images (MapBiomas, 2015), which is a platform that produces historical maps from Landsat satellites images with resolution 30 meters through a pixel-by-pixel based machine learning algorithms classification using Google Earth Engine. The Mapbiomas methodology uses image with minimal cloud cover product of Landsat scenes mosaicked from various months of the year (MapBiomas, 2015).

Mapping and Calculation of historical deforestation

All the mapping data considers forests by eliminating secondary vegetation based on the methodology described by Silva Junior et al. (2020). This step was necessary to filter only primary forests. Also, with the objective of reducing the classification error between forest cover maps, a PRODES hydrography mask (FG Assis et al., 2019) was downloaded by *TerraBrasilis platform* and added in each forest cover maps map, in this way, this land use class remained unchanged in all years.

All other uses except primary forest and water were reclassified as non-forest. As a result of this processing, obtained annual land cover maps with three classes: forest, non-forest, and water.

To generate the deforestation maps, a cross-tabulation was made between land cover maps of the previous year and the following year, where the pixels that did not change were considered as stable forest; pixels that were converted from the forest class to the non-forest class were classified as deforestation; pixels that were converted from non-forest to the forest were classified as an error because the masking in the previous processing excluded the possibility of regeneration, that is, of secondary forests. There were no dynamics/changes in the hydrography class, due to the same mask for all years.

The areas of planned deforestation provided by the Mato Grosso State Secretaria (SEMA, 2022) were discounted from the area of unplanned deforestation and reclassified as authorized/planned deforestation for the year in which the license was issued and for all years after the overlapping deforestation to the polygon of the respective deforestation authorized by the environmental agency, distinguish legal deforestation from illegal deforestation. Thus, the values represented in this section correspond only to the rate of unplanned deforestation of the primary forest.

Map Accuracy Assessment

As required by VMD0007-BL-UP, a verifiable accuracy assessment of the maps produced in the previous sub-step is necessary to produce a credible estimate of the historical deforestation rate. Although the 30 m medium resolution Landsat imagery from MapBiomas was used in the calculations, and this meets the minimum pixel resolution and accuracy requirements, once MapBiomas products have an average accuracy of 95% (Souza Jr et al., 2020). An independent verifiable accuracy assessment was performed using a high-resolution image with 5 m resolution from Planet Image to confirm the minimum map accuracy of 90% for each land use class used. All the details of the methodology used, and the result of the accuracy analysis is available in the annex[117].

Estimation of the annual area of unplanned baseline deforestation in the RRD

The deforestation rate calculation considers the choose the conservative option, which reported the pattern of deforestation in recent years considering the methodology description. Following Figure 4.5, the red dash line highlighted the change in the deforestation pattern starting in 2008 (corresponding to a 10-year time).

In this case, the deforestation average since the project's start historical period (1999) did not correspond to the actual reality. Therefore, for the second baseline period, the calculation period starts from 2007 to 2019 covering no more than 12 years with a 3-year interval time. The bar graph (Figure 4.5) corresponds to the deforestation in Colniza municipality, which follows the same trend of the deforestation rate in the RRD area.

[117] Annex: Map_Accuracy_Assessment.pdf

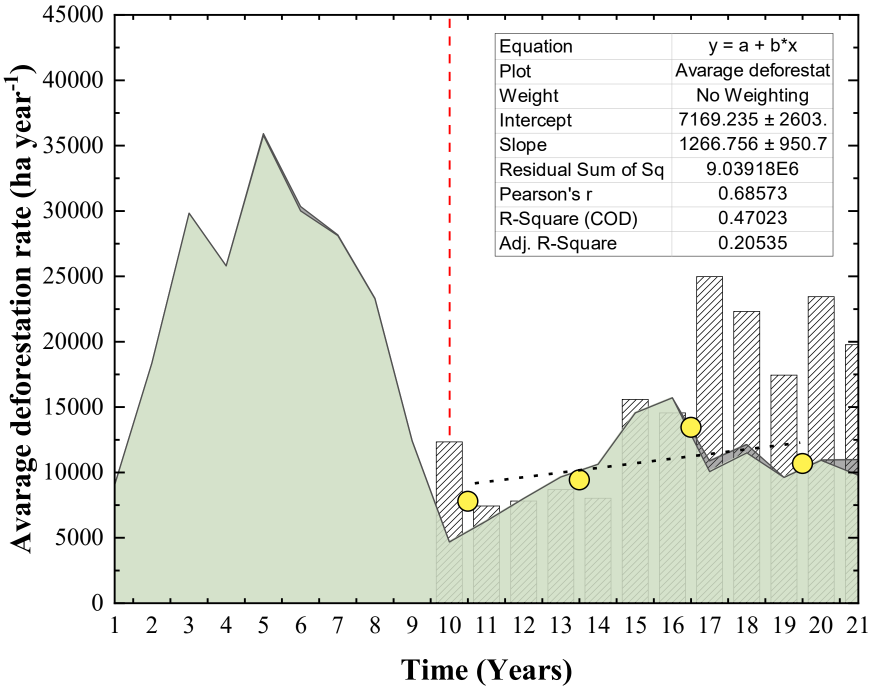

Figure 4.5. Average deforestation rate (ha year-1) with a start date in 1999 until 2019.

The column graph corresponds with the total deforestation in the Municipality of Colniza data based on Terra Brasilis [19] ( ). The area graph correlates the total deforestation ( ) and unplanned deforestation ( ) in the reference region for projecting location of deforestation (RRD). The scatter graph results from average unplanned deforestation in RRD with a 3-year interval time from 2008 to 2019 ( ) with the linear regression ( ) and respective information (inside table).

Considering the fact that no regression fits temporal deforestation values with R^2 of 0.47 (less than 0.75, Figure 4.5), so the historical average annual deforestation rate during the historical reference period, analyzed in intervals of 3 years was used, and in the period corresponding an average deforestation rate 10,336.13 ha year-1 (Table 4.2) in RRD (391,871.79 ha).

Table 4.2. Historical average annual deforestation during the historical reference period.

Timer (3-year interval)					Annual deforestation rate	
					Total (ha)	Avarage (ha year-1)
1	From	2007	to	2010	23,382.90	7,794.30
2	From	2010	to	2013	28,283.85	9,427.95
3	From	2013	to	2016	40,332.51	13,444.17
4	From	2016	to	2019	32,034.24	10,678.08
Average deforestation rate (ha year-1)						10,336.13

Estimation of annual areas of unplanned baseline deforestation in the project area

In the second baseline, about 6.5% (less than 25%) of the project geographic boundary is within 50 m of land that has been anthropogenically deforested within the 10 years prior to the project start date, in this case, according to methodology a location analysis was required. Thus, the projected area of unplanned baseline deforestation in the RRL is estimated based on Equation 3.

The ratio of forest area in the RRL at the start of the baseline period, 468,613.62 ha, to the total area of the RRD, 391,871.79 ha, while the historical average annual deforestation during the historical reference period obtained equals 10,336.13 hectares per year. Thus, the projected area of unplanned baseline deforestation in the reference region for location ($A_{BS,RR,unplanned,t}$) calculated was 12,360.29 ha year^{-1}, considering 12 years elapsed since the projected start of the project activity.

$$A_{BSL,RR,unplanned,t} = A_{BSL,RRD,unplanned,t} * P_{RRL} \quad \text{Equation 3}$$

Where:

$A_{BSL,RR,unplanned,t}$	Projected area of unplanned baseline deforestation in the reference region for location (RRL) in year t; ha
$A_{BSL,RRD,unplanned,t}$	Projected area of unplanned baseline deforestation in RRD in year t; ha
P_{RRL}	Ratio of forest area in the RRL at the start 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

4.1.3 Location and Quantification of Threat of Unplanned Deforestation

Determination of whether location analysis is required

The new RRL region defined for the baseline reassessment conforms to a “Transition Configuration”, as the RRL of the original PD. Since only about 6.5% (less than 25%) of the project geographic boundary is within 50 meters of land that has been anthropogenically deforested during the 10 years before the start of this second baseline period (that is, between 2009 and 2019), location analysis is required.

Preparation of data sets for spatial analysis

Location analysis is a procedure for predicting future deforestation using presently available data. The procedure is based on an estimate of the probability that a forest to non-forest transition will occur at a given pixel of the map. The probability map is constructed with the help of statistical techniques that consider the influence of several possible deforestation drivers, or variables, spatially represented as factor maps. In what follows, we go into more detail on how the transition probabilities are computed for the chosen spatial modeling approach, how the variables relevant for the present case were selected, and how the corresponding factor maps were generated.

Requirements of spatial models

Our location analysis model is based on the combination of two freely available codes: the software DinamicaEGO (Soares-Filho et al., 2002), and the open-source package ForestAtRisk (Vieilledent, 2021).

Specifically, DinamicaEGO is used for the generation of transition probability maps, or risk maps, that serve as inputs to ForestAtRisk. The latter is then used for allocating deforestation in both validation (past) and baseline (future) periods. Auxiliary tools are used for pre-processing and post-processing data, such as the georeferencing program QGIS.

The transition probabilities are computed by DinamicaEGO through the Weights of Evidence (WOE) method – a Bayesian approach that evaluates the probability of occurrence of a given event by combining data from a set of predictive variables (see, for example, Bonham-Carter and Bonham-Carter (1994). Here, the event is the forest to non-forest transition and categorized factor maps constitute the set of predictive variables. In a nutshell: a numerical value, the weight, is assigned to each of the categories belonging to each of the explanatory variables. At a given pixel, the transition probability depends on the sum of the weights of the variables overlapping at that point, and each variable makes the transition more or less likely depending on whether its weight is positive or negative at that location. Importantly, the weights associated with one variable are independent of the others provided their factor maps are spatially uncorrelated (an assumption that can be tested by examining standard correlation metrics). Notice that this characteristic of the WOE method permits quantifying the impact that a single variable has on the final probability map – for example, variables having large magnitude weights, either positive or negative, will dominate the likelihood of the transition.

ForestAtRisk, in turn, is equipped with functions for allocating deforestation according to a “higher-risk first” protocol, entirely compatible with the allocation procedure outlined in the methodology – more details will be given in Section 3.4.

Our location analysis model thus fulfills all the requirements of the methodology: (i) the abovementioned programs have been employed in peer-reviewed studies and provide extensive documentation regarding the algorithms they implement; (ii) factors expected to be correlated with deforestation are incorporated into the model in the form of spatial maps derived from either raster or vector data; (iii) the approach used for producing risk maps allows an assessment of the relative contribution of each driver (through its weights of evidence); and, finally, (iv) the predicted deforestation maps, produced precisely in the manner required by the methodology, can be readily compared with empirical data.

Preparation of spatial datasets

The deforestation drivers considered for the preparation of risk maps and their respective classes were the following: elevation (landscape); distance to roads and distance to water bodies (accessibility), distance to recent deforestation, and presence/absence of or proximity with settlements (anthropogenic), and presence/absence of or proximity with indigenous land (actual land tenure and management). For reasons that will be made clear, the presence/absence of the project area itself (a land management factor) must be included as a variable in the model. Table 1 summarizes this information.

Table 4.3. Factor maps considered in the location analysis

Classes	Variables
I. Landscape	elevation
II. Accessibility	distance to roads distance to water bodies
III. Anthropogenic	settlements (presence/absence or proximity with) distance to recent deforestation
IV. Actual land tenure and land management	indigenous land (presence/absence or proximity with) project area (presence/absence)

Elevation data was obtained from NASA's Shuttle Radar Topography Mission[118] dataset available through the Google Earth Engine tool. The spatial configuration of these factors is unchanged during the historical period – they are the "fixed variables" of the model. The corresponding factor maps are displayed in Figure 4.6 and Figure 4.7.

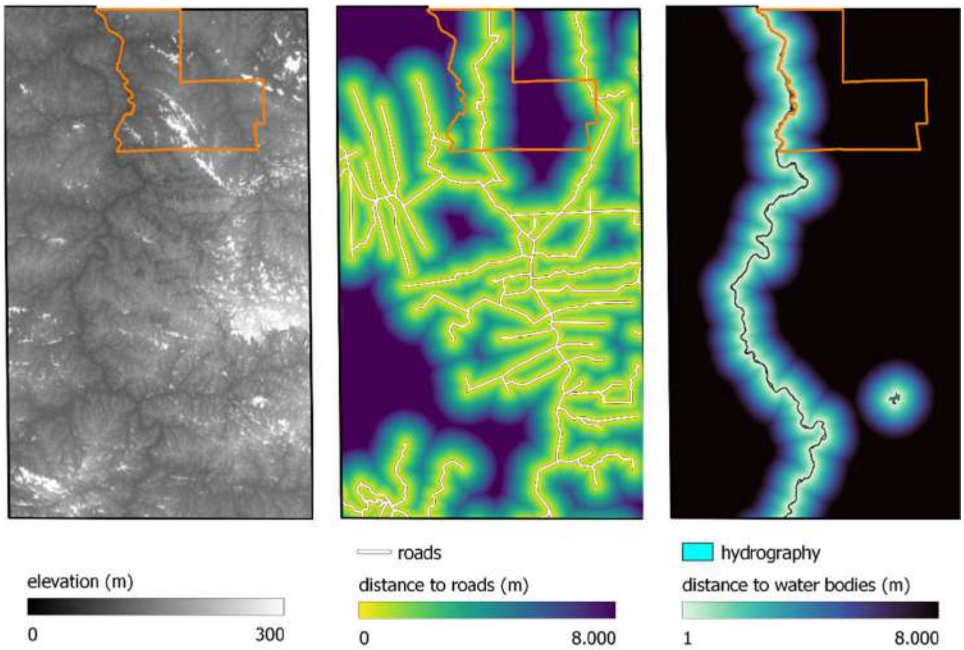

Figure 4.6. Landscape and accessibility factor maps.

[118] NASA JPL (2013). NASA Shuttle Radar Topography Mission Global 1 arc second [Data set]. NASA EOSDIS Land Processes DAAC. Accessed 2022-07-30 from https://doi.org/10.5067/MEaSUREs/SRTM/SRTMGL1.003.

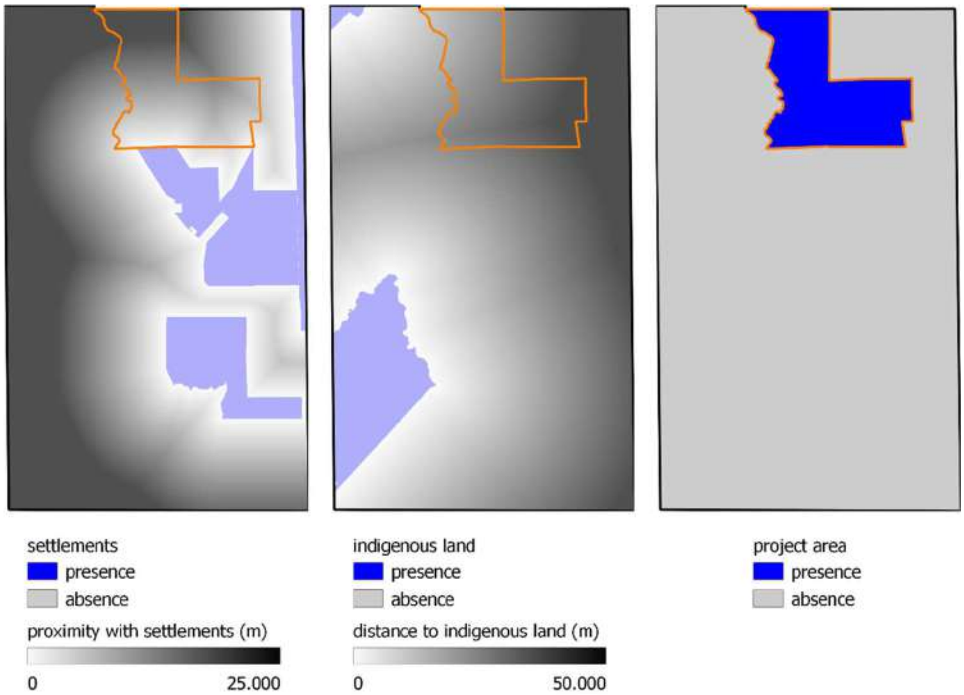

Figure 4.7. Anthropogenic and actual land tenure and management factor maps.

Our dataset also includes the variable "distance to recent deforestation": in this case, distance to areas deforested within 6 years. The spatial configurational of this variable is different at the start of each period (calibration, confirmation, and baseline) – it is a "mutable" variable in the model.[119] It is also the most relevant variable for predicting deforestation. Figure 4.8 shows the accumulated deforestation maps at the start of each period. The corresponding "distance to recent deforestation" maps overlayed with the 6-year deforestation patches are displayed in Figure 4.9.

[119] To be explicit: in the calibration period, starting at 2007, we use distance to deforestation accumulated between start of 2001 and end of 2006; in the validation period, starting at 2013, we use distance to accumulated deforestation between the start of 2007 and end of 2012; in the baseline period, starting at 2019, we use distance to accumulated deforestation between the start of 2013 and end of 2018.

Figure 4.8. Forest cover change maps (6 years) in different periods.

Different combinations of the variables presented in Table 4.3 were used to construct eligible models whose predictive capacity was tested during the confirmation stage. The relatively small number of drivers imposes constraints: All models had to include (i) elevation, since this is the only landscape variable of the dataset; (ii) distance to recent deforestation, since this is the variable that best correlates with future deforestation; (iii) distance to roads, since this is widely recognized as a major deforestation driver (with many roads existing within the RRL region); and (iv) the presence/absence of or proximity with indigenous lands, since these areas are notable inhibitors of deforestation in the RRL region so that their influence cannot be neglected.

Moreover, the presence/absence of the project area is also a mandatory categorical variable in all models: without it no meaningful predictions can be made in the confirmation stage since the project was in effect throughout the (updated) historical period. Indeed, the large and negative weight of evidence of this variable indicates that its presence is a dominating factor that mitigates the forest to non-forest transition within project boundaries. This, of course, is expected and testifies to the fact that the project is having the desired impact on the region.

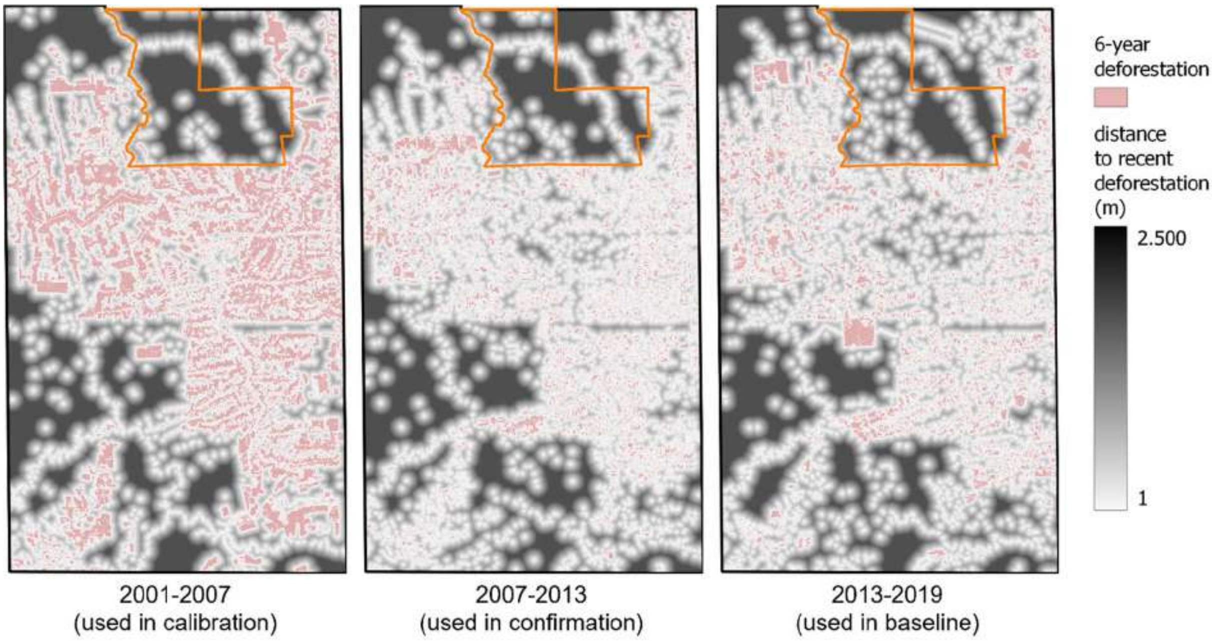

Figure 4.9. "Distance to recent deforestation" factor maps.

For consistency, the project area must be used as a factor both in the confirmation and baseline projection stages. However, it must be treated differently when predicting confirmation-period and baseline-period deforestation. This is because the purpose of the model is different in each case: in the confirmation stage one seeks a description of what *actually happened* during the confirmation period. In contrast, when projecting future baseline deforestation, one seeks to understand what *would happen* in the region in case the project ceased to exist.

To cope with this change in perspective the weight of evidence associated with the presence of the project area must be altered when predicting future deforestation (otherwise the area will once more act as a major deforestation inhibitor which, we emphasize, is incorrect given the scenario that one is seeking to describe[120]). The question then is how to introduce a sensible modification.

We adopted the following rationale: it is reasonable to assume that, once the project ceases to exist, it will be subjected to the same deforestation pressure of its surrounding areas. Thus, we defined an auxiliary area, or "proxy zone", evaluated its weight of evidence for the forest to non-forest transitions, and then assigned this weight to the project area before computing the risk maps of the baseline period. Only the weight corresponding to the project area presence is altered; the region of project absence retains its original weight of evidence. No changes are made in any of the other variables. Meanwhile, the weights of the proxy zone (presence and absence) are set to zero – this zone is never used as an

[120] The standard procedure is to employ weights of evidence measured during the confirmation stage for constructing the baseline risk map. Maintaining the confirmation-period weight of the project area variable would only make sense if we were seeking to describe future deforestation in a "with project" scenario, which is not the case.

explanatory variable. Figure 4.10 shows the proxy zone alongside the forest cover change map at the start of the baseline period.

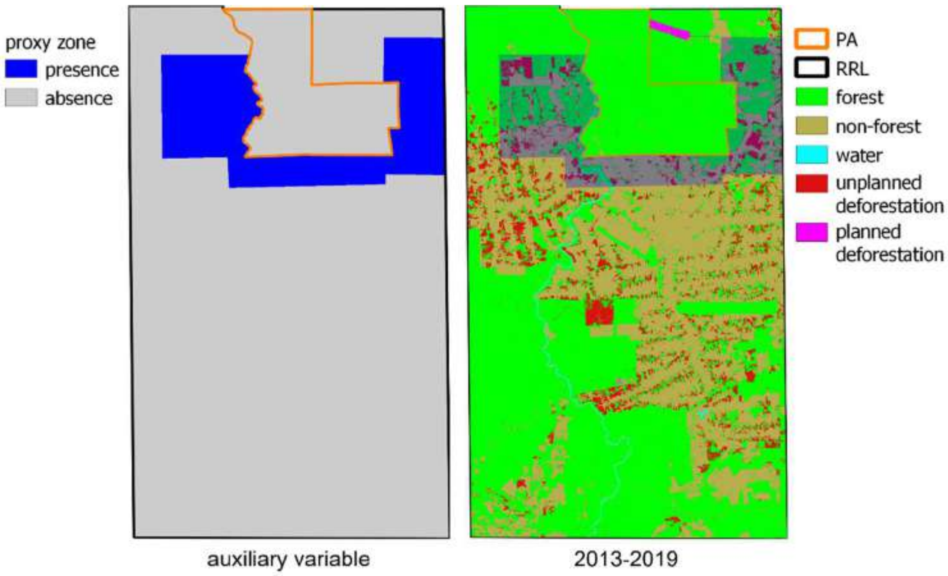

Figure 4.10. The "proxy zone" used for estimating the project area baseline risk.

Preparation of risk maps for deforestation

The WOE method only works with categorized variables. Therefore, the first step in the preparation of risk maps is to perform the categorization of continuous factor maps. This is done in the calibration stage using the spatial configuration of driver variables at the start of the calibration period (2007) – recall that the "distance to recent deforestation" map changes with time. The ranges defining the categories of discretized variables are maintained in the confirmation and baseline projection stages. The ranges are computed automatically by DinamicaEGO after a small set of parameters is adjusted. This calculation already takes into account forest to non-forest transitions in the analyzed period, so the output categories are not merely equal-interval data slices. The quality of the categorization – that is, its faithfulness to the original data – can be judged by visually inspecting the categorized maps. After some trial and error, a good discrete representation was achieved for all continuous variables.

Next, a correlation metric is calculated between all pairs of variables. This allows us to later identify which models are permissible since a valid model must include only spatially uncorrelated factors. The metric used for assessing spatial correlations was the Joint Uncertainty Information (JUI). Except for "presence/absence" and "proximity with" maps relating to the same driver – which are never employed in the same model – all variables are found to be sufficiently independent (JUI < 0.20), thus satisfying the basic assumption of the WOE method.

Finally, weights of evidence coefficients are computed for the individual categories belonging to each variable using the initial landscape map at the start of the calibration period (2007) and the forest cover change map at the end of the calibration period (2013).

The risk map used for predicting deforestation in the confirmation is then produced by combining information from the weights of evidence computed in the calibration stage and the spatial configurational of driver variables at the start of the confirmation period (2013), with "distance to recent deforestation" being the only variable requiring an update. Risk maps for different models are built by keeping only a predetermined set of variables in the input files.

The procedure for preparing the risk map for predicting deforestation in the baseline period is very similar. As previously mentioned, the category ranges are the same as those of the calibration period. The weight of evidence coefficient of each category, however, must be updated since now they are calculated using the initial landscape map at the start of the confirmation period (2013) and the forest cover change map at the end of the confirmation period (2019); this is effectively a "recalibration" of the model to account for the more recent deforestation trends. The correlation analysis is also repeated to ensure that variables employed in the constructed models remain uncorrelated. As before, the spatial configuration of driver variables at the start of the baseline period (2019) must be used in conjunction with the WOE data to build the baseline risk map. As explained in the last section, a special step is necessary at this point to correct the risk of the project area so that it conforms to the scenario of project non-existence -- the reasoning being that, under that scenario, the project area will inherit the risk of areas located in its immediate vicinity. This is done by manually editing the WOE file: the weight of the 'project presence' category is replaced with the weight of the 'proxy zone presence' category and the proxy zone variable is deleted.

The risk maps corresponding to each model are then fed into ForestAtRisk, which is the code employed for allocating deforestation in both confirmation and baseline periods.

Selection of the most accurate deforestation risk map

Since most of the variables considered are mandatory for the reasons discussed above, the eligible models for location analysis differ only with respect to inclusion or exclusion of the two remaining non-mandatory variables: distance to water bodies and either presence/absence or proximity with settlements. Which of the models is the most suitable for projecting future deforestation is decided by evaluating a figure of merit (FOM). This metric measures the accuracy of a model by comparing its predictions against real deforestation data in the confirmation period which, in our case, encompasses the 6 years between 2013 and 2019.

The risk map at the start of the confirmation period dictates which pixels will be deforested at the end of the period. The number of pixels to be allocated is determined by the total deforestation observed in the RRL region between the years of interest. Satellite data shows that a total of 54,679.05 ha of forest areas have been deforested in the RRL between the start of 2013 and the start of 2019, corresponding to a total of 607.545 pixels in our 30m x 30m resolution maps.

We employ the built-in function "deforest" of ForestAtRisk to perform the location: it starts by assigning deforestation to the pixel with the highest probability of transition and proceeds in descending order of probability until all 607.545 pixels are allocated in the RRL region, exactly as required by the methodology.[121] The result is the predicted deforestation map in the confirmation period, from which the figure of merit is evaluated by computing the area of correct, false-negative and false-positive predictions and then combining this information into Equation 6.

$$FOM = \frac{CORRECT}{CORRECT + Err_A + Err_B}$$ Equation 4

Where:

$CORRECT$	Area correct due to observed change predicted as change; ha
Err_A	Area of error due to observed change predicted as persistence; ha
Err_B	Area of error due to observed persistence predicted as change; ha

Several combinations of variables were tested and the FOMs evaluated for the corresponding models. We report results from three representative models that allow for a discussion of how the best model was identified. The information is summarized in Table 4.4Table 4.4. Models considered for location analysis..

According to the methodology, models are only acceptable if their FOM is higher than a threshold value defined by the ratio between the total area of change observed in the RRL region during the calibration period (2007-2013) and the area of the RRL region. In our case, we get: FOM threshold = (39,758.31 ha / 789,120.63 ha) = 0.05038, thus all models are acceptable.

Table 4.4. Models considered for location analysis.

Classes	Model 1 (FOM = 0.2773)	Model 2 (FOM = 0.2856)	Model 3 (FOM = 0.2848)
I	elevation	elevation	elevation
II	distance to roads	distance to roads	distance to roads distance to water bodies
III	distance to recent deforestation	distance to recent deforestation settlements (presence/absence)	distance to recent deforestation settlements (presence/absence)
IV	indigenous land (presence/absence) project area (presence/absence)	indigenous land (proximity with) project area (presence/absence)	indigenous land (proximity with) project area (presence/absence)

[121] There is a small allocation error so the number of pixels might differ slightly; this has no significant impact in the analysis.

We begin the discussion with Model 1, which is the simplest conceivable model. It includes only mandatory variables and uses indigenous land as a presence/absence type of variable. Model 1 gives a FOM of 0.2773.

Next, models involving both indigenous land and settlements were tested, taking these factors either as "presence/absence" or "proximity with" type of variables. The best combination was found to be that of Model 2, which uses "proximity with indigenous land" and "presence/absence of settlements", yielding a FOM of 0.2856.

Then, we attempted a more complex model by including the "distance to water bodies" factor; this is Model 3, whose FOM was evaluated at 0.2848. The additional variable, therefore, leads to a slight deterioration of accuracy.

This leads us to conclude that Model 2 is our model of choice.

Figure 4.11 shows the confirmation period risk maps obtained for Models 1, 2, and 3. Pixel values vary between 1 and 65355, with higher values – represented by more intense colors – corresponding to higher forest to non-forest transition probability.

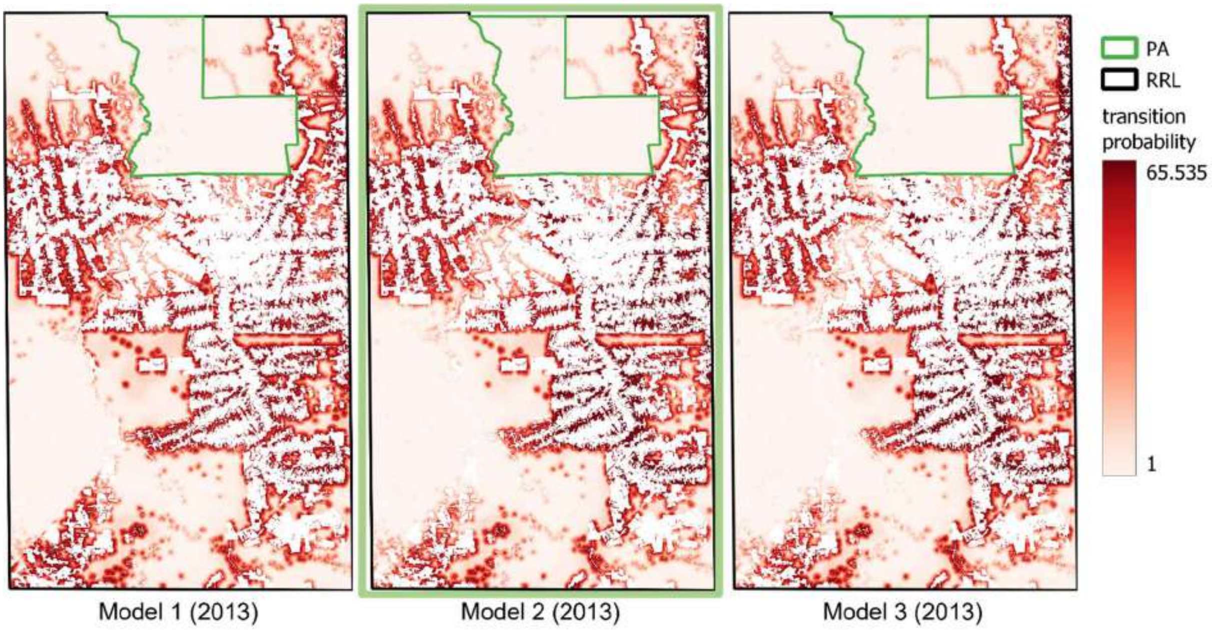

Figure 4.11. Risk maps of the confirmation step for the discussed models.

