Verified Carbon Standard

ITAMARATI GROUPED REDD PROJECT

FUTURE CARBON GROUP

Document Prepared by Future Forest

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CONTENTS

1   PROJECT DETAILS

1.1   Summary Description of the Project

In Brazil, 58.39% of its entire 851,029,591.4 ha territory[1] is covered by forests, representing almost 497 million hectares of forest area[2] and putting it in second place for nations with most forest area worldwide. Brazil has also been at times the country with the highest levels of deforestation in the world, having lost almost 15 million hectares of its forest area from 2010 to 2020[3]. The expansion of the agriculture frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The State of Mato Grosso is one of the main grain and meat producers in Brazil. Currently, the State is the 5th largest exporter, mainly with soy, cotton and beef[4]. Simultaneously, Mato Grosso also registers high deforestation rates, reaching in 2018 the highest in 10 years[5]; in 2019 in addition to the states of Pará, Amazonas and Rondônia, it accounted for 84.56% of all deforestation observed in the Brazilian Legal Amazon[6].

The primary objective of the Itamarati REDD Project is to avoid the unplanned deforestation (AUD) within the 22,753.60 ha project area, consisting of 64% Amazon rainforest and 36% Cerrado. The project area is located within 4 private properties, which are located in Nova Olímpia, Denise, Barra do Bugres, Salto do Céu and Reserva do Cabaçal municipalities, in the State of Mato Grosso. This project was designed as a grouped project, as to be able to increase its contribution to the standing forest with the addition of new project activity instances in the future.

It is expected that, with the carbon project, it will be possible to expand the monitoring of the area, hiring new professionals to work on the farms. In addition to the project's ecological and carbon benefits, a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project region, specifically contributing to improving deforestation control, aiming at the propagation of environmental awareness, generation of alternative sources of income and environmental education actions.

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[1] IBGE – Instituto Brasileiro de Geografia e Estatística. Brazil. 2019. Available at: <https://www.ibge.gov.br/cidades-e-estados>.
[2] FAO and UNEP. 2020. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. Available at: <https://doi.org/10.4060/ca8642en>.
[3] FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. Available at: < https://doi.org/10.4060/ca9825en>.
[4] Available at <https://g1.globo.com/mt/mato-grosso/noticia/2021/07/21/valor-de-exportacoes-neste-ano-em-mt-aumenta-26percent-em-comparacao-com-2020.ghtml>
[5] Available at <https://g1.globo.com/mt/mato-grosso/noticia/2018/12/10/mt-registra-o-maior-indice-de-desmatamento-da-amazonia-nos-ultimos-10-anos.ghtml>
[6] Available at <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5465>

The contribution to sustainability is being monitored through the application of the SOCIALCARBON® Standard, which is based on six main indicators: Biodiversity; Natural; Financial; Human; Social and Carbon Resources.

The present REDD project is expected to avoid predicted 4,861 ha of deforestation, equating to 1,264.521 tCO_2e in emissions reductions over the 30-year project lifetime, with an annual average of 42,151 tCO_2e.

1.2   Sectoral Scope and Project Type

Sectoral Scope: 14 – Agriculture, Forestry, Land Use

Project Category: Avoided Unplanned Deforestation (AUD Project Activity)

This is a grouped project.

1.3   Project Eligibility

According to the VCS Methodology Requirements, v4[7], for Reduced Emissions from Deforestation and Degradation (REDD) projects, eligible activities are those that reduce net GHG emissions by reducing deforestation. Thus, the project is eligible under the scopes of the VCS Program, following the VCS Standard, v4[8], Sections 3.1, 3.2 and Appendix A1.5 – A1.8:

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1	The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in the Applicability of Methodology section.
Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.13.1	The applied methodology is VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1. Applicability conditions are detailed in section 3.2.

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[7] Available at <https://verra.org/wp-content/uploads/2022/06/VCS-Methodology-Requirements-v4.2.pdf>
[8] Available at <https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf>

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	The project activity involves the conservation of native mangrove forest. This activity is eligible under the Brazilian law according to conditions set out in sections 1.14 and 3.5.
Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document Program Definitions for definition of model), such model shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals).	Not applicable. The Project applies the VM0015 Methodology.
Where projects apply methodologies that permit the project proponent its own choice of third party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements.	Not applicable. The Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline (i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project).	Not applicable. The Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment.
Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence	The Project applies an approved VCS methodology and tool. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.
Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document Program Definitions for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	The Project applies an approved VCS methodology and tool. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Where Verra issues new requirements relating to projects, registered projects do not need to adhere to the new requirements for the remainder of their project crediting periods (i.e., such projects remain eligible to issue VCUs through to the end of their project crediting period without revalidation against the new requirements). The new requirements shall be adhered to at project crediting period renewal, as set out in Section 3.8.9.	The Project was designed under the VCS Standard, v4 and VM0015, v1.1. Any new requirements shall be adhered to at project crediting period renewal (i.e 30 years, which may be renewed up to 100 years from Project Start Date).
There are currently six AFOLU project categories eligible under the VCS Program, as defined in Appendix 1 Eligible AFOLU Project Categories below: afforestation, reforestation and revegetation (ARR), agricultural land management (ALM), improved forest management (IFM), reduced emissions from deforestation and degradation (REDD), avoided conversion of grasslands and shrublands (ACoGS), and wetland restoration and conservation (WRC).	This is an eligible AFOLU project category under the VCS Program: Reduced Emissions from Deforestation and Degradation (REDD).
Where projects are located within a jurisdiction covered by a jurisdictional REDD+ program, project proponents shall follow the requirements in this document and the requirements related to nested projects set out in the VCS Program document Jurisdictional and Nested REDD+ Requirements.	This Project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities with respect to the project, including but not limited to, implementation, management and monitoring of the project, over the project crediting period	Any implementation partners are described on the Project Description, in sections 1.5 and 1.6.
Activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any ARR, ALM, WRC or ACoGS project areas were not cleared of native ecosystems to create GHG credits (e.g., evidence indicating that clearing occurred due to natural disasters such as hurricanes or floods). Such proof is not required where such clearing or conversion took place at least 10 years prior to the proposed project start date.	This Project does not convert native ecosystems to generate GHG. The project area only contains native forested mangrove for a minimum of 10 years prior to the project start date.
Activities that drain native ecosystems or degrade hydrological functions to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any AFOLU project area was not drained or converted to create GHG credits. Such proof is not required where such draining or conversion took place prior to 1 January 2008.	This Project does not occur on wetlands and does not drain native ecosystems or degrade hydrological functions.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. Where no new project activities have been implemented during a verification period, project proponents shall demonstrate that previously implemented project activities continued to be implemented during the verification period (e.g., forest patrols or improved agricultural practices of community members).	PP will demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design.
For all IFM, APDD (except where the agent is unknown), RWE, APWD, APC, and ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years and have this validated at the same time as the subsequent verification. For all AUDD, APDD (where the agent is unknown), AUC and AUWD project types, 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.	The baseline reassessment will be conducted every six years as this is an AUDD project.
Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below de minimis or can be conservatively excluded as set out in the VCS Program document VCS Methodology	Not applicable. The project activity does not occur on wetlands.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
Requirements, in which case the project shall not be subject to the WRC requirements.	
Projects shall prepare a non-permanence risk report in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool at both validation and verification. In the case of projects that are not validated and verified simultaneously, having their initial risk assessments validated at the time of VCS project validation will assist VCU buyers and sellers by providing a more accurate early indication of the number of VCUs projects are expected to generate. The non-permanence risk report shall be prepared using the VCS Non-Permanence Risk Report Template, which may be included as an annex to the project description or monitoring report, as applicable, or provided as a stand-alone document.	The Project has conducted a non-permanence risk analysis on validation, according to the VCS Program document *AFOLU Non-Permanence Risk Tool*, v4.0, and shall perform the same report during subsequent verifications.
Eligible REDD activities are those that reduce net GHG emissions by reducing deforestation and/or degradation of forests. The project area shall meet an internationally accepted definition of forest, such as those based on UNFCCC hostcountry thresholds or FAO definitions, and shall qualify as forest for a minimum of 10 years before the project start date. The definition of forest may include mature forests, secondary forests, and degraded forests. Under the VCS Program, secondary forests are considered to be forests that have been cleared and have recovered naturally and that are at least 10-years-old and meet the lower bound of the forest threshold	The Project Area is composed of 100% native forest. The area is considered forest as per the definition of forest adopted by FAO[9]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ.

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[9] Available at
<https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predomina>

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
parameters at the start of the project. Forested wetlands, such as floodplain forests, peatland forests and mangrove forests, are also eligible provided they meet the forest definition requirements mentioned above.	
Activities covered under the REDD project category are those that are designed to stop planned (designated and sanctioned) deforestation or unplanned (unsanctioned) deforestation and/or degradation. Avoided planned degradation is classified as IFM.	The project activity is designed to stop unplanned (unsanctioned) deforestation as described throughout the PD.
Activities that stop unsanctioned deforestation and/or illegal degradation (such as removal of fuelwood or timber extracted by non-concessionaires) on lands that are legally sanctioned for timber production are eligible as REDD activities. However, activities that reduce or stop logging only, followed by protection, on forest lands legally designated or sanctioned for forestry activities are included within IFM. Projects that include both avoided unplanned deforestation and/or degradation as well as stopping sanctioned logging activities, shall follow the REDD guidelines for the unplanned deforestation and/or degradation and the IFM guidelines for the sanctioned logging activities, and shall follow the requirements set out in the VCS Program document *VCS Standard*.	In case future project activity instances have areas legally sanctioned for timber production, baseline and project activity shall comprehend unsanctioned deforestation and/or illegal degradation, not the reduction of logging.
Eligible REDD activities include: 1) Avoiding Planned Deforestation and/or Degradation (APDD): This category includes activities that reduce net GHG emissions by	The Itamarati Grouped REDD Project is within category AUDD: Avoided Unplanned Deforestation and/or Degradation.

Eligibility Conditions	Itamarati Grouped REDD Project Justification of Eligibility
stopping or reducing deforestation or degradation on forest lands that are legally authorized and documented for conversion. 2) Avoiding Unplanned Deforestation and/or Degradation (AUDD): This category includes activities that reduce net GHG emissions by stopping deforestation and/or degradation of degraded to mature forests that would have occurred in any forest configuration.	

1.4   Project Design

The project is a grouped project

Eligibility Criteria

A set of eligibility criteria for the inclusion of any new areas as instances willing to participate within the grouped project are described below.

As Itamarati Grouped REDD Project is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15 and 3.5.16, as well as the specific AFOLU Projects criteria (3.5.17 and 3.5.18) of the VCS Standard, v4.

In addition, new areas willing to become instances of the project shall comply with the applicability conditions of the selected methodology, including conditions applicable to each activity, as described in Section 3.2.

Table 1. Grouped Project eligibility criteria

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Itamarati Grouped REDD Project	Instance 1
Projects shall meet the applicability conditions set out in the methodology applied to the project.	The GHG emission reductions shall be calculated according to the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020.	Instance 1 complies with this requirement because it adopts the Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020.
Projects shall use the technologies or measures specified in the project description. Projects shall apply the technologies or measures in the same manner as specified in the project description.	All new instances shall use and apply the same technologies or measures specified in the Project description - forest conservation by avoiding unplanned deforestation and planned deforestation, with or without forest management in project scenario.	The Instance 1 project activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Itamarati Grouped REDD Project. Also, this instance is in the same reference region described on the VCS PD. Instance 1 applies the same technologies or measures specified on the present Project Description: forest conservation by avoiding unplanned deforestation and planned deforestation, without forest management in project scenario.
Projects are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	The Project shall be in accordance with the same baseline scenario established in Section 3.4. of the VCS PD: "In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the reference region, project area and leakage belt. Therefore, the project falls into the AFOLU-REDD".	The Instance 1 Project Activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Itamarati Grouped REDD Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD.

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Itamarati Grouped REDD Project	Instance 1
Projects must have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instances.	All instances must be additional to be included in the Grouped Project. The project activity must be consistent with Grouped Project Description: forest conservation by avoiding unplanned deforestation and planned deforestation. In this case, the project activity may or may not include Sustainable Forest Management Plan. In the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v 3.0 tool. 1) Instances may or may not include Sustainable Forest Management Plan. 2) In case the project activity does not involve Sustainable Forest Management Plan: - The instance should have financial, technical and scale consistent with the described in the VCS PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied. 3) In case the project activity includes a Sustainable Forest Management Plan: - A new additionality analysis shall be provided. In this case, the investment comparison analysis	Since the PD was developed based on the characteristics, reference region and activity of the initial instance, Instance 1 complies with this additionality criterion. The additionality analysis for Instance 1 was made according to Option I of VCS VT0001 v3.0, as detailed in section 3.5.

