FLORESTAL SANTA MARIA PROJECT MONITORING REPORT

Document Prepared by SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The FSM is a rural property solely dedicated to the sustainable management of natural forests located in the Municipality of Colniza, in the State of Mato Grosso. The FSM REDD 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. It is important to mention that the project underwent a change of proponents. On 09.22.2020, Florestal Santa Maria Ltda (previous project proponent) and Caraguá Ltda (new project proponent together with Systemica Inteligência em Sustentabilidade S.A.) signed a Public Deed of Purchase and Sale with Resolutive Clause.

The project started on April 13, 2009, and is expected to end on April 12, 2039, resulting in a crediting period of 30 years. The first baseline of the project was from April 13, 2009, to April 12, 2019. During the first baseline period 18,391.2 ha of unplanned deforestation were avoided and an accumulated emission reduction of 8,001,838.6 t CO_{2-e} achieved.

It is important to note that the main objective of the FSM REDD project is to prevent unplanned deforestation through the implementation of conservation activities. To do so, during the monitoring period (April 13, 2019, to April 12, 2022), the following project activities were in progress:

- Patrolling and surveillance: the FSM farm has 7 monitoring bases, and the patrol method consists in periodic visits to them. It is important to note that one of the positive impacts perceived by the community from the adjacent of the project area was tenure security because of the farm operations.
- Satellite monitoring: fundamental activity to ensure the success of the project is the monitoring strategy to control deforestation and forest invasion. The approach adopted involves a system combining satellite images with field visits.
- Fire brigade: formed by local labor, the fire brigade is responsible for containing the expansion of fires in areas inside and outside the FSM farm. To do so, Caraguá provides training, material and planning for fire prevention and control.
- Sustainable forest management: the FSM farm successfully renewed its FSC certification in July 2022, delivering several benefits to the region. It is imperative to highlight the farm's dedication to the well-being of its workforce. The management diligently adheres to the collective agreement regarding workers' best interests. Furthermore, a program for medical and health control has been implemented and occupational risks are identified and addressed in the Risk Management Program. Additionally, the farm actively raises awareness among employees about the importance of employee registration.
- Leakage control: the strategy adopted is based on monitoring and a cooperative effort with local stakeholders to promote a new approach to forest use and land use.
- Periodic maintenance of roads and bridges: part of the operation carried out by the farm that caused positive impacts to the local community.

All the activities discussed contributed to a net GHG emission reduction of 402,312.98 t CO_{2-e} and 922.14 ha of deforestation avoided during the monitored period.

In Table 1.1 it is possible to observe the audit history of the project.

Table 1.1. Audit history of FSM REDD project

Audit Type	Period	Program	VVB Name	Number of years
Validation (1st baseline)	04-May-2012	VCS	Rainforest Alliance	---
Verification	13-April-2009 to 03-May-2012	VCS	Rainforest Alliance	3 years
Verification	04-May-2012 to 12-April-2019	VCS + Social Carbon	RINA Services S.p.A. (RINA)	7 years
Validation (2nd baseline)	18-May-2023	VCS	Earthood Services Limited	---
Verification	13-April-2019 to 12-April-2022	VCS	Earthood Services Limited	3 years
Total	N/A	N/A	N/A	13 years

1.2 Sectoral Scope and Project Type

The FSM REDD 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 Proponent

Organization name	Caraguá Agronegócios LTDA
Contact person	Thiago G. de O. Ricci
Title	Legal representative
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Organization name	SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.[1]*
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*See Section 3.2.2. On September 2, 2024, a Deed of Partial Release[2] was submitted between Caraguá Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A., allowing Systemica to withdraw as the project proponent. As a result, Caraguá Agronegócios LTDA will remain the sole proponent of the FSM REDD project.

1.4 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
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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.

[1] Before Systemica (MYS E JLFL TREINAMENTO GERENCIAL LTDA)

[2] 240902_Deed of Partial Release – September 2024.pdf

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1.5 Project Start Date

Project start date was on 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.

1.6 Project Crediting Period

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

1.7 Project Location

The project is in Colniza Municipality, state of Mato Grosso, Brazil. The project area has a size of 71,317.98 ha[3]. The boundaries are also defined by the following geodesic coordinates referenced in datum WGS84, UTM 21:

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

1.8 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)"[4].

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 FSM project are listed below:

Carbon Pool Modules:

[3] The project area boundaries are also available in the annex: 202208_FSM_PD_Project Area.kml
[4] Annex: VM0007-REDDMF_v1.6.pdf

CP-AB, "VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools", Version 1.1[5].

CP-W, "VMD0005 Estimation of carbon stocks in the long-term wood products pool", Version 1.1[6].

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[7].

Leakage Modules:

LK-ASU, "VMD0010 Estimation of emissions from activity shifting for avoided unplanned deforestation", Version 1.2[8].

LK-ME, "VMD0011 Estimation of emissions from market-effects", Version 1.1[9].

Emissions Modules:

E-BPB, "VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning", Version 1.2[10].

Monitoring Module:

M-REDD, "VMD0015 Methods for monitoring of greenhouse gas emissions and removals", Version 2.2[11].

Miscellaneous Modules:

X-STR, "VMD0016 Methods for stratification of the project area", Version 1.2[12].

X-UNC, "VMD0017 Estimation of uncertainty for REDD project activities", Version 2.2[13].

Tools:

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[14].

T-BAR, "VCS AFOLU Non-Permanence Risk Tool", Version 4.0[15].

T-SIG, "CDM Tool for testing significance of GHG emissions in A/R CDM project activities", Version 1.0[16].

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[5] Annex: VMD0001-CP-AB-v1.1.pdf
[6] Annex: VMD0005-CP-W-v1.1.pdf
[7] Annex: VMD0007-BL-UP-v3.3.pdf
[8] Annex: VMD0010-LK-ASU-v1.2.pdf
[9] Annex: VMD0011-LK-ME-v1.1.pdf
[10] Annex: VMD0013-E-BPB-v1.2.pdf
[11] Annex: VMD0015-M-REDD-v2.2.pdf
[12] Annex: VMD0016-X-STR-v1.2.pdf
[13] Annex: VMD0017-X-UNC-v2.2.pdf
[14] Annex: VT0001-T-ADD-v1.0.pdf
[15] Annex: AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf
[16] Annex: T-SIG-v1.pdf

1.9 Participation under other GHG Programs

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.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

The project does not reduce GHG emissions from activities included in an emission trading program or any other mechanism that includes GHG allowance trading. Moreover, 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 and did not affect emissions associated with a good or service (Supply Chain Scope 3).

1.11 Sustainable Development Contributions

The FSM 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[17].	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[18].	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 Labor 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) [19]	Lowered the number of unregistered labor in the municipality of Colniza.

[17] Annex: 202208_FSM_PD_Modical and health program.pdf
[18] Annex: 202208_FSM_PD_Colective Convention.pdf
[19] 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	Tons 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 tons of carbon into the atmosphere during the monitoring period.	Prevented the release of 1.2 million tons 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[20] 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)[21].
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[22].
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[23], 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[24].

[20] Annex: 202208_FSM_PD_Reduced Impact Forest Management Training.pdf
[21] Annex: 202208_FSM_PD_AUTEX 2021.pdf
[22] Annex: 202208_FSM_PD_Map with Land Cover.jpg
[23] Annex: 202208_FSM_PD_Decree Nº 5,438.pdf
[24] Annex: 202208_FSM_PD_Map with Ecological Parks.jpg

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 REDD project 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 is 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[25]. For the safety of workers, the farm 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 [26],[27].

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 REDD project 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[28]. Some of the activities that are carried out before, during, or after a fire outbreak are the following:

[25] Annex: PGR Caragua Agronegocios Ltda.pdf
[26] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf
[27] Annex: Programa de controle médico de saúde ocupacional 2022.pdf
[28] Annex: PO_PCI_13_ PREVENCAO_COMBATE_INCENDIO.pdf

- 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[29].

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.

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[30].

Possible conflicts arising 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 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[31]). 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 [32].

Local roads erosion as a result of the timber-loaded trucks traffic.

[29] Annex: Evidência do treinamento de brigada de incêndio.pdf
[30] Annex: monitoramento_operacoes.pdf
[31] Annex: MONITORAMENTO PATRIMONIAL.docx
[32] Annex: Avaliacao Socioambiental Caragua 2022.pdf

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[33]. 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.

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 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[34]. 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[35].

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[36]. 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 REDD project 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[37]. On this visit, a questionnaire was applied 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,

[33] Annex: evidencias manutencao estradas.docx
[34] Annex: 04_FSM_Community assessment report.pdf and 04_FSM_Interview files.pdf
[35] Annex: 03_FSM_Whatsapp group invite and group evidence.pdf
[36] Annex: 04_FSM_Audit communication.pdf
[37] Annex: 03_FSM_Informative Poster_1.pdf

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[38] with stakeholders throughout the project, as one of the channels of consultation and feedback, considering that it will be applied recurrently during the project lifetime, 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 REDD project operations perceived by the local community results from the 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 Section 2.1. For more information about the consultation see the annexes: evidence of visits to local stakeholders[39]; report of socio-environmental diagnosis[40]; and the project summary[41] 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 report, 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.

It is important to note that to inform about the audit process, a careful stakeholders' communication 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[42].

[38] Link: https://forms.gle/Zf9koYTqx4NXyAsr9
[39] Annex: evidências das visitas aos stakeholders locais.pdf
[40] Annex: Avaliacao Socioambiental Caragua 2022.pdf
[41] Annex: Resumo Projeto REDD Florestal Santa Maria.pdf
[42] Annex: 04_FSM_Audit communication.pdf

SEMA, specifically, was made aware of the auditing process by means of telephone calls and emails (annex).

It is also 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)[43], 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 [44],[45]. 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[46].

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 AFOLU-Specific Safeguards

Four main groups of stakeholders were identified, namely: FSM REDD project 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:

[43] Annex: decreto_5452_CLT.pdf
[44] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf
[45] Annex: Programa de controle médico de saúde ocupacional 2022.pdf
[46] Annex: PGR Caragua Agronegocios Ltda.pdf

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.

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[47]. There is periodic fire brigade training with farm employees, through a fire-fighting course planned for May 2022[48].

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 measures for transport-related risks are described in the attached PGR[49] (p.30). In addition, monitoring of forest management procedures is being adopted by the farm in order to minimize risks and improve procedures[50].

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

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)[51]. 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 [52].

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

The periodic maintenance of the roads is part of an operation carried out by the farm management[53]. 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.

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, a more direct communication channel with the farm management.

[47] Annex: PO_PCI_13_ PREVENCAO_COMBATE_INCENDIO.pdf
[48] Annex: Evidência do treinamento de brigada de incêndio.pdf
[49] Annex: PGR Caragua Agronegocios Ltda.pdf
[50] Annex: monitoramento_operacoes.pdf
[51] Annex: MONITORAMENTO PATRIMONIAL.pdf
[52] Annex: Avaliacao Socioambiental Caragua 2022.pdf
[53] Annex: evidencias manutencao estradas.pdf

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 REDD 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) [54]. 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[55] 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 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[56].