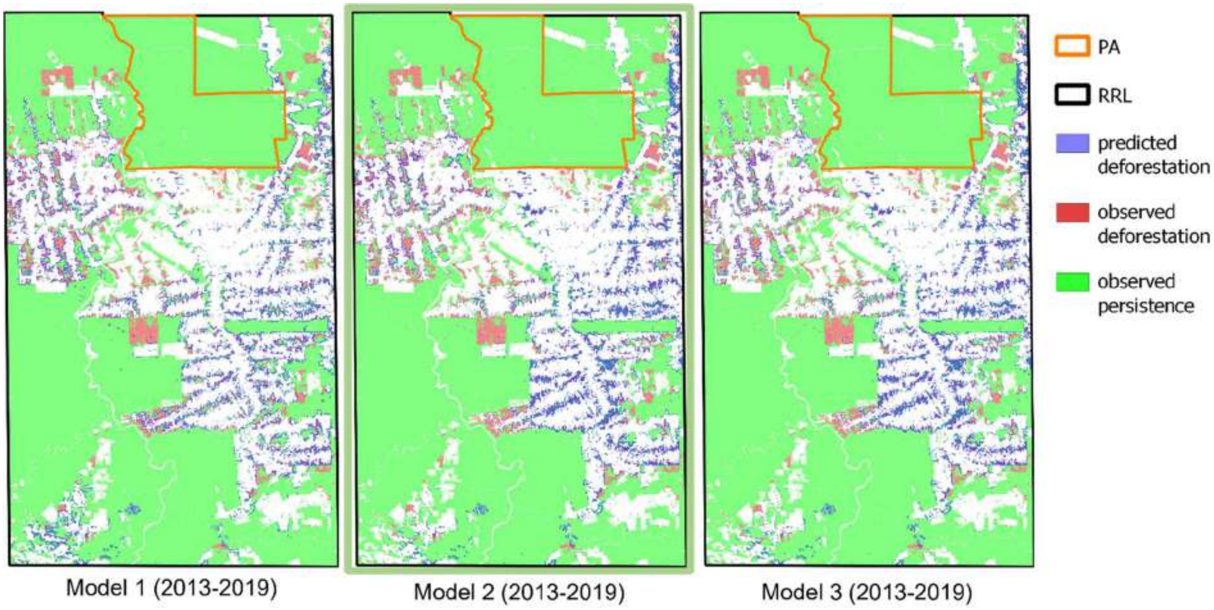

Figure 4.12. Predicted vs Observed deforestation maps for the discussed models.

Predicted and observed deforestation maps for each model are displayed in Figure 4.12. In these figures, the highlighted (middle) map corresponds to Model 2, the model used for projecting deforestation in the baseline years.

It is worth mentioning that the generally low values of the FOM index (which may vary between 0 and 1) are not indicative of a poor choice of modeling variables. Rather, they reflect the fact that deforestation in the region is influenced by human factors which cause deforestation patterns that simply cannot be accounted for in this type of analysis -- for example, the sudden appearance of large deforestation patches that can be spotted in the underlying observed deforestation layer (red pixels) in Figure 4.12.

Mapping of the locations of future deforestation

The mapping of future deforestation in the baseline period is very similar to that of the confirmation period, only this time the risk map computed for the baseline period is employed. We report the results for the chosen model, Model 2.

The baseline risk map of Model 2 is displayed in Figure 4.13 (leftmost map). Notice how the project area displays a much higher overall risk than in the confirmation period – as intended, the project area now assimilates the risk of its surrounding regions, and we can make sensible predictions for a scenario where the currently enforced deforestation control within the project area will no longer exist.

We once more employ the built-in function “deforest” of ForestAtRisk to perform the location. This time, however, deforestation is allocated yearly, using the historical average deforestation rate previously computed at the RRD, whose value is 12,360.29 ha/year. As a result, we obtain prediction deforestation patterns for each year of the baseline period – this result is also presented in Figure 4.13 (rightmost map).

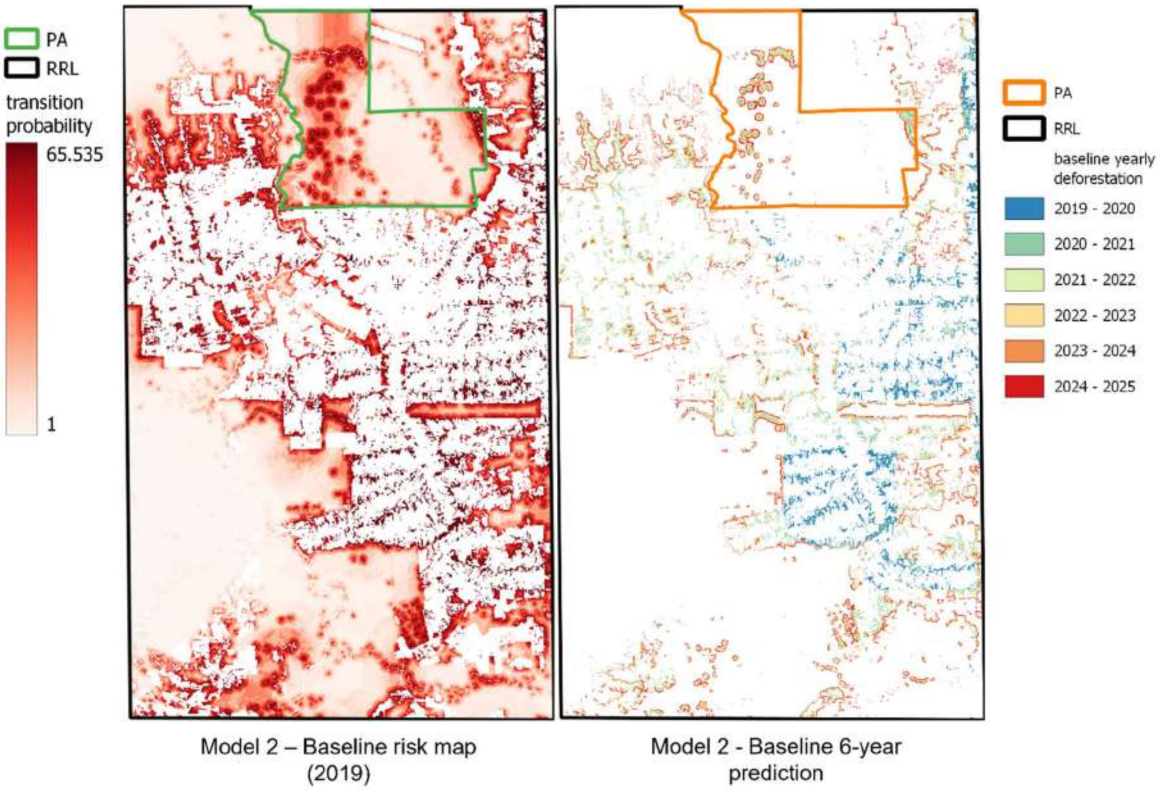

Figure 4.13. Model 2 baseline risk map and predicted yearly baseline deforestation.

With the prediction maps at our disposal, we may now employ standard zonal analysis techniques to compute the amount of deforestation predicted to occur in the project area over the baseline years. This result is reported in Table 4.5; According to the prediction of Model 2, therefore, a total of 5,783.58 ha of the forest will be deforested within project boundaries by 2025 in case the project is discontinued. Figure 4.14 shows more closely both the baseline risk map and the predicted baseline yearly deforestation within project boundaries.

Table 4.5. Project area baseline deforestation according to Model 2

Period	Deforestation [ha]
2019-2020	62.55
2020-2021	766.17
2021-2022	849.33
2022-2023	1,136.97
2023-2024	1,354.77
2024-2025	1,613.79
Total	5,783.58

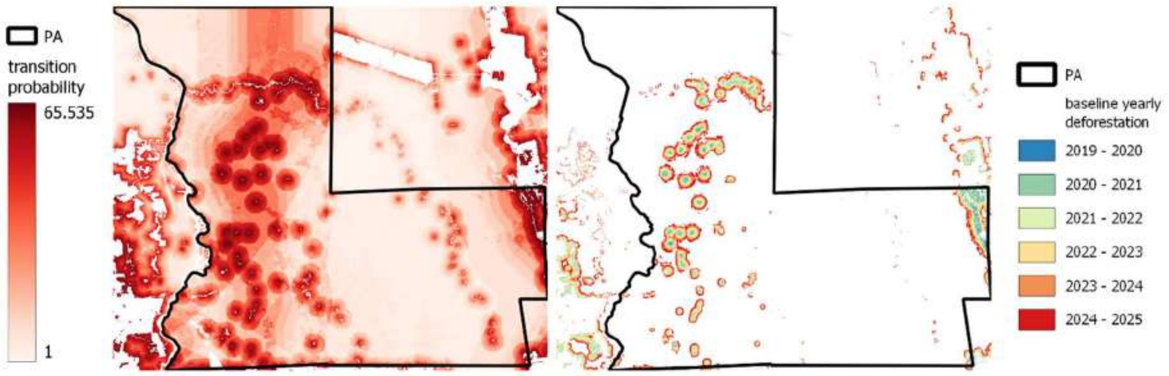

Figure 4.14. Model 2 baseline risk map and predicted deforestation.

In the following sections, we will be concerned with the deforestation per forest strata occurring inside the project area, at the same time subtracting project emissions that have already occurred during the first years of the baseline period, so that the number of VCS credits claimed by the project can be calculated.

4.1.4 Characterization of biomass in Project Area

According to module VMD0001 "Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools" (CP-AB), estimates of above- and belowground biomass is valid for 10 years, after which they must be re-estimated from new field measurements. Due to it, the Project Area underwent a new specific field forest inventory in 2022, according to the field inventory methodology described in the Standard Operating Procedure (SOP)[122], which is available for consultation by the auditors.

This SOP was specifically designed for FSM carbon inventories to be applied in the baseline assessment, as well as in the baseline renewal, considering the minimal sampling to reach the maximum relative sampling error of 15%. The field carbon inventory involved the installation of 18 transects, composed of a total of 130 permanent plots with 0.25 ha (10m x 2500m), as shown in Figure 4.15. The geographic coordinates of the permanent sampling plots are available for consultation by the auditors[123].

[122] Annex: SOP - Standard Operating Procedure.pdf

[123] Annex: pontos_parcelas.rar

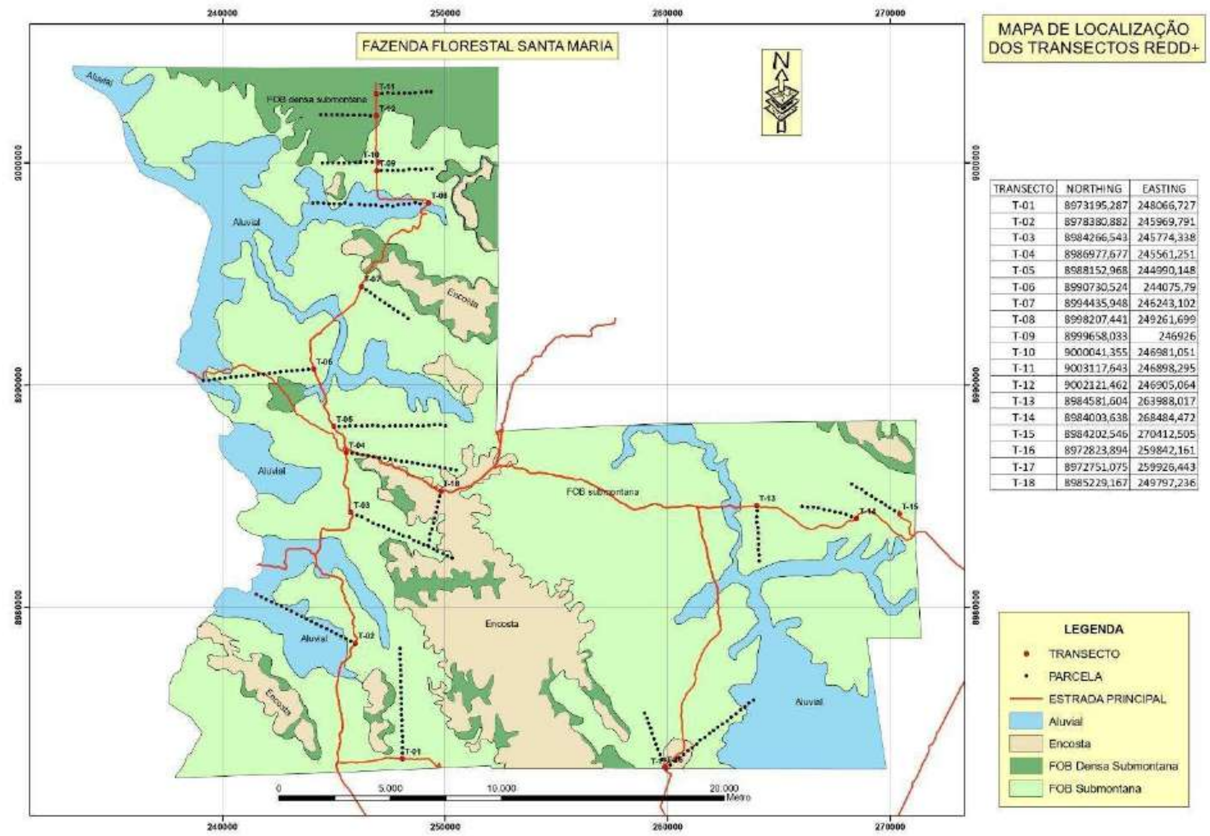

Figure 4.15. Distribution of permanent transects for the biomass carbon inventory.

The merchantable volume of trees was estimated by directly measuring the circumference at breast height (CBH). The data of CBH is converted into DBH (Diameter at Breast Height) and applied to allometric equations to estimation of merchantable stem volume[124]. All data processing was carried out in the RStudio Environment (4.1.2), with the aid of the package's "car", "ggplot2", "ggpubr", "esquisse", "dplyr" and "EcotoneFinder". For the application of the allometric equations, trees were divided into two classes of DBH:

- DBH ranging from 10 cm to 82 cm: application of allometric model from Spurr fitted by Nogueira et al. (2008) for trees in south Amazon. This equation was fitted for estimating bole volume of trees with DBH ranging from 5 to 82 cm (excepting palm trees). This equation has been derived using DBH based on datasets that comprise more than 30 trees (i.e. 298 trees). The model was based on linear regression and had a coefficient of determination higher than 0.8 (i.e., R^2 = 0.971):
    - $ln\,(Volume, m^3) = -\ 8.939 + 2.507\ \times ln\,(DBH, cm)$
- DBH higher than 82 cm: application of an allometric model of Kopexky and Gerhardt fitted by Colpini et al. (2009). The Kopezky – Gehrhardt allometric equation was applied to estimate the

[124] Annex: FSM_forest_inventory_data.xls

merchantable volume of trees (except palm trees). This equation has been derived using DBH based on datasets that comprise more than 30 trees (i.e., 91 trees). This equation was based on statistically significant regression and had a coefficient of determination higher than 0.8. According to Colpini et al. (2009), the Kopezky – Gehrhardt model showed the best performance among single-entry models for estimating volumes with bark in the same forest type observed in the FSM region. The Kopezky – Gehrhardt model, presented below, provided a coefficient of determination of 0.928. Given that the allometric equation has been obtained for individuals having DBH higher than 82 cm (i.e., ranging from 15 to 135 cm DBH), the equation was applied for trees with DBH higher than this threshold inside the FSM farm.

- $Volume, m^3 = -0.4306 + 0.0011 \times (DBH, cm)^2$

Both equations correspond to a local forest-type specific model, whose data were collected in the same type of forest, the ombrophilous open forest (IBGE, 2012b), at distances of about 120 km from the FSM farm.

The model described by Colpini et al. (2009) was adjusted for a forest fragment located at the municipality of Cotriguaçu (north-west region of the State of Mato Grosso) between latitudes 9º47' and 9º53' S and longitudes 58º13' and 58º19' W, with altitude varying between 100 and 150 m.

The data collection described by Nogueira et al. (2008) was also performed in the municipality of Cotriguaçu and other two municipalities: Juruena and Carlinda, State of Mato Grosso. In Nogueira et al. (2008) the vegetation was described as open forest in South Amazon sampling sites, including the Carlinda site in the north-western portion of the State of Mato Grosso. Except for the Carlinda site, where evidence of a previous disturbance was observed, all other plots were in primary forest, without invasion of pioneer trees or mortality associated with edges.

As already described in section 3.6.2 (Project Description Deviations), monocots, palms are evolutionarily, morphologically, and physiologically distinct from other trees. Using the same method to measure the biomass of trees and palms may neglect the amount of carbon sequestered because the specific measurement of palms takes into account height and diameter (Muscarella et al., 2020). Therefore, due to the difficulty in measuring tree heights in the field, palm trees were conservatively not accounted for in this forest inventory.

The results of the new field inventory are in conformance with the methodology accuracy requirements, as average biomass estimations inside each stratum have an error below 15%, as shown in Table 4.6. The overall relative sampling error of the biomass field inventory is estimated at 4.30%.

Table 4.6. Statistic summary of the number of permanent plots for each stratum and total

Parameter	Unit	Stratum				
		Aluvial	Encosta	FOB Densa Submontana	FOB Submontana	All strata
Mean aboveground trees biomass	t ha^{-1}	360.16	361.43	385.34	353.72	361.43
Mean basal area	m^2 ha	22.01	22.03	23.00	20.73	21.22
Área	ha	12944	9275	6696.00	42473.00	71388

Parameter	Unit	Stratum				
		Aluvial	Encosta	FOB Densa Submontana	FOB Submontana	All strata
Stratum area ratio	%	18.13	12.99	9.38	59.50	100
Nº Amostras	n	20	6	11	93	130
CV	%	27.61	28.58	22.92	26.93	
IC +	t ha-1	408.57	446.39	433.60	370.13	361.85
IC -	t ha-1	329.76	276.47	337.07	337.31	359.13

After calculating the forest inventory estimators, an analysis of variance was performed to verify the differences between the strata. The mean value and the confidence interval are represented in Figure 4.16. According to Figure 4.16, the estimative of biomass in each stratum does not present a significant difference between them.

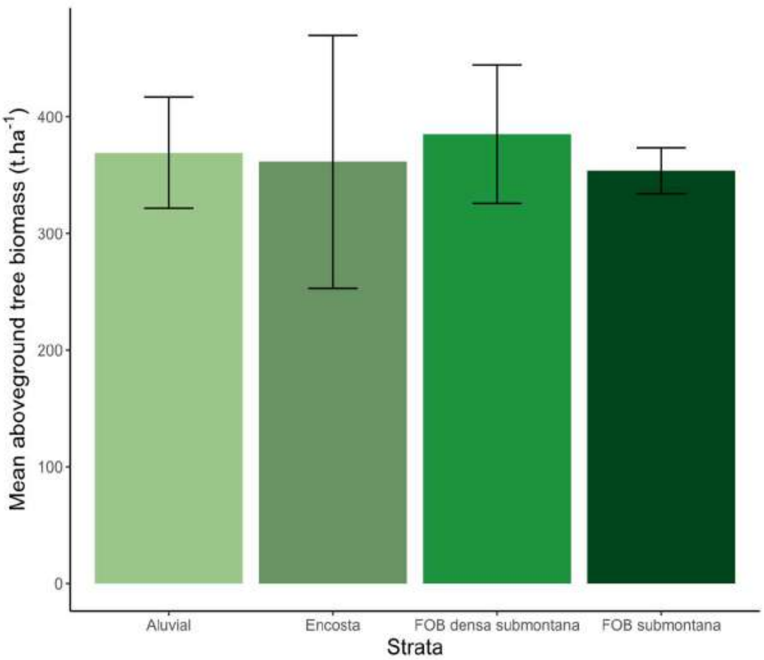

Figure 4.16: Average aboveground tree biomass per hectare.

The forest inventory showed a negative exponential diameter distribution (Figure 4.17) for all four strata. It is usually in even-aged stands in the Amazon biome. This distribution is common in forests with no intensive disturbance with a larger number of individuals with smaller DBH values (Rubin et al., 2006).

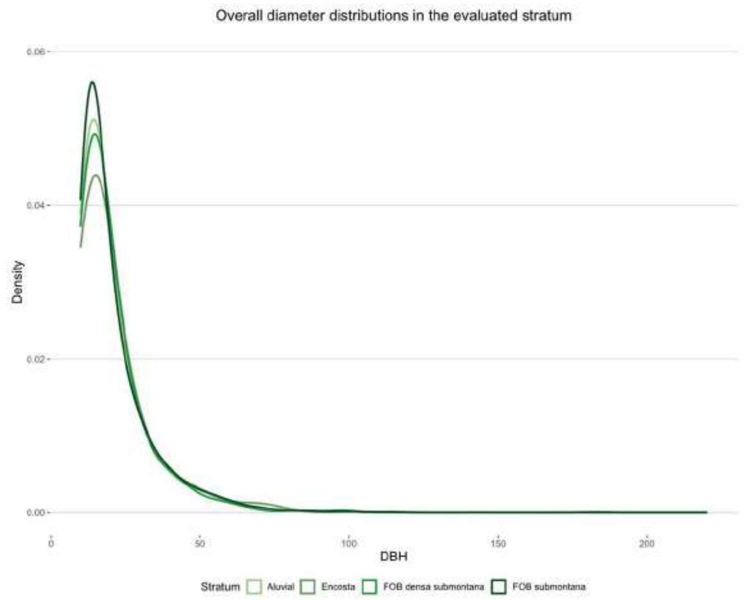

Figure 4.17. Overall diameter density distributions in the stratum were evaluated.

After the forest inventory ruled in 2022, the average aboveground biomass of local forest was estimated at 311.85361.43 t ha-1, matching with values presented by Malhi et al. (2006) between 250 and 350 t ha^{-1} in the Brazilian Amazon and Saatchi et al. (2007) with values above 376 t ha^{-1} for Amazon generally. This value represents an aboveground net primary productivity of 10.22 t ha^{-1} $year^{-1}$. A recent study de Avila et al. (2018) shows results of an aboveground net primary productivity of 7.6 t ha^{-1} $year^{-1}$ (±1.4) in a post-logging operation forest in the same ecoregion of Madeira-Tapajós moist forest. The ecoregion is based on the classification proposed by Olson et al. (2001). de Avila et al. (2018) conclude the low intensity of disturbance in a reduced-impact logging (RIL) permitted by the current legislation for the Brazilian Amazon can drive forest recovery due to a low reduce of basal area. Mazzei et al. (2010) and West et al. (2014) encounter a similar result (2.6 t ha^{-1} and 2.8 t ha^{-1}, respectively). After the forest inventory ruled in 2022, the average aboveground biomass of local forest was estimated at 311.85361.43 t ha-1, matching with values presented by. Immediately after RIL the forest presents a loss of aboveground biomass, but, in the following years, the forest starts to recover its aboveground biomass mainly because of the growth of residual trees.This result is in accordance with Figure 4.18, where there is an increase in mean biomass stock between the inventory effectuated in 2010 and 2022. Although there is registration and project emission quantification in the first baseline period about wood management in 2009, in the project area, this activity already existed by IBAMA license since 2002 (proceeding number of the 02054.000547/2022-58). Therefore, this increase can signal the recovered biomass due to the growth of residual trees in the project area. This is further evidence that the REED project is efficient for forest maintenance.

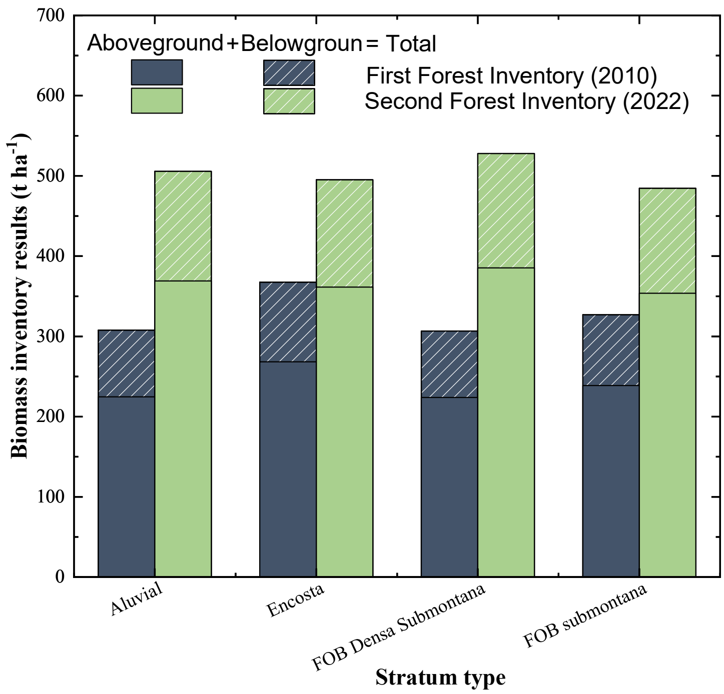

Figure 4.18. Total carbon stock in the first biomass inventory in 2010 and the second forest inventory in 2022.

The aboveground biomass per stratum was estimated from the forest inventory using the allometric equation (described above). After, these values are multiplied by a root-shoot factor of 0.37 (IPCC, 2006b) to calculate the belowground biomass per stratum. In sequence, the biomass in a ton of $CO_{2\text{-}e}$ ha^{-1} was measured using the carbon fraction of dry matter (CF) of the 0.47 tC $d.m^{-1}$ (IPCC, 2006b) and the conversion of carbon in carbon dioxide (44 g CO_2 mol^{-1}/12 g C mol^{-1}). Therefore, the sum of aboveground and belowground represents the total carbon stock in $tCO_{2\text{-}e}$ ha^{-1} (Table 4.7).

Table 4.7. Characterization of above and belowground carbon stocks in Project Area (FSM estate), for different vegetation strata

Parameter	Unit	Stratum			
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana
Aboveground (total)	$tCO_{2\text{-}e}$ ha^{-1}	636.19	622.86	664.07	609.58
Belowground (total)	$tCO_{2\text{-}e}$ ha^{-1}	235.39	230.46	245.71	225.55
Total Carbon Stock	$tCO_{2\text{-}e}$ ha^{-1}	**871.58**	**853.32**	**909.77**	**835.13**

Following the project area for each stratum, the value of the weighted average of the aboveground and total biomass was established (Table 4.8). These values were used in the carbon stock estimation in the following calculations.

Table 4.8. The percentage of stratum in the project area and the weighted average of the aboveground and total biomass.

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
Project management area	ha	12,944.00	9,275.00	6,696.00	42,473.00	71,388.00
%	%	18.1%	13.0%	9.4%	59.5%	
Aboveground biomass weighted average	tCO_{2-e} ha^{-1}	621.24				
Total biomass weighted average	tCO_{2-e} ha^{-1}	851.10				

4.1.5 Estimation of Carbon Stock Changes and GHG Emissions[125]

The carbon stock changes and GHG emission estimation in baseline were made besides on modules VMD0005-CP-W-v1.1 and VMD0013-E-BPB-v1.2. The baseline emissions presented in this section refer to the period between 13th April 2019 and 12th April 2025. The values for 2019-2020 correspond to data from 13th April 2019 and 12th April 2020, for 2020-2021 equals the date between 13th April 2020 and 12th April 2021, and so on (Figure 4.19).

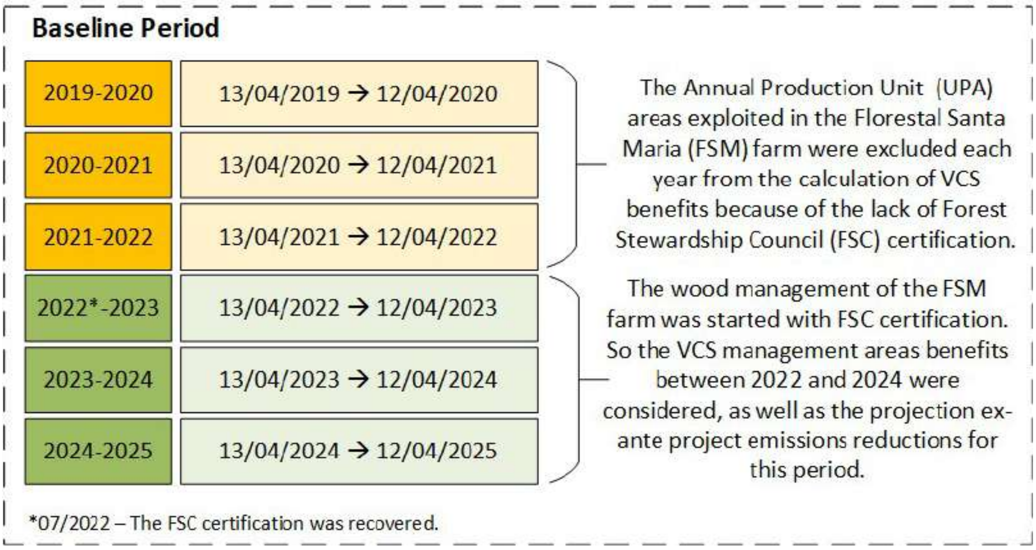

Figure 4.19. Baseline period description

The values present in Section 4.1.3 represents the deforestation area in the project area baseline according to location analysis. However, in the 2019-2020, 2020-2021, and 2021-20222 periods, the FSM project didn't have FSC (Forest Stewardship Council) certification. In this case, conservatively, the

[125] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

areas contemplated by the Annual Production Unit (Unidade de Produção Anual - UPA) for the specified years above (Figure 4.20) were not considered in the calculation. The areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 were excluded from the calculation of VCU benefits and project emissions.

However, in July 2022, the FSC certification was recovered[126,127]. These areas were not eligible for the Project Area according to the adopted methodology previously reported by Monitoring Report: VCS Version 3.0. The documents showing the exploited area within this period are available for consultation by auditors, they will be kept in a secure retrievable manner for at least two years after the end of the project crediting period. Thus, the values from 2022 the VCS management areas benefits were considered, as well as the projection ex-ante project emissions reductions for this period as stated in Section *3.6 methodology deviations*. Hence, the baseline deforestation per stratum in (i) 2019-2020, 2020-2021, and 2021-2022 contemplate the project area without UPA area for the corresponding period, and (ii) 2022-2023, 2023-2024, and 2024-2025 the project area with UPAs and the projection of management emissions were considered (Figure 4.20).

[126] Annex: FSC certification.pdf

[127] Annex: FSC certification_site information.PNG

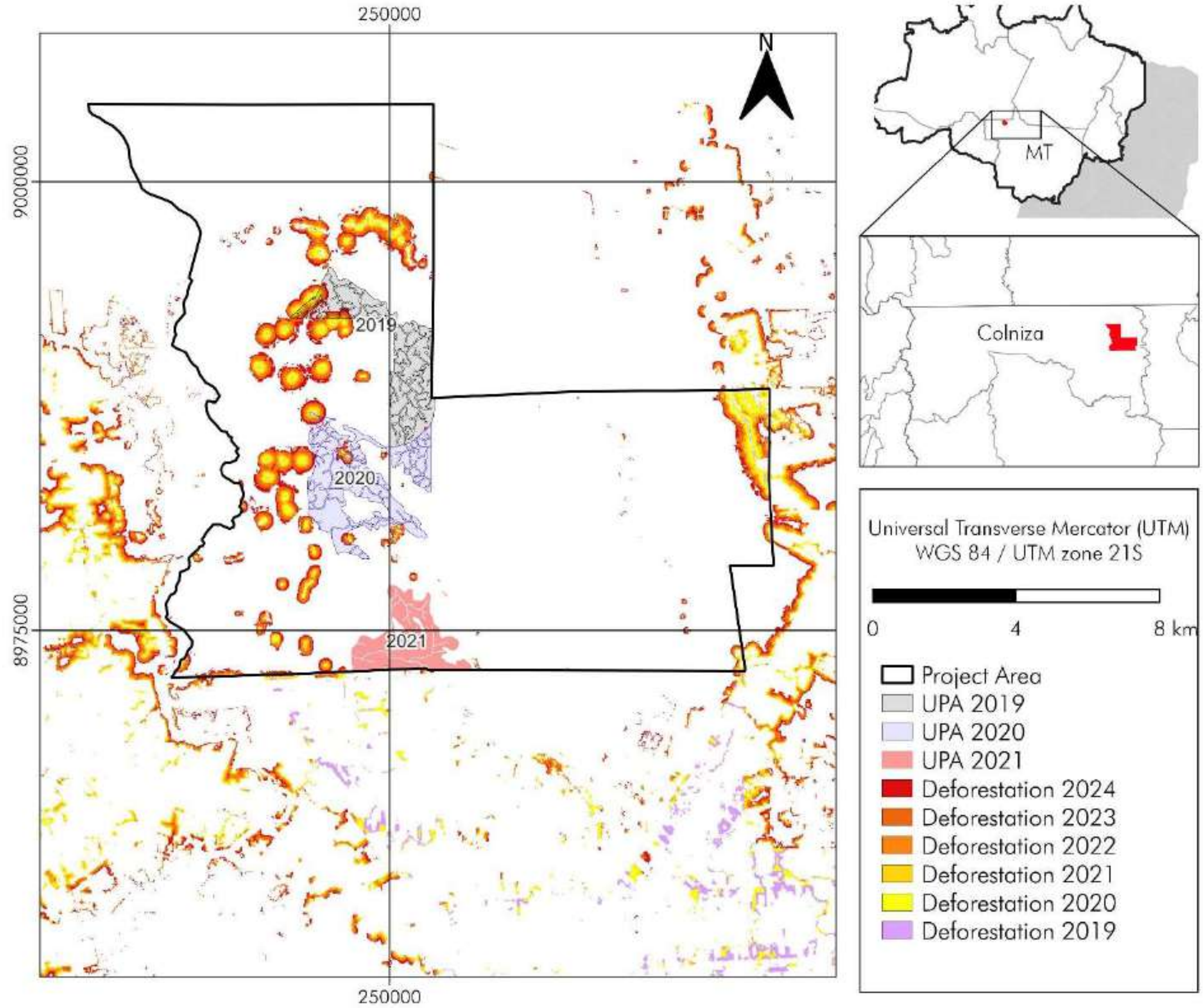

Figure 4.20. Annual Production Units (UPAs) areas from 13th April 2019 to 12th April 2022.