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Itamarati Grouped REDD Project	Instance 1
	(Option II) or the benchmark analysis (Option III) of the Tool VCS VT001 v 3.0 shall be used. - In addition, a new AFOLU non-permanence risk analysis shall be performed.	
New Project Activity Instances shall occur within one of the designated geographic areas specified in the project description.	Projects must be located within the Reference Region described in Section 3.3 of the VCS PD. The areas to be included must evidence the ownership of the property in accordance with Brazilian legislation, even if overlapping public areas such as Conservation Units. - As per the VCS Standard, new *AFOLU Non-Permanence Risk* assessments shall be carried out for each geographic area specified in the project description (for requirements related to geographic areas of grouped projects, see the VCS Standard). Where risks are relevant to only a portion of each geographic area, the geographic area shall be further divided such that a single total risk rating can be determined for each geographic area. Where a project is divided into more than one geographic areas for the purpose of risk analysis, the project's monitoring and verification reports shall list the total risk rating for each area and the corresponding net change in the project's carbon stocks in the same area, and the risk rating for each area applies only to the GHG emissions reductions generated	The project activity within the area referring to instance 1 is located in the project's reference region as described in section 3.3 of the VCS PD.

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Itamarati Grouped REDD Project	Instance 1
	by project activity instances within the area.	
Instances shall comply with at least one complete set of eligibility criteria for the inclusion of new project activity instances. Partial compliance with multiple sets of eligibility criteria is insufficient.	All Instances must comply with the complete set of eligibility criteria for the inclusion of new project activities instances.	Instance 1 complies with all eligibility criteria for the inclusion of a new Project Activity.
Instances must be included in the monitoring report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/verification body.	The Project Activity Instances must be included in the Monitoring Report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/ verification body.	Instance 1 complies with this criterion, as it is included in this Joint PD as the first Project Activity Instance.
New Project Activity Instances must be validated at the time of verification against the applicable set of eligibility criteria	The addition of new Project Activity Instances shall be made in the monitoring report for the Grouped Project, being validated at the time of verification.	Instance 1 complies with this criterion, as it is included in this Joint PD as the first Project Activity Instance.
New Project Activity Instances must have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).	All Project Activity instances must provide evidence of Project ownership (land title and related documents) and Project start date (agreements, protection or management plan, or others in accordance with the applicable VCS Standard definitions).	Instance 1 is in accordance with this criterion. The evidence of Project ownership and Project start date were provided, as described in Sections 1.7 and 1.8 of the VCS PD.

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Itamarati Grouped REDD Project	Instance 1
New Project Activity Instances must have a start date that is the same as or later than the grouped project start date.	The start date of the activity of each instance shall be the same as or after the start date of the grouped project, as established in Section 1.8 of the VCS PD.	Instance 1 project activity has the same start date of the grouped Project, as described in section 1.8 of the VCS PD.
Instances shall be eligible for crediting from the start date of the instance through the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period.	Instances shall be eligible for crediting from the start date of the instance activity until the end of the grouped project crediting period, i.e., the instance shall not generate credits after the end date of the Grouped Project. Where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period. New instances are eligible for crediting from the start of the next verification period.	Instance 1 project activity's crediting period has the same start and end dates of the grouped Project, as described in section 1.8 of the VCS PD.

1.5   Project Proponent

Organization name	Future Carbon Holding S.A. (Future Carbon Group)
Contact person	Marcelo Hector Sabbagh Haddad Bárbara Silva e Souza Carolina Chiarello de Andrade Carolina Pendl Abinajm Eliane Seiko Maffi Yamada Gabriel Fernandes de Toledo Piza Gabriella Hita Marangom Cesilio Guilherme Lucas Medeiros Prado Laura Cristina Pantaleão Letícia Moraes Teixeira Lyara Carolina Montone Amaral Yara Fernandes da Silva
Title	Marcelo Hector Sabbagh Haddad – Head of Forest Bárbara Silva e Souza – Technical Analyst Carolina Chiarello de Andrade – Technical Analyst Carolina Pendl Abinajm – Technical Coordinator Eliane Seiko Maffi Yamada – Technical Coordinator Gabriel Fernandes de Toledo Piza – Technical Coordinator Gabriella Hita Marangom Cesilio – Technical Analyst Guilherme Lucas Medeiros Prado – Technical Coordinator Letícia Moraes Teixeira – Technical Analyst Laura Cristina Pantaleão – Technical Analys Lyara Carolina Montone Amaral – Technical Coordinator Yara Fernandes da Silva – Technical Coordinator
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Telephone	+55 11 3045-3474
Email	forest@futurecarbon.com.br

1.6   Other Entities Involved in the Project

Organization name	Usinas Itamarati S/A
Role in the project	Owner of Nova Deniser Farm, Jauru Farm, Guanabara Farm and Cachoeira do Ouro Farm, composing Instance 1

Contact person	
Title	Sustainability Manager
Address	Fazenda Guanabara s/n, Zona Rural, Nova Olímpia – MT Postal Code: 78370-000
Telephone	-
Email	caetano.grossi@uisa.com.br

1.7 Ownership

Instance 1 is located within the municipalit*ies* of Nova Olímpia, Denise, Barra do Bugres, Salto do Céu and Reserva do Cabaçal, both in the State of Mato Grosso, Brazil. The project area is composed by the following properties:

- Fazenda Guanabara

- Fazenda Nova Denise

- Fazenda Jauru

- Fazenda Cachoeira do Ouro

The properties composing Instance 1 (hereafter "Instance 1"), are owned by Usinas Itamarati S/A.

As per the rules stated at Section 3.6 Ownership of the VCS Standard v.4.3, an enforceable and irrevocable agreement was set between, Usinas Itamarati S/A – the holder of the statutory, property and contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions or removals –, and Future Carbon Holding S.A., which vests project ownership in the project proponent (Future Forest[10]). Evidence of such agreement will also be made available at the audit.

The legal documents proving the land title and ownership of the properties will be made available to the auditors during the validation process.

1.8 Project Start Date

The region where the farms are located has been exploited for years for agricultural activities, which use fire to clear new areas. Due to the progress of these activities and the constant

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[10] Future Forest (Future Carbon Consultoria e Projetos Florestais Ltda.) is a company controlled by Future Carbon Holding S.A. Therefore, partnership agreements for project developments are signed on behalf of Future Carbon Holding.

occurrence of fire outbreaks in the region, Usinas Itamarati S/A needed to implement fire monitoring actions. For this, a fire monitoring system was contracted and implemented.

Therefore, the project start date is April 25, 2022. This date marked the first action implemented by the project owner of Instance 1 to carry out activities to mitigate deforestation and conserve the forest.

1.9   Project Crediting Period

The project has a crediting period of 30 years, from 25-April-2022 until 24-April-2052.

1.10   Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO$_2$e)
2022	49,977
2023	50,249
2024	50,522
2025	50,794
2026	51,066
2027	51,339
2028	46,613
2029	46,858
2030	47,103
2031	47,349
2032	46,446
2033	46,419
2034	41,894
2035	41,842
2036	41,790
2037	41,739
2038	41,802
2039	41,777
2040	37,704

2041	37,658
2042	37,611
2043	37,565
2044	37,621
2045	37,599
2046	33,934
2047	33,892
2048	33,850
2049	33,808
2050	33,859
2051	33,839
Total estimated ERs	**1,264,521**
Total number of crediting years	**30**
Average annual ERs	**42,151**

1.11 Description of the Project Activity

The Project Activity for the Itamarati Grouped REDD Project (hereafter "Itamarati" or "the Project") consists in conservation measures in the Project Area's properties.

Among the conservation measures adopted by Instance 1, there is maintenance of the fences that surround the properties, camera monitoring of the areas and managing teams present at the Project Area's location to monitor suspicious and/or illegal activities and control the entrance and exit within the area's boundaries. Keeping environmental and police entities updated on the suspicious and illegal activities around the Project Area is also a way to ensure that the Project is secure, these reports are made by filing formal complaints.

Other mitigation actions proposed by the Project to avoid unplanned deforestation will be carried out by strengthening surveillance in the area, mapping the local deforestation patterns, setting partnerships with educational and research institutions, and through the insertion of the surrounding communities in the Project Activities, aiming to minimize invasions and illegal deforestation, offering alternative income, education and professional training.

Therefore, besides forest conservation, the present project aims to improve and quantify its social and environmental activities that benefit the local communities and aims to deliver high-integrity benefits in each in order to improve social and environmental conditions in the project region.

The implementation of REDD mechanisms promotes sustainable development through forest conservation resulting in the permanence of carbon stocks, while reducing pressure for timber from other forest areas. In this way, biodiversity conservation and development of the local economy can be achieved simultaneously.

All the measures aid in achieving the net GHG emission reductions by preventing illegal deforestation agents to advance with their activities, as well as by retrieving their practices and, therefore, protecting and even restoring the carbon pools.

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

1.12 Project Location

The first Project Activity Instance Area is located in the municipalities of Nova Olímpia, Denise, Barra dos Bugres, Salto do Céu and Reserva do Cabaçal in the State of Mato Grosso. Instance 1 is located in the Amazon and Cerrado biomes. The total area of the properties of the Instance 1 is 69,207.15 ha.

These municipalities are located between 176 km and 350 km from Cuiabá, Mato Grosso State's capital.

Geodetic coordinates of the project location have been submitted separately as a KML file, as the Figure below presents the properties' location:

Figure 1. Project Location

Property area
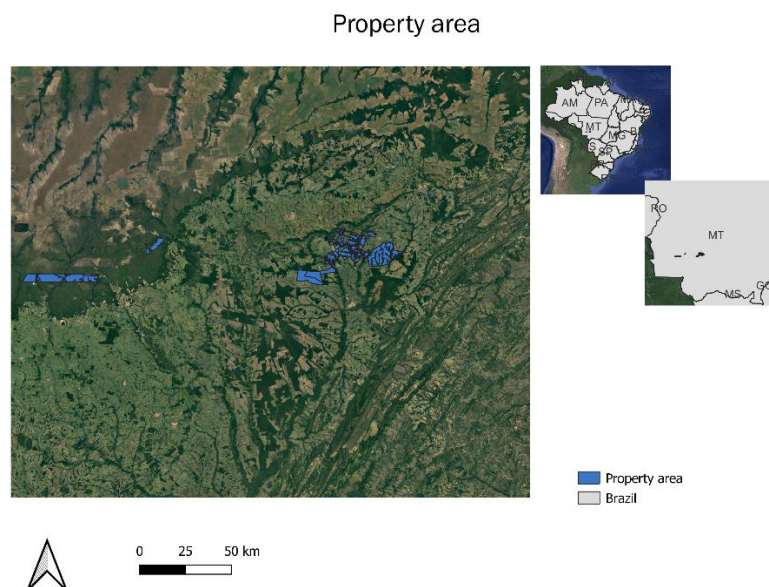
1.13 Conditions Prior to Project Initiation

Conditions prior to the project initiation as well as general characteristics of the project area and reference region are described below.

<u>Climate and Hydrography</u>

The project region is classified as Tropical, dry winter climate type – Aw category – according to the Köppen climate classification[11]. This means that it has a rainy season in summer, from November to April, and a distinct dry season in winter, from May to October (July is the driest month). The average temperature of the coldest month is above 18ºC and annual precipitation is on average 1,724.33 mm.

<u>Geology, Topography and Soils</u>

The Mato Grosso State has modest altitudes, with large, flattened surfaces, carved in sedimentary rocks and covers three distinct regions: in the north-central portion of the state, the sedimentary plateaus and crystalline plateaus (with altitudes between 400 and 800m), that make up the central Brazilian plateau. The sandstone-basalt plateau, located in the south, is a simple portion of the southern plateau. The part of the Pantanal Mato-Grossense, lowered from the central-western portion[12].

In the Project Area, altitude ranges from 309 to 384, and average slope is 2.66°.

The soils present in the project area and reference region are Haplic Organosols, Quartzarenic Neosols, Litholic Neosols and Neosols.

<u>Vegetation cover</u>

Mato Grosso is the only Brazilian State with three biomes: Amazon Rainforest, Cerrado and Pantanal. This makes the State's vegetation unique, with great diversity and conservation importance. The Itamarati Grouped REDD Project's Project Area is covered 64% by the Amazon biome and 36% by the Cerrado and are composed by 6 different phytophysiognomies: alluvial evergreen forest, floodplain evergreen forest, submontane deciduous forest, wooded savannah with gallery forest, wooded savannah and wooded savannah without gallery forest.