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 [57]. 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[58,59].

SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A. hereinafter Systemica, which was founded in 2012, supports the FSM project and has experience in projects related to ecosystem services;

[54] Annex: CONVENÇÃO COLETIVA 2001 A 2003.pdf
[55] Annex: Autoavaliacao_PoliticaTrabalhista_CARAGUA_Assinado.pdf
[56] Annex: Programa de controle médico de saúde ocupacional 2022.pdf
[57] Link: https://registry.verra.org/app/projectDetail/VCS/875
[58] Annex: SCR_Florestal Santa Maria_ Point_0_v2.pdf
[59] Annex: 2020_VCS_SCR_validation.pdf

incorporation of sustainability into governance strategies to generate value; public policies; and the most relevant for this analysis, the voluntary carbon market forest projects[60].

When it comes to the FSM REDD 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[61].

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

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 REDD project workers, who explained the project and provided the farm contact phone and WhatsApp number. On this visit, a questionnaire was applied 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[62] was sent to other stakeholders[63], 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[64] 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

[60] Annex: Systemica_Company_Portfolio.pdf

[61] Annex: Systemica_Project Development Team_Santa Maria.pdf
[62] Annex: email_stakeholders_MRV.pdf
[63]Annex: stakeholders_FSM.xlsx
[64] Link: https://forms.gle/Zf9koYTqx4NXyAsr9

of the project actions. Other forms of communication were implemented, such as the distribution of flyers [65], 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[66]; report of socio-environmental diagnosis[67]; and the project summary[68] 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 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 different communication channels to actively listen to the stakeholder's demands and provide proper information about the activities held by FSM REDD project. Regarding the local households living nearby the project area, WhatsApp and phone number function, among other things, as a grievance redress mechanism.

The FSM REDD project 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 REDD project 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 IMPLEMENTATION STATUS

[65] Annex: Cartaz-FSM-auditoria-VCS-2022.pdf
[66] Annex: evidências das visitas aos stakeholders locais.pdf
[67] Annex: Avaliacao Socioambiental Caragua 2022.pdf
[68] Annex: Resumo Projeto REDD Florestal Santa Maria.pdf

3.1 Implementation Status of the Project Activity

The main objective of the FSM REDD project is to prevent unplanned deforestation through the implementation of conservation activities, such as firefighting training, patrolling and surveillance of the property, remote mapping of deforested areas, maintenance of sustainable forest management activities, and leakage control. In this sense, the FSM 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. More specifically, during the monitoring period, the following project activities were in progress:

Patrolling and surveillance

The FSM REDD 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. The activity is 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 and maintain 24-hour communication. The patrol method 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[69]). It is relevant to note that one of the most recurrent positive impacts perceived by the local community was tenure security as a result of the farm operations[70].

Satellite monitoring

Another fundamental point to ensure the success of the 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.

Fire brigade

The fire brigade was organized by local labor. The fire brigade is 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[71]. To mitigate fire outbreaks and spread, FSM farm provides training, material, and planning for fire prevention and control, which is stated in the Operational Plan[72]. 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.

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[69] Annex: MONITORAMENTO PATRIMONIAL.docx
[70] Annex: Avaliacao Socioambiental Caragua 2022.pdf
[71] Annex: Treinamento_brigada_incêndio_2022.pdf
[72] Annex: PO_PCI_13_ PREVENCAO_COMBATE_INCENDIO.pdf

Provision of materials and equipment for firefighting and control activities.

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 neighbourhood in the prevention, measures, and good practices to avoid the beginning of fires.

Sustainable forest management

The FSM REDD project farm is certificated by FSC (Forest Stewardship Council)[73], which provides several benefits to the region, as it stimulates improvements in social and environmental aspects. It is important to note that in 2022, the new farm management renewed the 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[74].

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.

It is important to note that 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 FSM Sustainable Forest Management Plan[75], which is to create consistency in the wood supply. Technical qualifications, 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.

Regarding workers well-being, 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[76]. Furthermore, a program for the medic and healthy control of the forest management workers[77] was developed. Lastly, 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)[78].Also, it is

[73] Annex: Certificado_CoC_FSC_119901_07_2022.pdf
[74] Annex: PGR Caragua Agronegocios Ltda.pdf
[75] Annex: PMFS Santa Maria
[76] Annex: 202208_FSM_PD_Colective Convention.pdf
[77] Annex: 202208_FSM_PD_Modical and health program.pdf
[78] Annex: 202208_FSM_PD_PGR Caraguá.pdf

important to mention that the project has an internal policy[79] 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 sexual harassment in their work environments.

It is also relevant to note the relationship between the FSM REDD project farm and the neighbors of the project. In a community assessment carried out by the FSM team, 98% of the interviewed settlers informed that has a good or excellent relationship with FSM REDD project. They also informed their understanding that the farm activities have a positive impact, naming the roads maintenance carried out by FSM REDD project, environmental conservation, job creation, better legal and land security, and more security when it comes to a possible need of help in an emergency[80]. Those who informed negative impacts related with the FSM REDD project activities mentioned the road maintenance that could be better, and the risk posed by the heavy timber loaded trucks traffic.

Leakage control

The Project proponents adopted a proactive initiative for fighting leakage sources. This adoption is based on a cooperative effort with local stakeholders to promote a new approach to forest use and land use in the region. To mitigate leakage, the Project proponents continuously monitor and intervene in areas surrounding the Project (Leakage Belt). The results regarding leakage monitoring are periodically consolidated in the monitoring reports and the non-permanence risks discussed in its reports.

Periodic maintenance of roads and bridges

The periodic maintenance of the roads is part of an operation carried out by the farm management[81]. 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.

All the actions discussed contributed to a net GHG emission reduction of 402,312.98 t $CO_{2\text{-}e}$ and 922.14 ha of deforestation avoided during the monitored period.

Lastly, 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 Agronegócios LTDA (new project proponent together with SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.) 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 ha 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.

[79] Annex: Autoavaliacao_PoliticaTrabalhista_CARAGUA_Assinado.pdf

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

[81] Annex: evidencias manutencao estradas.docx

3.2 Methodology Deviations

3.2.1 Methodology Deviations

Baseline reassessment approach

The baseline reassessment involves special procedures (VM0007 v1.6 Section 3.2), in particular:

- The historic reference period (HRP) extends to include the original reference period and all subsequent monitoring periods up to the beginning of the current monitoring period.
- 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.

These instructions imply that some of the modeling procedures described in VMD0007 v.3.3 must be adapted. These adaptions are thoroughly discussed in Section 4.1.3 – Location and Quantification of Threat of Unplanned Deforestation. One of the adaptations characterizes a methodological deviation and is reported here.

Model calibration for constructing the baseline risk map

The modeling approach adopted for this second baseline period is based on location analysis. In this approach, a risk map is employed to determine the areas predicted to be deforested during baseline years. To construct the baseline risk map it is necessary to calibrate a set of spatial variables (that is, assigning a risk factor to each variable) using deforestation data collected during the extended historical period.

Because the carbon project existed during part of the extended historical period, if the calibration procedure is done using the standard approach (that is, using data from the entire RRL, which includes the Project Area) there will be a “protection bias” embedded in the correlation between the distribution of deforestation in the RRL and the values of the predictive variables. This bias should not be present when assessing deforestation risk for the baseline period, because the carbon project does not exist in the baseline scenario.

Therefore, to avoid this bias and correctly correlate deforestation risk with predictive variables, the project area is removed from the RRL during model calibration when constructing the baseline risk map, which is an adaptation of VMD0007’s instructions found to be necessary in the context of baseline reassessment.

Calculation of settlement density in the similarity analysis

According to VMD0007 v3.3, the similarity analysis for the settlement density variable must be performed in a 1 km buffer zone around the target areas. We instead considered 2 km buffer zones. This was done to compensate for excluded buffer portions that overlap either lands with special land tenure status or the project area itself (the necessity of such exclusions is explained in the subsection “Landscape, transportation networks, human infrastructure” of the similarity analysis section).

$PROP_{IMM}$ estimation

In the analysis of leakage outside the leakage belt, for calculating the estimated proportion of baseline deforestation caused by immigrating population ($PROP_{IMM}$), 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 3.1). 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 3.1. 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.

3.2.2 Project Description Deviations

Baseline reassessment

Most of the changes brought on by this revision revolve around a reassessment of the originally designed baseline scenario, as required by the guidelines found in VM0007 v1.6 Section 3.2 - Re-assessing the Baseline Scenario. In this context, the central requirement is that the reassessment “must capture changes in the drivers and/or behavior of agents that cause the change in land use” (VM0007 v1.6 Section 3.2) and, to comply with it, the boundaries of reference regions RRD/RRL and of LB areas utilized in the first baseline design have been modified. Since these changes constitute PD deviations they are reported and justified here.

Redefinition of the Leakage Belt

The Leakage Belt areas were redefined and are now in full accordance with the requirements of the approved VCS module VMD0007. Although the LB areas originally defined at the time of validation were demonstrated to be similar to the Project Area according to landscape, transport, political and social factors – thus satisfying criteria "d", "e", "f" and "g" listed in VMD0007 v3.3 Section 1.1.3 – it is our understanding that they did not meet criteria "a" and "c".

According to criterion “a”, the LB area must consist of the forest areas closest to the Project Area, however, some of the old LB polygons are approximately 60 km away from the farm’s borders. Distances of that magnitude should not be acceptable, since they create logistic difficulties during the management, accounting, and mitigation of leakage. In turn, the complementary criterion “c”, which dictates that the LB must “not be spatially biased in terms of its distance from the project without justification based on agent mobility or landscape and transportation criteria” was likewise not met, since no justification which took into consideration those factors was provided in the original PD.

Furthermore, during the second monitoring report of the project, a leakage of 1,110.0 ha was observed between 2018 and 2019, which resulted in a leakage emission of 628,991.4 t CO2-e. Considering the suspicious magnitude of this activity, a due diligence process was initiated to identify the cause and propose mitigation and control measures. It was concluded that the deforestation agent responsible for that emission differs from the expected agents of unplanned deforestation of the project’s baseline scenario, which are mainly the settlements and family-scale land grabbers (holding less than 150 ha of land on average) located around the Project Area. The investigation revealed that, in fact, the deforestation was caused by a company that owns an area of more than 40,000 ha right beside the west boundary of the project.[82] The project proponents reached out to the landowners of that neighboring property in an attempt to propose solutions to control this type of large-scale deforestation in the surrounding areas through technical assistance, financing in the carbon market and REDD mechanisms. This event demonstrated a failure of the old leakage areas to serve as proxies for measuring the activity shifting leakage that should be associated with the baseline scenario.

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[82] Information about this property and all supporting evidence for the claims made here were provided by the VVB and Verra auditors.