The project area ( ) with annual production unit (unidade de produção anual - UPA) for 2019 (, 13/04/2019 – 12/04/2020), 2020 (, 13/04/2020 – 12/04/2021), and 2021 (, 13/04/2021 – 12/04/2022) with the deforestation generated from the location analysis in decreasing gray scale from 2019-2024.

According to vegetation typologies, the forest deforestation area resulting from location analysis in the project area was classified by: (i) *Aluvia*, (ii) *Encosta*, (iii) *FOB densa submontana*, e (iv*) FOB submontana* (Table 4.9).

Table 4.9. Deforestation rate values in the project area through the allocation analysis disregarding the Annual Production Units (UPAs).

Parameter	Unit	Years						TOTAL
		2019-2020 [a]	2020-2021 [a]	2021-2022 [a]	2022-2023	2023-2024	2024-2025	
Aluvial	ha	3.24	91.80	128.61	193.6	225.4	328.9	971.46
Encosta	ha	7.02	117.90	110.07	122.8	166.1	153.0	676.80
FOB Densa Submontana	ha	10.80	78.75	56.61	71.3	70.7	81.0	369.18
FOB Submontana	ha	40.50	471.06	553.86	749.3	892.6	1,050.9	3,758.31
$A_{BSLPAt\ annual}$	ha	61.6	759.5	849.2	1,137.0	1,354.8	1,613.8	5,775.75
$A_{BSLPA\ cumulative}$	ha	61.56	821.07	1,670.22	2,807.19	4,161.96	5,775.75	

[a] Deforestation rate values in the project area through the allocation analysis disregarding the Annual Production Units - UPAs for each period, in which there was no FSC certification.

Special attention is paid to the project area's burn and unplanned deforestation. In the baseline period of this Joint Project Description & Monitoring Report document, there was not record from the project area of a burn or unplanned deforestation. This information is also confirmed by geospatial images. Whereas the high risk of these events can occur in the FSM farm area, there is a concern about this and the prevention action plan. These plans involve the prevention of intrusions, invasion, and fire. Also, support the work of forest stewardship management plan, thought calm consolidation and peaceful possession, cleaning of frontiers and its milestones, and internal organization of communication. More details about these pieces of information are described in Section *1.11 Description of the Project Activity.*

Wood products carbon pool in the baseline

For estimating emissions from unplanned deforestation that would occur in the Project Area in the absence of project (i.e., in the baseline case), the annual estimated area to be deforested was multiplied by the sum of aboveground and belowground carbon stocks in forest for each biomass stratum. The values resulting from the location analysis for each period and type of stratum were reported in Table 4.10. The total accumulated biomass in tCO_{2-e} over time is represented in Figure 4.21.

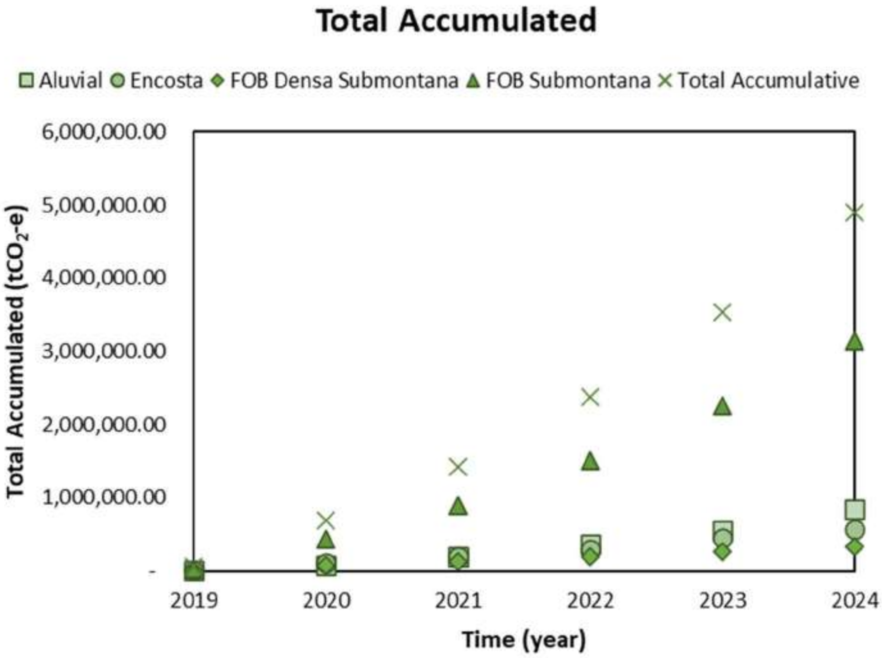

Figure 4.21. The biomass resultant accumulated in tCO_{2-e} over time.

Table 4.10. Summary of gross baseline emissions from unplanned deforestation that would occur within the Project Area in the baseline case.

				Year 2019	2020	2021	2022	2023	2024	TOTAL
Stratum	Aluvial	Area	ha	3.24	91.80	128.61	193.59	225.36	328.86	**971.46**
		$A_{BSLPAcumulative}$	ha	3.24	95.04	223.65	417.24	642.60	746.10	**2,127.87**
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	2,823.92	80,011.18	112,094.09	168,729.45	196,419.59	286,628.27	**846,706.50**
		Total Accumulated	tCO_2-e	2,823.92	82,835.10	194,929.19	363,658.64	560,078.23	846,706.50	
	Encosta	Area	ha	7.02	117.90	110.07	122.76	166.05	153.00	**676.80**
		$A_{BSLPAcumulative}$	ha	7.02	124.92	234.99	357.75	523.80	510.75	**1,759.23**
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	5,990.30	100,606.38	93,924.89	104,753.51	141,693.72	130,557.89	**577,526.69**
		Total Accumulated	tCO_2-e	5,990.30	106,596.68	200,521.57	305,275.08	446,968.79	577,526.69	
	FOB Densa Submontana	Area	ha	10.80	78.75	56.61	71.28	70.74	81.00	**369.18**
		$A_{BSLPAcumulative}$	ha	10.80	89.55	146.16	217.44	288.18	298.44	**1,050.57**
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	9,825.55	71,644.61	51,502.24	64,848.61	64,357.33	73,691.60	**335,869.94**
		Total Accumulated	tCO_2-e	9,825.55	81,470.16	132,972.40	197,821.01	262,178.34	335,869.94	
	FOB Submontana	Area	ha	40.50	471.06	553.86	749.34	892.62	1,050.93	**3,758.31**
		$A_{BSLPAcumulative}$	ha	40.50	511.56	1,065.42	1,814.76	2,707.38	2,865.69	**9,005.31**
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	33,822.74	393,396.10	462,544.83	625,795.94	745,453.30	877,662.65	**3,138,675.57**
		Total Accumulated	tCO_2-e	33,822.74	427,218.85	889,763.68	1,515,559.62	2,261,012.92	3,138,675.57	
		Total (sum of stratum)	tCO_2-e ha^{-1} $year^{-1}$	**52,462.52**	**645,658.27**	**720,066.04**	**964,127.51**	**1,147,923.94**	**1,368,540.42**	

Baseline emission from unplanned deforestation

As explained in previous topics, native forest maintenance is far from the most attractive economic scenario, allowing other activities with higher commercial value. In these regions is common the approach, which involves:(i) the deforestation process with timber harvesting for commercial markets, (ii) the burn of the resulting non-commercial wood, and (iii) conversion of these areas into pasture and coffee cultivation whereby represents 90% and 10% respectively of the cultivations in the region around the project. For this reason, this profile deforestation agent was considered in the baseline GHG emission calculation: (i) the commercial timber was calculated from the wood products carbon pool, (ii) the GHG emissions of the CH_4 and N_2O from the biomass burning, and (iii) the pasture and coffee carbon pool in the same proportion of the local cultivation.

Commercial inventory estimation

For estimating the biomass carbon of the commercial volume extracted in the process of deforestation, Equation 5 was applied, according to "Option 2: Commercial inventory estimation", as recommended in VMD0005-CP-W-v1.0.

$$C_{XB,i} = C_{AB_{tree},i} \times \frac{1}{BCEF} \times P_{com_i}$$ Equation 5

Where:

$C_{XB,i}$	Mean stock of extracted biomass carbon from stratum i; t CO_{2e} ha^{-1}
$C_{AB_{tree},i}$	Mean aboveground biomass carbon stock in stratum i; t CO_{2e} ha^{-1}
$BCFE$	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless $BCFE$ = 1.66 (Table 4, page 890, Brown et al. (1989))
P_{com_i}	Commercial volume as a percent of total aboveground volume in stratum i; dimensionless Calculated as the ratio between the volume of merchantable wood in exploitation, 35.08 m^{-3} ha^{-1} (da SILVA et al., 2001; Veríssimo et al., 1992), and the total volume of aboveground biomass per stratum.
i	1, 2, 3 … M strata, unitless

To calculate the proportion of biomass carbon extracted that remains sequestered in long-term wood products after 100 years, it was simply and conservatively assumed that all extracted biomass not retained in long-term wood products after 100 years is emitted in the year harvested, instead of tracking annual emissions through retirement, burning and decomposition (Equation 6).

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} \times (1 - WW_{ty}) \times (1 - SLF_{ty}) \times (1 - OF_{ty}) \quad \text{Equation 6}$$

Where:

$C_{WP,i}$	Carbon stock in long-term wood products pool (stock remaining in wood products after 100 years) from stratum i post deforestation; t CO_{2-e} ha^{-1}
$C_{XB,ty,i}$	Mean stock of extracted biomass carbon by class of wood product ty from stratum i; t CO_{2-e} ha^{-1}
WW_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless WW_{ty} = 0.24 (page 278, Winjum et al. (1998) and Pearson et al. (2012))
SLF_{ty}	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty; dimensionless SLF_{ty} = 0.2 (page 276, Winjum et al. (1998) and Pearson et al. (2012))
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless OF_{ty}= 0.8 (page 276, Winjum et al. (1998) and Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)
i	1, 2, 3 … M strata, unitless

The parameters used in the calculation of wood products carbon pool in the baseline, as well as the results of estimates (sum of strata), are demonstrated in Table 4.11 and Table 4.12.

Table 4.11. Summary of calculations of wood products carbon pool in the baseline scenario.

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
Stratum area	ha	971.46	676.80	369.18	3,758.31	5,775.75
Area distribution	%	16.8%	11.7%	6.4%	65.1%	100%
Total ABG per stratum	t	358,627.04	244,614.50	142,259.50	1,329,402.75	2,074,903.80
Total BLG per stratum	t	132,692.01	90,507.37	52,636.02	491,879.02	767,714.40
Carbon Pool_Aboveground per stratum	tCO_{2-e}	618,033.94	421,552.33	245,160.54	2,291,004.06	3,575,750.87
Carbon Pool_Belowground per stratum	tCO_{2-e}	228,672.56	155,974.36	90,709.40	847,671.50	1,323,027.82
$C_{ABtree,i}$	tCO_{2-e} ha^{-1}	636.19	622.86	664.07	609.58	
$C_{BBtree,i}$	tCO_{2-e} ha^{-1}	235.39	230.46	245.71	225.55	

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
$C_{BSL,i}$	tCO_{2-e} ha^{-1}	871.58	853.32	909.77	835.13	
$C_{DW,i}$	tCO_{2-e} ha^{-1}	-	-	-	-	
P_{com}	m^3 tCO_{2-e}^{-1}	0.055	0.056	0.053	0.058	
C_{XB}	tCO_{2-e} ha^{-1}	21.13	21.13	21.13	21.13	84.53
C_{WP}	tCO_{2-e} ha^{-1}	2.57	2.57	2.57	2.57	
$C_{WP\ AVERAGE}$	tCO_{2-e} ha^{-1}	2.57				

Emission from biomass burning in the baseline

Some GHG emissions can be measured, but the following method is used because of the high spatial and temporal variability, the following method is used. Based on the IPCC 2006 Inventory Guidelines, estimating greenhouse gas emissions from biomass burning is determined using Equation 7.

$$E_{biomassbur\,n,i,t} = \sum_{g=1}^{G} \left(\left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i}\right) \times 10^{-3}\right) \times GWP_g\right) \qquad \text{Equation 7}$$

Where:

$E_{biomassbur\,n,i,t}$	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, unitless $COMF_i = 0.59$ (Table 2.6, page 2.55, IPCC (2006a))
$G_{g,i}$	Emission factor for stratum i for gas g, kg t^{-1} d.m. burnt $G_{g,CH_4} = 4.8$ kg t^{-1}, $G_{g,NO_2} = 0.2$ kg t^{-1} (Table 2.5, page 2.54, IPCC (2006a))
GWP_g	Global warming potential for gas g, t CO_2/t gas g $GWP_{CH_4} = 28$ t CO_2 t_{gas}^{-1}, $GWP_{NO_2} = 265$ t CO_2 t_{gas}^{-1} (Box 3.2, Table 1, page 87, IPCC (2014) and Grennhouse (2014))
g	1, 2, 3 … G greenhouse gases including carbon dioxide1, methane and nitrous oxide, unitless
i	1, 2, 3 … M strata, unitless
t	1, 2, 3, … t* time elapsed since the start of the project activity, years

The average aboveground biomass stock before burning for a particular stratum is estimated using Equation 8.

$$B_{i,t} = (C_{AB\_tree,i,t} + C_{DWi,} + C_{LI,i,t}) \times \frac{12}{44} \times \frac{1}{CF}$$ Equation 8

Where:

$B_{i,t}$	Average aboveground biomass stock before burning for stratum i, year t, tonnes d.m. 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}
$C_{DWi,}$	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}
$\frac{12}{44}$	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. CF = 0.47 t C t^{-1} d.m. (pg. 4.48, Table 4.3, IPCC (2006b))
i	1, 2, 3 … M strata, unitless
t	1, 2, 3, … t* time elapsed since the start of the project activity, years

Table 4.12 shows the parameters used in calculating biomass burning for the baseline scenario, as well as results accounted for CH_4 and N_2O emissions generated because of incomplete biomass burning of non-commercial wood after logging.

Pasture and coffee carbon pools in the baseline

For calculation of the carbon pool remaining on pasture after deforestation, a conservative value of 15.0 tCO_2 ha^{-1} was applied (IPCC (2006c), page 6.27, Table 6.4). The proportion of baseline deforestation converted to pasture was considered as 90%. For calculation of the carbon pool remaining on coffee crops after deforestation, a conservative value of 84.0 tCO_2 ha^{-1} was applied (Dossa et al., 2008). The proportion of baseline deforestation converted to coffee cultivation was conservatively considered as 10%. The results obtained for coffee cultivation carbon pools in the baseline scenario are presented in Figure 4.22 and Table 4.12.

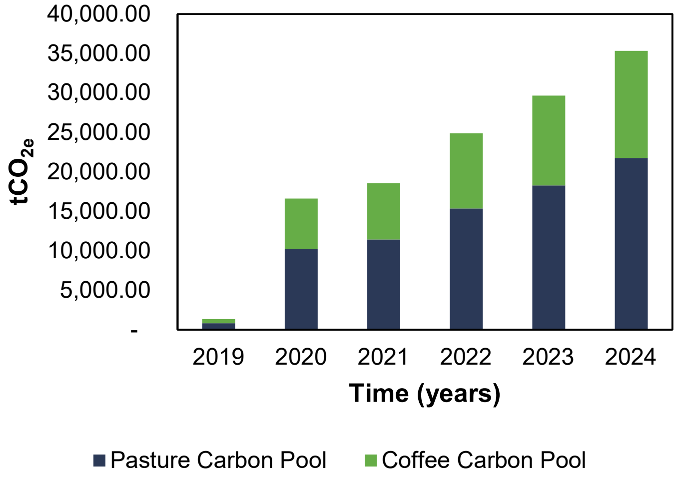

Figure 4.22. Pasture and coffee carbon pools in the baseline

Figure 4.23 shows the calculation of estimation baseline or removals. Hence, the total baseline emission and greenhouse gases determination is summarized in Table 4.12.

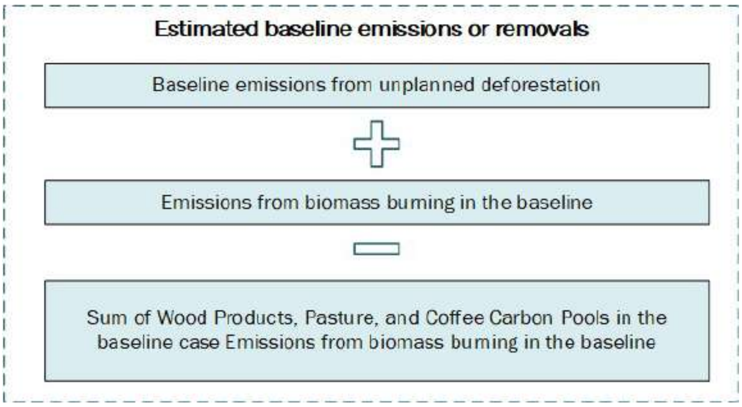

Figure 4.23. Total estimated baseline emissions or removals

Table 4.12. Total baseline emissions and greenhouse gases determination.

	Parameter	Unit	Years 2019	2020	2021	2022	2023	2024	TOTAL
Baseline Emissions	Total	tCO_2-e ha^{-1} $year^{-1}$	52,462.52	645,658.27	720,066.04	964,127.51	1,147,923.94	1,368,540.42	4,898,778.70
	Total Accumulative	tCO_2-e	52,462.52	698,120.79	1,418,186.83	2,382,314.34	3,530,238.28	4,898,778.70	
	$A_{BSL,PA,annual,t} = A_{Burn,i,t}$	ha	61.56	759.51	849.15	1,136.97	1,354.77	1,613.79	5,775.75
	$A_{BSL,PA,cumulative}$	ha	61.56	821.07	1,670.22	2,807.19	4,161.96	5,775.75	
Biomass Burning Emissions (CH_4)	E-CH_4 Biomass Burning	tCO_2-e	1,753.64	21,635.87	24,189.41	32,388.43	38,592.81	45,971.42	164,531.57
	E-CH_4 Biomass Burning Accumulative	tCO_2-e	1,753.64	23,389.51	47,578.92	79,967.34	118,560.16	164,531.57	
Biomass Burning Emissions (N_2O)	E-N_2O Biomass Burning	tCO_2-e	691.54	8,532.00	9,538.98	12,772.22	15,218.89	18,128.61	64,882.24
	E-N_2O Biomass Burning Accumulative	tCO_2-e	691.54	9,223.54	18,762.52	31,534.74	46,753.63	64,882.24	
	E-Biomass Burning = GHGP,E,i,t	tCO_2-e	2,445.17	30,167.87	33,728.39	45,160.65	53,811.70	64,100.02	229,413.81
Wood products carbon pool	E-Wood Carbon Pool	tCO_2-e	158.19	1,951.72	2,182.07	2,921.69	3,481.37	4,146.98	14,842.04
	E-Wood Carbon pool Accumulative	tCO_2-e	158.19	2,109.92	4,291.99	7,213.68	10,695.05	14,842.04	
Pasture Carbon Pool	E-Pasture Carbon Pool	tCO_2-e	830.67	10,248.60	11,458.18	15,341.93	18,280.86	21,776.00	77,936.24
	E-Pasture Carbon pool Accumulative	tCO_2-e	830.67	11,079.27	22,537.45	37,879.38	56,160.24	77,936.24	
Coffee Carbon Pool	E-Coffee Carbon Pool	tCO_2-e	516.90	6,377.35	7,130.03	9,546.76	11,375.55	13,550.46	48,497.05
	E-Coffee Carbon pool Accumulative	tCO_2-e	516.90	6,894.25	14,024.28	23,571.04	34,946.59	48,497.05	
		Total BL-GHG	53,401.93	657,248.46	733,024.15	981,477.78	1,168,597.86	1,393,167.00	

4.2 Project Emissions

As previously described in Section 4.1.5, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 were excluded from the calculation of VCU benefits, as well as the project emission reductions in the wood management areas, because of the absence of the forest stewardship council (FSC) certification. The documents showing the exploited area within this period are available for consultation by auditors, they will be kept in a secure retrievable manner for at least two years after the end of the project crediting period. Although the FSC certification is recovered[128,129] in July of 2022, the start of wood management in the FSM farm in May of 2022 contemplated the FSC management guidelines. So, from 13th April 2022 (2022-2023 period), the VCS benefits of the management areas and the projection project emissions are considered.

The project emissions[130] for forest management activities occurred inside the Project Area. The net emissions in the project case are estimated by combining:

- Emissions arising from logging gap: encompass emissions from felling timber trees and emissions from incidental damage caused by falling timber trees.
- Emissions from infrastructure: from constructing logging infrastructure for removal of timber, such as haul roads, skid trails, and logging decks.
- Wood products carbon pool from timber harvested in the Project Area.

4.2.1 Emissions arising through logging gap

In the project case, emissions occur as a direct result of the death of the timber tree and due to the death of trees killed when the timber tree is felled. The net emission in the project case is equal to the biomass of the wood extracted plus the logging damage factor multiplied by the extracted volume, summed across strata (Equation 9). For this, the logging damage factor (LDF) was used to represent the number of emissions that will ultimately arise per unit of extracted timber (m^3). These emissions arise from the noncommercial portion of the felled trees (the branched and stump) and the trees that are incidentally killed during felling. For broadleaf and mixed forests, a default value of 0.67 t C m^{-3} was used according to the VMD0015-M-REDD-v2.2 methodology. The conservative approach was used considering the maximum volume possible (30 m^3 ha^{-1}) of extracted wood following Brazilian federal law nº 12.651 (Nacional, 2012). This value was multiplied by the average of the last three years of the total area explored in the FSM farm (1,342.39 ha $year^{-1}$), resulting in a $V_{EXT,z,i,t}$ of the 40,271.79 m^3. The resultant calculation values are represented in Table 4.14.

$$C_{LG,i,t} = \sum_{z=1}^{Z}\left(C_{EXT,z,i,t} + \left(LDF_{z,i} \times V_{EXT,z,i,t} \times \frac{44}{12}\right)\right)$$

Equation 9

[128] Annex: FSC certification.pdf

[129] Annex: FSC certification_site information.PNG

[130] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

Where:

$C_{LG\ i\ t}$	Actual net project emissions arising in the logging gap , in stratum i in year t; t CO_{2e}
$C_{EXT,z,i,t}$	Biomass carbon stock of timber extracted within the project boundary for logging stratum z, in stratum i in year t; t CO_{2e}
$LDF_{z,i}$	Logging damage factor for logging stratum z, in stratum i; tC m^{-3} $LDF_{z,i} = 0.67$ t C m^{-3} (VMD0015 - Annex 1: To ensure a conservative estimate, for broadleaf and mixed forests a default value of 0.67 t C m^{-3} may be used)
$V_{EXT,z,i,t}$	Volume extracted from logging stratum z, in stratum i in year t; m^3 $V_{EXT,z,i,t}$ = 40,271.79 m^3 (conservative value of the 30 m^3 ha^{-1} following Brazilian federal law nº 12.651 (Nacional, 2012) multiplied by 1,342.39 ha $year^{-1}$ the average of the last three years of the total area explored in the FSM farm)
Z	1, 2, 3, …Z logging strata
i	1, 2, 3 … M strata
t	1, 2, 3 … t years elapsed since the start of the project activity

Equation 10 calculated the biomass of the total volume extracted from each logging stratum, which D_j = 0.59 t d.m.m^{-3} (IPCC, 2006a) and CF_j = 0.47 tC t^{-1} d.m (IPCC, 2006b).

$$C_{EXT,z,i,t} = \sum_{j=1}^{S} \left(V_{EXT,z,i,t} \times D_j \times CF_j \times \frac{44}{12} \right) \qquad \text{Equation 10}$$

Where:

$C_{EXT,z,i,t}$	Biomass carbon stock of timber extracted within the project boundary for logging stratum z, in stratum i in year t; t CO_{2e}
$V_{EXT,z,i,t}$	The volume of timber extracted of species j for logging stratum z, in stratum i in year t; m^3
D_j	Basic wood density of species j; t d.m.m^{-3} D_j = 0.59 t d.m.m^{-3} (IPCC (2006a), page 2.55, Table 2.6)
CF_j	Carbon fraction of biomass for tree species j; tC t^{-1} d.m. CF_j = 0.47 tC t^{-1} d.m (IPCC (2006b), page 4.48, Table 4.3)
Z	1, 2, 3, …Z logging strata
j	1, 2, 3 … S_{PS} tree species

t	1, 2, 3 … t years elapsed since the start of the project activity

4.2.2 Emissions arising through infrastructure emissions

The emissions arising through infrastructure emissions were estimated based on the VMD0015-M-MON-v2.1 methodology. The net emission in the project case is equal to the sum of emissions resulting from: (i) skid trails, (ii) roads, and (iii) logging decks created for selective logging operations (Equation 11). The resultant calculation values are represented in Table 4.14.

$$C_{LR,i,t} = \Delta C_{SKID,i,t} + \Delta C_{ROAD,i,t} + \Delta C_{DECKS,i,t}$$ Equation 11

Where:

$C_{LR,i,t}$	Actual net project emissions arising from logging infrastructure in stratum i at time t; t CO_{2e}
$\Delta C_{SKID,i,t}$	Change in carbon stock resulting from skid trail creation in stratum i at time t; t CO_{2e}
$\Delta C_{ROAD,i,t}$	Change in carbon stock resulting from logging road creation in stratum i at time t; t CO_{2e}
$\Delta C_{DECKS,i,t}$	Change in carbon stock resulting from logging deck creation in stratum i at time t; t CO_{2e}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

Skid Trails

The emissions from the creation of skid trails were estimated by multiplying the total length of skid trails created and a skid trail emission factor (Equation 12).

$$\Delta C_{SKID,i,t} = L_{SKID,i,t} \times SK_i$$ Equation 12

Where:

$\Delta C_{SKID,i,t}$	Change in carbon stock resulting from skid trail creation in stratum i at time t; t CO_{2e}
$L_{SKID,i,t}$	Length of skid trails in stratum i at time t; m The length of skid trails is the average number of logging decks (see **Table 4.13**) multiplied by the 250 m average length of the trail and by 3 the number of trails per deck [131].

[131] Annex: Trail Lengh_E-mail confirmation.pdf

SK_i	Skid trail emissions factor (Average emissions resulting from dead wood created in the process of skid trail creation per length of skid trail) in stratum i; t CO_{2e} m^{-1} SK_i = 0.29 t CO_{2e} m^{-1} (estimated based on Equation 13)
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

The estimate of project emission also considered the vegetation loss caused by the trails produced by skidders. For ex-ante calculations of emissions arising from creation of skid trails, roads, and logging decks, it was conservatively assumed the emission equivalent to the stratum with the highest biomass (i.e. "Encosta" stratum, with $C_{dest,i}$ = 792.73 t CO_{2e} ha^{-1}). It is assumed that the machinery used to create the skid trail kills all aboveground and belowground tree biomass located within the path of the skid trail. This biomass becomes deadwood and is assumed to be immediately emitted. The skid trail emission factor is estimated based on Equation 13.

$$SK_i = \left(C_{dest,i} + \Delta C_{SOC,sk,i}\right) \times \frac{1}{10{,}000} \times W_{SKID} \qquad \text{Equation 13}$$

Where:

SK_i	Skid trail emission factor (Average emissions resulting from dead wood created in the process of skid trail creation per length of skid trail) in stratum i; t CO_{2e} m^{-1}
$C_{dest,i}$	Mean live carbon stock of trees and non-tree biomass assumed to be killed per unit area in creation of skid trail in stratum i; t CO_{2e} ha^{-1} $C_{dest,i}$ = 792.73t CO_{2e} ha^{-1} (Conservative value is estimated by the high value of carbon in the stratum corresponding to the total carbon stock in the updated biomass inventory).
$\Delta C_{SOC,sk,i}$	Carbon stock change in organic carbon resulting from skid trail creation in stratum i; t CO_{2e} ha^{-1} $\Delta C_{SOC,sk,i}$ = 0 (Conservative value was used, see Section 3.3 Project Boundary)
W_{SKID}	Mean width of skid trails in stratum i; m W_{SKID} = 3.64 m (conservative estimate according VMD0015-M-MON-v2.1 methodology: skidder of the 2.6 m multiplied by 140% was used [132])
i	1, 2, 3 … M strata, unitless

Logging Roads

The emissions resulting from the creation of roads were determined by multiplying the area of roads created in each stratum by the carbon stock (Equation 14). A conservative approach is used for carbon stock in all pools in the baseline case in stratum ($C_{BSL,i}$) parameter, whereby the value is estimated by

[132] Annex: Trail Lengh_E-mail confirmation.pdf

the high value of carbon in the stratum (i.e. *Encosta* stratum, with $C_{BSL,i}$= 792.73 t CO_{2e} ha^{-1}). corresponding to the total carbon stock in the updated biomass inventory.

$$\Delta C_{ROAD,i,t} = A_{ROAD,i,t} \times C_{BSL,i}$$

Equation 14

Where:

$\Delta C_{ROAD,i,t}$	Change in carbon stock resulting from logging road creation in stratum i at time t; t CO_2-e
$A_{ROAD,i,t}$	Area of roads in stratum i at time t; ha^{-1} Area is calculated by the width multiplied by the length of the road (these values are the average for the last 3-years of wood management, see **Table 4.13**).
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i, t CO_2-e ha^{-1} $C_{BSL,i}$ = 792.73 t CO_{2e} ha^{-1} (Conservative value is estimated by the high value of carbon in the stratum corresponding to the total carbon stock in the updated biomass inventory).
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

Logging Decks

The emissions per unit of extraction from logging decks were determined by measuring the area of logging decks created in each stratum. The area was multiplied by the carbon stock (Equation 15).

$$\Delta C_{DECKS,i,t} = A_{DECKS,i,t} \times C_{BSL,i}$$

Equation 15

Where:

$\Delta C_{DECKS,i,t}$	Change in carbon stock resulting from logging deck creation in stratum i at time t; t CO_2-e ha^{-1}
$A_{DECKS,i,t}$	Area of logging decks in stratum i at time t; t CO_2-e ha^{-1} This value is the average for the last 3-years of wood management, see Table 4.13
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i, t CO_2-e ha^{-1}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

4.2.3 Commercial inventory estimation

The commercial inventory was estimated based on the VMD0005-CP-W-v1.1 methodology. The biomass carbon of the commercial volume extracted before or in the process of deforestation was calculated using

Equation 19. Where the conservative approach was used to estimate the mean aboveground biomass carbon stock ($C_{AB\ tree\ i}$ = 537.41 t $CO_{2\text{-}e}$ ha^{-1}) considering the aboveground biomass weighted average according to forest inventory values. In addition, the biomass conversion and expansion factor (BCEF) of 1.66 was used to convert merchantable volume to total aboveground tree biomass (Brown et al., 1989). P_{com_i} was calculated by the ratio between the volume of extracted wood (30 m^3 ha^{-1}) and the $C_{AB\ tree\ i}$ value. The resultant calculation values are represented in Table 4.14.

$$C_{XB,i} = C_{AB\ tree\ i} \times \frac{1}{BCEF} \times P_{com_i} \qquad \text{Equation 16}$$

Where:

$C_{XB,i}$	Mean stock of extracted biomass carbon from stratum i; t CO_2-e ha^{-1}
$C_{AB\ tree\ i}$	Mean aboveground biomass carbon stock in stratum i; t CO_2-e ha^{-1} $C_{AB\ tree\ i}$ = 537.41 t CO_2-e ha^{-1} (the conservative approach was used with aboveground biomass weighted average according to forest inventory values).
BCEF	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless BCFE = 1.66 (Table 4, page 890, Brown et al. (1989))
P_{com_i}	Commercial volume as a percent of total aboveground volume in stratum i; dimensionless P_{com_i} was the ratio between the volume of extracted wood (30 m^3 ha^{-1}) and the $C_{AB\ tree\ i}$ value.
i	1, 2, 3 … M strata, unitless