In recent years, the project region has been deforested due to the advancement of agricultural and livestock activities. This pressure is expected to continue, given the globalization of markets in the Amazon and Cerrado regions and international development policies planned for the region[13].

<u>Biodiversity</u>

Brazil harbours the greatest concentration of biodiversity on the planet. It has a great abundance of life forms – which translates to over 20% of the total species on Earth – and raises Brazil to

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[11] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928.
[12] GOVERNO DE MATO GROSSO. Geografia. http://www.mt.gov.br/geografia
[13] Nepstad, D. C.; C. M. Stickler e O. T. Almeida. 2006. Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation. Conservation Biology 20(6):1595-1603. Available at
http://www.rmpcecologia.com/disciplinas/comunidades/Artigos_2007/nepstad_ecs2007.pdf.

the main nation among the 17 countries with the highest biodiversity levels globally, containing over 70% of the planet's biodiversity[14].

Brazil has the greatest flora species richness globally, with 46,392 species described. Furthermore, it contains over 8,700 known species of vertebrates consisting of 720 mammals, 986 amphibians, 759 reptiles, 1,924 birds and 4,388 fish species. It is estimated that around 93 thousand invertebrate species are known[15].

The project region is covered by Amazon and Cerrado Biomes. This area has great environmental heterogeneity, allowing great diversity of fauna and flora. The Amazon is the most complex in terms of biodiversity in the world. Due to the difficulty of light entry, due to the abundance and thickness of the crowns, ground vegetation and land animals are very scarce in the Amazon. Most of the endemic fauna is made up of animals that inhabit the treetops. Among the birds in the canopy are parrots, toucans and woodpeckers. Among the mammals are bats, rodents, monkeys and marsupials. The Brazilian Cerrado is recognized as the richest savanna in the world, home to more than 10,000 species of native plants. There is a great diversity of habitats, which determine a remarkable alternation of species between different phytophysiognomies[16]. The Biome is habitat to some large emblematic mammals such as the maned Wolf (*Chrysocyon brachyurus*) and the jaguar (*Panthera onca*). In addition, the biome is also home to the giant armadillo (*Priodontes maximus*), the most impressive member of the Cerrado armadillos' fauna.

The contact zone between these biomes has a great heterogeneity of phytophysiognomies, biomass dynamics, and biogeochemical cycles, being an essential region in the floristic connections between adjacent biomes and in the dynamics of landscapes.

<u>Socio-economic conditions</u>

Nova Olímpia

Nova Olímpia is a 116,638.2 km² municipality located in the State of Mato Grosso, in Brazil. Its accounted population in the last census in 2010 was of 5,513 citizens, its demographic density being of 40.36 inhab/km². Of all population, in 2020, 242 people had formal or informal jobs, which is less than 7.7% of the municipality's population[17]. The average monthly wage of formal workers in 2020 was of 3 minimum wages, and the minimum wage R$ 1,045.00[18]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[19]), and an average monthly wage of formal workers equivalent to US$ 643.74.

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[14] Available at: <Information System about the Brazilian Biodiversity (SiBBr). Available at: <http://www.sibbr.gov.br/areas/?area=biodiversidade>. Last visit on: March 18th, 2021>

[15] Available at: <https://www.icmbio.gov.br/portal/especies-ameacadas-destaque>

[16]Available at: https://antigo.mma.gov.br/biomas/cerrado.html. Last visited on 28/04/2022.

[17] Available at https://cidades.ibge.gov.br/brasil/pr/nova-olimpia/panorama. Last visit: Jan 2023.

[18] Available at L14013 (planalto.gov.br). Last visit: Jan 2023.

[19] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.

Almost 98.8% of the municipality's population studied until a 6 to 14 years old-range. Nova Olímpia's IDHM in 2010 was of 0.710[17]. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[20]. Per capita GDP of the municipality was R$ 16,934.03 (equivalent to US$ 3,262.81) in 2020[21].

Barra do Bugres

Barra do Bugres is a 5,976.864 km² municipality located in the State of Mato Grosso, in Brazil. Its accounted population in the last census in 2010 was of 31,793 citizens, its demographic density being of 5.25 inhab/km². Of all population, in 2020, 5,609 people had formal or informal jobs, which is less than 15.9% of the municipality's population[22]. The average monthly wage of formal workers in 2020 was of 2.4 minimum wages, and the minimum wage R$ 1,045.00[23]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[24]), and an average monthly wage of formal workers equivalent to US$ 514.99.

Almost 96.9% of the municipality's population studied until a 6 to 14 years old-range. Barra do Bugre's IDHM in 2010 was of 0.0693[25]. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[26]. Per capita GDP of the municipality was R$ 40,051.09 (equivalent to US$ 7,716.97) in 2020[27].

Salto do Céu

Salto do Céu is a 1,753.378 km² municipality located in the State of Mato Grosso, in Brazil. Its accounted population in the last census in 2010 was of 3,226 citizens, its demographic density being of 2.23 inhab/km². Of all population, in 2020, 372 people had formal or informal jobs, which is less than 11.3% of the municipality's population[28]. The average monthly wage of formal workers in 2020 was of 1.7 minimum wages, and the minimum wage R$ 1,045.00[29]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[30]), and an average monthly wage of formal workers equivalent to US$ 364.78.

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[20] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html. Last visit: Jan 2023.
[21] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[22] Available at https://cidades.ibge.gov.br/brasil/pr/nova-olimpia/panorama. Last visit: Jan 2023.
[23] Available at L14013 (planalto.gov.br). Last visit: Jan 2023.
[24] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[25] Available at https://cidades.ibge.gov.br/brasil/mt/barra-do-bugres/panorama. Last visit: Jan 2023.
[26] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html. Last visit: Oct 2022.
[27] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[28] Available at https://cidades.ibge.gov.br/brasil/mt/salto-do-ceu/panorama. Last visit: Jan 2023.
[29] Available at L14013 (planalto.gov.br). Last visit: Jan 2023.
[30] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.

Almost 99.2% of the municipality's population studied until a 6 to 14 years old-range. Salto do Céu's IDHM in 2010 was of 0.0666[31]. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[32]. Per capita GDP of the municipality was R$ 19,892.28 (equivalent to US$ 3,832.80) in 2020[33].

Reserva do Cabaçal

Reserva do Cabaçal is a 1,331.677 km² municipality located in the State of Mato Grosso, in Brazil. Its accounted population in the last census in 2010 was of 2,754 citizens, its demographic density being of 1.92 inhab/km². Of all population, in 2020, 270 people had formal or informal jobs, which is 8.8% of the municipality's population[34]. The average monthly wage of formal workers in 2020 was of 2.1 minimum wages, and the minimum wage R$ 1,045.00[35]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[36]), and an average monthly wage of formal workers equivalent to US$ 450.61.

Almost 99.2% of the municipality's population studied until a 6 to 14 years old-range. Salto do Céu's IDHM in 2010 was of 0.0676[37]. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[38]. Per capita GDP of the municipality was R$ 16,073.11 (equivalent to US$ 3,096.93) in 2020[39].

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

In a brief context of Brazilian legislation, the Federal Constitution determines that it is concurrent between the Union, Member States and the Federal District the competence to legislate on matters related to the protection of the environment, conservation of nature, defense of the soil, protection of landscape heritage and responsibility for damages to the environment. The same document establishes that municipalities are responsible for legislation at the local level[40]. However, in the absence of a qualified environmental agency or environmental council in the municipality, the state must carry out municipal administrative actions until its creation. In turn,

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[31] Available at https://cidades.ibge.gov.br/brasil/mt/salto-do-ceu/panorama. Last visit: Jan 2023.
[32] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html. Last visit: Oct 2022.
[33] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[34] Available at https://cidades.ibge.gov.br/brasil/mt/salto-do-ceu/panorama. Last visit: Jan 2023.
[35] Available at L14013 (planalto.gov.br). Last visit: Jan 2023.
[36] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[37] Available at https://cidades.ibge.gov.br/brasil/mt/salto-do-ceu/panorama. Last visit: Jan 2023.
[38] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html. Last visit: Oct 2022.
[39] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes. Last visit: Jan 2023.
[40] Available at
http://www.mpsp.mp.br/portal/page/portal/documentacao_e_divulgacao/doc_biblioteca/bibli_servicos_produtos/bibli_boletim/bibli_bol_2006/RDC_07_23.pdf

in the absence of a qualified environmental agency or environmental council in the state and municipality, the Union will have to carry out administrative actions until its creation in one of those federative entities[41]. It is also necessary to observe that a municipal law cannot contradict a state law, which in turn cannot contradict a federal law, under penalty of unconstitutionality.

Figure 2. Structure of the Brazilian legislation
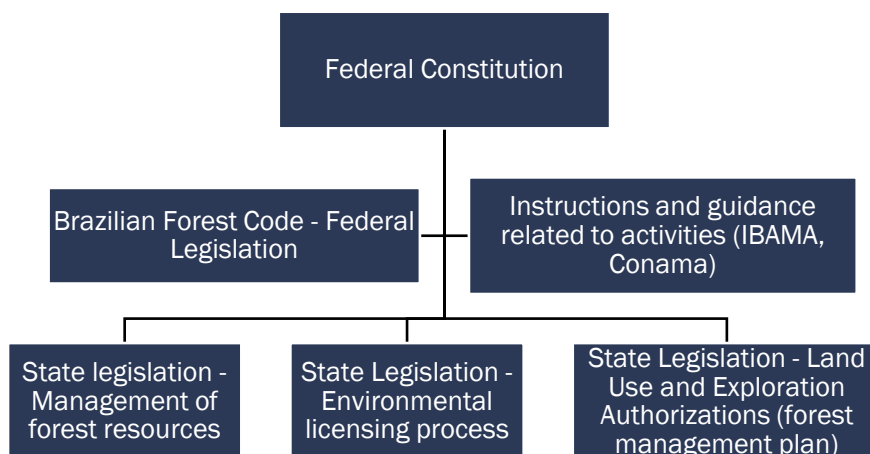
Thus, in the state of Mato Grosso, the Secretariat of the Environment (Sema/MT) is the body responsible for environmental licensing, including authorizations for forestry intervention.

- National legislation

  According to the current Brazilian Forest Code (Law N° 12.651, 25/05/2012[42]), all rural estates located in forest zones shall have:

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

  II. Legal Reserve: an area located within a rural property or possession which is required to be segregated, as well as the permanent preservation area, for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[43], eighty percent (80%) of a rural property should be preserved and in the Cerrado Biome, 65%.

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[41] Available at http://pnla.mma.gov.br/competencias-para-o-licenciamento-ambiental

[42] BRASIL. Law nº. 12.651, of 25 May 2012. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 25 May 2012. < http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>

[43] The concept of Legal Amazonia was originated in 1953 and its boundaries arise from the necessity of planning the economic development of the region. For this reason, Legal Amazonia's boundaries do not correspond to those of the Amazon biome. The former has an area of approximately 5 million km², distributed through the entirety or a proportion of 9 Brazilian states.

There is a clear disregard for legal conservation requirements in the region. Much of the deforestation occurs in areas that should be preserved. Lack of law enforcement by local authorities along with public policies seeking to increase commodities production and encourage land use for agricultural, bio energy and cattle breeding purposes created a scenario of almost complete disregard of the mandatory provisions of the Forest Code. High rates of criminality associated with land disputes usually jeopardize efforts concerning law enforcement improvement. In addition to that, to cover vast distances of areas with low demographic density makes tracking of illegal activities and land surveillance very difficult for the authorities[44]. Accordingly, policies implemented to address illegal deforestation only by means of command-and-control approaches have proven to be ineffective so far.

Given the permanent attempts against the Project Area, the project proponent uses their best efforts to prevent property invasion and to remain in compliance with Brazilian Forest Code.

- State legislation

Instance 1 does not have Sustainable Forest Management Plan activities. In the state of Mato Grosso, the Secretariat for the Environment (SEMA/MT) is the body responsible for environmental licensing and monitoring.

- Climate change legislation

Regarding other regulatory frameworks that exist in Brazil, on November 28th, 2019, occurred the approval of the Federal Decree 10,144/2019, which establishes the National Commission for Reducing Emissions of Greenhouse Gases from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+[45].

The development of this Project is not in conflict with such Decree. In terms of the object, jurisdictionally and scope of the Decree 10,144/2019, it is understood that its application is merely administrative, that is, it merely organizes the functioning of the Federal Government about the REDD+ agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, does not establish duties or obligations to the society.