Considering the above, and especially the fact that leakage areas are ideally expected to be located within a short buffer distance around the Project Area as implied by the methodology, the old leakage areas were discarded, and a new leakage belt was defined. More details regarding this procedure are found in Section 4.1.1, subsection “Leakage Belt” in the PD.

Redefinition of the RRD and RRL

The new delineation of the RRD was primarily motivated by changes in regional deforestation trends over the last years, both quantitative and qualitative: namely, a significant drop in deforestation rates was observed in the municipality of Colniza-MT, while the deforestation frontier threatening the project, which during earlier times advanced primarily from south to north, is now starting to embrace the project’s eastern and western borders. The new boundary seeks to better reflect the new pattern and the current level of risk faced by the project.

Furthermore, the old RRD boundary – the perimeter of a settlement that originally contained the Florestal Santa Maria area – is found to be almost completely deforested, which would limit too much the size of the RRL region that could be used to model this second baseline period (because the RRD and RRL coverages are connected at the beginning of the new baseline period). Additionally, the old RRD is no longer compatible with the new LB areas.

The new RRD and RRL boundaries are presented in Section 4.1.1 – Definition of Boundaries (subsections “Reference Region for Projecting Deforestation Rate (RRD)” and “Reference Region for Projecting Location of Deforestation (RRL)”.

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[83] and Deed of Partial Release[84] in order transfer the project (Florestal Santa Maria Project ID 875) to Caraguá Agronegócios LTDA and on May 19, 2023 Verra Registry approved the request to change project proponents[85], making Caraguá Agronegócios LTDA company and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A. the proponents of the FSM REDD project[86,87]. Lastly, it is important to note that Systemica underwent a change in organization name from MYS e JLFL Treinamento Gerencial LTDA to SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.

The inclusion of Systemica as project proponent is a valid measure to involve this company, which as project developer wants to make a technical contribution to the revalidation of the project and to the

[83] Annex: Deed of Accession – December 2021.pdf
[84] Annex: Deed of Partial Release – April 2022.pdf
[85] Annex: Verra Registry Project Transfer Approved.pdf
[86] Annex: 230519_AccessionRegistrationRepresentation.pdf
[87] Annex: 230519_CommunicationsAgreement.pdf

improvement and quality of other issues related to the project and its implementation, as it has a great deal of know-how from other projects. This in no way affects issues such as the longevity, base line and additionality of the project, since the entry of this new proponent adapts to the conditions already assessed by verra since the beginning of the project and does not change them. It only brings greater technical security and the implementation of higher quality activities with a high level of knowledge of the standards.

Systemica takes comprehensive measures to ensure that all entities involved in the project (whether employees or contractors) who are involved in the planning and implementation of the project are not associated with or support any form of discrimination or sexual harassment. All the contracts with project service providers have a contractual clause that oblige them to adopt all the Systemica guidelines and norms that also concern discrimination. The institutions hired are required to sign a commitment agreement document[88] that outlines specific guidelines and work conduct practices aimed at preventing discrimination-related issues. Even the project team itself that signs and follows a code of ethics. Furthermore, the project's communication procedure[89] includes a feedback and grievance redressal mechanism that also serves the purpose of addressing and resolving any potential issues related to discrimination that may arise during the course of the project.

On September 2, 2024, a Deed of Partial Release[90] was submitted between Caraguá Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A., allowing Systemica to withdraw as the project proponent. As a result, Caraguá Agronegócios LTDA will remain the sole proponent of the FSM REDD project.

FSC certification for forest management

Areas managed under the FSM REDD project operation from April 13, 2019, to April 12, 2022 (current monitoring period) were excluded from the Project Area for the purposes of quantification. This is because the corresponding forest management areas were not certified by the FSC (Forest Stewardship Council) during this period and, therefore, according to the approach previously addressed in Monitoring Report: VCS versions 2.1 and 4.0, these areas were not eligible for the project at the time. The documents showing the management areas exploited within this period are available for consultation by auditors. These documents will be kept safe for two years after the final credit period of the FSM REDD project.

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[91,92] in line with the principles of the FSC, culminating in the renewal of the FSC certification in July 2022[93,94]. Considering this, all areas scheduled to be exploited from that date onwards will be eligible for the project – this is reflected in the Project Description's ex-ante quantification from 2022 onwards,

[88] 240113_Code of ethics and conduct
[89] 230510_Project Communication Procedure
[90] 240902_Deed of Partial Release – September 2024.pdf
[91] Annex: Anexo_Palestra_Segurança_Trabalho_Normas_Internas.pdf
[92] Annex: Treinamento_Impacto_Reduzido
[93] Annex: FSC certification_site information.PNG
[94] Annex: FSC certification.pdf

which does not exclude any UPA from the calculation. However, it must be kept in mind that, during the next monitoring period, the validity of the FSC certification must be confirmed again, and the adequate quantification procedure shall be applied to the ex-post calculations.

LFME estimation

The deduction factor (LFME) was adopted as 0.7 instead of 0.2 (Monitoring Report) or 0.4 (first baseline 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:

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

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

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 the corresponding Project Description. 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 (8,747,468.12 t)[95] and total biomass (15,771,732.31 t)[96], 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.

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)[97], which is available for consultation by the auditors.

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)[98]". Non-tree aboveground biomass must 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.

Previous monitoring reports: project description deviations

First monitoring report: Monitoring Report - VCS Version 3 (from April 13th, 2009, to May 3rd, 2012):

[95] Annex: Forest inventory_DBH 40.xlsx
[96] Annex: Forest inventory total.xlsx
[97] Annex: SOP - Standard Operating Procedure

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

In this report, the first deviation adopted was related to the Forest Stewardship Council (FSC) certification. Between April 13th, 2009, and December 31st, 2011, the areas exploited inside the FSM farm were excluded from the calculation of the VCU benefits, since they were not certified by the FSC and consequently were not eligible to the project, as stated in the mentioned Monitoring Report. Therefore, the baseline emissions and the project emissions occurred within the areas exploited were not quantified.

Lastly, the deduction factor LF_{ME} adopted in the monitoring report was 0.2 instead of 0.4 (Project Description: VCS Version 3), since the forest biomass is considered to be less in Project Area than in the average of Amazon Biome, according to the first monitoring report.

Second monitoring report: Monitoring Report - VCS Version 4.0 (from May 4th, 2012, to April 12th, 2019):

In this report, the deviation associated with the FSC certification was cited. The report states that the areas exploited inside the FSM farm from April 13th, 2009, to December 31st, 2011 (first monitoring period) and from April 1st, 2017, to April 12th, 2019 (second monitoring period) were excluded from the VCUs benefits calculation, since they were not eligible, as stated in the mentioned report.

Moreover, in the second monitoring report, two aspects related to the calculation of deforestation rate were highlighted. Firstly, the interval of the satellite images used to calculate the deforestation rate had to be adjusted, since the difference between the ones used in the VCS-PD (Project Description: VCS Version 3) was not three years. Secondly, the deforestation rate within the project area decreased thanks to the exclusion of areas harvested without FSC certification.

According to the monitoring report, there had been an adjustment of the factor 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).The sum of the parameter 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) and OF_{ty} cannot be superior than 1. Since the SLF_{ty} adopted came from a default value indicated for sawnwood of 0.2 (VCS Module VMD0005) the OF_{ty} was adjusted to 0.8. Besides, the logging damage factor used has been set as 0.67 tC/m^3, being the most conservative default value, as stated in the mentioned report.

In regard of the deduction factor LF_{ME}, it was adopted a value of 0.2 instead of 0.4 (Project Description: VCS Version 3), since the forest biomass is less in the Project Area than in the average of Amazon Biome, according to the first monitoring report.

Lastly, during the development of the second monitoring report, the authors noted a mistake in the frequency of monitoring of $A_{RRL,forest,t}$ (Remaining area of forest in RRL at time t), which was set to 5 years in the First Monitoring Report (Monitoring Report - VCS Version 3) and VCS-PD (Project Description: VCS Version 3. This frequency was corrected to every 10 years since it is only applicable to the baseline renewal.

3.3 Grouped Projects

Not applicable since the project is not grouped.

4 DATA AND PARAMETERS

4.1 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	Nogueira et al. (2007)
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 BCEF 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 C m^{-3}
Purpose of Data	Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	

Data / Parameter	BEF
Data unit	dimensionless
Description	Biomass expansion factor (BEF) for expansion of merchantable biomass 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 biomass conversion and expansion factor Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	BCEF
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) IPCC (2006a) page 2.55, Table 2.6
Value applied	0.9794
Justification of choice of data or description of measurement methods and procedures applied	Results of multiplying the BEF by wood density as recommended by IPCC (2006a) page 4.13, Box 2 $$\mathrm{BCEF} = 1.66 \cdot 0.59$$
Purpose of Data	Calculation of aboveground tree biomass Calculation of baseline emissions Calculation of project emissions Calculation of leakage
Comments	The source database has a precise approach.

Data / Parameter	$\mathrm{P_{com_i}}$
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	Calculation of baseline emissions
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_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. “Tropical forest”: For CH4 from 6.8 ± 2.0 (6.8-2.0= 4.8) g kg^{-1} dry matter burnt; For N2O: 0.20 g kg^{-1} dry matter burnt.
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-e} t gas g^{-1}
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	$V_{BSL,EX,i,t}$
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, 2021; 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 “Definition of Boundaries” of the corresponding Project Description.

Data / Parameter	C_{OLB}
Data unit	t CO_{2-e} 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	t CO_{2-e} 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	380.74
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 "Characterization of biomass in project Area" of the corresponding Project Description.

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	$\mathrm{PML_{FT}}$
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	The $\mathrm{PML_{FT}}$ is estimated considering the literature data. According to Homma (2011) from 45 billion m^3 of Amazon wood

measurement methods and procedures applied	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 in the corresponding Project Description 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 (8,747,468.12 t)[99] and total biomass (15,771,732.31t)[100], resulting in 55%.
Purpose of Data	Calculation of leakage
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.

[99] Annex: Forest inventory_DBH 40.xlsx
[100] Annex: Forest inventory total.xlsx

Purpose of Data	Calculation of baseline emissions; Calculation of project emissions; Calculation of leakage
Comments	

Data / Parameter	$\text{Volume, m}^3 = -0.4306 + 0.0011 \times (\text{DBH, cm})^2$
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	$\text{Volume, m}^3 = -0.4306 + 0.0011 \times (\text{DBH, cm})^2$
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	

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 4.18, Table 4.4, IPCC (2019)
Value applied	0.221
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.

4.2 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 REDD project farm. As demonstrated in the VCS-PD, the FSM REDD project has a system for monitoring boundaries and for hindering any invasion that might endanger the forest. The only carbon loss inside the FSM REDD project is attributed to low-impact Sustainable Forest Management.

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 April 13, 2019, to April 12, 2022, the wood management effecting in the FSM REDD project 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 REDD 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.
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 monitored	N/A
Monitoring equipment	Remote sensing and GPS.