The biomass carbon entering the wood products pool at the time of deforestation was estimated by Equation 17. The fraction immediately emitted through mill inefficiency by class of wood product ty used is 0.24 (Pearson et al., 2012; Winjum et al., 1998).

$$C_{WP\ i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} \times (1 - WW_{ty}) \qquad \text{Equation 17}$$

Where:

$C_{WP\ i}$	Carbon stock entering the wood products pool from stratum i; t CO_2-e ha^{-1}
$C_{XB,ty,i}$	Mean stock of extracted biomass carbon by class of wood product ty from stratum I; t CO_2-e ha^{-1}
WW_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless WW_{ty} = 0.24 (Commodity Wood and Waste, page 278, Winjum et al. (1998); Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)

i	1, 2, 3 … M strata, unitless

The number of wood products entering the pool during deforestation is expected to be emitted over a 100-year timeframe. This calculation was determined by Equation 18. In this case, it was considered SLF_{ty} and OF_{ty} equal to 0.2 and 0.8, respectively (Pearson et al., 2012; Winjum et al., 1998).

$$C_{WP100,i} = C_{WP,i} - C_{WP,i} \times (1 - SLF_{ty}) \times (1 - OF_{ty})$$

Equation 18

Where:

$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; t CO_2-e ha^{-1}
$C_{WP,i}$	Carbon stock entering wood products pool at time of deforestation from stratum i; t CO_2-e ha^{-1}
SLF_{ty}	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty; dimensionless SLF_{ty} = 0.2 (Commodity Wood, page 276, Winjum et al. (1998); Pearson et al. (2012))
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless OF_{ty} = 0.8 (Commodity Wood, page 276, Winjum et al. (1998); Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)
i	1, 2, 3 … M strata, unitless

4.2.4 Commercial inventory estimation

The commercial inventory was estimated based on the VMD0005-CP-W-v1.1 methodology. The biomass carbon of the commercial volume extracted before or in the process of deforestation was calculated using Equation 19. Where the conservative approach was used to estimate the mean aboveground biomass carbon stock ($C_{AB\ tree\ i}$ = 537.41 t CO_{2-e} ha^{-1}) considering the aboveground biomass weighted average according to forest inventory values. In addition, the biomass conversion and expansion factor (BCEF) of 1.66 was used to convert merchantable volume to total aboveground tree biomass (Brown et al., 1989). P_{com_i} was calculated by the ratio between the volume of extracted wood (30 m^3 ha^{-1}) and the $C_{AB\ tree\ i}$ value. The resultant calculation values are represented in Table 4.14.

$$C_{XB,i} = C_{AB\ tree\ i} \times \frac{1}{BCEF} \times P_{com_i}$$

Equation 19

Where:

$C_{XB,i}$	Mean stock of extracted biomass carbon from stratum i; t CO_2-e ha^{-1}
$C_{AB\ tree\ i}$	Mean aboveground biomass carbon stock in stratum i; t CO_2-e ha^{-1} $C_{AB\ tree\ i}$ = 537.41 t CO_2-e ha^{-1} (the conservative approach was used with aboveground biomass weighted average according to forest inventory values).
BCEF	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless BCFE = 1.66 (Table 4, page 890, Brown et al. (1989))
P_{com_i}	Commercial volume as a percent of total aboveground volume in stratum i; dimensionless P_{com_i} was the ratio between the volume of extracted wood (30 m^3 ha^{-1}) and the $C_{AB\ tree\ i}$ value.
i	1, 2, 3 … M strata, unitless

The biomass carbon entering the wood products pool at the time of deforestation was estimated by Equation 17. The fraction immediately emitted through mill inefficiency by class of wood product ty used is 0.24 (Pearson et al., 2012; Winjum et al., 1998).

$$C_{WP\ i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} \times (1 - WW_{ty}) \qquad \text{Equation 20}$$

Where:

$C_{WP\ i}$	Carbon stock entering the wood products pool from stratum i; t CO_2-e ha^{-1}
$C_{XB,ty,i}$	Mean stock of extracted biomass carbon by class of wood product ty from stratum I; t CO_2-e ha^{-1}
WW_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless WW_{ty} = 0.24 (Commodity Wood and Waste, page 278, Winjum et al. (1998); Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)
i	1, 2, 3 … M strata, unitless

The number of wood products entering the pool during deforestation is expected to be emitted over a 100-year timeframe. This calculation was determined by Equation 18. In this case, it was considered SLF_{ty} and OF_{ty} equal to 0.2 and 0.8, respectively (Pearson et al., 2012; Winjum et al., 1998).

$$C_{WP100,i} = C_{WP,i} - C_{WP,i} \times (1 - SLF_{ty}) \times (1 - OF_{ty}) \qquad \text{Equation 21}$$

Where:

$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; t CO_2-e ha^{-1}
$C_{WP,i}$	Carbon stock entering wood products pool at time of deforestation from stratum i; t CO_2-e ha^{-1}
SLF_{ty}	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty; dimensionless SLF_{ty} = 0.2 (Commodity Wood, page 276, Winjum et al. (1998); Pearson et al. (2012))
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless OF_{ty} = 0.8 (Commodity Wood, page 276, Winjum et al. (1998); Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)
i	1, 2, 3 … M strata, unitless

4.2.5 Project emissions estimation due to wood management

For a more precise and conservative approach to the ex-ante baseline projection, the project emissions consist of the average values of the last three years of wood management in the project area (Table 4.13). These values were collected as follows:

- The total area explored was estimated based on the forest movement report of the FSM farm[133].
- Volume of extracted wood was a conservative approach used considering the maximum volume possible (30 m^3 ha^{-1}) of extracted wood following Brazilian federal law nº 12.651 (Nacional, 2012)
- The number of the logging decks is defined by the number of "*Esplanadas*". The deck area of is the dimensions 20 x 25 (m^2) multiplied by the number of the logging decks divided by 10,000 resulting in the value in ha. The length of the road is the extension of existing roads plus primary and secondary roads. The conservative approach was used, considering the maximum value of the 6 m road width for all types of roads[134],[135],[136].
- The biomass expansion and conversion factor is the minimum value deducted from the lowest limit, according to Brown et al. (1989).

[133] Annex: Forest movement report.pdf

[134] Annex: Wood management_1.pdf

[135] Annex: Wood management_2.pdf

[136] Annex: Wood management_3.pdf

Table 4.13. The average values of the last three years of wood management in the project area.

	Parameter	Unit	Values of the last three years of wood management in the project area			Avarage
Logging emissions	Total area explored	ha year^{-1}	1,188.91	1,399.20	1,439.06	1,342.39
	$Volume_{Extracted\_Wood}$	m^{3} ha^{-1}	30.00	30.00	30.00	30.00
Infrastructure emissions	Number of logging decks		123.00	107.00	141.00	123.67
	Lengh of road	m	63,706.71	66,908.00	45,433.00	58,682.57
	Widht of road	m	6.00	6.00	6.00	6.00
	Area of decks	ha	6.15	5.35	7.05	6.18
Wood carbon pool	BCEF		1.66	1.66	1.66	1.66

In the following subsections, the calculations made for project emissions ex-ante due to wood management are presented following methodology (Figure 4.24), and the final values are shown in Table 4.14.

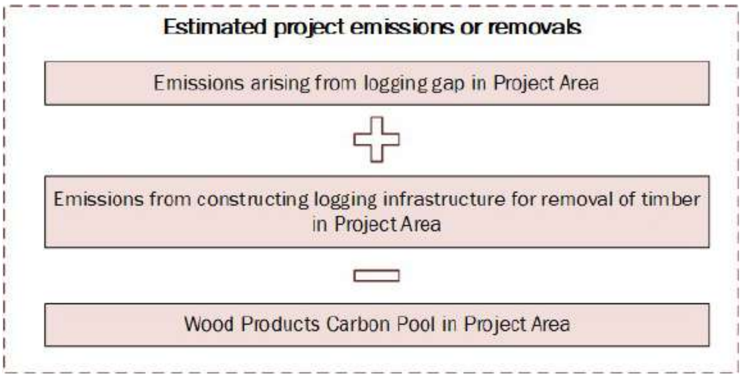

Figure 4.24. Project emissions or removals estimation

Table 4.14. Project emissions estimation due to wood management.

	Parameter	Unit	Year					
			2019	2020	2021	2022	2023	2024
Logging emissions	Total area explored	ha $year^{-1}$	-	-	-	1,342.39	1,342.39	1,342.39
	$Volume_{Extracted\_Wood}$	m^3 ha^{-1}	-	-	-	30.00	30.00	30.00
	V_{ext}	m^3 $year^{-1}$	-	-	-	40,271.79	40,271.79	40,271.79
	V_{ext}	t $year^{-1}$	-	-	-	23,760.36	23,760.36	23,760.36
	C_{ext}	tCO_{2-e}	-	-	-	40,947.01	40,947.01	40,947.01
	$C_{LG,i,t}$	tCO_{2-e}	-	-	-	139,881.38	139,881.38	139,881.38
Infrastructure emissions	Number of logging decks					123.67	123.67	123.67
	Total length skid trails		-	-	-	92,750.00	92,750.00	92,750.00
	ΔC_{SKID}	tCO_{2-e}	-	-	-	30,714.84	30,714.84	30,714.84
	Lengh of road	m				58,682.57	58,682.57	58,682.57
	Widht of road	m				6.00	6.00	6.00
	Area of road	ha	-	-	-	35.21	35.21	35.21
	$\Delta C_{ROAD,t}$	tCO_{2-e}	-	-	-	30,044.99	30,044.99	30,044.99
	Area of decks	ha				6.18	6.18	6.18
	ΔC_{DECKS}	tCO_{2-e}	-	-	-	5,276.36	5,276.36	5,276.36
	$\Delta C_{DECKS}+\Delta C_{ROAD,t}+\Delta C_{SKID}$	tCO_{2-e}	-	-	-	66,036.19	66,036.19	66,036.19
Wood carbon pool	$Volume_{Extracted\_Wood}$	m^3 ha^{-1}	-	-	-	30.00	30.00	30.00
	C_{ab_tree}	tCO_{2-e} ha^{-1}	-	-	-	621.24	621.24	621.24
	BCEF					1.66	1.66	1.66
	P_{com}		-	-	-	0.05	0.05	0.05
	$Cx_{b,i}$		-	-	-	18.07	18.07	18.07
	C_{wp}		-	-	-	13.73	13.73	13.73
	$C_{wp(100)}$		-	-	-	11.54	11.54	11.54
Project emissions reductions (PER)		tCO_{2-e}	-	-	-	**200,653.31**	205,906.03	205,906.03

4.3 Leakage

As previously described in Sections 3.6 and 4.1.1 of this document, the leakage belt area is changed in this baseline reassessment since the wrong approach in the leakage belt boundaries at the first baseline period according to methodology VMD0007-BL-UP_v3.3. Although a leakage belt may have to be defined in the surrounding or immediate vicinity of the project area, the leakage belt area must be the forest areas closest to the project area. Additionally, all parts of the leakage belt must, at a minimum, be accessible and reachable by project baseline deforestation agents with consideration of agent mobility. Also, the belt must not be spatially biased in terms of the distance of the edge of the belt from the edge of the project area without justification based on agent mobility or criteria for landscape and transportation. The second baseline period's leakage belt area is closer to the project area and satisfies all the methodology's parameters.

There were no records of a burn or unplanned deforestation from the leakage belt throughout the baseline period of this Joint Project Description & Monitoring Report document. Geospatial imagery also supports this information. There is a high probability that these incidents will occur in this area, so the preventive action plan is being adopted in the leakage belt zones (see Section 1.11 Description of the Project Activity).

4.3.1 Leakage Market-Effect[137]

The Leakage Market-Effect was made beside module VMD0011-LK-ME-v1.1.

Total leakage due to market effects is equal to the sum of market-effects leakage through decreased timber harvest and decreased harvest for fuelwood/charcoal production (Equation 22). As explained in previous topics, the process of deforestation in the baseline scenario involves timber harvesting for commercial markets, prior to the implementation of pasture or coffee crops. The implementation of these activities is usually financed by means of initial capital obtained in wood logging. Similarly, to the Reference Area and Project Area, the Leakage Belt is also subject to serious risks of land-grabbing promoted by illegal organizations (i.e., family-scale land-grabber associations, land-property documentation forgers), mostly supported by unscrupulous sawmills and political interests. As seen in "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" of the VCS-PD, the maintenance of native forests is far of being the most attractive economic scenario, giving the opportunity for land use shifting from native forest to pasture and coffee crops. In this context, the local communities have a widespread culture of deforestation, mainly led by economic factors. Thus, market leakage estimate is mandatory for this project. Hence, the leakage due to market effects is applicable just market- effects leakage of the decreased timber harvest, so the $LK_{MarketEffects,FW/C}$ and $LK_{MarketEffects,Peat}$ were considered null.

$$\Delta C_{LK-ME} = LK_{MarketEffects,timber} + LK_{MarketEffects,FW/C} + LK_{MarketEffects,Peat}$$

Equation 22

[137] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

Where:

ΔC_{LK-ME}	Net greenhouse gas emissions due to market-effects leakage (t CO_{2e})
$LK_{MarketEffects,timber}$	Total GHG emissions due to market- effects leakage through decreased timber harvest; t CO_{2-e}
$LK_{MarketEffects,FW/C}$	Total GHG emissions due to market-effects leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets (t CO_{2e})
$LK_{MarketEffects,Peat}$	Total GHG emissions due to market-effects leakage through decreased timber, fuelwood and charcoal harvest resulting in increased peatland drainage (t CO-e)

Leakage due to market effects is equal to the baseline emissions from logging multiplied by a leakage factor and, where applicable, by a leakage management factor (Equation 23).

$$LK_{MarketEffects,timber} = \sum_{i=1}^{M} \left(LF_{ME} \times LK_{MAF} \times AL_{T,i}\right) \qquad \text{Equation 23}$$

Where:

$LK_{MarketEffects,timber}$	Total GHG emissions due to market- effects leakage through decreased timber harvest; t CO_{2-e}
LF_{ME}	Leakage factor for market-effects calculations; dimensionless
$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project; t CO_{2-e}
LK_{MAF}	Leakage management adjustment factor (dimensionless)
i	1,2,3,…M strata

The deduction factor (LF_{ME}) was adopted based on the relation between mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type ($\mathrm{PML_{FT}}$) and merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary ($\mathrm{PMP_i}$). The $\mathrm{PML_{FT}}$ is estimated considering the literature data. According to Homma (2011), from 45 billion m^3 of Amazon wood stocks, almost 15 billion m^3 was marketable. Thus, the $\mathrm{PML_{FT}}$ adopted is 31% for legal Amazon. The $\mathrm{PMP_i}$ is calculated from forest inventory. In the forest inventory, commercial biomass was estimated through the allometric equation conforming described in Section 4.1.4. Characterization of biomass in Project Area. According to the VMD0011-LK-ME-v1.1 methodology, the merchantable biomass is defined by the total gross biomass (including bark) of a tree 40 cm DBH or larger from a 30 cm stump to a minimum 10 cm top of the central stem. In this case, $\mathrm{PMP_i}$ is calculated as the ratio between marketable biomass of DBH trees higher than 40 cm (14,207,847.38 t) [138] and total biomass (25,734,621.53 t) [139], resulting in 55%. Hence, like $\mathrm{PML_{FT}} > 15\%\ \mathrm{less\ than\ PMP_i}$ the leakage factor for market-effects calculations adopted is 0.7. In other words, it is expected that the areas to be deforested in the Amazon Biome in the presence of the project are greater than would be observed in the project region.

Deduction factors for LF_{ME}:

$\mathrm{PML_{FT}} = \pm 15\%\ \mathrm{toPMP_i}$	$\mathrm{LF_{ME}} = 0.4$
$\mathrm{PML_{FT}} > 15\%\ \mathrm{less\ than\ PMP_i}$	$\mathrm{LF_{ME}} = 0.7$
$\mathrm{PML_{FT}} > 15\%\ \mathrm{greater\ than\ PMP_i}$	$\mathrm{LF_{ME}} = 0.2$

Where:

$\mathrm{PML_{FT}}$	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type (%)
$\mathrm{PMP_i}$	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary (%)
$\mathrm{LF_{ME}}$	Leakage factor for market-effects calculations; dimensionless

Leakage management activities established within areas under the control of the project proponent can minimize the displacement of land use activities to areas outside the project area. A leakage management adjustment factor (LKMAF) may be applied if total biomass production is maintained in merchantable commercial species. In the FSM project, wood management in the project area attends to the wooding market. This wood exploration occurs according to *Código Florestal, Lei Federal nº 12.651/2012* (Nacional, 2012), minimizing the environmental impact in comparison to illegal wood exploration. For this reason, the Production of biomass in commercial species that is merchantable in leakage management areas ($PRODMB_{LMA,t}$) was 30 t per year. This value was conservative because of presents the maximum value allowed by law (Nacional, 2012) that allowed to explore in the project area. The production of biomass in commercial species that is merchantable in the baseline case ($PRODMB_{BL,t}$) was 35.1 t per year (da SILVA et al., 2001; Veríssimo et al., 1992), the same value of the merchantable wood in the explanation adopted and validated in the Monitoring Report: VCS Version 4.0. So, the leakage factor for market-effects calculations (LK_{MAF}) was 0.14 (Equation 24).

$$LK_{MAF} = 1 - \left(\frac{PRODMB_{LMA,t}}{PRODMB_{BL,t}}\right) \quad \text{Equation 24}$$

Where:

[138] Annex: Forest inventory_DBH 40.xlsx

[139] Annex: Forest inventory total.xlsx

LF_{ME}	Leakage factor for market-effects calculations; dimensionless
$PRODMB_{LMA,t}$	Production biomass in commercial species that is merchantable in year t in leakage management areas; t per year
$PRODMB_{BL,t}$	Production of biomass in commercial species that is merchantable in year t in the baseline case; t per year
t	1, 2, 3, … t* time elapsed since the start of the project activity; years

In compliance with Equation 25, the summed emissions from timber harvest in the stratum ($AL_{T,i}$) are equivalent to carbon emissions due to displaced timber harvests in the baseline scenario ($C_{BSL,XBT,i,t}$).

$$AL_{T,i} = \sum_{t=1}^{i} (C_{BSL,XBT,i,t}) \qquad \text{Equation 25}$$

Where:

$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case laced through implementation of carbon project; t CO_{2e}
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t; t CO_{2e}
i	1, 2, 3, …M strata
t	1, 2, 3, … t* time elapsed since the projected start of the REDD project activity; years

The $C_{BSL,XBT,i,t}$ was estimated by Equation 26. With $AL_{T,i}$determination, the $LK_{MarketEffects,timber}$ was estimated using Equation 23 resulting in net greenhouse gas emissions due to market-effects leakage (See the results in Table 4.15).

$$C_{BSL,XBT,i,t} = \left((V_{BSL,EX,i,t} \times D_{mn} \times CF) + (V_{BSL,EX,i,t} \times LDF) + (V_{BSL,EX,i,t} \times LIF) \right) \times \frac{44}{12} \qquad \text{Equation 26}$$

Where:

$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t; t CO_{2e}
$V_{BSL,EX,i,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i in year t; m^3 $V_{BSL,EX,i,t}$ = 35.1 m^3 ha^{-1} (da SILVA et al., 2001; Veríssimo et al., 1992)

D_{mn}	Mean wood density of commercially harvested species; t d.m.m^{-3} D_{mn} = 0.59 t d.m. m^{-3} (IPCC (2006a) page 2.55, Table 2.6).
CF	Carbon fraction of biomass for commercially harvested species j; t C t d.m.$^{-1}$ CF = 0.47 t C t d.m.$^{-1}$ (IPCC (2006b) page 4.48, Table 4.3).
LDF	Logging damage factor; t C m^{-3} LDF = 0.67 t C m^{-3} (VMD0015 Annex 1).
LIF	Logging infrastructure factor; t C m^{-3} LIF = 0.29 t C m^{-3} (VMD0011 page 8)
i	1, 2, 3, …M strata
t	1, 2, 3, … t* time elapsed since the projected start of the REDD project activity; years

Table 4.15. Leakage Market-Effects determination.

	Parameter	Description	Unit	Year 2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	Total
Market-Effects Leakage Through Decreased Timber Harvest	$A_{BSLPAt\ annual}$		ha $year^{-1}$	61.56	759.51	849.15	1,136.97	1,354.77	1,613.79	
	$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t	tCO_{2-e} ha^{-1}	159.15	159.15	159.15	159.15	159.15	159.15	
	$AL_{T,i}$ = $C_{BSL,XBT,i,t}$	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of the project	tCO_{2-e}	9,797.26	120,875.85	135,142.03	180,948.52	215,611.34	256,834.31	919,209.31
	$PRODFC_{LMA,t}$	Production biomass in commercial species that is merchantable in year t in leakage management areas	t $year^{-1}$	30.00	30.00	30.00	30.00	30.00	30.00	
	$PRODFC_{BL,t}$	Production of biomass in commercial species that is merchantable in year t in the baseline case	t $year^{-1}$	35.08	35.08	35.08	35.08	35.08	35.08	
	$LKFC_{MAF}$	Leakage management adjustment factor		0.14	0.14	0.14	0.14	0.14	0.14	
	$LK_{MarketEffects,timber}$	Total GHG emissions due to market-effects leakage through decreased timber harvest	tCO_{2-e}	993.13	12,252.98	13,699.12	18,342.44	21,856.16	26,034.86	93178.69
Total leakage ME	ΔC_{LK-ME}	Net greenhouse gas emissions due to market-effects leakage	tCO_{2-e}	993.13	12,252.98	13,699.12	18,342.44	21,856.16	26,034.86	93178.69

4.3.2 Leakage Outside the Leakage Belt: Local Deforestation Agents[140]

The Leakage Market-Effect was made beside module VMD0010-LK-ME-v1.2. The leakage belt was estimated considering the second baseline, which details aboutthese leakage definition boundaries are in Section 4.1.1.

Based on the expected effectiveness of the proposed REDD project activities, conservatively estimated the carbon stock changes and greenhouse gas emissions in the ex-ante assessment of the leakage belt. In this case, emissions must occur due to the implementation of the REDD project activity, which would not happen in the baseline case. Calculations were made by multiplying the estimated baseline carbon stock changes and greenhouse gas emissions for the project area by a 10% deforestation expected to be displaced into the leakage belt. This value besides on Project Description: VCS version 3, which considers a series of activities for leakage mitigation that will also be adopted in the second baseline according to Section 1.8.

The result is added to the estimated baseline for the leakage belt to estimate carbon stock changes and greenhouse gas emissions (GHG) in the leakage belt under the project scenario (Table 4.17). The GHG in the leakage activity shifting ex-ante was estimated based on the same equations that GHG emission in baseline (see Section 4.1.5, Estimation of Carbon Stock Changes and GHG Emissions), considering the deforestation projected in the leakage belt area resulting from allocation analysis (Table 4.16). In the emission, the value resulting from the weighted average of the total biomass (above and belowground) of the 736.26 tCO_{2-e} ha^{-1} was used. Briefly, in this GHG emission calculation, the same profile of deforestation agent was considered, which removes the trees for commercialization of wood, burning the rest biomass, resulting in wood products and pasture or coffee production.

Table 4.16. Leakage belt area projected by allocation analysis.

	Parameter	Unit	Years 2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	TOTAL
Leakage Belt_projected	(Fe)Floresta Ombrofila Densa Submontana	ha	-	12.33	19.80	48.69	87.48	130.95	299.25
	(Fo)Floresta Ombrofila Aberta Submontana	ha	-	0.27	1.89	2.52	6.30	8.10	19.08
	(FoFe) Contato	ha	-			0.45	0.45	0.18	1.08
	$A_{BSLLBt\ annual}$	ha	-	12.60	21.69	51.66	94.23	139.23	319.41
	$A_{BSLLB\ cumulative}$	ha	-	12.60	34.29	85.95	180.18	319.41	

The result is added to the estimated baseline for the leakage belt to estimate carbon stock changes and greenhouse gas emissions (GHG) in the leakage belt under the project scenario (Table 4.17). The GHG in the leakage activity shifting ex-ante was estimated based on the same equations that GHG emission in baseline (see Section 4.1.5, Estimation of Carbon Stock Changes and GHG Emissions), considering the deforestation projected in the leakage belt area resulting from allocation analysis. In the emission, the value resulting from the weighted average of the total biomass (above and belowground) of the 736.26 tCO_{2-e} ha^{-1} was used. Briefly, in this GHG emission calculation, the same profile of deforestation agent

[140] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

was considered, which removes the trees for commercialization of wood, burning the rest biomass, resulting in wood products and pasture or coffee production.

The difference between project and baseline carbon stock changes and greenhouse gas emissions in the leakage belt is the ex-ante estimated leakage due to displacement of unplanned deforestation from the project area to the leakage belt (Table 4.18).

Table 4.17. Greenhouse gas emissions in the leakage belt ex-ante under the project scenario.

	Parameter	Unit	Years 2019	2020	2021	2022	2023	2024	TOTAL
Baseline Emissions	Total	tCO_2-e ha^{-1} $year^{-1}$	-	10,723.91	18,460.44	43,968.01	80,199.49	118,499.15	271,851.00
	Total Accumulative	tCO_2-e	-	10,723.91	29,184.34	73,152.35	153,351.85	271,851.00	
	$A_{BSL,PA,annual,t} = A_{Burn,i,t}$	ha	-	12.60	21.69	51.66	94.23	139.23	319.41
	$A_{BSL,PA,cumulative}$	ha	-	12.60	34.29	85.95	180.18	319.41	
Biomass Burning Emissions (CH_4)	E-CH_4 Biomass Burning	tCO_2-e	-	360.18	620.02	1,476.72	2,693.60	3,979.94	9,130.45
	E-CH_4 Biomass Burning Accumulative	tCO_2-e	-	360.18	980.19	2,456.91	5,150.51	9,130.45	
Biomass Burning Emissions (N_2O)	E-N_2O Biomass Burning	tCO_2-e	-	142.03	244.50	582.34	1,062.21	1,569.47	3,600.55
	E-N_2O Biomass Burning Accumulative	tCO_2-e	-	142.03	386.53	968.87	2,031.08	3,600.55	
	E-Biomass Burning = GHGP,E,i,t	tCO_2-e	-	502.21	864.52	2,059.06	3,755.81	5,549.41	12,731.00
Wood products carbon pool	E-Wood Carbon Pool	tCO_2-e	-	32.38	55.74	132.75	242.14	357.78	820.79
	E-Wood Carbon pool Accumulative	tCO_2-e	-	32.38	88.12	220.87	463.01	820.79	
Pasture Carbon Pool	E-Pasture Carbon Pool	tCO_2-e	-	170.02	292.68	697.08	1,271.51	1,878.73	4,310.02
	E-Pasture Carbon pool Accumulative	tCO_2-e	-	170.02	462.70	1,159.78	2,431.29	4,310.02	
Coffee Carbon Pool	E-Coffee Carbon Pool	tCO_2-e	-	105.80	182.12	433.77	791.22	1,169.07	2,681.98
	E-Coffee Carbon pool Accumulative	tCO_2-e	-	105.80	287.92	721.69	1,512.91	2,681.98	
		Total LK-GHG	-	10,917.92	18,794.42	44,763.46	81,650.43	120,642.99	

Table 4.18. Leakage Outside the Leakage Belt: Local Deforestation Agents.

				Parameter	Description	Unit	Year 2019	2020	2021	2022	2023	2024
Leakage - Activity Shifting	Ex-ante	Baseline	Project area	$\Delta C_{BSL,unplanned\_B\_PA}$	Net greenhouse gas emissions in the baseline from unplanned deforestation up to year t*	tCO_{2-e}	53,401.93	657,248.46	733,024.15	981,477.78	1,168,597.86	1,393,167.00
Leakage - Activity Shifting	Ex-ante	Baseline	Leakage belt	$\Delta C_{BSL,LK,unplanned\_B\_LB}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation + GHG emission in the leakage belt up to year t* - estimated baseline for the leakage belt to estimate carbon stock changes and greenhouse gas emissions in the leakage belt under the project scenario	tCO_{2-e}	-	10,917.92	18,794.42	44,763.46	81,650.43	120,642.99
Leakage - Activity Shifting	Ex-ante	Project Scenary	Project area	$\Delta C_{BSL,unplanned\_\_PA\_PA}$	Net greenhouse gas emissions in the project scenario from unplanned deforestation up to year t*	tCO_{2-e}	5,340.19	65,724.85	73,302.42	98,147.78	116,859.79	139,316.70
Leakage - Activity Shifting	Ex-ante	Project Scenary	Leakage belt	$\Delta C_{BSL,unplanned\_PA\_B\_LB}$	The result is added to the estimated baseline for the leakage belt to estimate carbon stock changes and greenhouse gas emissions in the leakage belt under the project scenario	tCO_{2-e}	5,340.19	76,642.76	92,096.83	142,911.24	198,510.21	259,959.69
				LK-Activity Shifting - Ex ante	The difference between project and baseline carbon stock changes and greenhouse gas emissions in the leakage belt is the ex-ante estimated leakage due to displacement of unplanned deforestation from the project area to the leakage belt.	tCO_{2-e}	5,340.19	65,724.85	73,302.42	98,147.78	116,859.79	139,316.70

4.3.3 Leakage Outside the Leakage Belt: Immigrant Deforestation Agents[141]

The Leakage Market-Effect was made beside module VMD0010-LK-ME-v1.2. The leakage belt was estimated considering the second baseline, which details about these leakage definition boundaries are in Section 4.1.1.

Total available national forest area

Conservatively, the immigrants who were prevented from deforesting the project area can be found in alternative exploration areas. The alternative forest area could be within the Leakage Belt, or elsewhere in the country. The proportion migrating to the Leakage Belt is calculated as the area of the Leakage Belt as a proportion of the total available forest area nationally (AVFOR). AVFOR was estimated as following Equation 27.

$$\mathrm{AVFOR} = \mathrm{TOTFOR} - \mathrm{PROTFOR} - \mathrm{MANFOR}$$

Equation 27

Where:

AVFOR	Total available national forest area for unplanned deforestation, ha
TOTFOR	Total available national forest area, ha TOTFOR = 486,454,993.85 ha (IBGE, 2021; SEMA, 2022)
PROTFOR	Total area of fully protected forests nationally, ha PROTFOR = 128,899,480.00 ha (Murer & Futada, 2022)
MANFOR	Total area of forests under active management nationally, ha MANFOR = 1,400,000.00 ha (IBAMA, 2020)

As Brazil has many forest biome types in its large extension, the conservative approach was considered assuming only the Amazon Rainforest biome in the TOTFOR parameter. Thus, as a representation of the total area of the Amazon Rainforest in Brazilian Territory, TOTFOR consisted of the total area of 501,499,993.66 ha (IBGE, 2021) multiplied by the net preserved forest (0.97) (SEMA, 2022), resulting in 486,454,993.85 ha. As the Amazon biome is localized in Brazilian Northern and Centre-West macro-regions, the PROTFOR and the MANFOR parameters consider these regions. In addition, the value of PROTFOR includes the Conservation Units (UCs) instituted by Federal Law Nº.9985/2000: i) integral protection units and ii) sustainable use units. Therefore, the PROTFOR and MANFOR used are 128,899,480.00 ha (Murer & Futada, 2022) and 1,400,000 ha (IBAMA, 2020), respectively. Hence, through the presented data, the AVFOR estimated is 356,155,513.85 ha.

[141] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

Forest area in the leakage belt

The proportion of the Leakage Belt area related to the total available national forest area ($PROP_{LB}$) is calculated by dividing the Leakage Belt area (LBFOR; 37,590.03 ha) by AVFOR. This procedure results in $PROP_{LB}$ equal to 1.05544 × 10^{-4} (Equation 28).

$$\mathrm{PROP_{LB}} = \frac{\mathrm{LBFOR}}{\mathrm{AVFOR}}$$ Equation 28

Where:

$\mathrm{PROP_{LB}}$	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
LBFOR	Total available forest area for unplanned deforestation in the leakage belt, ha LBFOR = 37,590.03 ha (calculated from the Leakage Belt Forest Cover Benchmark Map)
AVFOR	Total available national forest area for unplanned deforestation, ha

Stratify AVFOR by carbon stock

The average carbon stock across the Leakage Belt ($\mathrm{C_{LB}}$) is 621.24 tCO_{2e} ha^{-1} based on the weighted average of biomass inventory aboveground in the project area and according to similarity analysis between the Leakage Belt area and the Project Area. According to Saatchi et al. (2007), the average carbon stock for all available forest area outside the Leakage Belt ($\mathrm{C_{OLB}}$) is 157.66 tC ha^{-1} corresponding to 578.1 tCO_{2e} ha^{-1}. The proportional difference in carbon stocks between areas of forest available for unplanned deforestation both inside and outside the Leakage Belt (PROPCS) is calculated by dividing $\mathrm{C_{OLB}}$ per $\mathrm{C_{LB}}$ resulting in a value of 0.93 (Equation 29).

$$\mathrm{PROP}_{CS} = \frac{C_{OLB}}{C_{LB}}$$ Equation 29

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, tCO_{2e} ha^{-1} C_{OLB} = 578.1 tCO_{2e} ha^{-1} (Saatchi et al., 2007)
C_{LB}	Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the leakage belt, tCO_{2e} ha^{-1}

C_{LB} = 621.24 tCO_{2e} ha^{-1} (the weighted average of biomass inventory aboveground)

Proportional leakage for areas with immigrating populations

The proportion of baseline deforestation caused by immigrating population ($\mathrm{PROP_{IMM}}$) was estimated for a period from 2015 to 2020. For calculating $\mathrm{PROP_{IMM}}$, the participatory rural appraisal (PRA) approach was replaced by local data available according to Monitoring Report: VCS Version 4.0. The Colniza local sources have a precise estimation approach of:

(i) The total annual population growth between 2015 and 2020 was 1,257.20 inhab. $year^{-1}$ (IBGE, 2020);

(ii) The number of annual births from 2015 to 2020 was 513.00 inhab. $year^{-1}$ (DataSus, 2020b);

(iii) The number of annual deaths from 2015-2020 was 121.20 inhab. $year^{-1}$ (DataSus, 2020a);

(iv) The total population in 2020 was 39,861.00 (IBGE, 2020).