Thus, Decree 10,144/2019 only limits the Federal Government's understanding of what shall be accounted for in order to comply with mitigation commitments of other countries to the United Nations Framework Convention on Climate Change. It does not impose a

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[44] MOUTINHO, P. *et al*. REDD no Brasil: um enfoque amazônico: fundamentos, critérios e estruturas institucionais para um regime nacional de Redução de Emissões por Desmatamento e Degradação Florestal – REDD. Brasília, DF: Instituto de Pesquisa Ambiental da Amazônia, 2011. < https://ipam.org.br/wp-content/uploads/2015/12/redd_no_brasil_um_enfoque_amaz%C3%B4nico.pdf>

[45] The Decree is available in Portuguese at: < http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm>

barrier or obstacles to the implementation of REDD projects and the commercialization of carbon assets generated from these projects. This consideration in the Decree does not affect or interfere with the voluntary or regulated carbon market, domestic or international.

There is no law in Brazil that does not allow or restrict the execution of REDD projects or that does not allow or restrict any commercial transaction of assets resulting from REDD projects. On the contrary, such transactions are valid and legally permitted. Thus, there is no contradiction or irregularity between the Itamarati Grouped REDD Project and such Decree.

The Table below presents the compliance of the Project with aforementioned laws:

Law	Content	Compliance
Federal Legislation		
Law Nº 12.651	This Law establishes general rules on the protection of vegetation, Permanent Preservation areas and Legal Reserve areas; forest exploitation, the supply of forest raw materials, the control of the origin of forest products and the control and prevention of forest fires and provides economic and financial instruments to achieve its objectives.	Instance 1 complies with the current Federal legislation, as evidenced by the regularity in the CAR and the absence of legal pending issues on environmental matters.
Decree 5975	Provides information for the exploitation of forests and successor formations, comprising the regime of sustainable forest management and the regime of suppression of forests and successor formations for alternative land use.	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Decree does not apply.
State Legislation		
Complementary law 233	Provides information for the Forest Policy of the State of Mato Grosso and other provisions.	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Complementary law does not apply.
Decree 1313	Regulates Forest Management in the State of Mato Grosso and makes other provisions.	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Decree does not apply.
Complementary law 668[46]	Amends provisions of Complementary Law No. 592, of May 26, 2017, which provides for the Environmental Regularization Program - PRA,	Instance 1 complies with the current State legislation and does not perform

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[46] Available at
https://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/b88b0eb8f863f2 23042585b2005f778a?OpenDocument

	regulates the Rural Environmental Registry - CAR, the Environmental Regularization of Rural Properties and the Environmental Licensing of Polluting Activities or users of natural resources, within the scope of the State of Mato Grosso, and other measures; as well as the provision of Complementary Law No. 233, of December 21, 2005, which provides for the Forest Policy of the State of Mato Grosso and other measures.	sustainable forest management within its forest area.
Complementary law 698	Amends provisions of Complementary Law No. 233, of December 21, 2005, which provides for the Forest Policy of the State of Mato Grosso and other provisions.	Instance 1 complies with the current State legislation and does not perform sustainable forest management within its forest area.
IN SEMA 1	Approves procedural rules for the issuance, use and control of Forestry Guides – GF, in internal and interstate operations.	Instance 1 does not perform sustainable forest management within its forest area; therefore, it does not apply.
IN SEMA 2	Provides for the procedure for transporting forest products and by-products with a vehicle without mandatory license plates for enterprises that consume and transform forest products and by-products, within the scope of the State Secretariat for the Environment - SEMA/MT.	Instance 1 does not perform sustainable forest management within its forest area; therefore, it does not apply.
Standards and guidelines from national agencies		
Administrative Rule 1 IBAMA	It institutes, within the scope of this autarchy, the technical guidelines for the elaboration of sustainable forest management plans – SFMP mentioned in art. 19 of Law 4,771, of September 15, 1965	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Administrative Rule 5 IBAMA	Provides for technical procedures for the preparation, presentation, execution and technical evaluation of sustainable forest management plans - SFMP in primitive forests and their forms of succession in the legal Amazon, and other measures	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Normative Instruction 2 MMA	Amends provisions of normative instruction no. 5, of December 11, 2006, and makes other provisions	Instance 1 does not perform sustainable forest management within its forest area; therefore, this Normative Instruction does not apply.
Resolution 406 CONAMA	Establishes technical parameters to be adopted in the preparation, presentation, technical evaluation and execution of a sustainable forest	Instance 1 does not perform sustainable forest management within its forest

	management plan - SFMP for timber purposes, for native forests and their forms of succession in the Amazon biome	area; therefore, this Resolution does not apply.
Legislation on climate change and carbon market		
Decree 10144	Establishes the National Commission for the Reduction of Greenhouse Gas Emissions from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+.	The development of this Project is not in conflict with such Decree. In terms of the object, jurisdictionally and scope of the Decree 10,144/2019, it is understood that its application is merely administrative, that is, it merely organizes the functioning of the Federal Government about the REDD+ agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, it does not establish duties or obligations to the society.
Decree 11075[47]	Establishes the procedures for the elaboration of Sectoral Plans for Mitigation of Climate Changes, institutes the National System for the Reduction of Greenhouse Gas Emissions	The decree defines the carbon credit as a financial asset, the institution of the National System for the Reduction of Greenhouse Gas Emissions and organizes the functioning of the Government about the carbon agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law, it does not establish duties or obligations to the society.

1.15 Participation under Other GHG Programs

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

This project has not been registered and is not seeking registration under any other GHG Programs.

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[47] Available at https://presrepublica.jusbrasil.com.br/legislacao/1505298704/decreto-11075-22

1.15.2 Projects Rejected by Other GHG Programs

Not applicable. This project has not requested registration under any other GHG Programs, therefore, the project has not been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project activity is not included in an emission trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

The project area has not sought or received any other form of GHG-related environmental credit, including renewable energy certificates.

Supply Chain (Scope 3) Emissions

The present REDD project's GHG emission reductions are not part of a supply chain, i.e., there is no network of organizations (e.g., manufacturers, wholesalers, distributors, and retailers) involved in the production, delivery, and sale of a product or service to the consumer. Therefore, there are no organizations upstream nor downstream of the goods and services whose GHGs are impacted by the present REDD project activity.

1.17 Sustainable Development Contributions

The primary objective of the Itamarati Grouped REDD Project is to avoid the unplanned deforestation (AUD) of its instances, consisting of 64% Amazon and 36% Cerrado biomes. The Project also has the function of establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Amazon and Cerrado biodiversity and also to climate regulation in Brazil and South America.

These measures contribute to several nationally stated sustainable development priorities, such as the objectives from the Brazilian Government related to the UN Sustainable Development Goals (SDGs)[48] and the Nationally Determined Contribution (NDC).

In Brazil, the National Commission for Sustainable Development Objectives (CNODS) is responsible for internalizing, disseminating and providing transparency to the process of implementing the 2030 Agenda for Sustainable Development in Brazil[49]. The Commission is made up of eight government representatives (Government Secretariat of the Presidency of the

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[48] UN's Sustainable Development Goals and targets available at: https://sdgs.un.org/goals
[49] More information on the CNODS available at < https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/comissao-nacional-para-os-objetivos-do-desenvolvimento-sustentavel-cnods>

Republic; Civil House of the Presidency of the Republic; Ministry of Foreign Affairs; Ministry of Citizenship; Ministry of Economy; Ministry of Environment; representative of the state/district levels; representative of the municipal level) and by eight representatives of civil society and the private sector. The monitoring of the country's advances in relation to the SDGs established as priorities is carried out by the Institute of Applied Economic Research (IPEA) and the Brazilian Institute of Geography and Statistics (IBGE), which are also permanent technical advisory bodies.

There is no monitoring at the specific level of projects, and progress at the national level can be accompanied by the synthesis report carried out by IBGE[50] and by the IPEA reports[51]. In addition, in 2018 there was the SDG Award, an initiative of the Federal Government whose objective is to encourage, value and give visibility to practices that contribute to achieving the goals of the 2030 Agenda throughout the national territory. The first edition of the Award had 1045 entries to compete in four categories: government; for-profit organizations; non-profit organizations; and teaching, research and extension institutions.

The Itamarati Grouped REDD Project main planned contributions to the Brazilian Priority Goals are listed below[52]. These contributions are monitored by the parameters defined by the REDD project:

- SDG 1: No poverty

The project positively impacts people in situations of poverty and vulnerability, mainly through investments in the local community that lives in the vicinity of the project area, thus ensuring access to basic and essential services for human development. Thus, the project collaborates with targets such as:

- 1.3 "Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable";

- 1.4 "By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance";

- 1.5 "By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters".

- SDG 2: Zero hunger

The project itself enhances better management of non-timber forest products as, through the carbon credits sales, qualifies investments in the local community training and capacity building programs. Likewise, strengthen ecosystem conservation and preservation. Guideline targets are:

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[50] Available at < https://odsbrasil.gov.br/relatorio/sintese>
[51] Available at < https://www.ipea.gov.br/ods/publicacoes.html>
[52] Available at < https://odsbrasil.gov.br>

- 2.4"By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality".

- SDG 3: Good health and well-being

Via carbon credits income, the project promotes the community's well-being and helps to solve local common issues. Therefore, the project may contribute to the following targets:

- 3.3 "By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases".

- SDG 4: Quality education

The carbon project encourages the local community to participate in courses regarding technical skills and educational basis. Moreover, the carbon project encourages the development of partnerships with educational entities striving for socioenvironmental scholarly initiatives. The targets determined by the UN that will act as a guideline for monitoring actions are:

- 4.1 "By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes";

- 4.4 "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship";

- 4.5 "By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations";

- 4.6 "By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy";

- 4.7 "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development".

- SDG 5: Gender equality

The carbon project expects a continuous improvement concerning women's inclusion, such as through sponsoring events and initiatives which promote a gender equality environment. Thus, the project may have initiatives that contribute to the following targets:

- 5.2 "Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation";

- 5.4 "Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate".

- SDG 8: Decent work and economic growth

The REDD project aims to offer training and income generation in the project region as a measure to conserve native forest standing and promote economic viability and growth in the local community. Guideline targets are:

- 8.3 "Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small-and medium-sized enterprises, including through access to financial services";

- 8.6 "By 2020, substantially reduce the proportion of youth not in employment, education or training".

- SDG 12: Ensure sustainable production and consumption patterns

The carbon project nurtures a better environmental management system since increases stakeholder awareness concerning the climate changes mitigations, and whichever environmental activity the landowners intend to apply. Alongside, the project is based on encouraging sustainable development and maintaining the standing forest, and it aims to optimize access to non-timber forest products and the consumption of local inputs. One of the main objectives is to reduce illegal deforestation and profit from this activity, offering alternatives for income and extraction. The REDD Project has the following target and guidelines:

- 12.6 "Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle";

- 12.8 "By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature".

- SDG 13: Take urgent action to combat climate change and its impacts

Another of the main objectives of the REDD project is to reduce greenhouse gas emissions through the conservation of standing forest. Thus, its activity is already an action to combat climate change and its effects. In addition, the project stimulates biodiversity monitoring initiatives in a measure to combat climate changes. The targets and guidelines for this objective are:

- 13.2 "Integrate climate change measures into national policies, strategies and planning";

- 13.3 "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

- SDG 15: To protect, restore and promote the sustainable use of terrestrial ecosystems, to manage forests sustainably, to combat desertification, to halt and reverse land degradation, and to halt the loss of biodiversity

The project is based on the conservation and restoration of forests in the Amazon and Cerrado biomes, ensuring forest services, preservation of natural resources, and biodiversity. The targets and guidelines related to this objective are:

- 15.1 "By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements";

- 15.5 "Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species";

- 15.9 "By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts";

- 15.a "Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems";

- 15.c "Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities".

Reducing deforestation and promoting sustainable development in the Amazon and Cerrado is also a key component to Brazil's Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, Ministério do Meio Ambiente), the implementation of REDD+ activities are an important component to meet the Country's contribution under the United Nations Framework Convention on Climate Change while preserving natural forest resources[53].

The following components of the Brazilian commitments under the Convention are reinforced by the development of the Itamarati Grouped REDD Project:

- Strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels;

- Strengthening policies and measures with a view to achieve, in the Brazilian Amazon, zero illegal deforestation by 2030 and compensate for greenhouse gas emissions from legal suppression of vegetation by 2030;

1.18 Additional Information Relevant to the Project

Leakage Management

Although there is a risk of leakage, the proponents believe that the project activity will have positive impacts on surrounding areas. This project activity might be a successful benchmark of the following technical and economic aspects:

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[53] Commitments available in Brazil's iNDC, from 2016, and reinforced in its update in 2020/2021. Available at <https://www4.unfccc.int/sites/NDCStaging/Pages/Party.aspx?party=BRA>

I.   Sustainable management of forest resources generating success and profit;

II.   Additional return to forest management, thanks to REDD incentives, which can compensate avoiding deforestation for other activities;

III.   Positive example of sustainable real estate maintenance, in addition to profits with sustainable management plus REDD revenues.