Data / Parameter	Project Forest Cover Monitoring Map
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 the 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 monitored	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 the 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 monitored	<table><tr><th>Year</th><th>Project Area</th><th>Leakage Belt</th></tr><tr><td>2019-2020</td><td>-</td><td>-</td></tr><tr><td>2020-2021</td><td>-</td><td>-</td></tr><tr><td>2021-2022</td><td>-</td><td>-</td></tr></table>
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the 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 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.
Source of data	Remote sensing data.

Data / Parameter	$A_{DelfPA,i,t}$
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 monitored	Year: 2019-2020 — $A_{DelfPA,i,t}$: - Year: 2020-2021 — $A_{DelfPA,i,t}$: - Year: 2021-2022 — $A_{DelfPA,i,t}$: -
Monitoring equipment	Remote sensing and GPS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the 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 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.
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 monitored	Year — $A_{DelfLB,i,t}$

	2019-2020 - 2020-2021 - 2021-2022 -
Monitoring equipment	Satellite imagery.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of the 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.

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 monitored	0.25
Monitoring equipment	GPS and measuring tape.
QA/QC procedures to be applied	GPS coordinates are double checked in the field.
Purpose of the 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 monitored	130
Monitoring equipment	N/A.
QA/QC procedures to be applied	Standard statistic equation.
Purpose of the 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 t Student "t" value (1.6568) CV Coefficient of variation (%) $E\%$ Permissible sampling error (10%) N Number of parcels in total area
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.

Data / Parameter	DBH
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Measured 1.3m above ground. Measure all trees above some minimum DBH in the sample plots. The minimum DBH varies 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 monitored	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 the 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	Systematic sampling must take place to ensure all decks within the area logged are identified and a conservative estimate of area produced.

Data / Parameter	$A_{DECKS,i,t}$
and procedures to be applied	
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 monitored	N/A
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 the 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 [101],[102],[103].
Comments	The areas exploited inside the FSM farm from April 13, 2019, to April 12, 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.
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

[101] Annex: Wood management_1.pdf
[102] Annex: Wood management_2.pdf
[103] Annex: Wood management_3.pdf

Data / Parameter	$A_{ROAD,i,t}$
	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.
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 monitored	N/A
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 the 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) [104],[105],[106].
Comments	The areas exploited inside the FSM farm from April 13, 2019, to April 12, 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.

[104] Annex: Wood management_1.pdf
[105] Annex: Wood management_2.pdf
[106] Annex: Wood management_3.pdf

Data / Parameter	L_{skid}
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 and procedures to be applied	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 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 at a frequency of less than every 5 years examination must occur prior to any verification event.
Value monitored	N/A
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 the 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 [107].
Comments	The areas exploited inside the FSM farm from April 13, 2019, to April 12, 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.

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

Data / Parameter	W_{SKID}
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. 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 monitored	N/A
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 the 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	The areas exploited inside the FSM farm from April 13, 2019, to April 12, 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	$V_{ex,i}$
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 monitored	N/A
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 the data	Calculation of project emissions
Calculation method	Timber inventory[108].
Comments	The areas exploited inside the FSM farm from April 13, 2019, to April 12, 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	t CO_{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.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value monitored	See Section 0
Monitoring equipment	The same cited for field measurements in sample plots.

[108] Annex: Forest movement report.pdf

Data / Parameter	$C_{BSL,i}$
QA/QC procedures to be applied	The same cited for field measurements in sample plots.
Purpose of the data	Calculation of baseline emissions
Calculation method	Field measurements in sample plots and application of allometric equations. More details in section "Field inventory of biomass" of the corresponding Project Description.
Comments	N/A

Data / Parameter	$C_{AB,tree,i}$
Data unit	t CO_{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 BEF (Biomass expansion factor: 1.66, Brown et al. (1989), page 890, Table 4) for expansion of merchantable biomass to total aboveground tree biomass.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value monitored	See Section 0
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 the data	Calculation of baseline emissions
Calculation method	Field measurements in sample plots, application of allometric equations and multiplication of the merchantable volume by the BEF (Biomass expansion factor: 1.66, Brown et al. (1989), page 890, Table 4) for expansion of merchantable biomass to total aboveground tree biomass. More details in section "Field inventory of biomass" of the corresponding Project Description.
Comments	N/A.

Data / Parameter	$C_{BB,tree,i}$
Data unit	t CO_{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 (0.221, IPCC (2019), pg. 4.18, Table 4.4) for calculation of total belowground tree biomass.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value monitored	See Section 0
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 the 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 (0.221, IPCC (2019) , pg. 4.18, Table 4.4) for calculation of total belowground tree biomass. More details in section "Field inventory of biomass" of the corresponding Project Description.
Comments	N/A.

Data / Parameter	$C_{WP,i}$
Data unit	t CO_{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 the corresponding Project Description.
Description of measurement methods and procedures to be applied	As described in Sections "Baseline Emissions" and "Project Emissions" of the corresponding Project Description.
Frequency of monitoring/recording	Annually

Data / Parameter	$C_{WP,i}$
Value monitored	2.61
Monitoring equipment	As described in Sections “Baseline Emissions” and “Project Emissions” of the corresponding Project Description.
QA/QC procedures to be applied	As described in Sections “Baseline Emissions” and “Project Emissions” of the corresponding Project Description.
Purpose of the data	Calculation of baseline emissions Calculation of project emissions
Calculation method	As described in Sections “Baseline Emissions” and “Project Emissions” of the corresponding Project Description.
Comments	N/A.

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	t CO_{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 the corresponding Project Description.
Description of measurement methods and procedures to be applied	As described in Section “Baseline Emissions” of the corresponding Project Description.
Frequency of monitoring/recording	Monitoring must occur at least every ten years for baseline renewal.
Value monitored	See Section 5.1
Monitoring equipment	As described in Section “Baseline Emissions” of the corresponding Project Description.
QA/QC procedures to be applied	As described in Section “Baseline Emissions” of the corresponding Project Description.
Purpose of the data	Calculation of baseline emissions
Calculation method	As described in Sections “Baseline Emissions” of the corresponding Project Description.
Comments	N/A.

4.3 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 REDD project farm. As demonstrated in the VCS-PD, the FSM REDD project has a system for monitoring boundaries and for hindering any invasion that might endanger the forest. The only carbon loss inside the FSM REDD project 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.

4.3.1 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.

4.3.2 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 ha 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	N/A

and procedures to be applied	
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

4.3.3 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 REDD project and will consist of large investments in policing the FSM REDD project, 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 REDD project 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 4.1, shows the 7 bases already established by the project owner to work as monitoring points at FSM REDD project. 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.

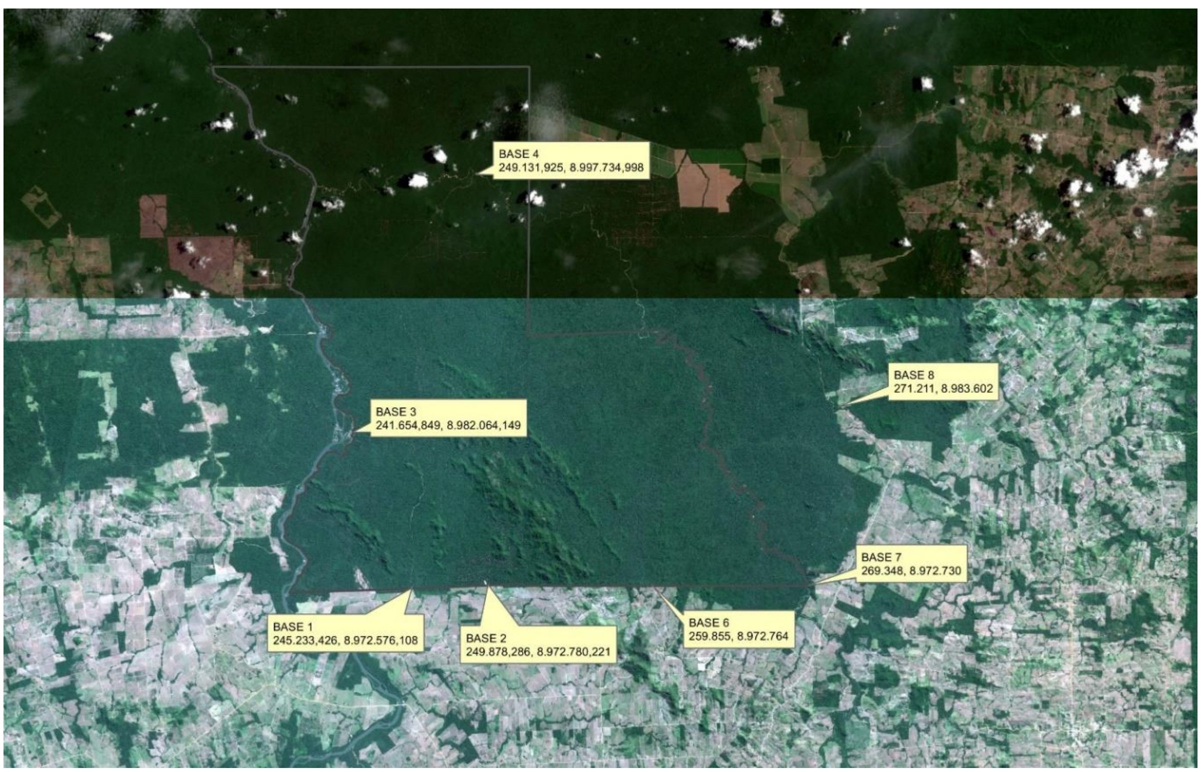
All bases communicate 24 hours, the Manager of BASE 1 is authorized for any decision making and action.

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[109].

Figure 4.1. Distribution of the infrastructure for the project monitoring



[109] Annex: PMFS Santa Maria.pdf

4.3.4 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.

4.3.5 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:

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

Where:

$C_{LG\ i\ t}$	Actual net project emissions arising in the logging gap, in stratum i in year t; t $CO_{2\text{-}e}$
$C_{EXT,z,i,t}$	Biomass carbon stock of timber extracted within the project boundary for logging stratum z, in stratum i in year t; t $CO_{2\text{-}e}$
$LDF_{z,i}$	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.

4.3.6 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.

$$\Delta C_{SKID,i,t} = L_{SKID,i,t} \times SK_i \quad \text{Equation 2}$$

Where:

$\Delta C_{SKID,i,t}$	Change in carbon stock resulting from skid trail creation in stratum i at time t; t CO_{2-e}
$L_{SKID,i,t}$	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_{2-e} 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. "FOB Densa Submontana" 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.

$$\Delta C_{ROAD,i,t} = A_{ROAD,i,t} \times C_{BSL,i} \quad \text{Equation 3}$$

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.

$$\Delta C_{DECKS,i,t} = A_{DECKS,i,t} \times C_{BSL,i} \quad \text{Equation 4}$$

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. There were no project emissions due to forest management issues, as can be seen in Section 3.2.2 – Project Description Deviations. Consequently, precise calculations of emissions from roads and decks are unattainable. Nevertheless, research by Braz et al. (2018) suggests optimal parameters for road density at 26 m ha-1, with a width of 4 m, and construction sites measuring 20 m x 20 m, accounting for an area opening of 1.35%. This adheres to the legal threshold of 2%. Consequently, assuming a consistent carbon stock, emissions from roads and decks will remain below 5%.