The number of immigrants can be estimated by subtracting the annual population growth from the difference in rates of the number of annual births and death, dividing by the total population (Equation 30). This technique also assumes that the IBGE assessment is applicable to estimate population migration between urban and rural zones (i.e., there is similar accuracy between urban and rural immigrants' estimations). According to the number of immigrants, we have inferred the proportion of deforestation attributed to immigrant agents ($\mathrm{PROP_{IMM}}$) as 2.17%.

$$\mathrm{PROP_{IMM}} = \left(\frac{1{,}257.20\ -\ (513.00\ -121.20)}{39{,}861.00}\right) = 0.0217$$ Equation 30

Where:

$\mathrm{PROP_{IMM}}$ Estimated proportion of baseline deforestation caused by immigrating population, proportion

The proportional leakage for areas with immigrating populations ($\mathrm{LK_{PROP}} = 0.0234$) was then equal to the immigrating proportion multiplied by the proportion of available national forest area outside the Leakage Belt multiplied by the proportional difference in stocks between forests inside and outside the Leakage Belt (Equation 31).

$$\mathrm{LK_{PROP}} = \mathrm{PROP_{IMM}} \times (1 - \mathrm{PROP_{LB}}) \times \mathrm{PROP_{CS}}$$ Equation 31

Where:

LK_{PROP}	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

Leakage Outside the Leakage Belt - Immigrant Deforestation Agents: Ex-ante

Ex-ante, leakage due to the proportion of the baseline deforestation actors who are displaced to areas outside the leakage belt is estimated by Equation 32. Briefly, $\Delta C_{LK-ASU,OLB}$ is the change in stocks in the leakage belt in the baseline scenario minus the change in stocks in the leakage belt in the project scenario multiplied by the proportional leakage factor for areas with immigrating populations. If $\Delta C_{LK-ASU,OLB}$ < 0, the zero amount was considered. Therefore, the values of leakage ex-ante are represented in Table 4.19.

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

Equation 32

Where:

$\Delta C_{LK-ASU,OLB}$	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

4.3.4 Total estimation of the Leakage ex-ante[142]

The total estimation of the leakage ex-ante is equal to the sum of the calculated leakage previously subsections (Figure 4.25). The result was calculated in Table 4.20.

[142] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

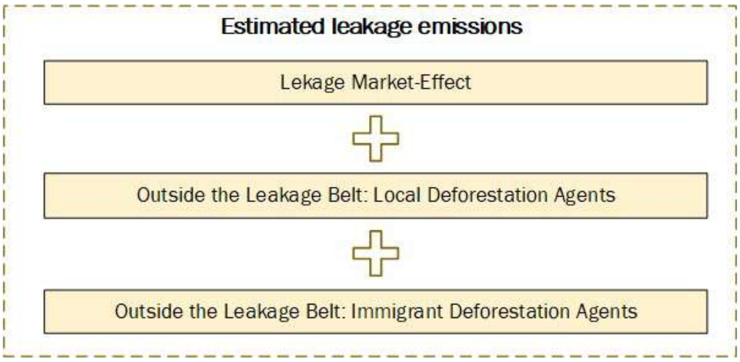

Figure 4.25. Total estimation of the leakage belt ex-ante

Table 4.19. Leakage Outside the Leakage Belt: Immigrant Deforestation Agents.

	Parameter	Description	Unit	Year					
				2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025
Ex ante	$\Delta C_{LK\text{-}ASU,OLB}$	Net CO_2 emissions due to unplanned deforestation displaced outside the leakage belt up to year t*	$tCO_{2\text{-}e}$	-107.87	-1,107.11	-1,101.07	-1,078.37	-711.23	-377.21
Ex ante	$\Delta C_{BSL,LK,unplanned}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation in the leakage belt up to year t*	$tCO_{2\text{-}e}$	-	10,917.92	18,794.42	44,763.46	81,650.43	120,642.99
Ex ante	$\Delta C_{P,LB}$	Net CO_2 equivalent emissions within the leakage belt in the project case up to year t*	$tCO_{2\text{-}e}$	5,340.19	65,724.85	73,302.42	98,147.78	116,859.79	139,316.70
	LK-Outside - Ex ante		$tCO_{2\text{-}e}$	-	-	-	-	-	-

Table 4.20. Total estimation of the Leakage ex-ante.

Leakage Ex-Ante	Unit	Year						Total
		2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	
Market-Effect	$tCO_{2\text{-}e}$	993.13	12,252.98	13,699.12	18,342.44	21,856.16	26,034.86	93,178.69
Outside the Leakage Belt: Local Deforestation Agents	$tCO_{2\text{-}e}$	5,340.19	65,724.85	73,302.42	98,147.78	116,859.79	139,316.70	498,691.72
Outside the Leakage Belt: Immigrant Deforestation Agents	$tCO_{2\text{-}e}$	-	-	-	-	-	-	-
Total Leakage	$tCO_{2\text{-}e}$	6,333.32	77,977.83	87,001.53	116,490.22	138,715.94	165,351.56	591,870.41

4.4 Estimated Net GHG Emission Reductions and Removals

The summary of the net GHG emission reductions or removals calculation is described in Figure 4.26 [143].

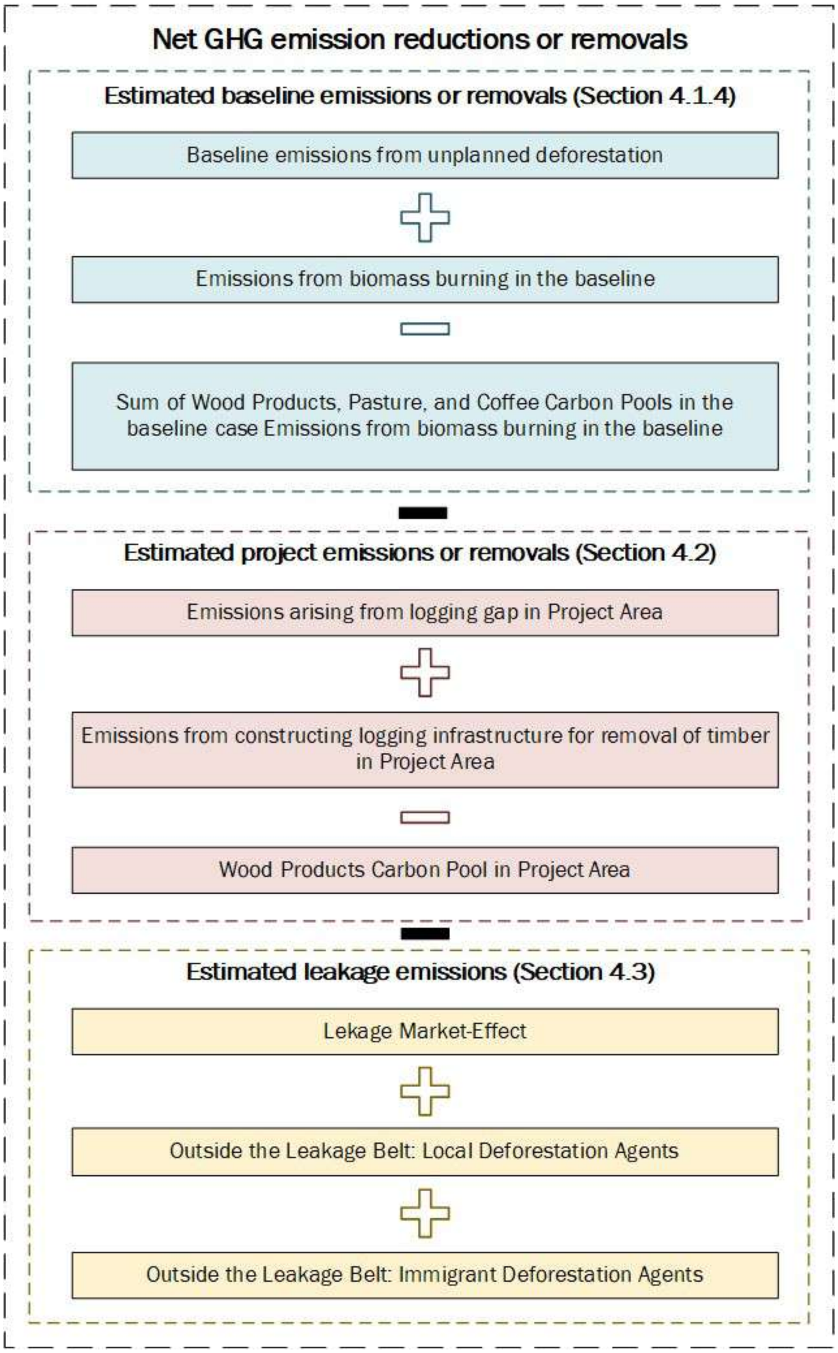

Figure 4.26 Summary of the calculation of Net GHG emission reductions or removals

[143] All ex-ante calculations are available to the auditor in the 4 Calculations folder.

The FSM farm's exploited lands between April 13, 2019, and April 12, 2022, were not included in the assessment of VCU benefits and the project emissions. This is a result of these lands not having previously received FSC (Forest Stewardship Council) certification, making them ineligible for the Project. Auditors may review the records outlining the areas exploited during this period, which will be stored in a safe place that can be accessed for at least two years following the conclusion of the crediting period.

The buffer pool allocation was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value for the second baseline period was 10% (see Section 4. of the Non-Permanence Risk document). Hence, the estimated net GHG emission reductions or removals result from the difference between (i) the net GHG emission reductions or removals and (ii) buffer pool allocation (Table 4.21).

Table 4.21. Net GHG Emission Reductions and Removals.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2019-2020	53,401.93	-	6,333.32	47,068.61	4,706.86	42,361.75
2020-2021	657,248.46	-	77,977.83	579,270.64	57,927.06	521,343.58
2021-2022	733,024.15	-	87,001.53	646,022.62	64,602.26	581,420.36
2022-2023	981,477.78	205,906.03	116,490.22	659,081.53	65,908.15	593,173.38
2023-2024	1,168,597.86	205,906.03	138,715.94	823,975.88	82,397.59	741,578.30
2024-2025	1,393,167.00	205,906.03	165,351.56	1,021,909.42	102,190.94	919,718.47
Total	4,986,917.19	617,718.09	591,870.41	3,777,328.69	377,732.87	3,399,595.82

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	CF
Data unit	t C t d.m.$^{-1}$

Description	Carbon fraction of biomass for commercially harvested species j
Source of data	IPCC (2006b) page 4.48, Table 4.3
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	The default value was used to be more conservative.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	Where new species are encountered in the course of monitoring, new carbon fraction values must be sourced from the literature or otherwise use the default value.

Data / Parameter	D_{mn}
Data unit	t C t d.m.$^{-1}$
Description	Mean wood density of commercially harvested species
Source of data	IPCC (2006a) page 2.55, Table 2.6
Value applied	0.59
Justification of choice of data or description of measurement methods and procedures applied	The default value was used to be more conservative.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	LDF
Data unit	t C m^{-3}
Description	Logging damage factor
Source of data	VMD0015 Annex 1
Value applied	0.67
Justification of choice of data or description of measurement methods and procedures applied	Annex 1: To ensure a conservative estimate, for broadleaf and mixed forests a default value of 0.67 t C m^{-3} may be used
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	

Data / Parameter	LIF
Data unit	t C m^{-3}
Description	Logging infrastructure factor
Source of data	VMD0011 page 8
Value applied	0.29
Justification of choice of data or description of measurement methods and procedures applied	Default 0.29 t t C m^{-3}
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	

Data / Parameter	BCFE
Data unit	dimensionless
Description	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass
Source of data	Table 4, page 890, Brown et al. (1989)
Value applied	1.66
Justification of choice of data or description of measurement methods and procedures applied	Minimum value deducted from lowest limit.: 1.743 - 0.083 = 1.66.
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	P_{com_i}
Data unit	dimensionless
Description	Calculated as the ratio between the volume of merchantable wood in exploitation, 35.08 m^3 ha^{-1} (da SILVA et al., 2001), and the total volume of aboveground biomass per stratum.
Source of data	da SILVA et al. (2001)
Value applied	Calculated
Justification of choice of data or description of measurement methods and procedures applied	Calculation of baseline emissions
Purpose of Data	
Comments	The source database has a precise approach.

Data / Parameter	WW_{ty}
Data unit	dimensionless
Description	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty
Source of data	Commodity Wood and Waste, page 278, Winjum et al. (1998) and Pearson et al. (2012)
Value applied	0.24
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The source database has a precise approach.

Data / Parameter	SLF_{ty}
Data unit	dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty
Source of data	Step 3. Commodity Wood, page 276, Winjum et al. (1998) and Pearson et al. (2012)
Value applied	0.2
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The source database has a precise approach.

Data / Parameter	OF_{ty}
Data unit	dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty
Source of data	Step 3. Commodity Wood, page 276, page 276, Winjum et al. (1998) and Pearson et al. (2012)
Value applied	0.8
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of project emissions
Comments	The source database has a precise approach.

Data / Parameter	$COMF_i$
Data unit	dimensionless
Description	Combustion factor for stratum I.
Source of data	Table 2.6, page 2.55, IPCC (2006a)
Value applied	0.59
Justification of choice of data or description of measurement methods and procedures applied	Local values are not known, and the IPCC factor is a conservative value.
Purpose of Data	Calculation of baseline emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	$G_{g,i}$
Data unit	kg t^{-1} d.m.
Description	Emission factor for stratum i for gas g
Source of data	Table 2.5, page 2.54, IPCC (2006a)
Value applied	G_{g,CH_4} = 4.8 kg t^{-1}, G_{g,NO_2} = 0.2 kg t^{-1}
Justification of choice of data or description of measurement methods and procedures applied	Local values are not known, and the IPCC factor is a conservative value.
Purpose of Data	Calculation of baseline emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	GWP_g
Data unit	t CO_2/t gas g
Description	Global warming potential for gas g
Source of data	Box 3.2, Table 1, page 87, IPCC (2014), Grennhouse (2014)
Value applied	GWP_{CH_4} = 28 t CO_2 t_{gas}^{-1}, GWP_{NO_2} = 265 t CO_2 t_{gas}^{-1}
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of baseline emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	CF
Data unit	t C t^{-1} d.m.
Description	Carbon fraction of biomass
Source of data	pg. 4.48, Table 4.3.IPCC (2006b)
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	The default value was used to be more conservative
Purpose of Data	• Calculation of baseline emissions; • Calculation of project emissions; • Calculation of leakage
Comments	Where new species are encountered while monitoring, new carbon fraction values must be sourced from the literature or otherwise use the default value.

Data / Parameter	$V_{BSL,EX,i,t}$
Data unit	m^3 ha^{-1}
Description	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i in year t
Source of data	da SILVA et al., 2001; Veríssimo et al., 1992
Value applied	35.1
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	• Calculation of baseline emissions; • Calculation of project emissions; • Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	TOTFOR
Data unit	ha
Description	Total available national forest area.
Source of data	IBGE, 2021b; SEMA, 2022
Value applied	486,454,993.85
Justification of choice of data or description of measurement methods and procedures applied	TOTFOR is the total amazon forest area equal to 501,499,993.66 ha multiplied by preserved forest (97%)
Purpose of Data	Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	PROTFOR
Data unit	ha
Description	Total area of fully protected forests nationally.
Source of data	Murer & Futada, 2022
Value applied	128,899,480.00
Justification of choice of data or description of measurement methods and procedures applied	The value of PROTFOR includes the Conservation Units (UCs) instituted by Federal Law Nº.9985/2000: i) integral protection units and ii) sustainable use units.
Purpose of Data	Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	$PROP_{IMM}$
Data unit	proportion
Description	Estimated proportion of baseline deforestation caused by immigrating population
Source of data	IBGE (2020), DataSus (2020b), DataSus (2020a),and IBGE (2020)
Value applied	0.0217
Justification of choice of data or description of measurement methods and procedures applied	• The total annual population growth between 2015 and 2020 was 1,257.20 inhab. year^{-1} (IBGE, 2020); • The number of annual births from 2015 to 2020 was 513.00 inhab. year^{-1} (DataSus, 2020b); • The number of annual deaths from 2015-2020 was 121.20 inhab. year^{-1} (DataSus, 2020a); • The total population in 2020 was 39,861.00 (IBGE, 2020). $PROP_{IMM} = \left(\frac{1,257.20 - (513.00 - 121.20)}{39,861.00}\right) = 0.0217$
Purpose of Data	Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	MANFOR
Data unit	ha
Description	Total area of forests under active management nationally.
Source of data	IBAMA, 2020
Value applied	1,400,000.00
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	LBFOR
Data unit	ha
Description	Total available forest area for unplanned deforestation in the leakage belt
Source of data	Calculated from the Leakage Belt Forest Cover Benchmark Map
Value applied	37,590.03
Justification of choice of data or description of measurement methods and procedures applied	The leakage area was estimated by remote sensing.
Purpose of Data	Calculation of leakage
Comments	See Section 4.1.1 Definition of Boundaries

Data / Parameter	C_{OLB}
Data unit	$tCO_{2e}\ ha^{-1}$
Description	Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the leakage belt.
Source of data	Saatchi et al., 2007
Value applied	578.1
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Calculation of leakage
Comments	The conservative chosen value belongs to the climatic zone and forest type that most closely matches the project circumstances.

Data / Parameter	C_{LB}
Data unit	tCO_{2e} ha^{-1}
Description	Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the leakage belt.
Source of data	The weighted average of biomass inventory aboveground
Value applied	621.24
Justification of choice of data or description of measurement methods and procedures applied	Calculated from the update Forest Inventory made in 2022.
Purpose of Data	Calculation of leakage
Comments	See section 4.1. Characterization of biomass in Project Area

Data / Parameter	$\mathrm{LF_{ME}}$
Data unit	dimensionless
Description	Leakage factor for market-effects calculations
Source of data	VMD0011-LK-ME-v1.1 methodology and Homma (2011)
Value applied	0.7
Justification of choice of data or description of measurement methods and procedures applied	$\mathrm{PML_{FT}} = \pm 15\%\ \mathrm{to PMP_i}$ $\quad \mathrm{LF_{ME}} = 0.4$ $\mathrm{PML_{FT}} > 15\%\ \text{less than}\ \mathrm{PMP_i}$ $\quad \mathrm{LF_{ME}} = 0.7$ $\mathrm{PML_{FT}} > 15\%\ \text{greater than}\ \mathrm{PMP_i}$ $\quad \mathrm{LF_{ME}} = 0.2$
Purpose of Data	Calculation of leakage
Comments	See $\mathrm{PML_{FT}}$ and $\mathrm{PMP_i}$ parameters.

Data / Parameter	PML_{FT}
Data unit	%
Description	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type
Source of data	Update forest inventory
Value applied	31
Justification of choice of data or description of measurement methods and procedures applied	The PML_{FT} is estimated considering the literature data. According to Homma (2011) from 45 billion m³ of Amazon wood stocks, almost 15 billion m³ was marketable. Thus, the PML_{FT} adopted is 31% for legal Amazon.
Purpose of Data	Calculation of leakage
Comments	See LF_{ME} and PMP_i parameters.

Data / Parameter	PMP_i
Data unit	%
Description	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary
Source of data	Homma (2011)
Value applied	55
Justification of choice of data or description of measurement methods and procedures applied	The PMP_i is calculated from forest inventory. In the update forest inventory, commercial biomass was estimated through the allometric equation conforming described in Section 4.1.4 Characterization of biomass in Project Area. According to the VMD0011-LK-ME-v1.1 methodology, the merchantable biomass is defined by the total gross biomass (including bark) of a tree 40 cm DBH or larger from a 30 cm stump to a minimum 10 cm top of the central stem. In this case, PMP_i is calculated as the ratio between marketable biomass of DBH trees higher than 40 cm (14,207,847.38nt)[144] and total biomass (25,734,621.53 t)[145], resulting in 55%.
Purpose of Data	Calculation of leakage

[144] Annex: Forest inventory_DBH 40.xlsx

[145] Annex: Forest inventory total.xlsx

Comments	See LF_{ME} and PML_{FT} parameters.

Data / Parameter	$\ln(\text{Volume}, \text{m}^3) = -8.939 + 2.507 \times \ln(\text{DBH}, \text{cm})$
Data unit	m^3 $tree^{-1}$
Description	Allometric equation to estimation of aboveground merchantable volume of trees, in the range between 5 cm and 82 cm DBH
Source of data	Nogueira et al. (2008)
Value applied	$\ln(\text{Volume}, \text{m}^3) = -8.939 + 2.507 \times \ln(\text{DBH}, \text{cm})$
Justification of choice of data or description of measurement methods and procedures applied	Peer-reviewed work performed in the region of FSM farm, with a similar vegetation typology. The statistical quality of model is in conformance with methodology requirements.
Purpose of Data	• Calculation of baseline emissions; • Calculation of project emissions; • Calculation of leakage
Comments	The result of such equation must be converted to mass by multiplying it by the wood density

Data / Parameter	$\text{Volume}, \text{m}^3 = -0.4306 + 0.0011 \times (\text{DBH}, \text{cm})^2$
Data unit	m^3 $tree^{-1}$
Description	Allometric equation to estimation of aboveground merchantable volume of trees with DBH higher than 82 cm
Source of data	Colpini et al. (2009)
Value applied	$\text{Volume}, \text{m}^3 = -0.4306 + 0.0011 \times (\text{DBH}, \text{cm})^2$
Justification of choice of data or description of measurement methods and procedures applied	Peer-reviewed work performed in the region of FSM farm, with a similar vegetation typology. The statistical quality of model is in conformance with methodology requirements.
Purpose of Data	• Calculation of baseline emissions; • Calculation of project emissions; • Calculation of leakage
Comments	The result of such equation must be converted to mass by multiplying it by the wood density

Data / Parameter	R
Data unit	t root d.m.t^{-1} shoot d.m.
Description	Root to shoot ratio appropriate to species or forest type/biome; note that as defined here, root to shoot ratio is applied as belowground biomass per unit area: aboveground biomass per unit area (not on a per stem basis)
Source of data	Page 4.49, table 4.4, IPCC (2006b)
Value applied	0.37
Justification of choice of data or description of measurement methods and procedures applied	Local values are not known, and the IPCC factor is a conservative value.
Purpose of Data	• Calculation of baseline emissions; • Calculation of project emissions; • Calculation of leakage
Comments	The conservative chosen value belongs to the climatic zone and forest type that most closely matches the project circumstances.

5.2 Data and Parameters Monitored

In a conservative approach, the project proponent opted not to monitor forest degradation in the Reference Area and Project Area. According to previous studies for characterization of the Reference Area, illegal extraction of smaller trees for fuelwood and charcoal is not a usual practice in the FSM region. Moreover, the practice of illegal logging of smaller trees and forest degradation is expected to be pretty much more pronounced in non-protected areas, as those observed in the Reference Area, than in protected forest areas, as the FSM farm. As demonstrated in the VCS-PD, the FSM farm has a system for monitoring boundaries and for hindering any invasion that might endanger the forest. The only carbon loss inside the FSM farm is attributed to low-impact Sustainable Forest Management.

The forest inventory was made in this second baseline period. As required by the methodology, the baseline reassessment process (10 in 10 years) entails updating the biomass inventory with data collected in the field, using the same procedures defined in the first baseline. All inventory procedures were previously described in Section 4.1.4. Due to the difficulty in measuring tree heights in the field, the conservative approach was used, in which palm trees were not counted in this forest inventory. As monocots, palms are evolutionarily, morphologically, and physiologically distinct from other trees, and these differences have important implications for ecosystem services (such as carbon sequestration and storage) and responses to climate change. Using the same method to measure the biomass of trees and palms may neglect the amount of carbon sequestered because the specific measurement of palms takes into account height and diameter (Muscarella et al., 2020). Thus, the parameter of the total height of the tree (H) was not contemplated here.

Data / Parameter	Project Forest Cover Monitoring Map
Data unit	N/A
Description	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event.
Source of data	Remote sensing in combination with GPS data collected during ground truthing
Description of measurement methods and procedures to be applied	The measurement methods and procedures applied are described in Approved VCS Module VMD0015-M-REDD-v2.2 - methods for monitoring of GHG emissions and removals in REDD and CIW projects, Sectoral Scope 14, pages 3 to 14.
Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	N/A
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	The minimum map accuracy must be 90% for the classification of forest/non-forest in the remote sensing imagery. If the classification accuracy is less than 90% then the map is not acceptable for further analysis. More remote sensing data and ground truthing data will be needed to produce a product that reaches the 90% minimum mapping accuracy.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	Leakage Belt Forest Cover Monitoring Map
Data unit	N/A
Description	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt

Source of data	Remote sensing in combination with GPS data collected during ground truthing
Description of measurement methods and procedures to be applied	Map accuracy is 90%.
Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	N/A
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	The minimum map accuracy must be 90% for the classification of forest/non-forest in the remote sensing imagery. If the classification accuracy is less than 90% then the map is not acceptable for further analysis. More remote sensing data and ground truthing data will be needed to produce a product that reaches the 90% minimum mapping accuracy.
Purpose of data	• Calculation of leakage emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$A_{burn,i,t}$
Data unit	ha
Description	Area burnt in stratum i at time t
Source of data	Remote sensing data.
Description of measurement methods and procedures to be applied	It is considered that burning is a common practice in the region, and that all deforested area undergoes burning in a given moment.
Frequency of monitoring/recording	Areas burnt will be monitored every 5 years or if verification occurs on a frequency of less than every 5 years, examination will occur prior to any verification event.
Value applied	Year / Project Area / Leakage Belt 2019-2020 / - / -

	2020-2021 - - 2021-2022 - - 2022-2023 - - 2023-2024 - - 2024-2025 - -
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Calculation method	N/A
Comments	No burning areas were observed in the project area and leakage belt

Data / Parameter	$A_{DelfPA,i,t}$
Data unit	ha
Description	Area of recorded deforestation in the project area in stratum i at time t
Source of data	Remote sensing data.
Description of measurement methods and procedures to be applied	Remote sensing tools.
Frequency of monitoring/recording	Areas burnt will be monitored every 5 years or if verification occurs on a frequency of less than every 5 years, the examination will occur prior to any verification event.
Value applied	Year / $A_{DelfPA,i,t}$ 2019-2020 - 2020-2021 - 2021-2022 - 2022-2023 -

	2023-2024 - 2024-2025 -
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	• Calculation of project emissions
Calculation method	Periodic analysis of the progression of deforested areas in the Project Area.
Comments	No underwent deforestation areas were observed in the project area

Data / Parameter	$A_{DelfLB,i,t}$
Data unit	ha
Description	Area of recorded deforestation in the leakage belt in stratum i at time t
Source of data	Remote sensing data.
Description of measurement methods and procedures to be applied	Periodic analysis of remote sensing imagery.
Frequency of monitoring/recording	Areas burnt will be monitored every 5 years or if verification occurs on a frequency of less than every 5 years, the examination will occur prior to any verification event.
Value applied	Year / $A_{DelfLB,i,t}$ 2019-2020 - 2020-2021 - 2021-2022 - 2022-2023 - 2023-2024 - 2024-2025 -
Monitoring equipment	Satellite imagery.

QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	• Calculation of leakage emissions
Calculation method	Periodic analysis of the progression of deforested areas in the leakage belt.
Comments	No underwent deforestation areas were observed in the leakage area. The leakage belt area was changed considering the second baseline.Details about these leakage definition boundaries are in Section 4.1.1.

Data / Parameter	$A_{RRL,forest}$
Data unit	ha
Description	Remaining area of forest in RRL at time t
Source of data	Remote sensing data.
Description of measurement methods and procedures to be applied	Periodic analysis of the progression of deforested area in RRL.
Frequency of monitoring/recording	Monitored every 10 years for baseline revision. These value is presented in this second baseline report.
Value applied	Year / $A_{RRL,forest}$: 2007: 37,629.45 2008: 37,620.27 2009: 37,615.50 2010: 37,615.41 2011: 37,608.57 2012: 37,607.85 2013: 37,604.34 2014: 37,607.04 2015: 37,603.26 2016: 37,604.52 2017: 37,593.90 2018: 37,593.09 2019: 37,590.03 2020: 37,565.10
Monitoring equipment	Remote sensing imagery.

QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	• Calculation of baseline emissions
Calculation method	Analysis of satellite images.
Comments	Monitored every 10 years for baseline renewal.

Data / Parameter	A_{sp}
Data unit	ha
Description	Area of sample plots in ha
Source of data	Recording and archiving of number and size of sample plots.
Description of measurement methods and procedures to be applied	Rectangular plots are obtained by means of stakes and metric tapes.
Frequency of monitoring/recording	At least every ten years for baseline renewal.
Value applied	0.25
Monitoring equipment	GPS and measuring tape.
QA/QC procedures to be applied	GPS coordinates are double checked in the field.
Purpose of data	• Calculation of baseline emissions
Calculation method	N/A
Comments	Carbon stock estimation occurs only for determination or renewal of the baseline

Data / Parameter	N
Data unit	Dimensionless
Description	Number of sample plots
Source of data	Recording and archiving of number of sample points.

Description of measurement methods and procedures to be applied	Calculated with statistic equation.
Frequency of monitoring/recording	At least every ten years for baseline renewal.
Value applied	130
Monitoring equipment	N/A.
QA/QC procedures to be applied	Standard statistic equation.
Purpose of data	• Calculation of baseline emissions
Calculation method	Calculated using the following formula: $$n = \frac{(t^2 \times CV^2)}{\left(E\%^2 + \left(\frac{t^2 \times CV^2}{N}\right)\right)}$$ Where: n Number of parcels sampled in each stratum (variable for each stratum) t Student "t" value (2.262) CV Coefficient of variation (%) (variable for each stratum) E% Permissible sampling error (10%) N Number of parcels in total stratum area (variable for each stratum)
Comments	Carbon stock estimation occurs only for determination or renewal of the baseline

Data / Parameter	DBH
Data unit	cm
Description	Diameter at breast height of a tree in cm.
Source of data	Field measurements in sample plots.
Description of measurement methods	Measured 1.3m above ground. Measure all trees above some minimum DBH in the sample plots. The minimum DBH varies

and procedures to be applied	depending on tree species and climate; for instance, the minimum DBH may be as small as 2.5 cm or as high as 20m. Minimum DBH employed in inventories is held constant for the duration of the project
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal. Where carbon stock enhancement is included, monitoring shall occur at least every five years.
Value applied	N/A
Monitoring equipment	Measuring type.
QA/QC procedures to be applied	Standard quality control procedures for forest inventory including field data collection and data management were applied. The procedure of DBH measurement is already applied in national forest monitoring and is available from published handbooks, and from Penman et al. (2003) (an example of a handbook is MacDicken (1997)).
Purpose of data	• Calculation of baseline emissions
Calculation method	Diameter (DBH) is calculated based on circumference at breast height (CBH) measurement, by means of the basic perimeter equation: $$DBH = \frac{CBH}{\pi}$$
Comments	N/A

Data / Parameter	$A_{DECKS,i,t}$
Data unit	ha
Description	Area of logging decks in stratum i at time t.
Source of data	Reported measurements such as post-harvest assessment reports and post-harvest maps that are based on field measurements.
Description of measurement methods and procedures to be applied	Systematic sampling must take place to ensure all decks within the area logged are identified and a conservative estimate of area produced.
Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.

Value applied	6.18 ha
Monitoring equipment	Data obtained from annual FSM forest management and reports.
QA/QC procedures to be applied	The measured area of logging decks in current logging gaps will be compared with those of previous logging gaps.
Purpose of data	• Calculation of project emissions
Calculation method	The deck area of is the dimensions 20 x 25 (m^2) multiplied by the number of the logging decks divided by 10,000 resulting in the value in ha [146],[147],[148].
Comments	Project emissions and VCU benefits that occurred between 04/13/2019 and 04/12/2022 were not quantified due to a lack of FSC certification [149,150]. After that, the FSC certification was recovered, so the average values of the last three years of wood management was used in the estimation ex-ante project area from 13/04/2022 to 12/05/2025 for this parameter determination.