In this context, the project may well stimulate other landowners to adhere to this project concept.

<u>Leakage Management Plan</u>

The main objective of the project is to avoid unplanned deforestation. This goal will be achieved through the expansion of monitoring of the area, along with the inclusion of the local community in the project activities, with environmental education and alternative sources of income to minimize risks of invasion and deforestation within the project area and the reference region.

As aforementioned throughout this project description document, the Itamarati Grouped REDD Project plans to implement activities and training as a way of providing an alternative income source for the local communities that surround the project area.

The non-timber forest product is still to be chosen, as further study is necessary.

Brazilian law such as Decree No. 6,040 ensures the rights of traditional people and communities of attaining sustainable development, and by this, activities such as collection of forest products are permitted as long as they do not cause any damage to the area in question[54]. Hereupon, the project proponents neither can (by law) or want to prohibit the local communities from collecting NTFP in the project area.

Moreover, the project activities will enable the creation of jobs to monitor the area, prioritizing the hiring of local residents for monitoring of the area, with professional training. Income from the sale of credits will make it possible to invest in the educational and professional training of children and adults in the community.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Further Information

No further information to disclose.

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[54] Further detailed information about legal guarantees is discussed on sections 1.14 and 2.5 of this document.

2 SAFEGUARDS

2.1 No Net Harm

The project is designed so that there are no negative impacts. The Table below provides details on the identified potential risks which might affect the project activities and will be monitored.

Table 2. Project Risks

Identified Risk	Potential impact of risk on climate, community and/or biodiversity benefits	Actions needed and designed to mitigate the risk
Uncertainties relating to standing native vegetation cover in the future	GHG emissions, loss of habitat, ecological interactions and animal and plant species.	Monitoring and supervision to avoid deforestation of forest within the project area.
Catastrophic natural and/or human-induced events (e.g. landslides, fire)	Potential risk to community life and permanence, loss of habitat, ecological interactions, animal and plant species.	
Illegal activities within the project area	Deforestation, social conflicts, development of parallel and illegal economies, increase in criminality.	Job creation, development of socioeconomic actions involving the community, promotion of formal and environmental education.
Increase suppression of native vegetation within the project area	Deforestation, land use change, GHG emissions.	REDD+ Project: the additional income generated by carbon credits aims to mitigate the absence of another economic activity that would be carried out in the forest area.
Conflict management with communities in the project area, due to banning of negative impacting/illegal activities	Conflicts with the community can prevent/hinder the implementation of new socioeconomic activities aimed at the local society.	Encouragement and investment in social, economic and environmental aspects in the project region; Increasing independence of the communities in the project area.

These risks will be monitored as part of the monitoring report described on the section Monitoring Plan of this VCS PD and also as part of the monitoring of the non-permanence risk, which shall be evaluated at each verification event.

2.2 Local Stakeholder Consultation

As preconized in the VCS Standard v4 (item 3.17.3), the project proponent will assess the local stakeholders potentially impacted by the project.

Local entities having some influence and activities developed in the Reference Region were chosen through a process to identify them and their possible impact on the Project Activity. Stakeholders chosen for local consultation also include communities and neighbors that might be impacted and set potential partnerships in the future. Thus, the output list of stakeholders from this analysis is described below:

Table 3. Profile of the stakeholders identified

Stakeholder Classification	Justification
Government agency and/or representatives -Direct public administration (State and Municipality)	The carbon project is believed to be in the public sector's interest as it can help the state and municipalities achieve their goals of mitigating greenhouse gas emissions and illegal deforestation. In addition, partnerships with the public sector are very important for the development of activities throughout the project.
Public Administration Company (Autarchy) • INCRA (National Institute of Colonization and Agrarian Reform) • ICMBio (Chico Mendes Institute for Biodiversity Conservation)	These are agencies that are related to the project activity. INCRA is the institute responsible for regulating all rural properties and public lands in the Union and may also assist in verifying the ownership of properties included in the project. ICMBio is an institution linked to the Ministry of the Environment that works in the administration and conservation of protected areas. Since a REDD project is a conservation project, communication with this type of stakeholder is considered essential.

Unions	The participation of unions is important to spread knowledge of the carbon market and include the vision of employees and workers in the region in the development of the project.
Universities and Research institutes	It is believed that the participation of education and research institutions throughout the project is important to develop partnerships and help in the search for sustainable technological innovations, as well as the development of monitoring of fauna and flora, employees and communities training, carbon stock research, etc.
NGOs	NGOs are entities focused on the population's objectives, whether social, environmental or economic, without ties to public governmental entities. Thus, they bring a different point of view to the activity, and communication with these entities brings transparency to the project. In addition, they are key agents for the development of partnerships to strengthen the project activity and enhance socio-environmental co-benefits.
Private organizations	Organizations responsible for carrying out outsourced activities related to forest conservation and social impact.
Local communities	Communities surrounding the Project Area are fundamental agents for the conservation of the region, and the strengthening of their relationship with the property will enhance the generation of socio-environmental co-benefits. Thus, in addition to communicating with the resident families, it is also important to communicate with associations, cooperatives and public health programs that deal directly with the people of the region and can bring insight on the needs of these communities, generating opportunities for improvement with the income from the carbon project.

As required on the VCS Standard, v.4 item 3.17.15, "the management teams involved in the project have expertise and prior experience implementing land management and carbon projects with community engagement at the project scale". Information on the Project Management Team will be further detailed as part of the Non-Permanence Risk analysis.

As required on the VCS Standard, v4, item 3.17.17 – Communication and Consultation, for the Local Stakeholder Consultation, a comprehensive project summary will be actively presented to the communities and other stakeholders in Portuguese. The Project Proponent will objectively communicate in a culturally appropriate manner, including language and gender sensitivity, directly with local stakeholders or their legitimate representatives when appropriate:

i) The project design and implementation, including the results of monitoring;

ii) The risks, costs and benefits the project may bring to local stakeholders;

iii) All relevant laws and regulations covering workers' rights in the host country;

iv) The process of VCS Program validation and verification and the validation/verification body's site visit.

The project proponent understands that stakeholders want and need to be involved in the Project design, implementation, monitoring and evaluation throughout the Project's lifetime. Therefore, complying with the VCS Standard v4 (item 3.17.18), a communication channel will be established for stakeholders to continually express their concerns and to solve eventual conflicts and grievances that arise during project planning, implementation, and monitoring.

It is expected that the communication channel will be a mechanism to ensure that the project proponent and all other entities involved in project design and implementation are not involved in or complicit in any form of discrimination or harassment with respect to the project. All complaints will be available to stakeholders and auditors.

The process for receiving, hearing, responding to and attempting to resolve grievances will be performed within a reasonable time period. This Grievance Redress Procedure has three stages (VCS Standard, v4; item 3.17.18):

1) The project proponent shall attempt to amicably resolve all grievances and provide a written response to the grievances in a manner that is culturally appropriate;

2) Any grievances that are not resolved by amicable negotiations shall be referred to mediation by a neutral third party;

3) Any grievances that are not resolved through mediation shall be referred either to a) arbitration, to the extent allowed by the laws of the relevant jurisdiction or b) 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 (the time to accomplish this stage depends on local jurisdiction delays).

The Stakeholder Consultation is going to be divided into two events: a remote meeting and an on-site consultation with the local community that resides near the project area, both to be scheduled throughout the project development process.

Furthermore, the participants will be informed that the period for requesting information and comments about the Itamarati Grouped REDD Project was open. The deadline for comments will be 30 days from the presentation date, and it could be done by phone or e-mail, both of which were provided in the presentation and explanatory letters.

2.3   Environmental Impact

Deforestation and the associated GHG emissions are a global environmental issue but its effects, locally and regionally, are particularly concerning in developing countries, where economies and livelihoods are more closely linked to farming and use of natural resources. This REDD project will result in positive environmental benefits by conserving forest land leading to less deforestation than would have occurred in the baseline deforestation dynamics.

The Amazon Biome, the location of a hugely diverse fauna and flora, spreads over almost 50% of the Brazilian territory[55]. However, the uncontrolled deforestation is breaking up the forest in this habitat and, without necessary care, entire regions with local fauna and ancient habitats of unique species are at risk of complete destruction[56]. To further quantify, this biome holds the biggest variety of species in the world, and deforestation and degradation of tropical forests are the main cause of global biodiversity loss[57].

The Cerrado biome spreads over almost 25% of the Brazilian territory[58]. However, with the advance of deforestation, the Cerrado loses the native vegetation that gives way to pasture and soybean plantations. This loss of natural areas causes imbalances in species of fauna and flora. In addition to negative consequences of water resources, since the Cerrado is one of the most important sources of water for Brazil[59].

Another benefit, as mentioned on previous Sections of this VCS PD, is that the Itamarati Grouped REDD Project also has the function of establishing a barrier against the advancement of the Brazilian Arc of Deforestation, in addition to protecting the standing forest in a high-pressure cattle ranching region. This creates an urgent situation on which levels of pressure and priority for conservation are high.

2.4   Public Comments

The present PD is now being submitted as under validation to the VCS Pipeline Listing in order to start the public comment period.

2.5   AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

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[55] BRASIL. Ministério do Meio Ambiente (MMA). Projeto de monitoramento do desmatamento nos biomas brasileiros por satélite (PMDBBS). Brasília, 2012. Available at: http://siscom.ibama.gov.br/monitora_biomas/

[56] Margulis S. Causas do Desmatamento da Amazônia Brasileira. BANCO MUNDIAL. Brasil. July, 2003. Available at: http://www.terrabrasilis.org.br/ecotecadigital/pdf/causas-do-desmatamento-da-amazonia-brasileira.pdf .

[57] BRASIL. Ministério do Meio Ambiente (MMA). Inter-relações entre biodiversidade e mudanças climáticas: Recomendações para a integração das considerações sobre biodiversidade na implementação da Convenção-Quadro das Nações-Unidas sobre Mudança do Clima e seu Protocolo de Kyoto. Brasília, 2007. 220 p. (Biodiversidade, v.28). Available at:http://www.terrabrasilis.org.br/ecotecadigital/index.php/estantes/diversos/2115-serie-biodiversidade-28-inter-relacoes-entre-biodiversidade-e-mudancas-climaticas .

[58] Available at: <https://www.icmbio.gov.br/cbc/conservacao-da-biodiversidade/biodiversidade.html/>.

[59] Available at: <https://www.bbc.com/portuguese/brasil-60435369>.

According to the VCS Standard, v4, the project proponent shall conduct a thorough assessment of the local stakeholders that will be impacted by the project, including:

1. The process(es) used to identify the local stakeholders likely impacted by the project and a list of such stakeholders:

   Stakeholders will be identified through research, visits to the project region, and local knowledge from the Instance 1 landowner and management team. As detailed in Section 2.2, stakeholders will be identified considering the communities, government agencies, and educational and research entities, considering relevant Mato Grosso State and Amazon and Cerrado biomes institutions and NGOs within the Reference Region. Sustainable development and rural development agencies will also be contacted. The list is available in the section Local Stakeholders Consultation above.

2. The Project and actions involving local communities will be monitored by SOCIALCARBON indicators or any other applicable social-environmental standard at each verification event to analyze the extent of alternative income generation sources and other programs besides the applied methods for local stakeholders' consultation. Identification of any legal or customary tenure/access rights to the territories and resources, including collective and/or conflicting rights, held by local stakeholders:

   There are no communities living within the Project Area. Instance 1 landowner recognize the presence of the communities near the Project Area and take efforts to maintain a healthy relationship with them. These communities have no rights over the Project Area nor conflicts over land tenure or use rights with the owners.

   On July 13, 2006, the Commission for the Sustainable Development of Traditional Communities was instituted in Brazil by decree[60] and updated in 2016[61], with the objective of implementing a national policy especially directed at such communities.

   The Decree No. 6,040 of February 7, 2007[62], called National Policy for the Sustainable Development of Traditional People and Communities, has the specific objective of promoting the aforementioned "sustainable development" with an emphasis on the recognition, strengthening and guarantee of their territory, social rights, environment, economic and culture. It also advocates the respect and appreciation of the identity of traditional people and communities, as well as their forms of organization and their different institutions[63].