4.3.7 Field inventory of biomass

The field inventory methodology is described in a Standard Operating Procedure (SOP)[110], 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 conversion and expansion factor (BCEF).

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

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).
  1) 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.
- 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 REDD project 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.

4.3.8 Monitoring of leakage carbon stock changes and greenhouse gas emissions

For the leakage belt, the net greenhouse gas emissions in the project case are equal to the sum of stock changes due to deforestation in the leakage belt:

$$\Delta C_{P,LB} = \sum_{t=1}^{t}\sum_{i=1}^{M} \Delta C_{P,DefLB,i,t} \qquad \text{Equation 5}$$

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

4.3.9 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.

$$\Delta C_P = \sum_{t=1}^{t}\sum_{i=1}^{M}\left(\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t}\right) \quad \text{Equation 6}$$

Where:

ΔC_P	Net greenhouse gas emissions within the project area under the project scenario; t $CO_{2\text{-}e}$
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum i at time t; t $CO_{2\text{-}e}$
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum i at time t; t $CO_{2\text{-}e}$
$GHG_{P-E,i,t}$	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 $CO_{2\text{-}e}$
$\Delta C_{P,Enh,i,t}$	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 $CO_{2\text{-}e}$
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 deforested multiplied by the emission per unit area.

$$\Delta C_{P,DefPA,i,t} = \sum_{n-1}^{U}\left(\Delta C_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t}\right) \quad \text{Equation 7}$$

$$\Delta C_{P,DefLB,i,t} = \sum_{n-1}^{U}\left(\Delta C_{DefLB,u,i,t} * \Delta C_{pools,P,Def,u,i,t}\right) \quad \text{Equation 8}$$

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:

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{wp,i} \quad \text{Equation 9}$$

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 stocks in 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 10

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 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

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. This information is in line with studies by Dibaba et al. (2019), Pereira Júnior et al. (2016) and Walker et al. (2013), where they considered that the contribution of carbon reservoirs from herbaceous vegetation, litter and non-arboreal woody vegetation was insignificant (with herbaceous biomass of 0.57 t d.m. ha^{-1}).

4.3.10 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.

4.3.11 Organizational structure, responsibilities, and competencies

Caraguá Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A. were responsible for the development of the current 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 4.1 below.

Table 4.1. 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

4.3.12 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 REDD project 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 Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.

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 Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A.. Furthermore, monitored parameters described in the section above were monitored with the frequency described in the sub-section Organizational structure, responsibilities, and competencies, above.

4.3.13 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 REDD project employees to help monitor the area within the project area.

4.3.14 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 Agronegócios LTDA and SYSTEMICA INTELIGÊNCIA EM SUSTENTABILIDADE S.A. All the necessary taskforce and procedures will be in place to meet the highest levels of governance.

Caraguá Agronegócios LTDA 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 INTELIGÊNCIA EM SUSTENTABILIDADE S.A., 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[111].

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

Baseline emissions for this monitoring period are computed using the values of the forest inventory made in 2022, which is fully described in the Project Description (PD) document. The carbon densities for each forest strata are summarized in Table 5.1

Table 5.1. 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}	223.41	227.53	235.12	216.50	**220.93**
Belowground (total)	t ha^{-1}	49.37	50.28	51.96	47.85	**49.37**
Aboveground (total)	t CO_{2-e} ha^{-1}	385.01	392.11	405.20	373.09	**380.74**
Belowground (total)	t CO_{2-e} ha^{-1}	85.09	86.66	89.55	82.45	**85.09**
Total Carbon Stock	t CO_{2-e} ha^{-1}	**470.09**	**478.77**	**494.75**	**455.55**	**470.09**
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%
Aboveground biomass weighted average	**t CO_{2-e} ha^{-1}**	380.74				
Total biomass weighted average	**t CO_{2-e} ha^{-1}**	464.88				

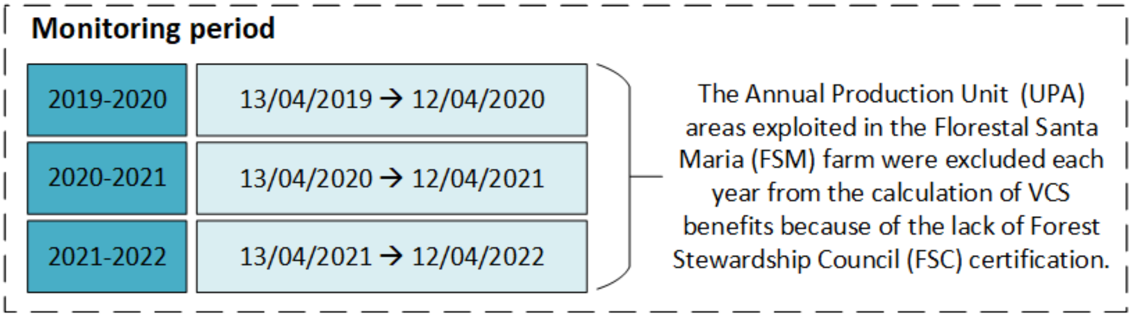
5.1.1 Estimation of Carbon Stock Changes and GHG Emissions[112]

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 April 13, 2019, to April 12, 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 5.1).

[111] Annex: QA_QC_Systemica

[112] All ex-post calculations are available to the auditor.

Figure 5.1. Monitoring Period



Because in the 2019-2020, 2020-2021, and 2021-20222 periods, the FSM project didn't have FSC (Forest Stewardship Council) certification, the Annual Production Units (Unidade de Produção Anual - UPA) for the specified years above were not considered in the quantification. In July 2022, the FSC certification was recovered. The documents showing the exploited areas 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.

The baseline deforestation expected to occur in different vegetation typologies of the Project Area according to the location analysis model described in the PD is presented in Table 5.2.

Table 5.2. Deforestation rate values in the project area

	Parameter	Unit	Years			TOTAL
			2019-2020	2020-2021	2021-2022	
Project Area (excluding uncertified UPA's)	Aluvial	ha	0.00	1.44	90.09	**91.53**
	Encosta	ha	26.46	60.39	75.15	**162.00**
	FOB Densa Submontana	ha	19.53	37.44	37.98	**94.95**
	FOB Submontana	ha	110.34	142.11	321.21	**573.66**
	$A_{BSLPAt\ annual}$	ha	156.33	241.38	524.43	**922.14**
	$A_{BSLPA\ cumulative}$	ha	156.33	397.71	922.14	

As explained in the PD, the common process of unplanned deforestation occurs as follows: (i) illegal timber harvesting of commercial species, (ii) burning of remaining non-commercial wood, and (iii) conversion of the area into pasture and coffee cultivation. This process is then 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 CH4 and N2O from the biomass burning, and (iii) the pasture and coffee carbon pools under the assumption of a 90%/10% proportion between these land-uses.

Baseline emission from unplanned deforestation

For estimating baseline CO2 emissions from the unplanned deforestation expected to occur in Project Area in the absence of project the annual areas of deforestation estimated by the location analysis model were multiplied by the sum of aboveground and belowground carbon stocks in trees corresponding to each forest stratum. Results are reported in Table 5.3.

Table 5.3. Summary of gross baseline emissions from unplanned deforestation that would occur within the Project Area in the monitoring period.

				Year 2019	2020	2021	TOTAL
Stratum	Aluvial	Area	ha	-	1.44	90.09	**91.53**
		$A_{BSLPAcumulative}$	ha	-	1.44	91.53	**92.97**
		t CO_{2-e} ha^{-1} $year^{-1}$	t CO_{2-e} ha^{-1} $year^{-1}$	-	676.93	42,350.57	**43,027.50**
		Total Accumulated	t CO_{2-e}	-	676.93	43,027.50	
	Encosta	Area	ha	26.46	60.39	75.15	**162.00**
		$A_{BSLPAcumulative}$	ha	26.46	86.85	162.00	**275.31**
		t CO_{2-e} ha^{-1} $year^{-1}$	t CO_{2-e} ha^{-1} $year^{-1}$	12,668.25	28,912.92	35,979.56	**77,560.73**
		Total Accumulated	t CO_{2-e}	12,668.25	41,581.17	77,560.73	
	FOB Densa Submontana	Area	ha	19.53	37.44	37.98	**94.95**
		$A_{BSLPAcumulative}$	ha	19.53	56.97	94.95	**171.45**
		t CO_{2-e} ha^{-1} $year^{-1}$	t CO_{2-e} ha^{-1} $year^{-1}$	9,662.39	18,523.28	18,790.45	**46,976.12**
		Total Accumulated	t CO_2-e	9,662.39	28,185.67	46,976.12	
	FOB Submontana	Area	ha	110.34	142.11	321.21	**573.66**
		$A_{BSLPAcumulative}$	ha	110.34	252.45	573.66	**936.45**
		t CO_{2-e} ha^{-1} $year^{-1}$	t CO_{2-e} ha^{-1} $year^{-1}$	50,265.05	64,737.77	146,326.23	**261,329.04**
		Total Accumulated	t CO_{2-e}	50,265.05	115,002.82	261,329.04	
		Total (sum of stratum)	t CO_{2-e} ha^{-1} $year^{-1}$	**72,595.69**	**112,850.90**	**243,446.80**	

Emission from biomass burning in the baseline.

Based on the IPCC 2006 Inventory Guidelines, estimating greenhouse gas emissions from biomass burning is determined using Equation 13.

$$E_{\text{biomassbur n,i,t}} = \sum_{g=1}^{G}\left(\left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i}\right) \times 10^{-3}\right) \times GWP_g\right) \quad \text{Equation 11}$$

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_{2-e}

$A_{burn,i,t}$ 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^{-1} 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 12

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

Where:

$B_{i,t}$	Average aboveground biomass stock before burning for stratum i, year t, tons d.m. ha^{-1}
$C_{AB\_tree,i,t}$	Carbon stock in aboveground biomass in trees in stratum i in year t, t CO_{2-e} ha^{-1}
$C_{DWi,}$	Carbon stock in dead wood for stratum i in year t, t CO_{2-e} ha^{-1}
$C_{LI,i,t}$	Carbon stock in litter for stratum i in year t, t CO_{2-e} ha^{-1}
$\frac{12}{44}$	Inverse ratio of molecular weight of CO_2 to carbon, t CO_{2-e} 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 5.5 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 t CO_{2-e} ha^{-1} was applied (IPCC (2006c), page 6.27, Table 6.4). The proportion of baseline deforestation converted to pasture was considered 90%. For calculation of the carbon pool remaining on coffee crops after deforestation, a conservative value of 84.0 t $CO_{2\text{-}e}$ 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 and pasture carbon pools in the baseline scenario are presented in Table 5.5.