Data / Parameter	$A_{ROAD,i,t}$
Data unit	ha
Description	Area of roads in stratum i at time t.
Source of data	Reported measurements such as post-harvest assessment reports and post-harvest maps that are based on field measurements.
Description of measurement methods and procedures to be applied	The area of roads created may be based on the length of roads multiplied by the average width of roads. The length of all roads created during selective logging must be measured by systematically sampling the entire area logged to produce a conservative estimate of the length of roads created. Enough measurements of road width shall be measured to achieve a precision equal to or less than 15% of the mean at the 95% confidence interval. Where different categories of roads exist, different average road widths should be used.

[146] Annex: Wood management_1.pdf

[147] Annex: Wood management_2.pdf

[148] Annex: Wood management_3.pdf

[149] Annex: FSC certification.pdf

[150] Annex: FSC certification_site information.PNG

Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied	35.21 ha
Monitoring equipment	Data obtained from annual FSM forest management and reports.
QA/QC procedures to be applied	The measured area of logging decks in current logging gaps will be compared with those of previous logging gaps.
Purpose of data	• Calculation of project emissions
Calculation method	The measured area of roads is estimated by length of road (existing roads plus primary and secondary roads) multiply by width road (the conservative approach was used, considering the maximum value of the 6 m road width for all types of roads) [151],[152],[153].
Comments	Project emissions and VCU benefits that occurred between 04/13/2019 and 04/12/2022 were not quantified due to a lack of FSC certification [154,155]. After that, the FSC certification was recovered, so the average values of the last three years of wood management was used in the estimation ex-ante project area from 13/04/2022 to 12/05/2025 for this parameter determination.

Data / Parameter	L_{skid}
Data unit	m
Description	Length of skid trail sk.
Source of data	Reported measurements such as post-harvest assessment reports, post-harvest maps that are based on field measurements, or Annual Operational Plans of the Sustainable Management Plan.
Description of measurement methods	The length of skid trails may be estimated through using systematic sampling with a random start of the entire area logged or within a sampled known logged area within the project

[151] Annex: Wood management_1.pdf

[152] Annex: Wood management_2.pdf

[153] Annex: Wood management_3.pdf

[154] Annex: FSC certification.pdf

[155] Annex: FSC certification_site information.PNG

and procedures to be applied	boundary to produce a conservative estimate of the length of skid trails created. The total length of all skid trails can be equal to the mean length of skid trails per unit area multiplied by the total area logged
Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event.
Value applied	92,750.00 m
Monitoring equipment	Data obtained from annual FSM forest management and reports.
QA/QC procedures to be applied	The measured area of logging decks in current logging gaps will be compared with those of previous logging gaps.
Purpose of data	• Calculation of project emissions
Calculation method	The length of skid trails is the average number of logging decks multiplied by the 250 m average length of the trail and by 3 the number of trails per deck [156].
Comments	Project emissions and VCU benefits that occurred between 04/13/2019 and 04/12/2022 were not quantified due to a lack of FSC certification [157,158]. After that, the FSC certification was recovered, so the average values of the last three years of wood management was used in the estimation ex-ante project area from 13/04/2022 to 12/05/2025 for this parameter determination.

Data / Parameter	W_{SKID}
Data unit	m
Description	Mean width of skid trails.
Source of data	Reported measurements such as post-harvest assessment reports and post-harvest maps that are based on field measurements.
Description of measurement methods and procedures to be applied	The average width of skid trails created within a stratum i can be based on reported widths; a conservative estimate based on machinery used; or additional field measurements.

[156] Annex: Trail Lengh_E-mail confirmation.pdf

[157] Annex: FSC certification.pdf

[158] Annex: FSC certification_site information.PNG

	Conservative estimate: Width edge of tires on largest skidder type * 140% is used, as the skidder type is known and used to create all skid trails.
Frequency of monitoring/recording	The estimated mean width of skid trails shall be monitored and updated prior to each verification report.
Value applied	2.6 m × 140% = 3.64 m [159]
Monitoring equipment	Data obtained from annual FSM forest management and reports.
QA/QC procedures to be applied	The measured area of logging decks in current logging gaps will be compared with those of previous logging gaps.
Purpose of data	• Calculation of project emissions
Calculation method	Conservative estimate: Width edge of tires on largest skidder type multiplied by 140% is used, as the skidder type is known and used to create all skid trails
Comments	It is assumed that all diameter trees are destroyed and therefore the aboveground and belowground tree biomass that is destroyed by the skidder conservatively equates to the maximum aboveground biomass carbon stock observed in all strata. Based on the overall area of skid trails related to the Project Area, the values estimated for emissions from skid trails are not significant according to T-SIG, as they represent much less than 5% of total emissions. Thus, the inclusion of these emissions in final calculations is indisputably conservative per se.

Data / Parameter	A_i
Data unit	ha
Description	Total area of stratum i.
Source of data	GPS delineation and remote sensing imagery.
Description of measurement methods and procedures to be applied	GPS delineation and remote sensing imagery.
Frequency of monitoring/recording	At a minimum every time the baseline is updated (at least every 10 years).

[159] Annex: Trail Lengh_E-mail confirmation.pdf

Value applied	<table><tr><th>Stratum</th><th>Area (ha)</th></tr><tr><td>Aluvial</td><td>12,944.00</td></tr><tr><td>Encosta</td><td>9,275.00</td></tr><tr><td>FOB Densa Submontana</td><td>6,696.00</td></tr><tr><td>FOB Submontana</td><td>42,473.00</td></tr></table> The areas exploited inside the FSM farm from 13/04/2019 to 12/01/2021 were excluded from the calculation of VCU benefits. This is since these areas were not certified by the FSC (Forest Stewardship Council) at the moment of timber harvest and, consequently, were not eligible to the Project, according to VMD0015-M-MON-v2.1. The documents showing the areas exploited within this time are available for consultation by auditors and will be kept in a secure retrievable manner for at least two years after the end of the project crediting period. Thus, the baseline emissions and project emissions occurring inside these areas were not quantified for the present verification period.
Monitoring equipment	GPS and satellite image.
QA/QC procedures to be applied	GPS data is confirmed by field survey.
Purpose of data	• Calculation of project emissions
Calculation method	Satellite image analysis.
Comments	Deforested area inside the Project Area is excluded from the project activity.

Data / Parameter	$V_{ex,i}$
Data unit	m^3
Description	The volume of timber in m^3 extracted from within the stratum (does not include slash left onsite), reported by wood product class and preferably species.
Source of data	Timber harvest records.
Description of measurement methods	Timber inventory, performed in FSM.

and procedures to be applied	
Frequency of monitoring/recording	Annually
Value applied	40,271.79 m^3 $year^{-1}$
Monitoring equipment	The same equipment applied in forest inventory.
QA/QC procedures to be applied	The same control procedures applied to forest inventory.
Purpose of data	• Calculation of project emissions
Calculation method	Timber inventory.
Comments	Project emissions and VCU benefits that occurred between 04/13/2019 and 04/12/2022 were not quantified due to a lack of FSC certification. After that, the FSC certification was recovered [160,161], so the average values of the last three years of wood management was used in the estimation ex-ante project area from 13/04/2022 to 12/05/2025 for this parameter determination.

Data / Parameter	$V_{ex,i}$
Data unit	m^3
Description	The volume of timber in m^3 extracted from within the stratum (does not include slash left onsite), reported by wood product class and preferably species.
Source of data	Timber harvest records.
Description of measurement methods and procedures to be applied	Timber inventory, performed in FSM.
Frequency of monitoring/recording	Annually
Value applied	40,271.79 m^3 $year^{-1}$
Monitoring equipment	The same equipment applied in forest inventory.

[160] Annex: FSC certification.pdf

[161] Annex: FSC certification_site information.PNG

QA/QC procedures to be applied	The same control procedures applied to forest inventory.
Purpose of data	• Calculation of project emissions
Calculation method	• Timber inventory. • Volume of extracted wood was a conservative approach used considering the maximum volume possible (30 m^3 ha^{-1}) of extracted wood following Brazilian federal law nº 12.651 (Nacional, 2012) multiplied by total area explored[162] in ha $year^{-1}$.
Comments	Project emissions and VCU benefits that occurred between 04/13/2019 and 04/12/2022 were not quantified due to a lack of FSC certification. After that, the FSC certification was recovered [163,164], so the average values of the last three years of wood management was used in the estimation ex-ante project area from 13/04/2022 to 12/05/2025 for this parameter determination.

Data / Parameter	$C_{BSL,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in all pools in the baseline in stratum i
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Field measurements in sample plots and application of allometric equations, as described in “Field inventory of biomass” of this Joint Project Description & Monitoring Report.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value applied	N/A.
Monitoring equipment	The same cited for field measurements in sample plots.
QA/QC procedures to be applied	The same cited for field measurements in sample plots.

[162] Annex: Forest movement report.pdf

[163] Annex: FSC certification.pdf

[164] Annex: FSC certification_site information.PNG

Purpose of data	• Calculation of baseline emissions
Calculation method	Field measurements in sample plots and application of allometric equations, as described in "Field inventory of biomass" of this Joint Project Description & Monitoring Report.
Comments	N/A.

Data / Parameter	$C_{AB,tree,i}$
Data unit	$tCO_{2-e}\ ha^{-1}$
Description	Carbon stock in aboveground biomass in trees in the project case in stratum i
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Field measurements in sample plots, application of allometric equations and multiplication of the merchantable volume by the BCEF (Biomass conversion and expansion factor: 1.66, Brown et al. (1989), page 890, Table 4) for conversion of merchantable volume to total aboveground tree biomass, as described in "Field inventory of biomass" of this Joint Project Description & Monitoring Report.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value applied	N/A.
Monitoring equipment	The same cited for field measurements in sample plots.
QA/QC procedures to be applied	The same cited for field measurements in sample plots.
Purpose of data	• Calculation of baseline emissions
Calculation method	Field measurements in sample plots, application of allometric equations and multiplication of the merchantable volume by the BCEF (Biomass conversion and expansion factor: 1.66, Brown et al. (1989), page 890, Table 4) for conversion of merchantable volume to total aboveground tree biomass, as described in "Field inventory of biomass" of this Joint Project Description & Monitoring Report.
Comments	N/A.

Data / Parameter	$C_{BB,tree,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in belowground biomass in trees in the project case in stratum i
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Field measurements in sample plots, application of allometric equations and multiplication of the total aboveground biomass by the root-shoot ratio (0.37, IPCC (2006b), pg. 4.49, Table 4.4) for calculation of total belowground tree biomass, as described in "Field inventory of biomass" of this Joint Project Description & Monitoring Report.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value applied	N/A.
Monitoring equipment	The same cited for field measurements in sample plots.
QA/QC procedures to be applied	The same cited for field measurements in sample plots.
Purpose of data	• Calculation of baseline emissions
Calculation method	Field measurements in sample plots, application of allometric equations and multiplication of the total aboveground biomass by the root-shoot ratio (0.37, IPCC (2006b), pg. 4.49, Table 4.4) for calculation of total belowground tree biomass, as described in "Field inventory of biomass" of this Joint Project Description & Monitoring Report.
Comments	N/A.

Data / Parameter	$C_{WP,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in wood products in the project case in stratum i
Source of data	As described in Sections "Baseline Emissions" and "Project Emissions" of this Joint Project Description & Monitoring Report.
Description of measurement methods	As described in Sections "Baseline Emissions" and "Project Emissions" of this Joint Project Description & Monitoring Report.

and procedures to be applied	
Frequency of monitoring/recording	Annually
Value applied	2.57 tCO_{2-e} ha^{-1}
Monitoring equipment	As described in Sections "Baseline Emissions" and "Project Emissions" of this Joint Project Description & Monitoring Report.
QA/QC procedures to be applied	As described in Sections "Baseline Emissions" and "Project Emissions" of this Joint Project Description & Monitoring Report.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Calculation method	As described in Sections "Baseline Emissions" and "Project Emissions" of this Joint Project Description & Monitoring Report.
Comments	N/A.

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	tCO_{2-e} ha^{-1}
Description	Non-CO_2 emissions due to biomass burning in stratum i in year t
Source of data	As described in Section "Baseline Emissions" of this Joint Project Description & Monitoring Report.
Description of measurement methods and procedures to be applied	As described in Section "Baseline Emissions" of this Joint Project Description & Monitoring Report.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value applied	N/A
Monitoring equipment	As described in Section "Baseline Emissions" of this Joint Project Description & Monitoring Report.
QA/QC procedures to be applied	As described in Sections "Baseline Emissions" of this Joint Project Description & Monitoring Report.
Purpose of data	• Calculation of baseline emissions

Calculation method	As described in Section "Baseline Emissions" of this Joint Project Description & Monitoring Report.
Comments	N/A.

5.3 Monitoring Plan

This monitoring plan has been developed based on the module VMD0015 "Methods for monitoring of greenhouse gas emissions and removals (M-REDD)" of the VM0007 "REDD Methodology Framework (REDD-MF)". These methods aim to monitor changes in land cover due to deforestation and carbon stock enhancement, and to calculate activity data for each of these categories of change. These methods are applied for monitoring Reference Area, Project Area, and Leakage Belt.

In a conservative approach, the project proponent opted not to monitor forest degradation in the Reference Area and Project Area. According to previous studies for characterization of the Reference Area, illegal extraction of smaller trees for fuelwood and charcoal is not a usual practice in the FSM region. Moreover, the practice of illegal logging of smaller trees and forest degradation is expected to be pretty much more pronounced in non-protected areas, such as those observed in the Reference Area, than in protected forest areas, as the FSM farm. As demonstrated in the VCS-PD, the FSM farm has a system for monitoring boundaries and for hindering any invasion that might endanger the forest. The only carbon loss inside the FSM farm is attributed to low-impact Sustainable Forest Management. The emissions occurring from Sustainable Forest Management (logging gaps, roads, and decks) will be continuously monitored and reported by the project proponent during the entire project period.

5.3.1 Revision of the baseline

The baseline of a REDD project activity is estimated ex-ante. It will be monitored in a reference area (unplanned deforestation) to periodically adjust the baseline. Ex-ante baseline estimations are therefore used in both the ex-ante and ex-post estimation of net carbon stock changes and greenhouse gas emission reductions.

The starting point for the baseline revision of the project will be the forest cover projected to exist at the end of the baseline period. The project proponent shall, for the duration of the project, reassess the baseline every six years and have this validated at the same time as the subsequent verification.

Reassessments must capture changes in the drivers and/or behavior of agents that cause the change in land use and/or land management practices and changes in carbon stocks. The new baseline scenario must be incorporated into revised estimates of baseline emissions. This baseline reassessment must include the evaluation of the validity of proxies for GHG emissions.

Information required to periodically reassess the project baseline must be collected during the entire project crediting period. Key variables to be measured are:

- Changes in forest cover in the Reference Regions for Deforestation (RRD) (at a minimum of every 6 years), as specified in Module M-REDD and where relevant in Module BL-UP.

- Spatial variable datasets were used to model the location of deforestation, as specified in Module BL-UP. As a minimum, the variables used in the first baseline assessment must be monitored at the time of the re-assessment to determine if they have changed.
- Carbon stock data, as specified in Module M-REDD.

5.3.2 Data collected

The data collected are given in the following tables:

Data / Parameter	Any spatial feature included in the spatial model that is subject to changes over time (Factor Maps)
Data unit	According to spatial feature selected
Description	Factor Maps
Source of data	Digital maps – Landsat5
Description of measurement methods and procedures to be applied	Update of digital maps
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	Risk Maps
Data unit	N/A
Description	A Risk Map shows, for each pixel location, the risk, or "suitability", for deforestation as a numerical scale (e.g. from 0 = minimum risk to some upper limit representing the maximum).
Source of data	Digital maps – Landsat5
Description of measurement methods and procedures to be applied	Update of digital maps

Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	Baseline deforestation Maps
Data unit	N/A
Description	Maps showing the location of deforested hectares in each year of the baseline period
Source of data	Digital maps – Landsat5
Description of measurement methods and procedures to be applied	Update of digital maps
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	AA_U
Data unit	%
Description	The accuracy assessment of the rate of unplanned deforestation (equals 90% or more)
Source of data	Existing maps or models, expert consultation, literature
Description of measurement methods and procedures to be applied	Multi-criteria analysis implemented in a Geographical Information System
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)

QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	Correct
Data unit	Ha
Description	Area correct due to observed change predicted as change
Source of data	Spatial model of deforestation location
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	Err_A
Data unit	Ha
Description	Area of error due to observed change predicted as persistence
Source of data	Spatial model of deforestation location
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	Err_B
Data unit	ha
Description	Area of error due to observed persistence predicted as change
Source of data	Spatial model of deforestation location
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	FOM
Data unit	N/A
Description	Figure of Merit
Source of data	Calculated using equation FOM = CORRECT / (CORRECT + ErrA + ErrB)
Description of measurement methods and procedures to be applied	Described above
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	LB
Data unit	Ha
Description	Leakage belt area

Source of data	GPS coordinates and/or remote sensing data
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	LSC_{RRL}
Data unit	Ha
Description	The area of RRL suitable for conversion from forest to an alternate land use
Source of data	Remote sensing data
Description of measurement methods and procedures to be applied	Calculated from the result of analysis of forest areas in the reference region for projection of location of deforestation with regard to constraints to deforestation (including elevation, climate, protected status, etc.). Uses parameter $A_{RRL,forest,t}$ derived from M-REDD
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	Monitored at least once every 6 years (when the baseline is revisited). Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / Parameter	PA
Data unit	Ha
Description	Unplanned deforestation project area
Source of data	GPS coordinates and/or remote sensing data

Description of measurement methods and procedures to be applied	Best practices in remote sensing
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes.

Data / Parameter	P_{LK}
Data unit	Dimensionless
Description	Ratio of the area of the leakage belt to the total area of RRD
Source of data	Leakage belt area and RRD area, determined by satellite imaging
Description of measurement methods and procedures to be applied	Calculated from the result of remotely sensed data analysis
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / Parameter	$P_{LSC,RRL}$
Data unit	Dimensionless
Description	Ratio of the parameter LSCRRL to the area of RRD
Source of data	LSC_{RRL} area and RRD area, determined by satellite imaging
Description of measurement methods and procedures to be applied	Calculated from the result of remotely sensed data analysis

Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / Parameter	P_{PA}
Data unit	Dimensionless
Description	Ratio of the project area to the total area of RRD
Source of data	Project area and RRD area, determined by satellite imaging
Description of measurement methods and procedures to be applied	Calculated from the result of remotely sensed data analysis
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / Parameter	P_{RRL}
Data unit	Dimensionless
Description	Ratio of the forest area in the RRL at the start of the historical reference period to the total area of RRD
Source of data	Forest area in the RRL and RRD, determined by satellite imaging
Description of measurement methods and procedures to be applied	Calculated from the result of remotely sensed data analysis
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)

QA/QC procedures to be applied	Best practices in remote sensing
Comments	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / Parameter	RRD
Data unit	Ha
Description	Geographic boundaries of the reference area for projection of rate of deforestation
Source of data	GPS coordinates and/or remote sensing data
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing
Comments	N/A

Data / Parameter	RRL
Data unit	Ha
Description	Geographic boundaries of the reference area for projection of location of deforestation
Source of data	GPS coordinates and/or remote sensing data
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	Best practices in remote sensing

Comments	N/A

Data / Parameter	T_{hrp}
Data unit	Yr
Description	Duration of the historical reference period in years
Source of data	GPS coordinates and/or remote sensing data
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Updated every time the baseline is revisited (at least every 6 years)
QA/QC procedures to be applied	N/A
Comments	Should be between 10 and 12 years

5.3.3 Monitoring of the actual carbon stock changes and greenhouse gas emissions

The implementation of the project activities will be monitored by the responsible group within FSM and will consist of large investments in policing the FSM, one monitoring base will be established in one of the already existing policing bases. All the bases communicate through radio every day to the main base.

The bases will be positioned in strategic points within the FSM farm and continuous monitoring activities with advanced remote sensing techniques will be implemented also satellite images and field studies will be used. The land use area monitoring will be done with remote sensing methods, using images of medium resolution, generated by MapBiomas. Associated with this, the Environmental Monitoring Program aims at involving the communities in mapping the threatened areas; identifying the risks and threats to which these areas are subjected. The large-scale monitoring will be done through satellite images made available by INPE (PRODES) and MapBiomas Alert data, which is a system that validates and refines deforestation alerts with high-resolution images by integrating and analyzing multiple alert systems, such as DETER, PRODES, SAD, Sirad-X, and so on. This platform data is widely used because it integrates and validates the alerts of several products increasing the reliability of the data and can be acquired on a daily frequency.

All of this reliable data that is collected and documented will be used as a technical support tool for decision making in order to improve project outcomes, and to adapt the project according to the current needs and reality. These decisions will be made during the periodic meetings to review the Activity Plan. On these occasions, the design of the Monitoring Plan will be analyzed according to its efficiency in generating reliable feedback and all thenecessary information. If any changes in the Monitoring Plan or management actions are identified, corrective action will be designed and implemented.

Figure 5.1, shows the 7 bases already established by the project owner to work as monitoring points at FSM. All the bases have radio communication, and they communicate at least once a day. They are all equipped with motorcycles so they can easily move to other areas if needed.

As a strategy for looking after the property and assure the project it was considered the following assumptions:

1. Avoid entry of outsiders:
    1.1 Hunters
    1.2 Fishermen
    1.3 Intrusion
    1.4 Prevention of invasion
    1.5 Fire Prevention
    1.6 Support the Work of Forest Stewardship Management Plan
2. Consolidation of calm and peaceful possession
3 Cleaning of frontiers and its milestones
4. Internal organization of communication

On top of these issues, there is a strategic plan with seven fixed bases located in strategiclocations to meet the above assumptions, namely:

BASE 1 - SEDE

This base possesses the administrative office of the farm, main house (residence forDirectors, Officers and invited guests), kitchen and dining hall.

This base is equipped with electricity (including a generator), satellite internet, fixed andmobile telephone (both by means of an external aerial) and a motorcycle.

BASE 2 – LINHA 12

This base possesses lodgment for collaborators, dining hall, toilets, one house for the fixedemployee, building for storage and maintenance of machinery, and logging deck.

This base is equipped with electricity, mobile telephone (by means of an external aerial), anda motorcycle.

BASE 3 - ARIPUANÃ

This base possesses one house for the fixed employee, dining hall and kitchen for visitors.

This base is equipped with electricity (by means of a generator), mobile telephone (by meansof an external aerial), and a motorcycle.

BASE 4 - ACAMPAMENTO

This operational base possesses three houses: two houses are lodgments with toilets and one house has a kitchen, dining hall, storage room, office, toilets and two bedrooms. This base is equipped with electricity (by means of a generator), and a motorcycle.

BASE 6 – LINHA 6

This base possesses a house for the fixed employee. This base is equipped with solar electricity, and mobile telephone (by means of an external aerial).

BASE 7 – PACUTINGA

This base possesses a house for the fixed employee. This base is equipped with solar electricity, and mobile telephone (by means of an external aerial).

BASE 8 - MORERU

This base possesses a house for the fixed employee, with accommodation for 3 people. This base is in charge of the gate to the road Colniza/Moreru. This base is equipped with solar electricity, mobile telephone (by means of an external aerial), and a motorcycle.

All bases communicate 24 hours, the Manager of BASE 1 is authorized for any decision making and action.

BASES 2, 3 and 4 report to BASE 1.

BASES 6 and 7 report to BASE 8

To be able to receive the authorization to perform a sustainable management of the forest(so called AUTEX) the property was obligated to have a sustainable management plan in place and present it to the competent environmental agency SEMA / MT. The Management Plan is fully available to auditors.[165]

[165] Annex: PMFS Santa Maria.pdf

Figure 5.1 Distribution of the infrastructure for the project monitoring.

5.3.4 Monitoring degradation due to selective logging of forest management areas

The calculation procedure for estimating net ex-post emissions and removals related to selective logging activities in the project case will be equal to the summed emissions arising from selective logging operations. The net emissions in the project case are estimated by combining:

- Emissions arising from logging gap: encompass emissions from felling timbertree and emissions from incidental damage caused by falling timber tree,
- Emissions from infrastructure: from constructing logging infrastructure forremoval of timber, such as haul roads, skid trails and logging decks.

5.3.5 Emissions arising in the logging gap

In the project case, emissions occur as a direct result of the death of the timber tree and due to the death of trees killed when the timber tree is felled. The net emission in the project case is equal to the biomass of the wood extracted plus the logging damage factor multiplied by the extracted volume:

$$C_{LG,i,t} = \sum_{z=1}^{Z} \left(C_{EXT,z,i,t} + \left(LDF_{z,i} \times V_{EXT,z,i,t} \times \frac{44}{12} \right) \right)$$

Equation 33

Where:

$C_{LG\,i\,t}$	Actual net project emissions arising in the logging gap, in stratum i in year t; t CO_{2e}
$C_{EXT,z,i,t}$	Biomass carbon stock of timber extracted within the project boundary for logging stratum z, in stratum i in year t; t CO_{2e}
$LDF_{z,i}$	Logging damage factor for logging stratum z, in stratum i; tC m^{-3}
$V_{EXT,z,i,t}$	Volume extracted from logging stratum z, in stratum i in year t; m^3
Z	1, 2, 3, ...Z logging strata
i	1, 2, 3 … M strata
t	1, 2, 3 … t years elapsed since the start of the project activity

For ex-ante calculation of the total volume of wood extracted, it was assumed that wood extraction is always identical, independent on the type and biomass of strata. Thus, the volume of wood extracted is not dependent on strata biomass volume per hectare.

5.3.6 Emissions arising through logging infrastructure

The net emission in the project case is equal to the sum of emissions resulting from skid trails, roads, and logging decks created for selective logging operations.

The emissions from the creation of skid trails are estimated by multiplying the total length of skid trails created and a skid trail emission factor.

$$\Delta C_{SKID,i,t} = L_{SKID,i,t} \times SK_i$$

Equation 34

Where:

$\Delta C_{SKID,i,t}$	Change in carbon stock resulting from skid trail creation in stratum i at time t; t CO_{2e}
$L_{SKID,i,t}$	Length of skid trails in stratum i at time t; m
SK_i	Skid trail emissions factor (Average emissions resulting from dead wood created in the process of skid trail creation per length of skid trail) in stratum i; t CO_{2e} m^{-1}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

The calculation of SK is further explained in M-REDD. For ex-post calculations of emissions arising from creation of skid trails, roads, and logging decks, it was conservatively assumed the emission equivalent to the stratum with the highest biomass (i.e. “Encosta” stratum). It is assumed that the machinery used to create the skid trail kills all aboveground and belowground tree biomass located within the path of the skid trail. This biomass becomes deadwood and is assumed to be immediately emitted.

The emission resulting from the creation of roads is determined by multiplying the area of roads created by the carbon stock.

$$\Delta C_{ROAD,i,t} = A_{ROAD,i,t} \times C_{BSL,i}$$

Equation 35

Where:

$\Delta C_{ROAD,i,t}$	Change in carbon stock resulting from logging road creation in stratum i at time t; t CO_2-e
$A_{ROAD,i,t}$	Area of roads in stratum i at time t; ha^{-1}
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i, t CO_2-e ha^{-1}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

The emissions per unit of extraction from logging decks were determined by measuring the area of logging decks created in each stratum. The area was multiplied by the carbon stock (Equation 5).

$$\Delta C_{DECKS,i,t} = A_{DECKS,i,t} \times C_{BSL,i}$$

Equation 36

Where:

$\Delta C_{DECKS,i,t}$	Change in carbon stock resulting from logging deck creation in stratum i at time t; t CO_2-e ha^{-1}
$A_{DECKS,i,t}$	Area of logging decks in stratum i at time t; t CO_2-e ha^{-1}
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i, t CO_2-e ha^{-1}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

For conservativeness purposes, the biomass of the "Encosta" stratum is used in CBSL, as it has the highest biomass value among all strata.

Based on the overall area of roads and logging decks related to the Project Area, the values estimated for emissions from roads and decks are not significant according to T-SIG, as they represent much less than 5% of total emissions. Thus, the inclusion of these emissions in final calculations is indisputably conservative *per se*.

5.3.7 Field inventory of biomass

The field inventory methodology is described in a Standard Operating Procedure (SOP)[166], which is available for consultation by the auditors. This SOP was specifically designed for FSM carbon inventories, to be applied in the baseline assessment, as well as in the monitoring period. The field carbon inventory involved the installation of 18 permanent transects, composed by 130 permanent plots. These permanent plots will be periodically assessed throughout the project duration.

The merchantable volume of trees is estimated by directly measuring the circumference at breast height (CBH). The data of CBH is converted in DBH (Diameter at Breast Height) and applied to allometric equations for estimation of merchantable stem volume. For the application of allometric equations, trees were divided in two classes of DBH:

- DBH ranging from 4.46 cm to 81.99 cm: application of allometric equationfrom NOGUEIRA et al. (2008);
- DBH higher than 82.00 cm: application of allometric equation from COLPINIet al. (2009).

The total aboveground tree biomass was estimated by using a default biomass expansion factor (BEF). Palm tree data underwent the application of a specific allometric equation by SALDARRIAGA et al. (1988) for direct estimation of total aboveground biomass. For the estimation of belowground biomass, the aboveground sum of trees and palms biomass was multiplied by a default root-shoot ratio.

The field inventory SOP (available for consultation by the auditors) describes the guidelines for the following aspects:

- Procedures for allocation of transects and plots in the field;
- Documentation of coordinates of transects and plots;
- Standards for identification and signalization of transects and plots;
- Description of field inventory team;
- Standards for measurement of tree diameters under several conditions;
- Standards for measurement dynamics of the field inventory team;
- QA/QC procedures to guarantee the application of correct field procedures(annual training, evaluation and performance reporting);
- Items for annual evaluation of field inventory team;
- QA/QC procedures to guarantee that field data are within the range of treedimensions required in the field inventory;
- QA/QC procedures to guarantee that there was no misunderstanding in datanotation in the field;

[166] Annex: SOP - Standard Operating Procedure.pdf

- QA/QC procedures to guarantee reliability of data transfer;
- Model of data transfer error quantification and report;
- List of equipment and materials to be used in the field inventory.

After the annual evaluation of field inventory team, the team coordinator must produce an annual Evaluation Report for each field inventory technician. This Evaluation Report will be printed in two hardcopies: one for FSM records and other for the field inventory technician that was evaluated. This document will be the evidence of the annual evaluation of field inventory team.

5.3.8 Monitoring of leakage carbon stock changes and greenhouse gas emissions

For the leakage belt, the net greenhouse gas emissions in the project case is equal to the sum of stock changes due to deforestation in the leakage belt:

$$\Delta C_{P,LB} = \sum_{t=1}^{t}\sum_{i=1}^{M} \Delta C_{P,DefLB,i,t} \qquad \text{Equation 37}$$

Where:

$\Delta C_{P,LB}$	Net greenhouse gas emissions in the leakage belt in the project case; t CO_2-e
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the leakage belt the project case in stratum i at time t; t CO_2-e ha^{-1}
i	1, 2, 3 … M strata, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

5.3.9 Estimation of ex-post net carbon stock changes and greenhouse gas emissions

For the project area the net greenhouse gas emissions in the project case are equal to the sum of stock changes due to deforestation and degradation plus the total greenhouse gas emissions minus any eligible forest carbon stock enhancement.

$$\Delta C_{P} = \sum_{t=1}^{t}\sum_{i=1}^{M} \left(\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + GHG_{P-E,i,t} - \Delta C_{P,En\ \ ,i,t}\right) \qquad \text{Equation 38}$$

Where:

ΔC_{P}	Net greenhouse gas emissions within the project area under the project scenario; t CO_2-e
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum i at time t; t CO_2-e

$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum i at time t; t CO_2-e
$GHG_{P-E,i,t}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum i at time t; t CO_2-e
$\Delta C_{P,Enh,i,t}$	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 at time t; t CO_2-e
i	1, 2, 3 … M strata in the project scenario, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

The net carbon stock change as a result of deforestation is equal to the area deforestedmultiplied by the emission per unit area.

$$\Delta C_{P,DefPA,i,t} = \sum_{n-1}^{U} \left(\Delta C_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t}\right) \quad \text{Equation 39}$$

$$\Delta C_{P,DefLB,i,t} = \sum_{n-1}^{U} \left(\Delta C_{DefLB,u,i,t} * \Delta C_{pools,P,Def,u,i,t}\right) \quad \text{Equation 40}$$

Where:

$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project case in the project area in stratum i at time t; t CO_2-e
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the project case in the leakage belt in stratum i at time t; t CO_2-e
$\Delta C_{DefPA,u,i,t}$	Area of recorded deforestation in the project area stratum i converted to land use u at time t; ha
$\Delta C_{DefLB,u,i,t}$	Area of recorded deforestation in the leakage belt stratum i converted to land use u at time t; ha
$\Delta C_{pools,P,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use u, in stratum i at time t; t CO_2-e
u	1, 2, 3 … post-deforestation land uses

i	1, 2, 3 … M strata in the project scenario, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

The emission per unit area is equal to the difference between the stocks before and after deforestation minus any wood products created from timber extraction in the process of deforestation:

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{wp,i}$$

Equation 41

Where:

$\Delta C_{pools,Def,i,t}$	Net carbon stock changes in all pools as a result of deforestation in the project case in land use u in stratum i at time t; t CO_2-e
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i; t CO_2-e ha^{-1}
$C_{P,post,i}$	Carbon stock in all pools in post deforestation land use u in stratum i; t CO_2-e ha^{-1}
$C_{wp,i}$	Carbon stock sequestered in wood products from harvests in stratum i; t CO_2-e ha^{-1}
u	1, 2, 3 … U post-deforestation land uses
i	1, 2, 3 … M strata in the project scenario, unitless
t	1, 2, 3 … t years elapsed since the start of the project activity

For calculation of carbon stock sequestered in wood products, see the module "Estimationof carbon stocks and changes in carbon stocks in the harvested wood products carbon pool in REDD project activities" (CP-W).