   The Policy is structured around four strategic axes:

   1. Access to Traditional Territories and Natural Resources
   2. Infrastructure
   3. Social Inclusion and

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[60] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/dnn/dnn10884.htm> Last visit 20/07/2022
[61] Available at <http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Decreto/D8750.htm#art20> Last visit 20/07/2022
[62] Available at <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm> Last visited on 05/01/2021.
[63] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visit 05/01/2021

4. Promotion and Sustainable Production

As previously described in section 1.17, these are the same goals and guidelines of this REDD Project.

Article 215 of the Brazilian Constitution determines that the State will guarantee the full exercise of cultural rights. And as distinctive signs of the identity of the different groups that form Brazilian society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[64].

The REDD methodology and the application of additional standards such as the SOCIALCARBON methodology guarantee and are guidelines for the execution of a forest conservation project that ensures not only the avoidance of unplanned deforestation, but also the integration and benefits of the traditional communities surrounding the project area.

Thus, the project is neither based on or plans the removal or alteration of this people's way of life, guaranteeing land use and subsistence production, in addition to traditional customs and methods.

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

As stated in Item 1, project stakeholders might involve from government agencies to the resident community inside and outside the Project Area. Thus, by applying different forms of consultation, it is considered that the Project covers the social, economic, and cultural diversity of the different stakeholders.

For government agencies, private companies and NGOs, communication will be carried out remotely, through writing and speaking, with the presentation of the Project, its impacts and monitoring methodologies, accounting for credits and actions in the region. In a different way, for communicating the Project to local communities within the Reference Region, a presentation will be performed considering their particularities, as well as a socioeconomic diagnosis aiming the development of an action plan to be put into practice along the project lifetime.

These communities have their rights guaranteed by federal, state, and municipal legislation, in addition to assistance from NGOs and various agencies, characterizing the interaction between the groups of stakeholders.

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

Any future significant changes will be informed in this Section.

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

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[64] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visited on 05/01/2021.

The risks and impacts of the Project are analyzed at Section "No Net Harm", designing mitigation strategies for each impact observed. No alteration of communities' area, methodology or way of life in general is predicted. It is planned that the project's revenue will be invested on more socio-environmental programs to involve the local community in the Project and, therefore, minimize the damage to the environment and illegal deforestation.

Risks to Local Stakeholders

The Project Proponent understands that some risks are inherent to the Project Activity, and that others may arise from the stakeholder's point of view. Considering this, the Table below presents potential risks and impacts to local stakeholders and measures taken to mitigate those:

Table 4. Risks to Local Stakeholders

Identified Risk	Potential impact of risk on climate, community and/or biodiversity benefits	Actions needed and designed to mitigate the risk
Uncertainties relating to standing native vegetation cover in the future	GHG emissions, loss of habitat, ecological interactions and animal and plant species.	Monitoring and supervision to avoid deforestation of forest within the project area.
Catastrophic natural and/or human-induced events (e.g. landslides, fire)	Potential risk to community life and permanence, loss of habitat, ecological interactions, animal and plant species.	Monitoring and supervision to avoid deforestation of forest within the project area.
Illegal activities within the project area	Deforestation, social conflicts, development of parallel and illegal economies, increase in criminality.	Job creation, development of socioeconomic actions involving the community, promotion of formal and environmental education.
Increase suppression of native vegetation within the project area	Deforestation, land use change, GHG emissions.	REDD+ Project: the additional income generated by carbon credits aims to mitigate the absence of another economic activity that would be carried out in the forest area.
Conflict management with communities in the project area, due to banning of negative impacting/illegal activities	Conflicts with the community can prevent/hinder the implementation of new socioeconomic activities aimed at the local society.	Encouragement and investment in social, economic and environmental aspects in the project region; Increasing independence of the communities in the project area.

Respect for Local Stakeholder Resources

The Project recognizes, respects, and supports local stakeholders' customary tenure/access rights to territories and resources. The Project will never encroach on private properties or relocate people off their lands without consent. At present there are not any ongoing or unresolved conflicts over property ownership, usage or resources rights, the Project shall not undertake activities that could exacerbate the conflict or influence the outcome of unresolved disputes.

The Project intends to offer benefits and training for the local community, including health related benefits, in addition to providing education for the local community.

No community member has been or will be removed from their land, on the contrary, communities will be supported through programs and incentives the stimulated by the Project. In addition, the Project did not introduce any invasive species or allow an invasive species to thrive through its implementation.

Communication and Consultation

The project will take all appropriate measures to communicate and consult with local stakeholders in an ongoing process for the life of the project. As described above, the project intends to carry out local stakeholder consultations, which will be monitored by the additional standard SOCIALCARBON. Every consultation shall communicate:

- The project implementation, including the project results and the importance of forest conservation activities.

- The risks, costs and benefits the project brings to local stakeholders.

- The benefit sharing mechanism.

- Procedures related to resolving eventual conflicts with stakeholders.

- The process of VCS Program validation and verification and the validation/verification body's site visit.

Grievance redress and conflict management procedures, as well as benefit sharing mechanisms, will be discussed with communities through the stakeholder consultations.

For validation and verification, two consultations will be held, one remotely and the other one on-site, as per described at Section 2.2 – Local Stakeholder Consultation.

Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All the interested parts will received Future Carbon's contact addresses during the Local Stakeholder Consultation. All comments received will be responded, and grievances will be resolved in a suitable time frame whenever possible, taking into account culturally appropriate conflict resolution methods.

3   APPLICATION OF METHODOLOGY

3.1   Title and Reference of Methodology

This project uses the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012[65].

Furthermore, the following tools were used:

- VT0001 - Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3, published on 01-February-2012[66];

- AFOLU Non-Permanence Risk Tool v4, published on 19-September-2019[67].

3.2   Applicability of Methodology

VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1	
Applicability Conditions	Justification of Applicability
a) Baseline activities may include planned or unplanned logging for timber, fuelwood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.	None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4. The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvest, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure , such as waterways and roads. Therefore, in the baseline scenario, the Project Area would continue to be illegally

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[65] Available at https://verra.org/methodology/vm0015-methodology-for-avoided-unplanned-deforestation-v1-1/
[66] Available at https://verra.org/methodology/vt0001-tool-for-the-demonstration-and-assessment-of-additionality-in-vcs-agriculture-forestry-and-other-land-use-afolu-project-activities-v3-0/
[67] Available at https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

	deforested by the deforestation agents described above. With that said, the present criteria are fulfilled.
b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the methodology (table 1 and figure 2).	Within the categories of Table 1 and Figure 2 of the Methodology, the present Project Activity falls within category A, "Avoided Deforestation without Logging". The reason is that the project area contains 100% native vegetation and has never been deforested in the past. In addition, it is important to note that degradation is not included neither in the baseline nor in the project scenario.
c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agroforestry systems meeting the definition of "forest".	These forest classes composing the Project Area are named as per the Technical Manual for Brazilian Vegetation[68]. The area is considered forest as per the definition of adopted by FAO[69]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. No deforested, degraded or areas otherwise modified by humans were included in the Project Area at the Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The Project Area consisted of 100% tropical rainforest in 2007 – over 10 years prior to the project start date – all of which according to the Brazilian definition of forest[70]. This was ascertained using satellite images, as described in the section Baseline Scenario of the present VCS PD.
e) The project area can include forested	As described at Section 1.13 of the present

[68] Avaliable at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf
[69] Available at <
https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses>
[70] Brazil adopts the FAO forest definition: "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity in situ."
Available at: <http://www.fao.org/docrep/006/ad665e/ad665e06.htm>.

wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.

VCS PD, the only soil type within the Project Area is the dystrophic Red-Yellow Argosols. Therefore, no peat or peat swamp forests were found within the Project Area, satisfying this applicability criterion.

VT001	
a) AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced;	The present AFOLU project activity does not involve any economic activity apart from forest conservation, i.e., there are no financial or economic benefits other than VCUs related income. Therefore, it does not lead to violation of any applicable law even if the law is not enforced. Sustainable Forest Management Plan is an authorized and endorsed activity in Brazil, and Instances must have all environmental and legal authorizations necessary to conduct the activity, should it be the case for new Instances joining the Project, as Instance 1 does not perform sustainable forest management activities.
b) The use of this tool to determine additionality requires the baseline methodology to provide for a stepwise approach justifying the determination of the most plausible baseline scenario. Project proponent(s) proposing new baseline methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.	The Methodology provides a stepwise approach to justify the determination of the most plausible baseline scenario, which is detailed at Section 3.4 – Baseline Scenario, below.

3.3   Project Boundary

- Reference Region

    The Reference Region (RR) is an analytical domain through which information on rates, agents, drivers and underlying causes of land-use and land-cover (LU/LC) change are obtained, and subsequently used for future projection and monitoring.

    According to the applied Methodology, as no applicable sub-national or national baseline is available, and the country or subnational region has not been divided into spatial units for which deforestation baselines will be developed, a baseline must be developed for the Reference Region.

    The Reference Region must encompass the Project Area, the Leakage Belt and any other geographic area that is relevant to determine the baseline of the Project Area.

    A geographic area with agents, drivers and overall deforestation patterns observed during the minimum 10-year period preceding the start date was determined, representing a credible proxy for possible future deforestation patterns in the project area.

    The RR was defined in accordance with the Methodology, following two criteria:

    1. For projects below 100,000 ha, the Reference Region should be 20-40 times the size of the Project Area.

    2. The conditions determining the likelihood of deforestation within the Project Area being similar or expected to become similar to those found within the Reference Region, depending on: the landscape configuration and ecological conditions (elevation, slope, vegetation, and rainfall), socio-economic and cultural conditions, and agents and drivers of deforestation (agent groups, infrastructure or other drivers). The latter condition was the most important for adjusting the RR for it to represent the land-use dynamics more accurately. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the principal means of human and product transportation in the region. As such, from the areas directly surrounding the project, the RR was expanded to meet the nearest main waterways and roads.

    In addition, according to the Methodology, three main criteria are relevant to demonstrate that the conditions determining the likelihood of deforestation within the Project Area are similar or expected to become like those found within the Reference Region:

    - **Agents and drivers of deforestation:** Timber logging (both legal and illegal) and cattle ranching are important economic activities within the Reference Region. As detailed in Section 1.13 and to be presented in Section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats

- **Socio-economic and cultural conditions:** The Methodology implies that "the legal status of the land (private, forest concession, conservation concession, etc.) in the baseline case within the project area must exist elsewhere in the reference region. If the legal status of the project area is a unique case, demonstrate that legal status is not biasing the baseline of the project area". This is complied with the areas surrounding the properties that are not public or part of any protected area, such as the Project Area. These conditions also comply with Land Use and Land Tenure items once the conditions of the Project Area are found elsewhere in the Reference Region. The Project Area is governed by the same policies, legislation and regulations that apply elsewhere in the Reference Region. These policies are detailed in Section 1.14. Data presented of the private areas is available at Brazil's Environmental Rural Registration[71], National Protected Areas[72]. It is important to note that neither Indigenous Lands[73] nor Protected Areas were found nearby the Project Area.

- **Landscape configuration and ecological conditions:** To define the Reference Region, the watersheds located around the Project Area were used as units. For each of these watersheds, the average values of elevation, slope and precipitation were determined, as well as the percentages of the different types of vegetation. Based on these values, it was possible to visualize areas that presented similar values to the Project Area's parameters. The area units were then used to achieve an extent of approximately 20 times the size of the Project Area as the Reference Region.

From the definition of this area, which has 890,075.84 hectares (39.11 times the Project Area) and is distributed over the following municipalities Vale de São Domingos, Barra do Bugres, Jauru, Araputanga, Reserva do Cabaçal, Indiavaí, Salto do Céu, Tangará da Serra, Nova Olímpia, Denise and Alto Paraguai. The criteria related to the type of vegetation, elevation, slope and precipitation were tested to verify the similarity in relation to the Project Area and the rest of the Reference Region. For all four variables, the values met the criteria, which indicates an adequacy of the Reference Region.