Wood product carbon pool in the baseline

For estimating the biomass carbon of the commercial volume extracted in the process of deforestation, the Equation 13 was applied, according to “Option 2: Commercial inventory estimation”, as recommended in VMD0005-CP-W-v1.0.

$$C_{XB,i} = C_{AB_{tree},i} \times \frac{1}{BEF} \times P_{com_i}$$ Equation 13

Where:

$C_{XB,i}$	Mean stock of extracted biomass carbon from stratum i; t $CO_{2\text{-}e}$ ha^{-1}
$C_{AB_{tree},i}$	Mean aboveground biomass carbon stock in stratum i; t $CO_{2\text{-}e}$ ha^{-1}
BEF	Biomass expansion factor (BEF) for expansion of merchantable biomass to total aboveground tree biomass; dimensionless BEF = 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 14).

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} \times (1 - WW_{ty}) \times (1 - SLF_{ty}) \times (1 - OF_{ty})$$ Equation 14

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 $CO_{2\text{-}e}$ 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 5.4.

Table 5.4. 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	91.53	162.00	94.95	573.66	922.14
Area distribution	%	9.9%	17.6%	10.3%	62.2%	100%
Total ABG per stratum	t	20,448.49	36,860.14	22,325.04	124,194.60	203,828.26
Total BLG per stratum	t	4,519.12	8,146.09	4,933.83	27,447.01	45,046.05
Carbon Pool - Aboveground per stratum	t CO_{2-e}	35,239.56	63,522.30	38,473.48	214,028.70	351,264.04
Carbon Pool - Belowground per stratum	t CO_{2-e}	7,787.94	14,038.43	8,502.64	47,300.34	77,629.35
$C_{ABtree,i}$	t CO_{2-e} ha^{-1}	385.01	392.11	405.20	373.09	
$C_{BBtree,i}$	t CO_{2-e} ha^{-1}	85.09	86.66	89.55	82.45	
$C_{BSL,i}$	t CO_{2-e} ha^{-1}	470.09	478.77	494.75	455.55	
$C_{DW,i}$	t CO_{2-e} ha^{-1}	-	-	-	-	
P_{com}	m^3 t CO_{2-e}^{-1}	0.093	0.091	0.088	0.096	
C_{XB}	t CO_{2-e} ha^{-1}	21.49	21.49	21.49	21.49	85.95
C_{WP}	t CO_{2-e} ha^{-1}	2.61	2.61	2.61	2.61	
$C_{WP\ AVERAGE}$	t CO_{2-e} ha^{-1}	2.61				

Total baseline emission

Figure 5.2 schematizes the calculation of estimated baseline reductions or removals. Hence, the total baseline emission and greenhouse gas determination is summarized in Table 5.5.

Figure 5.2. Total estimated baseline emissions or removals

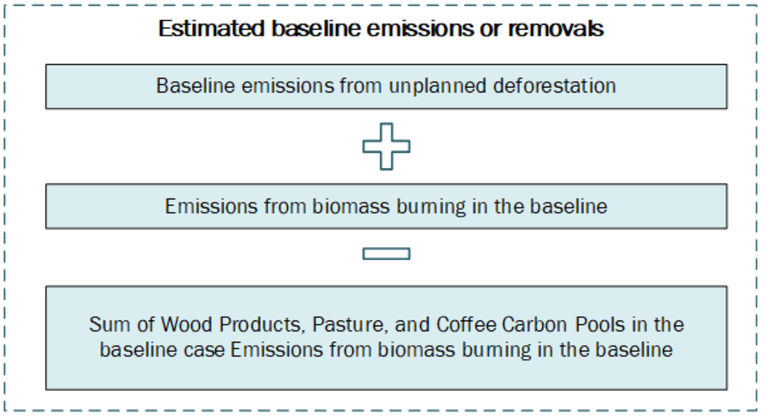


Table 5.5. Total baseline emissions and greenhouse gases determination

	Parameter	Unit	Years			TOTAL
			2019	2020	2021	
Baseline Emissions	Total	t CO_{2-e} ha^{-1} $year^{-1}$	72,595.69	112,850.90	243,446.80	428,893.39
	Total Accumulative	t CO_{2-e}	72,595.69	185,446.59	428,893.39	
	$A_{BSL,PA,annual,t} = A_{Burn,i,t}$	ha	156.33	241.38	524.43	922.14
	$A_{BSL,PA,cumulative}$	ha	156.33	397.71	922.14	
Biomass Burning Emissions (CH_4)	E-CH_4 Biomass Burning	t CO_{2-e}	2,731.37	4,217.34	9,162.74	16,111.45
	E-CH_4 Biomass Burning Accumulative	t CO_{2-e}	2,731.37	6,948.71	16,111.45	
Biomass Burning Emissions (N_2O)	E-N_2O Biomass Burning	t CO_{2-e}	1,077.10	1,663.09	3,613.28	6,353.47
	E-N_2O Biomass Burning Accumulative	t CO_{2-e}	1,077.10	2,740.19	6,353.47	
	E-Biomass Burning = GHGP,E,i,t	t CO_{2-e}	3,808.47	5,880.43	12,776.02	22,464.92
Wood products carbon pool	E-Wood Carbon Pool	t CO_{2-e}	408.46	630.68	1,370.23	2,409.37
	E-Wood Carbon pool Accumulative	t CO_{2-e}	408.46	1,039.14	2,409.37	
Pasture Carbon Pool	E-Pasture Carbon Pool	t CO_{2-e}	2,109.47	3,257.11	7,076.50	12,443.08
	E-Pasture Carbon pool Accumulative	t CO_{2-e}	2,109.47	5,366.58	12,443.08	
Coffee Carbon Pool	E-Coffee Carbon Pool	t CO_{2-e}	1,312.65	2,026.79	4,403.46	7,742.90
	E-Coffee Carbon pool Accumulative	t CO_{2-e}	1,312.65	3,339.44	7,742.90	
		Total BL-GHG	72,573.57	112,816.76	243,372.62	

5.2 Project Emissions

According to the VMD0015 v2.2 (Verra, 2020), for the project area of REDD project activities, the net GHG emissions in the project case was equal to the sum of stock changes due to deforestation and forest degradation plus the total GHG emissions minus any eligible forest carbon stock enhancement (Equation 15).

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

Where:

$\Delta C_{WPS-REDD}$	Net GHG emissions in the REDD project scenario up to year $t*$; 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* in year *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* in year *t*; t CO_{2-e}
$\Delta C_{P,DistPA,i,t}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* in year *t*; t CO_{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* in year *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* in year *t*; t CO_{2-e} *For areas with a degradation baseline (i.e. using Module BL-DFW) this parameter shall be set to zero, for areas with baseline set by Module BL-UP and Module BL-PL this parameter may be conservatively set to zero.
i	1, 2, 3, … M strata
t	1, 2, 3, … t* years elapsed since the start of the project activity

5.2.1 Monitoring deforestation and monitoring forest degradation

There were no records of a burn or unplanned deforestation from the project area throughout the baseline period of this Monitoring Report document. Geospatial imagery also supports this information[113]. Therefore, $\Delta C_{P,DefPA,i,t}$ and $GHG_{P-E,i,t}$ can be considered zero.

For the project area, the net greenhouse gas emission resulting from degradation equals the sum of stock changes due to degradation through extraction of trees for illegal timber or fuelwood and charcoal, and extraction of trees for selective logging from forest management areas possessing a FSC certificate:

$$\Delta C_{P,Deg,i,t} = \Delta C_{P,DegW,i,t} + \Delta C_{P,SelLog,i,t}$$ Equation 16

Where:

[113] 240124_Unificado_Monitoring_Results_FSM_2019_2022.pdf

$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* in year *t*; t CO_{2-e}
$\Delta C_{P,DegW,i,t}$	Net carbon stock change as a result of degradation through extraction of trees for illegal timber or fuelwood and charcoal in the project area in the project case in stratum *i* in year *t*; t CO_{2-e}
$\Delta C_{P,SelLog,i,t}$	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum *i* in year *t*; t CO_{2-e}
i	1, 2, 3, … M strata
t	1, 2, 3, … t* years elapsed since the start of the project activity

There were no records of a degradation through extraction of trees for illegal timber or fuelwood and charcoal in the project area the baseline period of this Monitoring Report document. Geospatial imagery also supports this information[114]. Therefore, $\Delta C_{P,DegW,i,t}$ can be considered zero.

5.2.1.1 Monitoring degradation due to selective logging of forest management areas possessing a FSC certificate

As already described in Section 3.2, the areas exploited inside the FSM REDD project farm from April 13, 2019, to April 12, 2022 (current monitoring period) were excluded from the GHG quantification. 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 carbon project. The documents showing the management areas exploited within this period are available for consultation by auditors. These documents will be kept safe for two years after the final credit period of the FSM REDD project. Therefore, the project emissions in this verification period were not quantified in the current monitoring report ($\Delta C_{P,SelLog,i,t} = 0$).

5.2.2 Monitoring areas undergoing natural disturbance and monitoring areas undergoing carbon stock enhancement

Amazon forests have a low incidence of natural disturbance (Espírito-Santo et al., 2014), so the corresponding emissions are set to zero ($\Delta C_{P,DistPA,i,t} = 0$). Furthermore, according to module VMD00015 v2.2 (Verra, 2020) carbon enhancement may be conservatively neglected, and the corresponding parameter also is set to zero ($\Delta C_{P,Enh,i,t} = 0$).

Based on the results presented here, it can be concluded that there are no project emissions to report during the audit ($\Delta C_{WPS-REDD} = 0$).

5.3 Leakage

As previously described in Section 3.2 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

[114] 240124_Unificado_Monitoring_Results_FSM_2019_2022.pdf

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 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.

5.3.1 Leakage Market-Effect[115]

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 17

$$LK_{MarketEffects,timber} = \sum_{i=1}^{M} \left(LF_{ME} \times LK_{MAF} \times AL_{T,i}\right) \qquad \text{Equation 17}$$

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 $LF_{ME} = 0.7$ 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-e}
LK_{MAF}	Leakage management adjustment factor (dimensionless)
i	1,2,3,...M strata

As mentioned in the previous Section 3.2, 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

[115] All ex-post calculations are available to the auditor in the 6 Calculations folder.

proportion of total aboveground tree biomass for stratum i within the project boundary (PMP_i). These parameters were estimated as follows:

- The 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 PML_{FT} adopted is 31% for legal Amazon.
- The PMP_i is calculated from forest inventory: in the forest inventory, commercial biomass was estimated through the allometric equation conforming described in corresponding Project Description. 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 (8,747,468.12 t) [116] and total biomass (15,771,732.31 t) [117], resulting in 55%.

Hence, like $PML_{FT} > 15\%\ \text{less than}\ PMP_i$ 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}:

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

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

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

Where:

PML_{FT}	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type (%)
PMP_i	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundary (%)
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

[116] Annex: Forest inventory_DBH 40.xlsx
[117] Annex: Forest inventory total.xlsx

area. The production of biomass in commercial species that is merchantable in the baseline case ($PRODMB_{BL,t}$) was 35.08 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.