Instead of tracking annual emissions through burning and/or decomposition, this methodology employs the simplifying assumption that all carbon stocks are emitted in the year deforested and that no stocks are permanently sequestered (beyond 100 years after deforestation). This assumption applies regardless of whether burning is employed as part of the forest conversion process or as part of post conversion land use activities.

For each post-deforestation land use (u) estimate the long-term carbon stock. Carbon stocksin the selected pools (must be the same as those used in the baseline modules) must be measured and estimated using the methods given in module CP-AB.

$$\Delta C_{post,u,i} = C_{AB\_tree\_i} + C_{BB\_tree\_i} + C_{AB\_non\_tree\_i} + C_{BB\_non\_tree\_i} + C_{DW\_i} + C_{LI,i} + C_{SOC,PD-BSL,i}$$ Equation 42

Where:

$\Delta C_{post,u,i}$	Carbon stock in all pools in post-deforestation land use u in stratum i at time t; t CO_2-e
$C_{AB\_tree\_i}$	Carbon stock in aboveground tree biomass in stratum i; t CO_2-e ha^{-1}
$C_{BB\_tree\_i}$	Carbon stock in belowground tree biomass in stratum i; t CO_2-e ha^{-1}
$C_{AB\_non\_tree\_i}$	Carbon stock in aboveground non-tree vegetation in stratum i; t CO_2-e ha^{-1}
$C_{BB\_non\_tree\_i}$	Carbon stock in belowground non-tree vegetation in stratum i; t CO_2-e ha^{-1}
C_{DW_i}	Carbon stock in dead wood in stratum i; t CO_2-e ha^{-1}
$C_{LI,i}$	Carbon stock in litter in stratum i; t CO_2-e ha^{-1}
$C_{SOC,PD-BSL,i}$	Mean post-deforestation stock in soil organic carbon in the post deforestation stratum i; t CO2-e ha^{-1}
u	1, 2, 3 … U post-deforestation land uses
i	1, 2, 3 … M strata in the project scenario, unitless

Carbon pools excluded from the project can be accounted as zero. Herbaceous non-tree vegetation is considered to be de minimis in all instances. For the determination which carbon pools must be included in the calculations as a minimum, use Tool T-SIG.

5.3.10 Monitoring areas undergoing carbon stock enhancement

It is conservative to assume that no carbon stock enhancement is occurring. The project elected to set $\Delta C_{P,Enh,I,t} = 0$ for the whole project area.

5.3.11 Organizational structure, responsibilities, and competencies

Caraguá Agronegócios Ltda and Systemica Ltda were responsible for the development of the current Joint Project Description & Monitoring Report. In order to ensure the operation of the monitoring activities during this period, the operational and managerial structure was established according to the Table 5.1 below.

Table 5.1 Type of Monitoring and Party Responsible for Monitoring.

Variables to be monitored	Responsible	Frequency
Revision of the baseline	Caraguá and Systemica	Every 6 years
Monitoring deforestation, actual carbon stock changes and GHG emissions	Caraguá and Systemica	Prior to each verification
Monitoring degradation due to selective logging of forest management areas	Caraguá and Systemica	Prior to each verification
Monitoring of leakage carbon stock changes and GHG emissions	Caraguá and Systemica	Prior to each verification
Field inventory of biomass	Caraguá and Systemica	At least, every 10 years
Estimation of ex-post net carbon stock changes and GHG emissions	Caraguá and Systemica	Prior to each verification

5.3.12 Methods for generating, recording, aggregating, collecting, and reporting data on monitored parameters

The parameters monitored on the project will be generated, recorded, aggregated, and collated using the system that it is already in place at FSM farm.

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by Caraguá Ltda and Systemica Ltda.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or convertedto a format accessible to future software applications, as needed.

All maps and records generated during the project implementation will be stored and made available to VCS verifiers at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

Monitored data will be kept for two years after the end of the crediting period or the last issuance of carbon credits for this project activity, whichever occurs later. For this purpose, the authority for the registration, monitoring, measurement, and reporting is Caraguá Ltda and Systemica Ltda. Furthermore, monitored parameters described in the section above were monitored with the frequency described in the sub-section Organizational structure, responsibilities, and competencies, above.

5.3.13 Quality Assurance/Quality Control

To ensure consistency and quality of results, spatial analysts carrying out the image processing, interpretation, and change detection procedures strictly adhered to the steps detailed in the Methodology and VCS PD. Project activities implemented within the project area were consistent with the management plans of the PD.

The implementation of the project activity was monitored by continuous monitoring activities using remote sensing techniques. Additionally, field data was also used. The land-use monitoring was carried out with remote sensing methods, using images generated by INPE (PRODES) and MapBiomas, which were subject to digital processing to perform the interpretation and classification of the land cover classes studied. The management structure also relies on FSM employees to help monitor the area within the project area.

5.3.14 Procedures for handling internal auditing and non-conformities

The procedures for handling internal auditing and non-conformities are established by the Operational Board of Caraguá and Systemica. All the necessary task-force and procedures will be in place to meet the highest levels of governance.

Caraguá manages forest resources according to a Sustainable Forest Management Plan approved by a State-level Environmental Agency, which was developed by third party experts and performed by its management team with significant expertise in forest management. Such plan has procedures to identify and assess non-conformities and risks. The plan also establishes procedures for the regular training of Caraguá staff.

Systemica, which was founded in 2012, has experience in projects related to ecosystem services; incorporation of sustainability into governance strategies to generate value; public policies; and in the voluntary carbon market forest projects. Systemica has its own internal process to ensure the quality and control of information, products, analyses, and other processes involved. Such quality control policy is available for consultation by the auditor[167].

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

In a conservative approach, the project's proponent decided without monitoring forest deterioration in the Reference Area and Project Area. According to earlier research for characterizing the Reference Area, Illegal tree harvesting for charcoal and fuelwood is not a common practice in the FSM region. Furthermore, compared to protected forest areas like the FSM farm, illicit logging of smaller trees and

[167] Annex: QA_QC_Systemica

forest degradation are projected to be significantly more prevalent in non-protected regions like those found in the Reference Area. The FSM farm has a mechanism for keeping an eye on its borders and preventing any intrusions that could threaten the forest, as seen in the VCS-PD. Low-impact activities within the FSM farm account for the only carbon loss.

The parameter of the total height of the tree (H) was not contemplated here, due to the difficulty in measuring tree heights in the field. Thus, the conservative approach was used, in which palm trees were not counted in this forest inventory.

During the current monitoring period, from 13/04/2019 to 12/04/2022, the wood management effecting in the FSM farm did not have FSC certification. Therefore, the VCU advantages and project emissions for managing wood during this time were not taken into consideration, since these areas were not eligible for the Project. The documents showing the management areas exploited within this period are available for consultation by auditors. These documents will be kept safely for two years after the final credit period of the FSM project.

Data / Parameter	Project Forest Cover Monitoring Map
Data unit	N/A
Description	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event.
Value applied:	N/A
Comments	Details on these areas' limits are in Section 4.1.1.

Data / Parameter	Leakage Belt Forest Cover Monitoring Map
Data unit	N/A
Description	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt
Value applied:	N/A
Comments	The minimum map accuracy must be 90% for the classification of forest/non-forest in the remote sensing imagery.

	If the classification accuracy is less than 90% then the map is not acceptable for further analysis. More remote sensing data and ground truthing data will be needed to produce a product that reaches the 90% minimum mapping accuracy. Details on these areas' limits are in Section 4.1.1.

Data / Parameter	$A_{burn,i,t}$
Data unit	ha
Description	Area burnt in stratum i at time t
Value applied:	Year / Project Area / Leakage Belt: 2019-2020: - / - 2020-2021: - / - 2021-2022: - / -
Comments	No burning areas were observed in the project area and leakage belt during the current monitoring period.

Data / Parameter	$A_{DelfPA,i,t}$
Data unit	ha
Description	Area of recorded deforestation in the project area in stratum i at time t
Value applied:	Year / $A_{DelfPA,i,t}$: 2019-2020: - 2020-2021: - 2021-2022: -
Comments	No underwent deforestation areas were observed in the project area during the current monitoring period.

Data / Parameter	$A_{DelfLB,i,t}$
Data unit	ha
Description	Area of recorded deforestation in the leakage belt in stratum i at time t
Value applied:	Year / $A_{DelfLB,i,t}$: 2019-2020: - 2020-2021: - 2021-2022: -
Comments	No underwent deforestation areas were observed in the leakage area. The leakage belt area was changed considering the second baseline. Details about these leakage definition boundaries are in Section 4.1.1.

Data / Parameter	$A_{RRL,forest}$
Data unit	ha
Description	Remaining area of forest in RRL at time t
Value applied:	see table below
Comments	Monitored every 10 years for baseline renewal.

Year	$A_{RRL,forest}$
2007	37,629.45
2008	37,620.27
2009	37,615.50
2010	37,615.41
2011	37,608.57
2012	37,607.85
2013	37,604.34
2014	37,607.04
2015	37,603.26
2016	37,604.52
2017	37,593.90
2018	37,593.09
2019	37,590.03
2020	37,565.10

Data / Parameter	A_{sp}
Data unit	ha
Description	Area of sample plots in ha
Value applied:	0.25
Comments	Carbon stock estimation occurs only for determination or renewal of the baseline

Data / Parameter	N
Data unit	Dimensionless
Description	Number of sample plots
Value applied:	130
Comments	Calculated using the following formula: $$n = \frac{(t^2 \times CV^2)}{\left(E\%^2 + \left(\frac{t^2 \times CV^2}{N}\right)\right)}$$ Where: n Number of parcels sampled in each stratum (variable for each stratum) t Student "t" value (2.262) CV Coefficient of variation (%) (variable for each stratum) $E\%$ Permissible sampling error (10%) N Number of parcels in total stratum area (variable for each stratum)

Data / Parameter	DBH
Data unit	cm
Description	Diameter at breast height of a tree in cm.
Value applied:	N/A
Comments	Diameter (DBH) is calculated based on circumference at breast height (CBH) measurement, by means of the basic perimeter equation: $$DBH = \frac{CBH}{\pi}$$

Data / Parameter	$A_{DECKS,i,t}$
Data unit	ha
Description	Area of logging decks in stratum i at time t.
Value applied:	N/A
Comments	As already described in Section 3.6 Methodology Deviations, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Data / Parameter	$A_{ROAD,i,t}$
Data unit	ha
Description	Area of roads in stratum i at time t.
Value applied:	N/A
Comments	As already described in Section 3.6 Methodology Deviations, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Data / Parameter	L_{skid}
Data unit	m
Description	Length of skid trail sk.
Value applied:	N/A
Comments	As already described in Section 3.6 Methodology Deviations, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Data / Parameter	W_{SKID}
Data unit	m
Description	Mean width of skid trails.
Value applied:	N/A
Comments	As already described in Section 3.6 Methodology Deviations, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Data / Parameter	A_i
Data unit	ha
Description	Total area of stratum i.
Value applied:	Stratum: Aluvial – Area (ha): 12,944.00; Encosta – 9,275.00; FOB Densa Submontana – 6,696.00; FOB Submontana – 42,473.00
Comments	GPS data is confirmed by field survey.

Stratum	Area (ha)
Aluvial	12,944.00
Encosta	9,275.00
FOB Densa Submontana	6,696.00
FOB Submontana	42,473.00

Data / Parameter	$V_{ex,i}$
Data unit	m^3
Description	The volume of timber in m^3 extracted from within the stratum (does not include slash left onsite), reported by wood product class and preferably species.
Value applied:	N/A
Comments	As already described in Section 3.6 Methodology Deviations, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Data / Parameter	$C_{BSL,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in all pools in the baseline in stratum i
Value applied:	N/A
Comments	Field measurements in sample plots and application of allometric equations, as described in “Field inventory of biomass” of this Joint Project Description & Monitoring Report.

Data / Parameter	$C_{AB,tree,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in aboveground biomass in trees in the project case in stratum i
Value applied:	N/A
Comments	Field measurements in sample plots, application of allometric equations and multiplication of the merchantable volume by the BCEF (Biomass conversion and expansion factor: 1.66, Brown et al. (1989), page 890, Table 4) for conversion of merchantable volume to total aboveground tree biomass, as described in “Field inventory of biomass” of this Joint Project Description & Monitoring Report.

Data / Parameter	$C_{BB,tree,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in belowground biomass in trees in the project case in stratum i
Value applied:	N/A
Comments	Field measurements in sample plots, application of allometric equations and multiplication of the total aboveground biomass by the root-shoot ratio (0.37, IPCC (2006b), pg. 4.49, Table 4.4) for calculation of total belowground tree biomass, as described in “Field inventory of biomass” of this Joint Project Description & Monitoring Report.

Data / Parameter	$C_{WP,i}$
Data unit	tCO_{2-e} ha^{-1}
Description	Carbon stock in wood products in the project case in stratum i
Value applied:	2.57 tCO_{2-e} ha^{-1}
Comments	As described in Sections “Baseline Emissions” and “Project Emissions” of this Joint Project Description & Monitoring Report.

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	tCO_{2-e} ha^{-1}
Description	Non-CO_2 emissions due to biomass burning in stratum i in year t
Value applied:	N/A
Comments	Monitoring must occur at least every ten years for baseline renewal. As described in Sections “Baseline Emissions” and “Project Emissions” of this Joint Project Description & Monitoring Report.

6.2 Baseline Emissions

The same updated values of the forest inventory made in 2022 are used during the monitoring report (please, see Section 4.1.4. Characterization of biomass in Project Area). So, Table 6.1 was presented to summarize the used values in the baseline emission in the monitoring period.

Table 6.1 Characterization of above and belowground carbon stocks in Project Area.

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
Aboveground (total)	t ha^{-1}	369.16	361.43	385.34	353.72	
Belowground (total)	t ha^{-1}	136.59	133.73	142.58	130.88	
Aboveground (total)	tCO_{2-e} ha^{-1}	636.19	622.86	664.07	609.58	
Belowground (total)	tCO_{2-e} ha^{-1}	235.39	230.46	245.71	225.55	
Total Carbon Stock	tCO_{2-e} ha^{-1}	871.58	853.32	909.77	835.13	
Project management area	ha	12,944.00	9,275.00	6,696.00	42,473.00	71,388.00
%	%	18.1%	13.0%	9.4%	59.5%	100.0%

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
Aboveground biomass weighted average	$tCO_{2-e}\ ha^{-1}$	621.24				
Total biomass weighted average	$tCO_{2-e}\ ha^{-1}$	851.10				

6.2.4 Estimation of Carbon Stock Changes and GHG Emissions[168]

The carbon stock changes and GHG emission estimation in baseline were made based on modules VMD0005-CP-W-v1.1 and VMD0013-E-BPB-v1.2. The baseline emissions presented in this section refer to the monitoring period between 13th April 2019 and 12th April 2022. The values for 2019-2020 correspond to data from 13th April 2019 and 12th April 2020, for 2020-2021 equals the date between 13th April 2020 and 12nd April 2021, and so on (Figure 6.1).

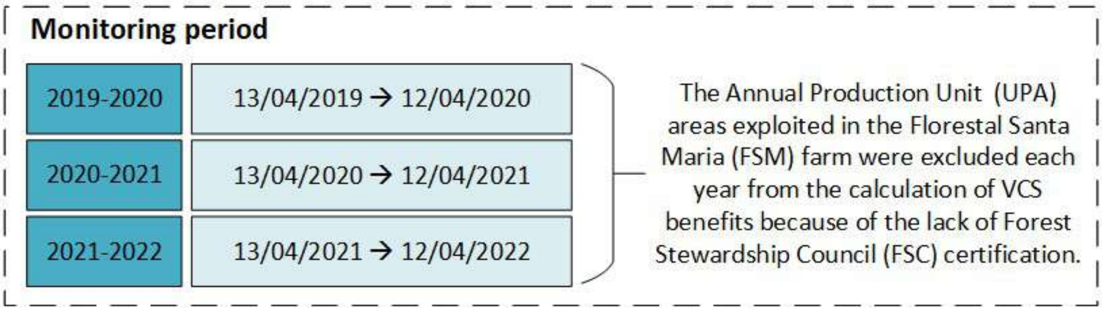

Figure 6.1. Monitoring period description

The FSM project didn't have FSC (Forest Stewardship Council) certification during the monitoring period. In this case, the areas contemplated by the Annual Production Unit (Unidade de Produção Anual - UPA) from 2019 to 2021, represented in Figure 6.2, were not considered in the calculation for a conservative scenario. In addition, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 were excluded from the calculation of VCU benefits. These areas were not eligible for the Project Area according to the adopted methodology previously reported by Monitoring Report: VCS Version 3.0. The documents showing the exploited area within this period are available for consultation by auditors. They will be kept in a secure retrievable manner for at least two years after the project crediting period ends.

[168] All ex-post calculations are available to the auditor in the 6 Calculations folder.

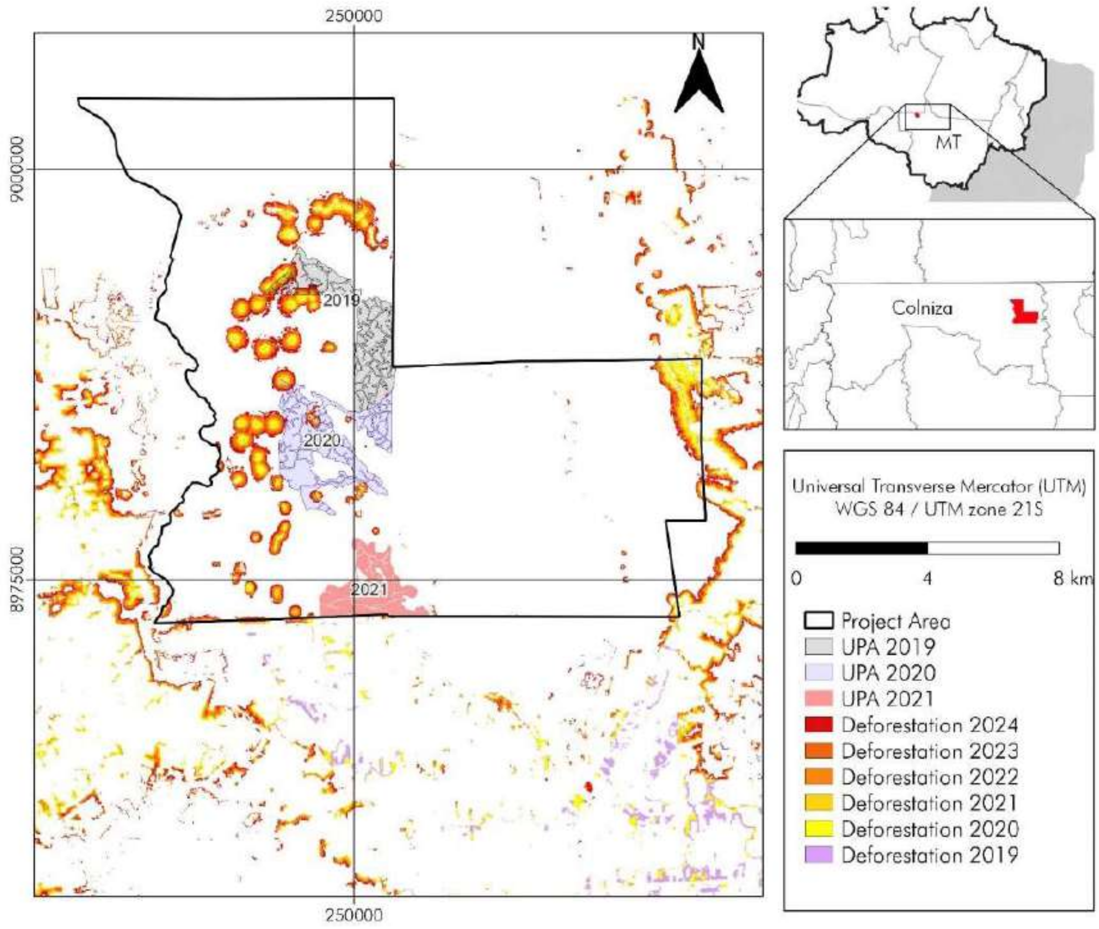

Figure 6.2. Annual production unit (unidade de produção anual - UPA) for 2019 to 2022.

The project area (▭) with annual production unit (unidade de produção anual - UPA) for 2019 (▭, 13/04/2019 – 12/04/2020), 2020 (▭, 13/04/2020 – 12/04/2021), and 2021 (▭, 13/04/2021 – 12/04/2022) with the deforestation generated from the location analysis in decreasing gray scale from 2019-2024.

According to vegetation typologies, the forest deforestation area resulting from location analysis in the project area was classified by: (i) *Aluvia*, (ii) *Encosta*, (iii) *FOB densa submontana*, e (iv) *FOB submontana* (Table 6.2).

Table 6.2. Deforestation rate values in the project area.

	Parameter	Unit	Years			TOTAL
			2019-2020 [a]	2020-2021 [a]	2021-2022 [a]	
Project Area without UPA's	Aluvial	ha	3.24	91.80	128.61	**223.65**
	Encosta	ha	7.02	117.90	110.07	**234.99**
	FOB Densa Submontana	ha	10.80	78.75	56.61	**146.16**
	FOB Submontana	ha	40.50	471.06	553.86	**1,065.42**

	Parameter	Unit	Years			TOTAL
			2019-2020 [a]	2020-2021 [a]	2021-2022 [a]	
	ABSLPAt annual	ha	61.6	759.5	849.2	1,670.22
	ABSLPA cumulative	ha	61.56	821.07	1,670.22	

[a] Deforestation rate values in the project area through the allocation analysis disregarding the Annual Production Units - UPAs areas from 13th April 2019 to 12th April 2020, in which there was no FSC certification

Special attention is paid to the project area's burn and unplanned deforestation. In the baseline period of this Joint Project Description & Monitoring Report document, there was no record of a burn or unplanned deforestation from the project area. This information is also confirmed by geospatial images. Whereas the high risk of these events can occur in the FSM farm area, there is a concern about this and the prevention action plan. These plans involve the prevention of intrusions, invasion, and fire. Also, support the work of forest stewardship management plan, thought calm consolidation and peaceful possession, cleaning of frontiers and its milestones, and internal organization of communication. More details about these pieces of information are described in Section *1.11 Description of the Project Activity*.

Wood products' carbon pool in the baseline

For estimating emissions from unplanned deforestation that would occur in Project Area in the absence of project (i.e. in the baseline case), the annual estimated area to be deforested was multiplied by the sum of aboveground and belowground carbon stocks in forest for each biomass stratum. The values resulting from the location analysis for each period and type of stratum were reported in Table 6.3.

Table 6.3. Summary of gross baseline emissions from unplanned deforestation that would occur within the Project Area in the monitoring period.

				Year			TOTAL
				2019	2020	2021	
Stratum	Aluvial	Area	ha	3.24	91.80	128.61	223.65
		ABSLPAcumulative	ha	3.24	95.04	223.65	321.93
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	2,823.92	80,011.18	112,094.09	194,929.19
		Total Accumulated	tCO_2-e	2,823.92	82,835.10	194,929.19	
	Encosta	Area	ha	7.02	117.90	110.07	234.99
		ABSLPAcumulative	ha	7.02	124.92	234.99	366.93
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	5,990.30	100,606.38	93,924.89	200,521.57
		Total Accumulated	tCO_2-e	5,990.30	106,596.68	200,521.57	
	FOB Densa Submontana	Area	ha	10.80	78.75	56.61	146.16
		ABSLPAcumulative	ha	10.80	89.55	146.16	246.51
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	9,825.55	71,644.61	51,502.24	132,972.40
		Total Accumulated	tCO_2-e	9,825.55	81,470.16	132,972.40	
	FOB Submontana	Area	ha	40.50	471.06	553.86	1,065.42
		ABSLPAcumulative	ha	40.50	511.56	1,065.42	1,617.48
		tCO_2-e ha^{-1} $year^{-1}$	tCO_2-e ha^{-1} $year^{-1}$	33,822.74	393,396.10	462,544.83	889,763.68
		Total Accumulated	tCO_2-e	33,822.74	427,218.85	889,763.68	
		Total (sum of stratum)	tCO_2-e ha^{-1} $year^{-1}$	52,462.52	645,658.27	720,066.04	

Baseline emission from unplanned deforestation

As explained in previous topics, protecting native forests is far from the most attractive economic option, as other activities with higher commercial value are possible. The common methods in this region include deforestation and harvesting timber for commercial markets, followed by burning the resulting non-commercial timber and converting these areas into pastures (90%) and/or coffee growing (10%) areas. So, the ex-post baseline calculations of GHG emissions in the monitoring period are based on: (i)carbon stock of wood products, (ii) GHG emissions of CH_4 and N_2O from biomass burning, and (iii) pasture and coffee carbon pools.

Commercial inventory estimation

For estimating the biomass carbon of the commercial volume extracted in the process of deforestation, the Equation 43 was applied, according to "Option 2: Commercial inventory estimation", as recommended in VMD0005-CP-W-v1.0.

$$C_{XB,i} = C_{AB_{tree},i} \times \frac{1}{BCEF} \times P_{com_i} \qquad \text{Equation 43}$$

Where:

$C_{XB,i}$	Mean stock of extracted biomass carbon from stratum i; t CO_{2e} ha^{-1}
$C_{AB_{tree},i}$	Mean aboveground biomass carbon stock in stratum i; t CO_{2e} ha^{-1}
BCFE	Biomass conversion and expansion factor (BCEF) for conversion of merchantable volume to total aboveground tree biomass; dimensionless BCFE = 1.66 (Table 4, page 890, Brown et al. (1989))
P_{com_i}	Commercial volume as a percent of total aboveground volume in stratum i; dimensionless Calculated as the ratio between the volume of merchantable wood in exploitation, 35.08 m^{-3} ha^{-1} (da SILVA et al., 2001; Veríssimo et al., 1992), and the total volume of aboveground biomass per stratum.
i	1, 2, 3 ... M strata, unitless

To calculate the proportion of biomass carbon extracted that remains sequestered in long-term wood products after 100 years, it was simply and conservatively assumed that all extracted biomass not retained in long-term wood products after 100 years is emitted in the year harvested, instead of tracking annual emissions through retirement, burning and decomposition (Equation 44).

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} \times (1 - WW_{ty}) \times (1 - SLF_{ty}) \times (1 - OF_{ty}) \qquad \text{Equation 44}$$

Where:

$C_{WP,i}$	Carbon stock in long-term wood products pool (stock remaining in wood products after 100 years) from stratum i post deforestation; t CO_{2-e} ha^{-1}
$C_{XB,ty,i}$	Mean stock of extracted biomass carbon by class of wood product ty from stratum i; t CO_{2-e} ha^{-1}
WW_{ty}	Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless WW_{ty} = 0.24 (page 278, Winjum et al. (1998) and Pearson et al. (2012))
SLF_{ty}	Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty; dimensionless SLF_{ty} = 0.2 (page 276, Winjum et al. (1998) and Pearson et al. (2012))
OF_{ty}	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless OF_{ty}= 0.8 (page 276, Winjum et al. (1998) and Pearson et al. (2012))
ty	Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)
i	1, 2, 3 … M strata, unitless

The parameters used in the calculation of wood products carbon pool in the baseline, as well as the results of estimates (sum of strata), are demonstrated in Table 6.4.

Table 6.4. Summary of calculations of wood products carbon pool in the baseline scenario.

Parameter	Unit	Stratum				Total
		Aluvial	Encosta	FOB Densa Submontana	FOB submontana	
Stratum area	ha	223.65	234.99	146.16	1,065.42	1,670.22
Area distribution	%	13.4%	14.1%	8.8%	63.8%	100%
Total ABG per stratum	t	82,563.29	84,931.98	56,321.17	376,864.14	600,680.58
Total BLG per stratum	t	30,548.42	31,424.83	20,838.83	139,439.73	222,251.82
Carbon Pool - Aboveground per stratum	tCO_{2-e}	142,284.08	146,366.11	97,060.15	649,462.54	1,035,172.87
Carbon Pool - Belowground per stratum	tCO_{2-e}	52,645.11	54,155.46	35,912.25	240,301.14	383,013.96
$C_{ABtree,i}$	tCO_{2-e} ha^{-1}	636.19	622.86	664.07	609.58	
$C_{BBtree,i}$	tCO_{2-e} ha^{-1}	235.39	230.46	245.71	225.55	
$C_{BSL,i}$	tCO_{2-e} ha^{-1}	871.58	853.32	909.77	835.13	
$C_{DW,i}$	tCO_{2-e} ha^{-1}	-	-	-	-	
P_{com}	m^3 tCO_{2-e}^{-1}	0.055	0.056	0.053	0.058	
C_{XB}	tCO_{2-e} ha^{-1}	21.13	21.13	21.13	21.13	84.53
C_{WP}	tCO_{2-e} ha^{-1}	2.57	2.57	2.57	2.57	
$C_{WP\ AVERAGE}$	tCO_{2-e} ha^{-1}	2.57				

Emission from biomass burning in the baseline

Some GHG emissions can be measured, but the following method is used because of the high spatial and temporal variability. Based on the IPCC 2006 Inventory Guidelines, estimating greenhouse gas emissions from biomass burning is determined using Equation 23.

$$E_{\text{biomassbur n,i,t}} = \sum_{g=1}^{G} \left(\left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i} \right) \times 10^{-3} \right) \times GWP_g \right) \quad \text{Equation 45}$$

Where:

$E_{\text{biomassbur n,i,t}}$	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, unitless $COMF_i = 0.59$ (Table 2.6, page 2.55, IPCC (2006a))
$G_{g,i}$	Emission factor for stratum i for gas g, kg t^{-1} d.m. burnt $G_{g,CH_4} = 4.8$ kg t^{-1}, $G_{g,NO_2} = 0.2$ kg t^{-1} (Table 2.5, page 2.54, IPCC (2006a))
GWP_g	Global warming potential for gas g, t CO_2/t gas g $GWP_{CH_4} = 28$ t CO_2 t_{gas}^{-1}, $GWP_{NO_2} = 265$ t CO_2 t_{gas}^{-1} (Box 3.2, Table 1, page 87, IPCC (2014), Grennhouse (2014))
g	1, 2, 3 … G greenhouse gases including carbon dioxide1, methane and nitrous oxide, unitless
i	1, 2, 3 … M strata, unitless
t	1, 2, 3, … t* time elapsed since the start of the project activity, years

The average aboveground biomass stock before burning for a particular stratum is estimated using Equation 46.

$$B_{i,t} = \left(C_{AB\_tree,i,t} + C_{DWi,} + C_{LI,i,t} \right) \times \frac{12}{44} \times \frac{1}{CF} \quad \text{Equation 46}$$

Where:

$B_{i,t}$	Average aboveground biomass stock before burning for stratum i, year t, tonnes d.m. 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}
$C_{DWi,}$	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}
$\frac{12}{44}$	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. CF = 0.47 t C t^{-1} d.m. (pg. 4.48, Table 4.3.IPCC (2006b))
i	1, 2, 3 … M strata, unitless
t	1, 2, 3, … t* time elapsed since the start of the project activity, years

Figure 6.4, and Table 6.5 shows the parameters used in calculating biomass burning for the baseline scenario, as well as results accounted for CH_4 and N_2O emissions generated because of incomplete biomass burning of non-commercial wood after logging.