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[71] Available at <https://www.car.gov.br/publico/municipios/downloads>
[72] Available at <https://metadados.snirh.gov.br/geonetwork/srv/api/records/9407d38f-84d2-48ea-97dd-ee152c493043>
[73] Available at <https://www.gov.br/funai/pt-br/atuacao/terras-indigenas/geoprocessamento-e-mapas>

Figure 3. Reference Region Location

Reference Region location

Project area
Reference Region

0 10 20 km
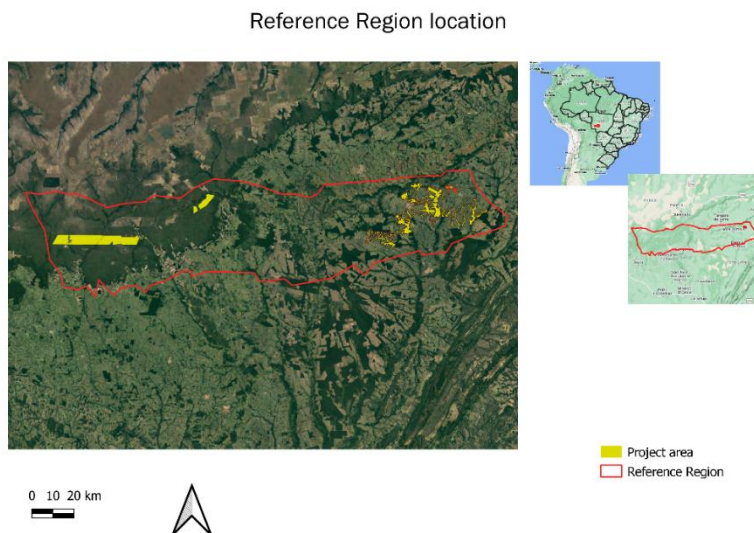
- Project Area

  The Project Area comprises the Instance 1.

  Instance 1 is composed by 4 properties, which have a total area of 69,089.36 ha (Guanabara Farm, Nova Denise Farm, Cachoeira do Ouro Farm and Jauru Farm). According to the VM0015 methodology, the Project Area "shall include only land qualifying as 'forest' for a minimum of 10 years prior to the project start date": the date when activities are initiated to protect against the risk of future deforestation. Thus, some adjustments and discounts are made to comply with the Methodology.

  To define the Project Area, areas deforested up to the Project Start Date, vegetation areas classified as pioneer formation (including peats and wetlands) and areas containing water bodies were excluded from the properties' area. As a result, the Project Area was defined as 22,753.60 ha. Further characteristics of the Project Area until the Project Start Date are described in Section 1.13.

Figure 4. Project Area of Itamarati Grouped REDD+ Project

Project Area

0 2 4 km
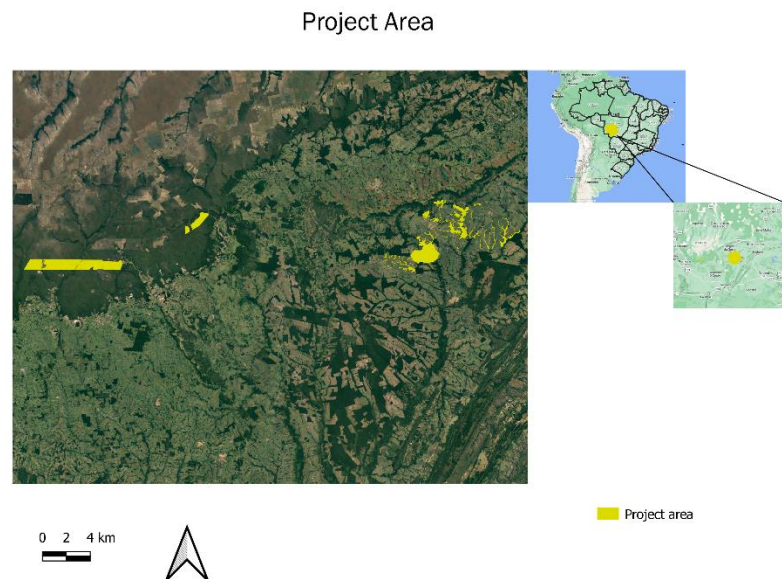
Project area

- Leakage Belt

The Leakage Belt is defined by the Methodology as "the land area or land areas surrounding or adjacent to the project area in which baseline activities could be displaced due to the project activities implemented in the project area", in other words, an area where emissions may occur due to the change in behavior of external agents in response to conservation actions carried out within the Project Area. These areas also include previously deforested areas given the region's economic patterns, but the focus is mainly on areas with potential for forest conversion for other uses.

In order to define the Leakage Belt area, the Opportunity Cost analysis (Option I) was performed. Therefore, the economic viability of livestock production was spatialized in the project's Reference Region. Cattle is one of the main drivers of deforestation in the region, since in addition to being very profitable, it is strongly associated with land grabbing, one of the greatest threats in the region. The analysis consisted of the difference between the selling price of the cattle (per ton) and the average production cost (per ton) plus the cost of transportation to take the product to the nearest consumer center.

The methodology for calculating road transportation costs regarding livestock in the region considered the sum of the distance that would be travelled in a straight line, between the pasture areas and the already open accesses (local highways and roads), with the distance travelled until the nearest commercial centers.

For monetary costs, the freight table of Ordinance No. 034/2017 (SEFAZ, 2017) for minimum prices for the provision of transportation services. Ordinance details the value

of freight for transporting live cargo, in which the scenario of a D. Deck 45/48 trailer transporting a load of 14,000 kg was considered.

The average costs per animal considering an extensive breeding system are approximately R$906.00 (CARRERO et al., 2015). The average price per arroba varies between R$80 and R$92 (CARRERO et al., 2015). In the analysis, the minimum value of R$80 was used. For an average of 13 arrobas per animal, the revenue would be around R$ 1040.00.

All values were corrected by the Broad National Consumer Price Index (IPCA) considering the Project Start Date.

Thus, the calculation of the potential profitability was carried out for each territorial unit in the Reference Region, which can be summarized using the following formula:

$$PPx_l = S\$x - PCx_i - \sum_{v=1}^{V}(TDv * TCv)$$

Where:

PPx$_I$: Potential profitability of product Px at location l (pixel or polygon); R$/t

S$x: Product Px sale price; R$/t

PCx$_I$: Average in situ production cost per tonne of product Px; R$/t

TDv: Transportation distance travelled; km

TCv: Average transportation cost per tonne of product Px; R$/t/km

V: 1, 2, 3…V, surface type on which transportation occurs; dimensionless

From this data, it is possible to conclude that the entire Reference Region is in an economically viable area for livestock production, where the sum of revenues minus total costs is positive.

From the aforementioned considerations, it is possible to conclude that the areas with the highest profitability value would be more attractive for the activity. Thus, the areas with the highest profitability rating and adjacent to the Project Area, within a radius of 10 km, would be where deforestation is most likely to occur due to the Project Activity. In more distant areas, the increase in deforestation, as it is already in course, is probably associated to their proximity to rivers and roads.

Finally, by overlapping the Project Area buffer with the areas with the highest profitability potential, an area of 47,747.00 ha was defined as the Leakage Belt. The Figure below

illustrates its location. In summary, the Leakage Belt was composed by areas within a 3km radius from the Project Area boundaries, which present higher economic viability for cattle ranching.

Figure 5. Leakage belt Location

Leakage Belt Location
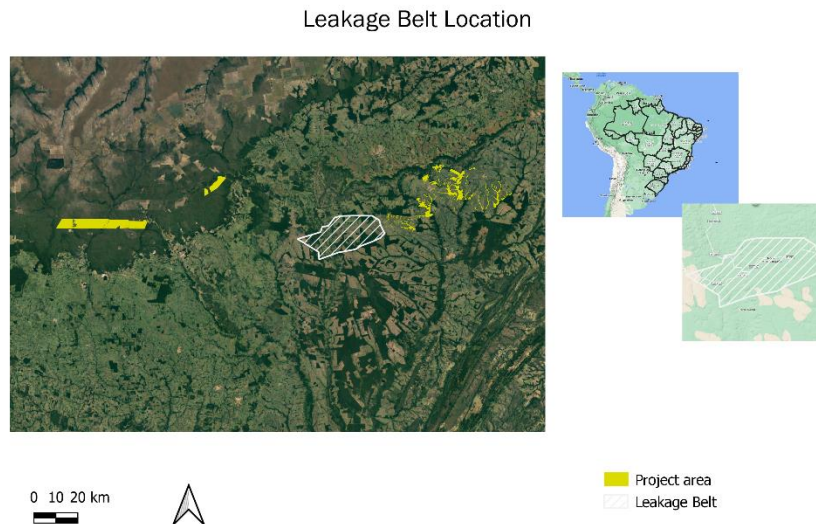
- Leakage Management Area

The Leakage Management Area (LMA) combines non-forest areas located outside the project boundary in which the Project intends to implement activities that will reduce the risk of leakage in the Project Scenario. These activities must include the agents of deforestation and seeks to implement alternative income sources to contribute to forest conservation. Leakage management could involve agricultural, agroforestry, reforestation, education, among other activities.

The Leakage Management Area was defined considering the nearest communities to Instance 1. Two Indigenous Lands (Figueiras and Umutina) and four settlements (Corgão, Triangulo, Riozinho, and Nova Conquista) were selected. Their location represented in the Figure below:

Figure 6. Leakage Management Area of the Itamarati Grouped REDD Project

- Forest

  The Brazilian Forest Service's definition of forests is lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE)[74], updated by the SIVAM project[75]. Brazil endorses the definition of forest adopted by FAO: "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 %, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use".

  In order to define the Project Area, as previously described in this Section, only areas that comply with the definition of forest were considered. From this, the Project Area was submitted to an analysis using MapBiomas mapping and classification. MapBiomas applies a hierarchical system with a combination of LULC classes in accordance with national definition[76]. Thus, this assessment guarantees that the Project Area meets a definition of forest that has international recognition.

  In addition to this, as per the VM0015 Methodology, "the Minimum Mapping Unit (MMU) size of the LULC maps created using RS imagery shall not be more than one hectare irrespective of forest definition". Thus, the 30m pixel resolution through LANDSAT images used for mapping have the minimum mapping unit defined at 30x30m (0.09ha), easily fitting into the Methodology requirements. Details on data and image processing can be verified at Section 3.4.

<u>Temporal Boundaries</u>

- Starting date and end date of the historical reference period

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[74] Available at <https://snif.florestal.gov.br/pt-br/conhecendo-sobre-florestas/168-tipologias-florestais?modal=1&tipo=tableau>

[75] As of 1996, through a contract signed between the Implementation Commission of the Airspace Control System - Ciscea, its Amazon's Surveillance System Project - SIVAM, and IBGE, updated the information that make up the Legal Amazon, attending, at the same time, the Systematization of Information on Natural Resources project. Information available at <https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf>; SIVAM Project: <https://www.camara.leg.br/noticias/55929-o-que-e-o-sivam/>

[76] A cross-reference of the MapBiomas LCLU classes with classes from other classification systems such as FAO, IBGE and National Inventory is available at Annex III of MapBiomas general handbook. Available at <https://mapbiomas-br-site.s3.amazonaws.com/Metodologia/Amazon_-_Appendix_-_ATBD_Collection_6.docx.pdf>

The adopted historical reference period was from 2011 to 2021.

- Starting date of the project crediting period of the AUD project activity

    The project has a crediting period of 30 years, from 25-April-2022 to 24-April-2052, which may be renewed up to 100 years.

- Starting date and end date of the first fixed baseline period

    The first baseline period is from 25-April-2022 to 24-April-2028.

<u>Carbon Pools</u>

The applied Methodology considers six carbon pools. Their inclusion or exclusion within the boundary of the proposed AUD Project Activity, as well as the respective justification/explanation, are described in the Table below:

Figure 7. Carbon pools included or excluded within the boundary of the proposed AUD Project Activity

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Carbon stock change in this pool is always significant
	Non-Tree: Excluded	Excluded in carbon stocks estimates
Below-ground	Included	Stock change in this pool is significant
Dead wood	Exluded	Excluded for simplification. In the baseline scenario, dead wood is not removed and/or used before the deforestation, as it is often in the process of decomposition in the forest, being left to burn in the baseline case. Therefore, not accounting for this carbon pool is conservative, as it does not consider GHG emissions from deforestation and burning in the baseline.
Harvested wood products	Excluded	Stock change in this pool is not considered in baseline and project scenarios.
Litter	Excluded	Excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the AUD project activity. This exclusion is conservative.
Soil organic carbon	Excluded	Recommended when forests are converted to cropland. Not to be measured in conversions to pasture grasses and perennial crop according to VCS Methodology Requirements, 4.2.

In accordance with the Methodology, approximately 1/10 of the carbon stock in the below-ground pool of the initial "forest" class will be released in a ten-year interval. This is further discussed at Section 4.1 – Baseline Emissions.