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 ($LK_{MAF} = 0.14$) was applicable in leakage market effect ex-post.

$$LK_{MAF} = 1 - \left(\frac{PRODMB_{LMA,t}}{PRODMB_{BL,t}}\right) \quad \text{Equation 18}$$

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

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 ($C_{BSL,XBT,i,t}$).

$$AL_{T,i} = \sum_{t=1}^{i} (C_{BSL,XBT,i,t}) \quad \text{Equation 19}$$

Where:

$AL_{T,i}$	Summed emissions from timber harvest in stratum i in the baseline case laced through implementation of carbon project; t CO_{2-e}
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in year t; t CO_{2-e}
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 20. With $AL_{T,i}$determination, the $LK_{MarketEffects,timber}$ was estimated resulting in net greenhouse gas emissions due to market-effects leakage.

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

Equation 20

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_{2-e}
$V_{BSL,EX,i,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i in year t; m^3 $V_{BSL,EX,i,t}$ = 35.08 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} (Nogueira et al., 2007).
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 5.6.

Table 5.6. Leakage Market-Effects ex-post determination

	Parameter	Unit	Year 2019	2020	2021	Total
Market-Effects Leakage Through Decreased Timber Harvest	A_{BSLPAt} annual	ha $year^{-1}$	156.33	241.38	524.43	
	$C_{BSL,XBT,i,t}$	t CO_{2-e} ha^{-1}	159.15	159.15	159.15	
	$AL_{T,i} = C_{BSL,XBT,i,t}$	t CO_{2-e}	24,879.88	38,415.57	83,462.92	146,758.37
	$PRODMB_{LMA,t}$	t $year^{-1}$	30.00	30.00	30.00	
	$PRODMB_{BL,t}$	t $year^{-1}$	35.08	35.08	35.08	
	$LKFC_{MAF}$	-	0.14	0.14	0.14	
	$LK_{MarketEffects,timber}$	t CO_{2-e}	2,522.03	3,894.12	8,460.49	14,876.65
Total leakage ME	ΔC_{LK-ME}	t CO_{2-e}	2,522.03	3,894.12	8,460.49	14,876.65

5.3.2 Leakage Outside the Leakage Belt for Local Deforestation Agents[118]

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 21). As indicated earlier, throughout the baseline period of this 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 FSM REDD project farm. 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.

$$\Delta C_{WPS-REDD,LB} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \Delta C_{P,DefLB,i,t} \qquad \text{Equation 21}$$

Where:

$\Delta C_{WPS-REDD,LB}$	Net GHG emissions in the leakage belt in the REDD project case up to year t*, 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 in year t, t CO_{2-e}
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

The $\Delta C_{BSL,LK,unplanned}$ of the leakage belt in the baseline was estimated ex-ante. 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 22).

$$\Delta C_{LK-ASU-LB} = \Delta C_{P,LB} - \Delta C_{BSL,LK,unplanned} \qquad \text{Equation 22}$$

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_{2-e}
$\Delta C_{BSL,LK,unplanned}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation in the leakage belt up to year t*, t CO_{2-e}

[118] All ex-post calculations are available to the auditor.

$\Delta C_{P,LB}$ Net CO_2 equivalent emissions within the leakage belt in the project case up to year t*, t CO_{2-e}

5.3.3 Leakage Outside the Leakage Belt: Immigrant Deforestation Agents[119]

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 of 1,257.20 inhab. year^{-1} (IBGE, 2020);

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

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

(iv) 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. 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%.

$$\mathrm{PROP_{IMM}} = \left(\frac{1{,}257.20\ -\ (513.00\ -121.20)}{39{,}861.00}\right) = 0.0217 \qquad \text{Equation 23}$$

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 24.

$$\mathrm{A_{LK-IMM,t}} = \mathrm{PROP_{IMM}} \times \mathrm{A_{BSL,PA,unplanned,t}} \qquad \text{Equation 24}$$

Where:

[119] All ex-post calculations are available to the auditor in the 6 Calculations folder.

$A_{LK-IMM,t}$	Total area deforested by immigrant agents in the baseline and project scenario in year t, ha
$PROP_{IMM}$	Proportion of area deforested by immigrant agents in the leakage belt and project area, proportion
$A_{BSL,PA,unplanned,t}$	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 25.

$$A_{LK-ACT-IMM,t} = PROP_{IMM} \times \left(\sum_{i=1}^{M} A_{DefPA,i,t} + A_{DefLB,i,t} \right) \qquad \text{Equation 25}$$

Where:

$A_{LK-ACT-IMM,t}$	Area deforested by immigrants in the project area and leakage belt under the project scenario in year t, ha
$PROP_{IMM}$	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.
$A_{DefPA,i,t}$	Area of recorded deforestation in the project area in the project case in stratum i in year t, ha
$A_{DefLB,i,t}$	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 26.

$$A_{ALK-OLB,t} = A_{LK-IMM,t} - A_{LK-ACT-IMM,t} \qquad \text{Equation 26}$$

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_{2-e}) according to Equation 27.

$$\Delta C_{LK-ASU,OLB} = C_{OLB} \times \left(\sum_{t=1}^{t^*} A_{LK-OLB,t} \right) \qquad \text{Equation 27}$$

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 t CO_{2-e} 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 5.7.

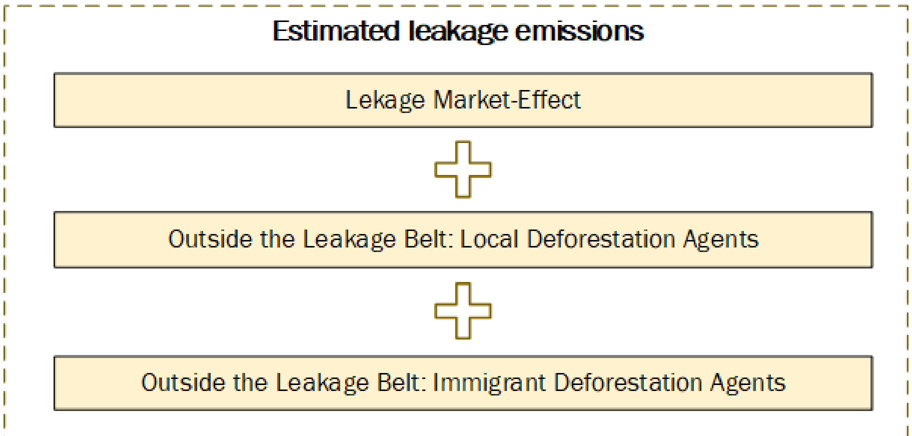
Table 5.7. Leakage outside ex-post

	Parameter	Unit	Year		
			2019-2020	2020-2021	2021-2022
Ex post	$A_{LK-IMM,t}$	ha	3.39	5.24	11.39
	$A_{BSL,PA,unplanned,t}$	ha	156.33	241.38	524.43
	$A_{DefPA,i,t}$	ha	-	-	-
	$A_{DefLB,i,t}$	ha	-	-	-
	$A_{LK-ACT-IMM,t}$	ha	-	-	-
	$A_{LK-OLB,t}$	ha	3.39	5.24	11.39
	$\Delta C_{LK-ASU,OLB}$		1,962.02	3,029.44	6,581.87
	LK-Outside - Ex post	t CO_{2-e}	1,962.02	3,029.44	6,581.87

5.3.4 Total estimation of the Leakage ex-post[120]

The total estimation of the leakage ex-post is equal to the sum of the calculated leakage previously subsections (Figure 5.3).

Figure 5.3. Total estimation of the leakage belt ex-post



Hence, the result was calculated in Table 5.8.

Table 5.8. Total estimation of the Leakage ex-post

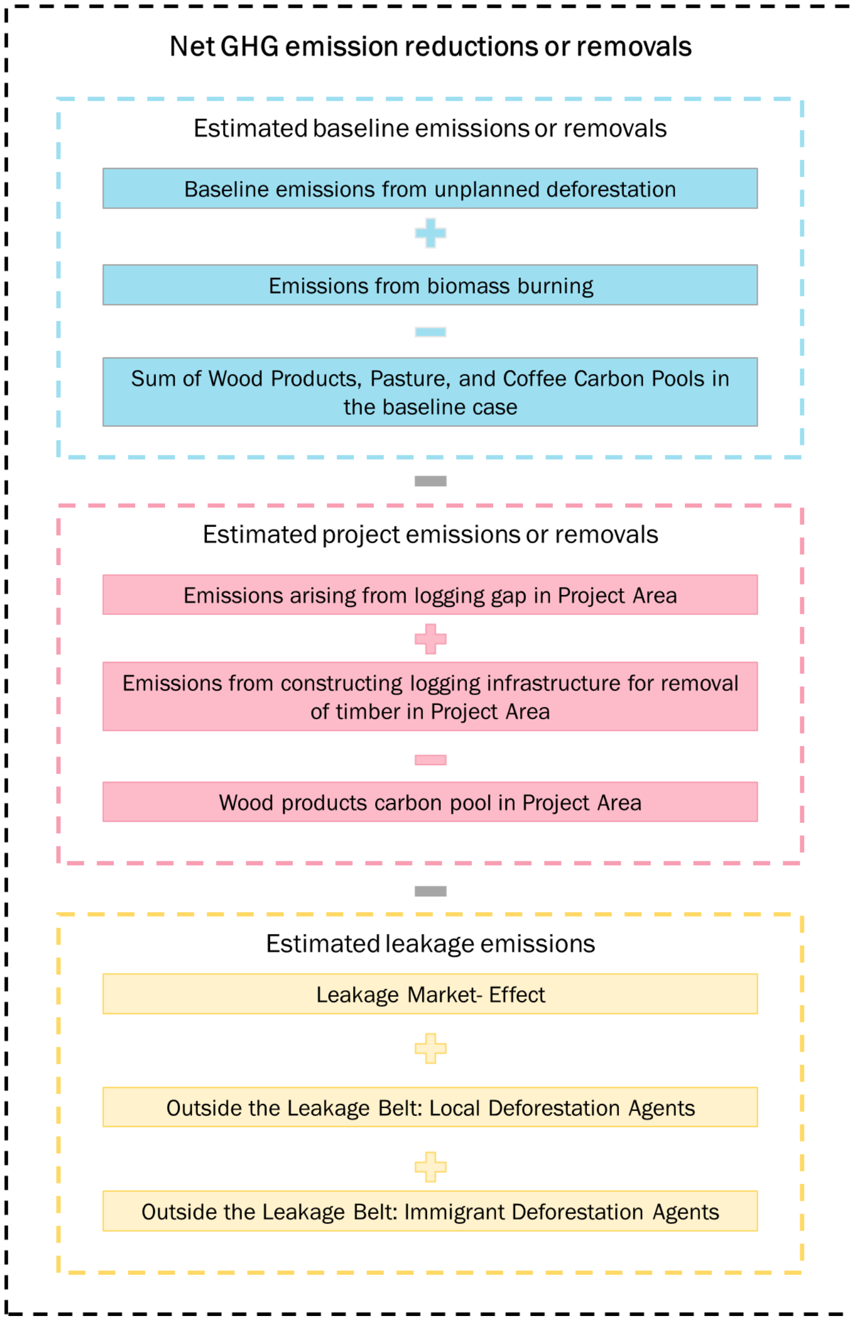
Leakage Ex-post	Unit	Year			Total
		2019-2020	2020-2021	2021-2022	
Market-Effect	t CO_{2-e}	2,522.03	3,894.12	8,460.49	14,876.65
Outside the Leakage Belt: Local Deforestation Agents	t CO_{2-e}	-	-	-	-
Outside the Leakage Belt: Immigrant Deforestation Agents	t CO_{2-e}	1,962.02	3,029.44	6,581.87	11,573.33
Total Leakage	t CO_{2-e}	4,484.05	6,923.57	15,042.36	26,449.98

5.4 Net GHG Emission Reductions and Removals

The summary of the net GHG emission reductions or removals calculation is described in Figure 5.4[121].