Pasture and coffee carbon pools in the baseline

For calculation of the carbon pool remaining on pasture after deforestation, a conservative value of 15.0 tCO_2 ha^{-1} was applied (IPCC (2006c), page 6.27, Table 6.4). The proportion of baseline deforestation converted to pasture was considered as 90%. For calculation of the carbon pool remaining on coffee crops after deforestation, a conservative value of 84.0 tCO_2 ha^{-1} was applied (Dossa et al., 2008). The proportion of baseline deforestation converted to coffee cultivation was conservatively considered as 10%. The results obtained for coffee cultivation carbon pools in the baseline scenario are presented in Figure 6.1, Figure 6.4, and Table 6.5.

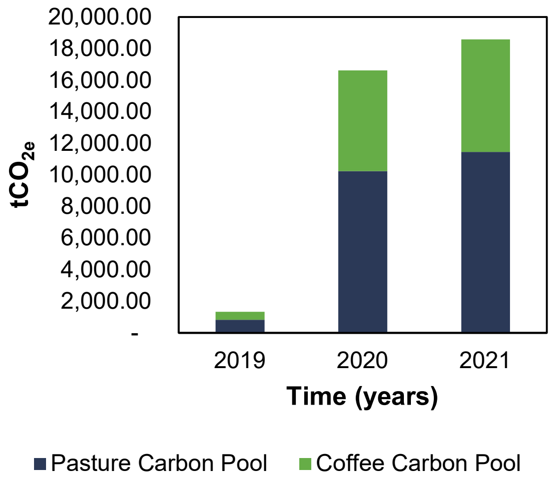

Figure 6.3. Pasture and coffee carbon pools in the baseline.

Figure 6.4 shows the calculation of estimation baseline or removals. Hence, the total baseline emission and greenhouse gas determination are summarized in Figure 6.4 and Table 6.5.

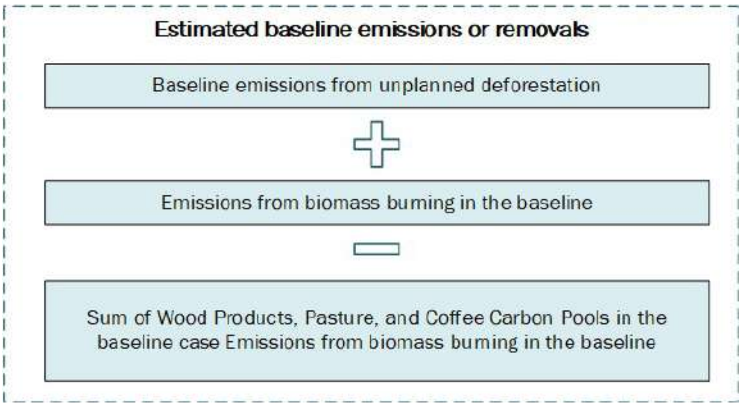

Figure 6.4. Total estimated baseline emissions or removals.

Table 6.5. Total baseline emissions and greenhouse gases determination.

	Parameter	Unit	Years 2019	2020	2021	TOTAL
Baseline Emissions	Total	tCO_2-e ha^{-1} year^{-1}	52,462.52	645,658.27	720,066.04	1,418,186.83
	Total Accumulative	tCO_2-e	52,462.52	698,120.79	1,418,186.83	
	$A_{BSL,PA,annual,t} = A_{Burn,i,t}$	ha	61.56	759.51	849.15	1,670.22
	$A_{BSL,PA,cumulative}$	ha	61.56	821.07	1,670.22	
Biomass Burning Emissions (CH_4)	E-CH_4 Biomass Burning	tCO_2-e	1,755.58	21,659.81	24,216.18	47,631.57
	E-CH_4 Biomass Burning Accumulative	tCO_2-e	1,755.58	23,415.39	47,631.57	
Biomass Burning Emissions (N_2O)	E-N_2O Biomass Burning	tCO_2-e	692.30	8,541.44	9,549.53	18,783.28
	E-N_2O Biomass Burning Accumulative	tCO_2-e	692.30	9,233.75	18,783.28	
	E-Biomass Burning = $GHG_{P,E,i,t}$	tCO_2-e	2,447.88	30,201.26	33,765.71	66,414.85
Wood products carbon pool	E-Wood Carbon Pool	tCO_2-e	158.19	1,951.72	2,182.07	4,291.99
	E-Wood Carbon pool Accumulative	tCO_2-e	158.19	2,109.92	4,291.99	
Pasture Carbon Pool	E-Pasture Carbon Pool	tCO_2-e	830.67	10,248.60	11,458.18	22,537.45
	E-Pasture Carbon pool Accumulative	tCO_2-e	830.67	11,079.27	22,537.45	
Coffee Carbon Pool	E-Coffee Carbon Pool	tCO_2-e	516.90	6,377.35	7,130.03	14,024.28
	E-Coffee Carbon pool Accumulative	tCO_2-e	516.90	6,894.25	14,024.28	
		Total BL-GHG	53,404.64	657,281.85	733,061.48	

6.3 Project Emissions

As already described in *Section 3.6 Methodology Deviations*, the areas exploited inside the FSM farm from 13th April 2019 to 12th April 2022 (current monitoring period) were excluded from the calculation of VCU benefits. That's because the forest management areas in this period were not certified by the FSC (forest stewardship council). According to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the Project. The documents showing the management areas exploited within this period are available for consultation by auditors. These documents will be kept safely for two years after the final credit period of the FSM project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report.

Although there was a lack of FSC certification during this period, wood managed to follow the line with the FSC principles and criteria. In this context, there is particular attention to the current FSM farm proponent in maintaining the policies from the FSC certification, this can be proven by recovering FSC certification in July 2022[169,170]. Thus, the project emission ex-post of the wood management will be estimated in the next monitoring report period.

6.4 Leakage

As previously described in Section 3.6 of this document, the leakage belt area is changed in this baseline reassessment since the wrong approach in the leakage belt boundaries at the first baseline period according to methodology VMD0007-BL-UP_v3.3. Although a leakage belt may have to be defined in the surrounding or immediate vicinity of the project area, the leakage belt area must be the forest areas closest to the project area. Additionally, all parts of the leakage belt must, at a minimum, be accessible and reachable by project baseline deforestation agents with consideration of agent mobility. Also, the belt must not be spatially biased in terms of the distance of the edge of the belt from the edge of the project area without justification based on agent mobility or criteria for landscape and transportation. The second baseline period's leakage belt area is closer to the project area and satisfies all the methodology's parameters.

There were no records of a burn or unplanned deforestation from the leakage belt throughout the baseline period of this Joint Project Description & Monitoring Report document. Geospatial imagery also supports this information. There is a high probability that these incidents will occur in this area, so the preventive action plan is being adopted in the leakage belt zones (see Section 1.11 Description of the Project Activity).

6.4.1 Leakage Market-Effect[171]

The Leakage Market-Effect was made beside module VMD0011-LK-ME-v1.1.

The leakage due to market effects is applicable just market-effects leakage of the decreased timber harvest. Hence, the net greenhouse gas emissions due to market-effects leakage are equal to total GHG emissions due to market-effects leakage through decreased timber harvest ($\Delta C_{LK-ME} = LK_{MarketEffects,timber}$).

The $LK_{MarketEffects,timber}$ was estimated using Equation 23.

169 Annex: FSC certification_site information.PNG

170 Annex: FSC certification.pdf

171 All ex-post calculations are available to the auditor in the 6 Calculations folder.

$$LK_{MarketEffects,timber} = \sum_{i=1}^{M} (LF_{ME} \times LK_{MAF} \times AL_{T,i})$$ Equation 47

Where:

$LK_{MarketEffects,timber}$	Total GHG emissions due to market- effects leakage through decreased timber harvest; t $CO_{2\text{-}e}$
LF_{ME}	Leakage factor for market-effects calculations; dimensionless $LF_{ME} = 0.7$ because $PML_{FT} > 15\%\ less\ than\ PMP_i$
$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project; t $CO_{2\text{-}e}$
LK_{MAF}	Leakage management adjustment factor (dimensionless)
i	1,2,3,…M strata

As mentioned in the previous Section *3.6 Methodology Deviations*, a deduction factor (LF_{ME}) of 0.7 was assumed. The deduction factor (LF_{ME}) was adopted based on the relation between mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type ($\mathrm{PML_{FT}}$) and merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary ($\mathrm{PMP_i}$). These parameters were estimated as follows:

- The $\mathrm{PML_{FT}}$ is estimated considering the literature data: according to Homma (2011), from 45 billion m^3 of Amazon wood stocks, almost 15 billion m^3 was marketable. Thus, the $\mathrm{PML_{FT}}$ adopted is 31% for legal Amazon.
- The $\mathrm{PMP_i}$ is calculated from forest inventory: in the forest inventory, commercial biomass was estimated through the allometric equation conforming described in Section 4.1.4. Characterization of biomass in Project Area. According to the VMD0011-LK-ME-v1.1 methodology, the merchantable biomass is defined by the total gross biomass (including bark) of a tree 40 cm DBH or larger from a 30 cm stump to a minimum 10 cm top of the central stem. In this case, $\mathrm{PMP_i}$ is calculated as the ratio between marketable biomass of DBH trees higher than 40 cm (14,207,847.38 t) [172] and total biomass (25,734,621.53 t) [173], resulting in 55%.

Hence, like $\mathrm{PML_{FT}} > 15\%\ \text{less than}\ \mathrm{PMP_i}$ the leakage factor for market-effects calculations adopted is 0.7. In other words, it is expected that the areas to be deforested in the Amazon Biome in the presence of the project are greater than would be observed in the project region.

Deduction factors for LF_{ME}:

$\mathrm{PML_{FT}} = \pm 15\%\ \text{to} \mathrm{PMP_i}$	$\mathrm{LF_{ME}} = 0.4$
$\mathrm{PML_{FT}} > 15\%\ \text{less than}\ \mathrm{PMP_i}$	$\mathrm{LF_{ME}} = 0.7$

[172] Annex: Forest inventory_DBH 40.xlsx

[173] Annex: Forest inventory total.xlsx

$\mathrm{PML_{FT}} >$ 15% greater than $\mathrm{PMP_i}$ $\mathrm{LF_{ME}} = 0.2$

Where:

$\mathrm{PML_{FT}}$	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type (%)
$\mathrm{PMP_i}$	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary (%)
$\mathrm{LF_{ME}}$	Leakage factor for market-effects calculations; dimensionless

Leakage management activities established within areas under the control of the project proponent can minimize the displacement of land use activities to areas outside the project area. A leakage management adjustment factor (LKMAF) may be applied if total biomass production is maintained in merchantable commercial species. In the FSM project, wood management in the project area attends to the wooding market. This wood exploration occurs according to *Código Florestal, Lei Federal nº 12.651/2012* (Nacional, 2012), minimizing the environmental impact in comparison to illegal wood exploration. For this reason, the Production biomass in commercial species that is merchantable in leakage management areas ($PRODMB_{LMA,t}$) was 30 t per year. This value was conservative because of presents the maximum value allowed by law (Nacional, 2012) that is allowed to explore in the project area. The production of biomass in commercial species that is merchantable in the baseline case ($PRODMB_{BL,t}$) was 35.1 t per year (da SILVA et al., 2001; Veríssimo et al., 1992), the same value of the merchantable wood in explanation adopted and validated in the Monitoring Report: VCS Version 4.0. So, the leakage factor for market-effects calculations (LK_{MAF}) was 0.14 (Equation 24).

Even without FSC certification, the timber was marketable in the project area during the monitoring period, thus supplying the timber market. Therefore, the same value of the leakage factor for market-effects calculations ($LK_{MAF} = 0.14$) considered in Section 4.3.1 was applicable in leakage market effect ex-post.

$$LK_{MAF} = 1 - \left(\frac{PRODMB_{LMA,t}}{PRODMB_{BL,t}}\right) \qquad \text{Equation 48}$$

Where:

LF_{ME}	Leakage factor for market-effects calculations; dimensionless
$PRODMB_{LMA,t}$	Production biomass in commercial species that is merchantable in year t in leakage management areas; t per year
$PRODMB_{BL,t}$	Production of biomass in commercial species that is merchantable in year t in the baseline case; t per year
t	1, 2, 3, … t* time elapsed since the start of the project activity; years

In compliance with Equation 25, the summed emissions from timber harvest in the stratum ($AL_{T,i}$) are equivalent to carbon emissions due to displaced timber harvests in the baseline scenario ($C_{BS\ ,XBT,i,t}$).

$$AL_{T,i} = \sum_{t=1}^{i} (C_{BSL,XBT,i,t}) \qquad \text{Equation 49}$$

Where:

$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case laced through implementation of carbon project; t CO_{2e}
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t; t CO_{2e}
i	1, 2, 3, …M strata
t	1, 2, 3, … t* time elapsed since the projected start of the REDD project activity; years

The $C_{BSL,XBT,i,t}$ was estimated by Equation 26. With $AL_{T,i}$determination, the $LK_{MarketEffects,timber}$ was estimated using Equation 23 resulting in net greenhouse gas emissions due to market-effects leakage.

$$C_{BSL,XBT,i,t} = \left(\left(V_{BSL,EX,i,t} \times D_{mn} \times CF\right) + \left(V_{BSL,EX,i,t} \times LDF\right) + \left(V_{BSL,EX,i,t} \times LIF\right)\right) \times \frac{44}{12} \qquad \text{Equation 50}$$

Where:

$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t; t CO_{2e}
$V_{BSL,EX,i,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i in year t; m^3 $V_{BSL,EX,i,t}$ = 35.1 m^3 ha^{-1} (da SILVA et al., 2001; Veríssimo et al., 1992)
D_{mn}	Mean wood density of commercially harvested species; t d.m.m^{-3} D_{mn} = 0.59 t d.m. m^{-3} (IPCC (2006a) page 2.55, Table 2.6).
CF	Carbon fraction of biomass for commercially harvested species j; t C t d.m.$^{-1}$ CF = 0.47 t C t d.m.$^{-1}$ (IPCC (2006b) page 4.48, Table 4.3).
LDF	Logging damage factor; t C m^{-3} LDF = 0.67 t C m^{-3} (VMD0015 Annex 1).
LIF	Logging infrastructure factor; t C m^{-3} LIF = 0.29 t C m^{-3} (VMD0011 page 8)
i	1, 2, 3, …M strata
t	1, 2, 3, … t* time elapsed since the projected start of the REDD project activity; years

The leakage market-effects ex-post determination is presented in Table 6.6.

Table 6.6. Leakage Market-Effects ex-post determination.

	Parameter	Unit	Year 2019	Year 2020	Year 2021	Total
Market-Effects Leakage Through Decreased	$A_{BSLPAt\ annual}$	ha $year^{-1}$	61.56	759.51	849.15	
	$C_{BSL,XBT,i,t}$	$tCO_{2\text{-}e}$ ha^{-1}	159.15	159.15	159.15	
	$AL_{T,i} = C_{BSL,XBT,i,t}$	$tCO_{2\text{-}e}$	9,797.26	120,875.85	135,142.03	265,815.14
	$PRODFC_{LMA,t}$	t $year^{-1}$	30.00	30.00	30.00	
	$PRODFC_{BL,t}$	t $year^{-1}$	35.08	35.08	35.08	
	$LKFC_{MAF}$		0.14	0.14	0.14	
	$LK_{MarketEffects,timber}$	$tCO_{2\text{-}e}$	993.13	12,252.98	13,699.12	26945.23
Total leak	$\Delta C_{LK\text{-}ME}$	$tCO_{2\text{-}e}$	993.13	12,252.98	13,699.12	26945.23

6.4.2 Leakage Outside the Leakage Belt for Local Deforestation Agents[174]

The Leakage Market-Effect was made based on module VMD0010-LK-ME-v1.2.

The methodology VMD0015 considers the net GHG emissions in the leakage belt ex-post assessment in the REDD project case ($\Delta C_{WPS-REDD,LB}$) equal to net carbon stock change as a result of deforestation in the leakage belt in the project case in stratum ($\Delta C_{P,DefLB,i,t}$) (Equation 51). As indicated earlier, throughout the baseline period of this Joint Project Description and Monitoring Report document, there were no records of fires or unplanned deforestation in the leakage belt and project area. This information is supported by the geospatial analyzes carried out in accordance with the monitoring plan and was confirmed in the field with the technical team of Fazenda FSM. Considering this, there is no need to write a loss event report, and therefore, the $\Delta C_{WPS-REDD,LB} = \Delta C_{P,DefLB,i,t} = 0$.

$$\Delta C_{WPS-REDD,LB} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \Delta C_{P,DefLB,i,t} \qquad \text{Equation 51}$$

Where:

$\Delta C_{WPS-REDD,LB}$	Net GHG emissions in the leakage belt in the REDD project case up to year t*, t CO_{2e}
$\Delta C_{P,DefLB,i,t}$	Net carbon stock change as a result of deforestation in the leakage belt the project case in stratum i in year t, t CO_{2e}
i	1, 2, 3, ...M strata in the project scenario
t	1, 2, 3, ... t* years elapsed since the projected start of the project activity

[174] All ex-post calculations are available to the auditor in the 6 Calculations folder.

The $\Delta C_{BSL,LK,unplanned}$ of the leakage belt in the baseline was estimated in the previous Section 4.3.2. However, since the value of $\Delta C_{P,LB}$ is null and this leakage value conservatively cannot be less than zero. Therefore, the net CO_2 emissions due to unplanned deforestation displaced from the project area to the leakage belt ($\Delta C_{LK-ASU-LB}$) is equal to zero (Equation 52).

$$\Delta C_{LK-ASU-LB} = \Delta C_{P,LB} - \Delta C_{BSL,LK,unplanned}$$

Equation 52

Where:

$\Delta C_{LK-ASU-LB}$	Net CO_2 emissions due to unplanned deforestation displaced from the project area to the leakage belt up to year t*, t CO_{2e}
$\Delta C_{BSL,LK,unplanned}$	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}

6.4.3 Leakage Outside the Leakage Belt: Immigrant Deforestation Agents[175]

The Leakage Market-Effect was made based on module VMD0010-LK-ME-v1.2.

The proportion of baseline deforestation caused by immigrating population ($\mathrm{PROP_{IMM}}$) was estimated for a period from 2015 to 2020. For calculating $\mathrm{PROP_{IMM}}$, the participatory rural appraisal (PRA) approach was replaced by local data available according to Monitoring Report: VCS Version 4.0. The Colniza local sources have a precise estimation approach of:

(v) The total annual population growth between 2015 and 2020 of 1,257.20 inhab. year^{-1} (IBGE, 2020);

(vi) The number of annual births from 2015 to 2020 of 513.00 inhab. year^{-1} (DataSus, 2020b);

(vii) The number of annual deaths from 2015-2020 of 121.20 inhab. year^{-1} (DataSus, 2020a);

(viii) The total population in 2020 of the 39,861.00 (IBGE, 2020).

The number of immigrants can be estimated by subtracting the annual population growth from the difference in rates of the number of annual births and death, dividing by the total population (Equation 30). This technique also assumes that the IBGE assessment is applicable to estimate population migration between urban and rural zones (i.e., there is similar accuracy between urban and rural immigrants' estimations). According to the number of immigrants, we have inferred the proportion of deforestation attributed to immigrant agents ($\mathrm{PROP_{IMM}}$) as 2.17%.

175 All ex-post calculations are available to the auditor in the 6 Calculations folder.

$$\mathrm{PROP_{IMM}} = \left(\frac{1{,}257.20 \; - \; (513.00 \; - 121.20)}{39{,}861.00}\right) = 0.0217$$ Equation 53

Where:

$\mathrm{PROP_{IMM}}$	Estimated proportion of baseline deforestation caused by immigrating population, proportion

The deforestation in the project area and leakage belt is measured and $\Delta C_{\mathrm{LK-ASU,OLB}}$ is estimated. Initially, the total area deforested by immigrant agents in the baseline and project scenario is calculated by Equation 54.

$$\mathrm{A_{LK-IMM,t}} = \mathrm{PROP_{IMM}} \times \mathrm{A_{BSL,PA,unplanned,t}}$$ Equation 54

Where:

$\mathrm{A_{LK-IMM,t}}$	Total area deforested by immigrant agents in the baseline and project scenario in year t, ha
$\mathrm{PROP_{IMM}}$	Proportion of area deforested by immigrant agents in the leakage belt and project area, proportion
$\mathrm{A_{BSL,PA,unplanned,t}}$	Projected area of unplanned baseline deforestation in the project area in year t, ha

In sequence, the area deforested by immigrants in the project area and leakage belt under the project scenario is estimated by Equation 55.

$$\mathrm{A_{LK-ACT-IMM,t}} = \mathrm{PROP_{IMM}} \times \left(\sum_{i=1}^{M} A_{\mathrm{DefPA,i,t}} + A_{\mathrm{DefLB,i,t}}\right)$$ Equation 55

Where:

$\mathrm{A_{LK-ACT-IMM,t}}$	Area deforested by immigrants in the project area and leakage belt under the project scenario in year t, ha
$\mathrm{PROP_{IMM}}$	Proportion of area deforested by immigrant agents in the leakage belt and project area, proportion Note: this proportion is estimated at least every 5 years.
$A_{\mathrm{DefPA,i,t}}$	Area of recorded deforestation in the project area in the project case in stratum i in year t, ha
$A_{\mathrm{DefLB,i,t}}$	Area of recorded deforestation in the leakage belt in the project case in stratum i in year t, ha

i	1, 2, 3 …M strata
t	1, 2, 3 …t* time elapsed since the start of the project activity, year

Next, the area deforested by immigrants outside the leakage belt and project area is assessed through Equation 56.

$$A_{ALK-OLB,t} = A_{LK-IMM,t} - A_{LK-ACT-IMM,t}$$

Equation 56

Where:

$A_{ALK-OLB,t}$	Area deforested by immigrants outside the leakage belt and project area under the project scenario in year t, ha
$A_{LK-IMM,t}$	Total area deforested by immigrant agents in the baseline and project scenario in year t, ha
$A_{LK-ACT-IMM,t}$	Area deforested by immigrants in the project area and leakage belt under the project scenario in year t, ha
t	1, 2, 3 …t* time elapsed since the start of the project activity, year

After, the area deforested by immigrants outside the leakage belt and the project area under the project scenario was used to evaluate whether leakage outside the leakage belt has occurred through the condition:

- If $A_{ALK-OLB,t}$ < 0: Leakage outside the leakage belt has not occurred.
- If $A_{ALK-OLB,t}$ > 0: Leakage outside the leakage belt has occurred.

If leakage outside the leakage belt has occurred, the $\Delta C_{LK-ASU,OLB}$ is calculated by a sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced outside the leakage belt (t CO_{2e}) according to Equation 57.

$$\Delta C_{LK-ASU,OLB} = C_{OLB} \times \left(\sum_{t=1}^{t^*} A_{LK- \quad ,t} \right)$$

Equation 57

Where:

$\Delta C_{LK-ASU,OLB}$	Net CO_2 emissions due to unplanned deforestation displaced outside the leakage belt up to year t*, t CO_{2-e}
C_{OLB}	Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the leakage belt, t CO_{2-e} ha^{-1} C_{OLB} = 578.1 tCO_{2e} ha^{-1} (Saatchi et al., 2007)
$A_{LK-OLB,t}$	Area deforested by immigrants outside the leakage belt and project area under the project scenario in year t, ha

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

Hence, the final values of Leakage ex-post are represented in Table 6.7.

Table 6.7. Leakage outside ex-post.

	Parameter	Unit	Year 2019-2020	Year 2020-2021	Year 2021-2022
Ex post	$A_{LK\text{-}IMM,t}$	ha	1.34	16.49	18.44
	$A_{BSL,PA,unplanned,t}$	ha	61.56	759.51	849.15
	$A_{DefPA,i,t}$	ha	-	-	-
	$A_{DefLB,i,t}$	ha	-	-	-
	$A_{LK\text{-}ACT\text{-}IMM,t}$	ha	-	-	-
	$A_{LK\text{-}OLB,t}$	ha	1.34	16.49	18.44
	$\Delta C_{LK\text{-}ASU,OLB}$		772.61	9,532.24	10,657.27
	LK-Outside - Ex post	$tCO_{2\text{-}e}$	772.61	9,532.24	10,657.27

6.4.4 Total estimation of the Leakage ex-post[176]

The total estimation of the leakage ex-post is equal to the sum of the calculated leakage previously subsections (Figure 6.5).

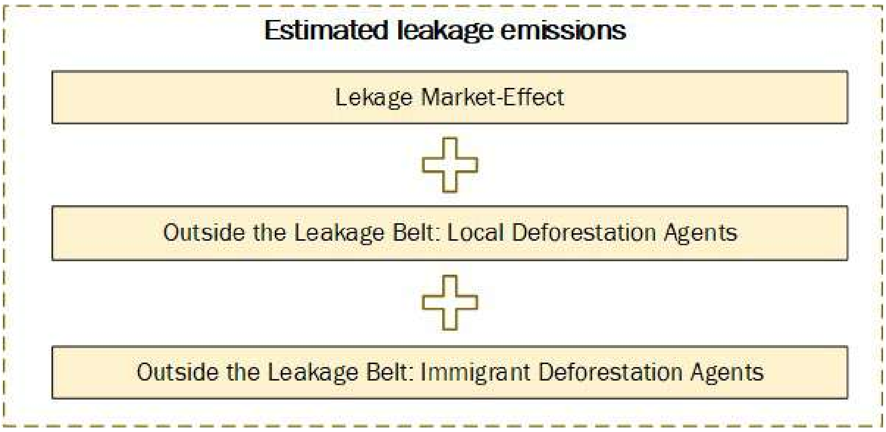

Figure 6.5. Total estimation of the leakage belt ex-post.

Hence, the result was calculated in Table 6.8.

Table 6.8. Total estimation of the Leakage ex-post.

Leakage Ex-post	Unit	Year 2019-2020	Year 2020-2021	Year 2021-2022	Total
Market-Effect	$tCO_{2\text{-}e}$	993.13	12,252.98	13,699.12	26,945.23
Outside the Leakage Belt: Local Deforestation Agents	$tCO_{2\text{-}e}$	-	-	-	-
Outside the Leakage Belt: Immigrant Deforestation Agents	$tCO_{2\text{-}e}$	772.61	9,532.24	10,657.27	20,962.13

176 All ex-post calculations are available to the auditor in the 6 Calculations folder.

Leakage Ex-post	Unit	Year			Total
		2019-2020	2020-2021	2021-2022	
Total Leakage	tCO_{2-e}	1,765.74	21,785.22	24,356.39	47,907.36

6.5 Net GHG Emission Reductions and Removals

The summary of the net GHG emission reductions or removals calculation is described in Figure 6.6[177].

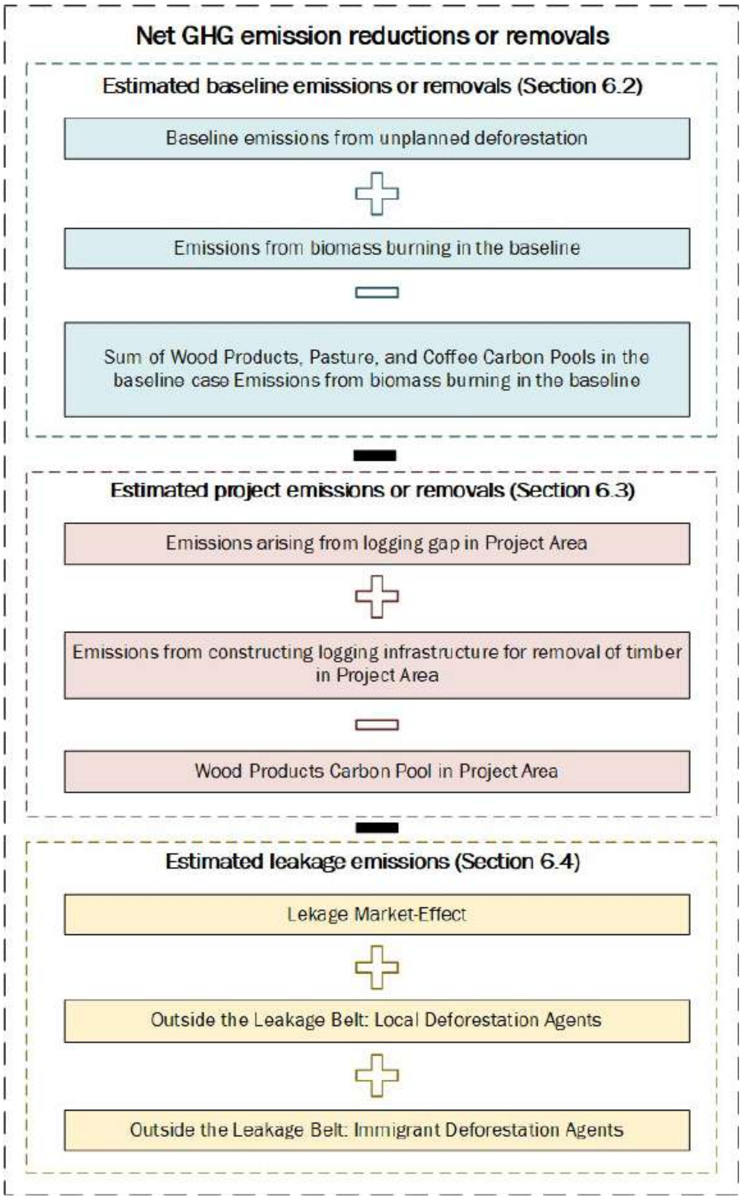

Figure 6.6 Summary of the calculation of Net GHG emission reductions or removals

As previously described in *Section 3.6 Methodology Deviations*, the wood management in the FSM farm is not included in the assessment of VCU benefits during the monitoring period (between April 13, 2019,

[177] All ex-post calculations are available to the auditor in the 6 Calculations folder.

and April 12, 2022). In addition, the project emissions were also excluded. In other words, the predicted project emissions resulting values are null throughout this monitoring period. This approach resulted from the absence of the FSC (Forest Stewardship Council) certification in the management wood during the monitoring period, making them ineligible for the Project. Auditors may review the records outlining the areas exploited during this period, which will be stored in a safe place that can be accessed for at least two years following the conclusion of the crediting period.

The buffer pool allocation was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value for the second baseline period was 10% (see Section 4. of the Non-Permanence Risk document). Hence, the estimated net GHG emission reductions or removals resulting from the difference between (i) the net GHG emission reductions or removals and (ii) buffer pool allocation (Table 6.9).

Table 6.9. Net GHG Emission Reductions and Removals.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2019-2020	53,404.64	-	1,765.74	51,638.89	5,163.89	46,475.01
2020-2021	657,281.85	-	21,785.22	635,496.63	63,549.66	571,946.96
2021-2022	733,061.48	-	24,356.39	708,705.09	70,870.51	637,834.58
Total	**1,443,747.96**	-	**47,907.36**	**1,395,840.61**	**139,584.06**	**1,256,256.55**

The resume of the FSM project ex-ante estimation and ex-post calculation is represented in Figure 6.7.

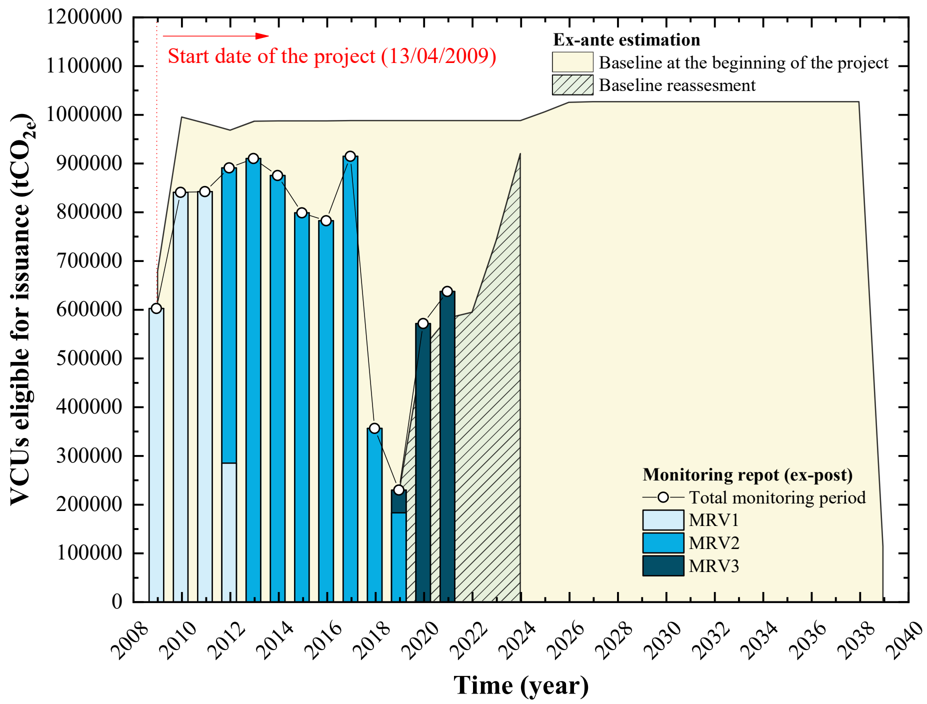

Figure 6.7. Resume of the ex-ante and ex-post calculation in the FSM project.

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