[120] All ex-post calculations are available to the auditor in the 6 Calculations folder.
[121] All ex-post calculations are available to the auditor in the 6 Calculations folder.

Figure 5.4. Summary of the calculation of Net GHG emission reductions or removals



The FSM REDD Project'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 5.9).

Table 5.9. Net GHG Emission Reductions and Removals

Year	Baseline emissions (t CO_{2-e})	Project emissions (t CO_{2-e})	Leakage emissions (t CO_{2-e})	Net GHG emission reductions (t CO_{2-e})	Buffer pool allocation (t CO_{2-e})	VCUs eligible for Issuance (t CO_{2-e})
13-April-2019 to 12-April-2020	72,573.57	-	4,484.05	68,089.52	6,808.95	61,280
13-April-2020 to 12-April-2021	112,816.76	-	6,923.57	105,893.20	10,589.32	95,303
13-April-2021 to 12-April-2022	243,372.62	-	15,042.36	228,330.26	22,833.03	205,497
Total	**428,762.96**	-	**26,449.98**	**402,312.98**	**40,231.30**	**362,080**

The resume of the FSM REDD project ex-ante estimation and ex-post calculation is represented in Table 5.10. To facilitate the comparison of ex-ante and ex-post emissions reductions or removals the Table 5.10 with values and their variation in percentages has been added. The values, both ex-ante and ex-post, are for net GHG emissions reductions or removal for the period from 2019 to 2022.

Table 5.10. The estimated ex-ante GHG emission reductions and removals and the achieved emission reductions and removals for this monitoring period

Ex-ante emissions reductions/removals	Achieved emissions reductions/removals	Percent difference	Justification for the difference
370,151.67	402,312.98	8.69%	The observed difference is related to a lower amount of emissions of activity shifting leakage directly surrounding the AUD Project Area, through the use of a Leakage Belt.

REFERENCES

Alves, J., Figueiredo, A. M., & Bonjour, S. C. (2009). Os assentamentos rurais em Mato Grosso: Uma análise dos dados do Censo da Reforma Agrária. *Panorama Socioeconómico, 27*(39), 152-167.

Ávila, M. L. d., Miranda Filho, R. J. d., Lima Neto, J. T. d., & Aldrighi, C. F. S. (2019). Atlas dos assentamentos rurais do Norte do Mato Grosso.

Brown, S., Gillespie, A. J., & Lugo, A. E. (1989). Biomass estimation methods for tropical forests with applications to forest inventory data. *Forest Science, 35*(4), 881-902. doi:https://doi.org/10.1093/forestscience/35.4.881

Colpini, C., Travagin, D. P., Soares, T. S., & Moraes e Silva, V. S. (2009). Determinação do volume, do fator de forma e da porcentagem de casca de árvores individuais em uma Floresta Ombrófila Aberta na região noroeste de Mato Grosso. *Acta Amazonica, 39*, 97-104.

da SILVA, S., Silva, J., Baima, A., Lobato, N., Thompson, I., & Costa Filho, P. (2001). Impacto da exploração madeireira em floresta de terra firme no município de Moju, Estado do Pará.

DataSus. (2020a). Mortalidade - Mato Grosso. Retrieved from http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/obt10mt.def

DataSus. (2020b). Nascidos vivos - Mato Grosso. Retrieved from http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinasc/cnv/nvmt.def

Dibaba, A., Soromessa, T., & Workineh, B. (2019). Carbon stock of the various carbon pools in Gerba-Dima moist Afromontane forest, South-western Ethiopia. *Carbon balance and management, 14*(1), 1-10.

Dossa, E., Fernandes, E., Reid, W., & Ezui, K. (2008). Above-and belowground biomass, nutrient and carbon stocks contrasting an open-grown and a shaded coffee plantation. *Agroforestry Systems, 72*(2), 103-115.

Espírito-Santo, F. D. B., Gloor, M., Keller, M., Malhi, Y., Saatchi, S., Nelson, B., . . . Phillips, O. L. (2014). Size and frequency of natural forest disturbances and the Amazon forest carbon balance. *Nature Communications, 5*(1), 3434. doi:https://doi.org/10.1038/ncomms4434

Galvão, A. C. F., Lourenço, A., & Moutinho, P. (2011). *REDD in Brazil: A Focus on the Amazon: Principles, Criteria, and Institutional Structures for a National Program for Reducing Emissions from Deforestation and Forest Degradation-REDD*: Center for Strategic Studies and Management.

Grennhouse, G. P. (2014). Global Warming Potential Values. Retrieved from https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

Homma, A. K. O. (2011). Madeira na Amazônia: extração, manejo ou reflorestamento? *Embrapa Amazônia Oriental-Artigo em periódico indexado (ALICE)*.

IBAMA. (2020). Manejo sustentável autorizado pelo Ibama em 2019 totalizou 39 mil hectares. Retrieved from https://www.gov.br/ibama/pt-br/assuntos/noticias/2020/manejo-sustentavel-autorizado-pelo-ibama-em-2019-totalizou-39-mil-hectares

IBGE. (2020). Estimativas da População Residente nos Municípios Brasileiros. Retrieved from https://ftp.ibge.gov.br/Estimativas_de_Populacao/

IBGE. (2021). Municípios da Amazônia Legal. Retrieved from https://www.ibge.gov.br/geociencias/cartas-e-mapas/mapas-regionais/15819-amazonia-legal.html?=&t=acesso-ao-produto

IPCC. (2006a). Chapter 2: Generic methodologies applicable to multiple landuse categories. *IPCC Guidelines for National Greenhouse Gas Inventories*. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Generic%20Methods.pdf

IPCC. (2006b). Chapter 4: Forest land. *IPCC Guidelines for National Greenhouse Gas Inventories*. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

IPCC. (2006c). Chapter 6: Grassland. *IPCC Guidelines for National Greenhouse Gas Inventories*. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_06_Ch6_Grassland.pdf

IPCC. (2014). Climate Change 2014: Synthesis Report. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 151.

IPCC. (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. *IPCC Guidelines for National Greenhouse Gas Inventories*. Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

Lee, M., & Diop, S. (2009). Millennium ecosystem assessment. *An Assessment of Assessments: Findings of the Group of Experts Pursuant to UNGA Resolution 60/30, 1*, 361.

Loft, L. (2011). Market mechanisms for financing the reduction of emissions from deforestation and degradation in developing countries (REDD)–learning from payments for ecosystem services schemes. *International Journal of Biodiversity Science, Ecosystem Services & Management, 7*(3), 204-216.

MacDicken, K. G. (1997). A guide to monitoring carbon storage in forestry and agroforestry projects.

Murer, B. M., & Futada, S. d. M. (2022). Painel de Dados. *Unidades de Conservação no Brasil*. Retrieved from https://uc.socioambiental.org/paineldedados#categorias

Muscarella, R., Emilio, T., Phillips, O. L., Lewis, S. L., Slik, F., Baker, W. J., . . . Affum-Baffoe, K. (2020). The global abundance of tree palms. *Global Ecology and Biogeography, 29*(9), 1495-1514.

Lei Federal nº 12.651: Código Florestal, (2012).

Nogueira, E. M., Fearnside, P. M., Nelson, B. W., Barbosa, R. I., & Keizer, E. W. H. (2008). Estimates of forest biomass in the Brazilian Amazon: new allometric equations and adjustments to biomass from wood-volume inventories. *Forest Ecology and Management, 256*(11), 1853-1867.

Nogueira, E. M., Fearnside, P. M., Nelson, B. W., & França, M. B. (2007). Wood density in forests of Brazil's 'arc of deforestation': Implications for biomass and flux of carbon from land-use change in Amazonia. *Forest Ecology and Management, 248*(3), 119-135. doi:https://doi.org/10.1016/j.foreco.2007.04.047

Pearson, T., Swails, E., & Brown, S. (2012). Wood product accounting and climate change mitigation projects involving tropical timber. *Report TMT-PA, 7*(11).

Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., . . . Tanabe, K. (2003). Good practice guidance for land use, land-use change and forestry. *Good practice guidance for land use, land-use change and forestry.*

Pereira Júnior, L. R., Andrade, E. M. d., Palácio, H. A. d. Q., Raymer, P. C. L., Ribeiro Filho, J. C., & Pereira, F. J. S. (2016). Carbon stocks in a tropical dry forest in Brazil. *Revista Ciência Agronômica, 47*, 32-40.

Saatchi, S. S., Houghton, R. A., Dos Santos Alvala, R., Soares, J. V., & Yu, Y. (2007). Distribution of aboveground live biomass in the Amazon basin. *Global change biology, 13*(4), 816-837.

SEMA. (2022). Unidade de Conservação. Retrieved from http://meioambiente.am.gov.br/unidade-de-conservacao/

Veríssimo, A., Barreto, P., Mattos, M., Tarifa, R., & Uhl, C. (1992). Logging impacts and prospects for sustainable forest management in an old Amazonian frontier: the case of Paragominas. *Forest ecology and management, 55*(1-4), 169-199. doi:https://doi.org/10.1016/0378-1127(92)90099-U

Verra. (2020). VMD0015 Methods for monitoring of GHG emissions and removals in REDD and CIW projects (M-REDD). *Verified Carbon Standard.* Version 2.2. Accessed on December 9th, 2022. Retrieved from https://verra.org/wp-content/uploads/imported/methodologies/VMD0015-M-REDD-v2.2.pdf

Walker, S. M., Swails, E., Petrova, S., Goslee, K., Grais, A., Casarim, F., & Brown, S. (2013). Technical guidance on development of a REDD+ reference level. *Washington, Estados Unidos, Winrock International*.

Winjum, J. K., Brown, S., & Schlamadinger, B. (1998). Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. *Forest Science, 44*(2), 272-284. doi:https://doi.org/10.1093/forestscience/44.2.272