Furthermore, the Methodology considers the two sources of GHG emissions listed in the Table below. Their inclusion or exclusion within the boundary of the proposed AUD Project Activity, as well as the respective justification/explanation, were also discussed:

Figure 8. Sources of GHG included or excluded within the boundary of the proposed AUD Project Activity

	Source	Gas	Included / Excluded	Justification / Explanation of choice
Baseline scenario	Biomass burning	CO_2	Excluded	Excluded as recommended by the applied methodology. Counted as carbon stock change.
		CH_4	Included	Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.
		N_2O	Included	Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.
		Other	Excluded	No other GHG gases were considered in this project activity.
	Livestock emissions	CO_2	Excluded	Not a significant source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
		Other	Excluded	No other GHG gases were considered in this project activity.
Project scenario	Biomass burning	CO_2	Excluded	No biomass burning increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		CH_4	Included	Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology.
		N_2O	Included	Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology.
		Other	Excluded	No other GHG gases were considered in this project activity.
		CO_2	Excluded	Not a significant source

Livestock emissions	CH_4	Included	Included as non-CO2 emissions from livestock in the leakage management area
	N_2O	Included	Included as non-CO2 emissions from livestock in the leakage management area
	Other	Excluded	No other GHG gases were considered in this project activity.

3.4   Baseline Scenario

In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the Reference Region, Project Area and Leakage Belt, as described below. Therefore, the project falls into the AFOLU-REDD category, specifically: Avoided Unplanned Deforestation (AUD). The revenue from the present REDD project is not only essential to maintain this area as standing forest, as described under the Additionality of the Project (Section 3.5), but also to carry out the present Project's Leakage Management Activities.

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

ANALYSIS OF AGENTS, DRIVERS, AND UNDERLYING CAUSES OF DEFORESTATION

As specified in the Methodology, it is necessary to understand "who" the deforesting agent is and what drives land-use decisions ("drivers" and "underlying causes"). This analysis is important for two main reasons: (i) Estimating the quantity and location of future deforestation; and (ii) Designing effective measures to address deforestation, including leakage prevention measures[77].

- Database organization and pre-processing

   The forest dynamics data, deforestation vectors and other base information from the region under analysis, which were used to build the Project Baseline, were organized in a spatialized database, in the File Geodatabase format of ArcGIS 10.8. The data come from different sources and have different cartographic scales (Table below). The files are stored in vector and matrix (raster) format.

   At first, several layers were pre-selected, which may be related to the greater chance of deforestation in the Reference Region and Project Area. For example, rivers and roads are usually vectors of deforestation because they are the access routes to forest areas,

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[77] VM0015: STEP 3: Analysis of agents, drivers and underlying causes of deforestation and their likely future development, page 37. Available at: <https://verra.org/wp-content/uploads/2018/03/VM0015-Methodology-for-Avoided-Unplanned-Deforestation-v1.1.pdf>.

where deforestation agents can encroach the territory to extract timber and other deforestation byproducts.

Table 5. Spatialized data for the determination of the deforestation dynamics in the Reference Region and baseline structure

Data	Scale/Resolution	Year	Source
Watershed database	1:1.000.000	2012	ANA
Water bodies database	1:100.000	2020	ANA
Municipalities database	1:250.000	2019	IBGE
Rivers database	1:1.000.000	2013	ANA
FUNAI Indigenous Lands database	1:500.000	2020	FUNAI
CNUC Protected Areas database	Varia de 1:5.000 a 1:100.000	2019	MMA
Federated Units Database	1:250.000	2019	IBGE
Rainfall database	1 km	2020	Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315.
Forest Class database	1:250.000	2019	IBGE
Road transport infrastructure database	1:250.000	2019	IBGE
Road transport infrastructure database		2012	Imazon
Cities Points database	1:250.000	2019	IBGE
Settlement Projects database		2020	INCRA
Elevation digital model	30m		SRTM

The following information is provided for the identified agent of deforestation:

a) Cattle ranching

Cattle ranching (pasture) is usually financed by means of initial capital obtained in wood logging. Deforestation is considered to occur through clear-cutting of forests for logging followed by pasture installation. This deforestation pattern may be caused by private landowners themselves and also by professional land-grabbers, by means of invasions in unguarded areas. The final use of virtually all occupied lands would be cattle ranching (pasture).

The representativeness of livestock in Mato Grosso is large both in terms of culture and economy. The colonization process in the region took place during the depletion of mines in central Brazil, and livestock was the main agent of formation and restructuring of the Mato Grosso's territory, especially in the south, where today is the state of Mato Grosso do Sul. In addition, after the Paraguay War, the region began to be restructured, receiving new residents who sought to rebuild areas affected by the war and to occupy pastures for raising cattle. The activity also helped to reduce the distance that separated the State from the large population centers, as the expansion of large cattle ranches and the occupation of fertile areas for agriculture created new population centers[78]. Thus, the economic base of the state gradually transmuted from mining to agro-pastoral activity.

The northern region of the state gained greater relevance in the livestock sector in the 70s, when the Brazilian military government decided to occupy the Amazon, and cattle once again accompanied the colonizers, resulting in an explosive expansion of pastures and herds. While the Brazilian herd increased by 60% between 1987 and 2013, the herd in the Amazon states (Mato Grosso, Pará, Acre, Rondônia, Roraima, Amazonas, Tocantins, Amapá, and Maranhão) practically tripled (280%), because livestock became the cheapest means of occupying the cleared land[79].

In summary, Brazilian beef cattle farming developed through the expansion of the agricultural frontier (which occurs through deforestation in regions lacking infrastructure) and through the use of lands depleted by agriculture. The activity has contributed decisively, since colonial times, to the occupation of Brazilian territory.

Thus, as commented in previous sections, cattle ranching is of great importance in the formation of the Mato Grosso territory, as a result of profitability and convenience, and pasture is the most common land use in deforested areas. The Figure below shows that from 2010 to 2021 it is possible to observe that cattle herd is increasing in both municipalities within the Reference Region and Project Area.

Given the historical context, it is relevant to emphasize the economic importance of livestock in Brazil, as a whole, and especially in the state of Mato Grosso. Although Brazil ended 2020 registering a GDP of BRL 7.4 trillion, 4.1% lower than 2019's GDP, on the other hand, livestock GDP totalled R$747.05 billion, 20.8% higher than the R$618.5 billion registered in 2019[80].

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[78] Available in <https://periodicos.ufms.br/index.php/AlbRHis/article/download/5100/3781/>
[79] Available at <https://csr.ufmg.br/pecuaria/portfolio-item/historico-3/>

[80] Available on pages 3 and 5 at <https://www.abiec.com.br/publicacoes/beef-report-2021/>

Figure 9. Livestock GDP and its average growth rate in nominal and real values (2010-2020)

Fonte: Athenagro, Abiec, Secex, IBGE, Cepea, BNDES
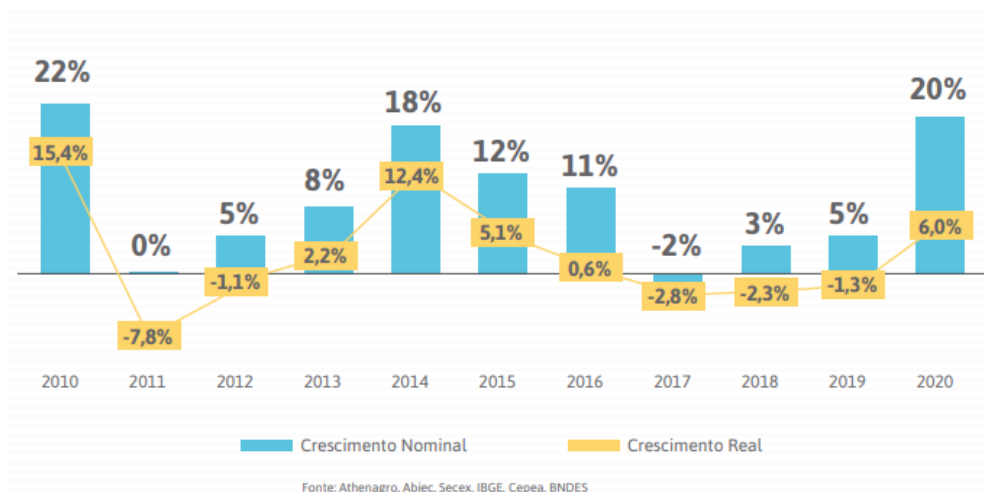
It is worth noting that in 2020, livestock GDP represented 10% of Brazil's total GDP, as may be observed in the Figure below:

Figure 10. Evolution of the participation of the beef cattle GDP on the total GDP of Brazil[81]
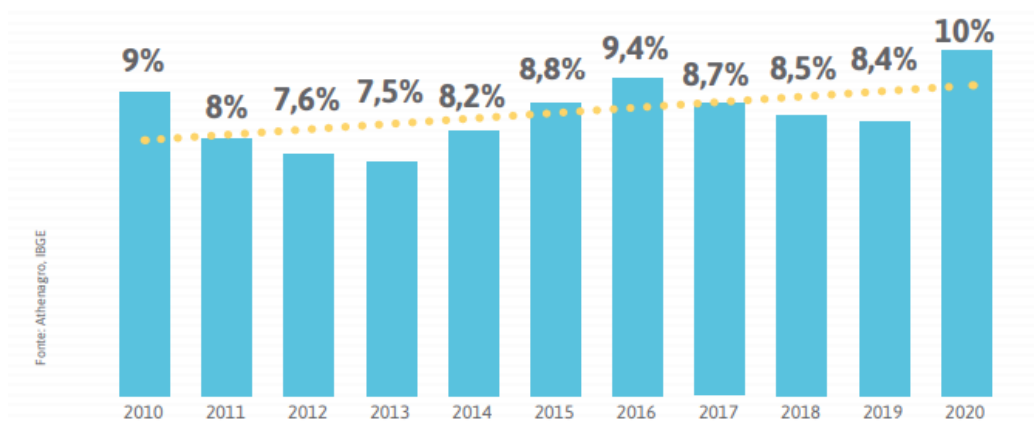
The state of Mato Grosso is the largest producer of cattle in Brazil, with a share of 14.08% of the total Brazilian herd, with a 2.07% growth in the last 10 years[82]. Thus, with the increase in exports, in addition to domestic consumption, the forecast is for an increase in animal production[83],[84].

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[81] Available on page 2 at <https://www.abiec.com.br/publicacoes/beef-report-2021/>

[82] Available on page 15 and 16 at <https://www.abiec.com.br/publicacoes/beef-report-2021/>

[83] Available at <https://bucket-xiruexterno-2.s3.sa-east-1.amazonaws.com/2/1206019866471899136/1208303492890828800-.pdf?X-Amz-Expires=432000&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIOZVUSV4HGV74RLA/20221109/sa-east-1/s3/aws4_request&X-Amz-Date=20221109T132905Z&X-Amz-SignedHeaders=host&X-Amz-Signature=833e1c01018ad0b6b4b63f8eaa42f4bc183945d33bce8a3847adddf03ce40878>.

[84] Available at <https://summitagro.estadao.com.br/tendencias-e-tecnologia/10-megatendencias-para-a-pecuaria-bovina-ate-2040/> and <https://www.embrapa.br/busca-de-noticias/-/noticia/53874497/embrapa-divulga-estudo-inedito-sobre-tendencias-para-a-cadeia-de-carne-bovina>

b) **Timber Harvesting**

As mentioned above, timber logging (both legal and illegal) is an important economic activity within the Reference Region.

For the period from August 2020 to July 2021, the legality of timber harvesting in the Brazilian Amazon was assessed by *Rede Simex* (Simex Network, in free translation), which comprises environmental institutions such as Imazon, Idesam, Imaflora and ICV.

From this assessment, it was possible to identify 377,624 hectares of logging during that period. Of the total area mapped, 235,196 hectares (62%) occurred in compliance with valid timber harvesting permits for the period, while 142,428 hectares (38%) occurred in an unauthorized fashion. The largest share of the area logged without authorization (72%) was identified as being inside registered rural properties[85]. This means that the Amazon had an area of forest equivalent to the city of São Paulo affected by irregular activity in just one year.

This rate of unauthorized exploitation is very high and represents serious socio-environmental damage to the Amazon, which contributes to preventing the region's sustainable development. Without sustainable forest management, aside from the forest's degradation and release of carbon stocks, there are more risks of conflicts, formal jobs cannot be generated, and environmental and land taxes are not charged.

According to the ICV (*Instituto Centro de Vida*, Life Center Institute in free translation)[86], seven out of ten hectares of forest with unauthorized logging in the Amazon occur in Mato Grosso. Between August 2020 and July 2021, 277,048 hectares of logging were mapped in Mato Grosso, which represents an 18% increase in the area logged in the State compared to the previous period (August 2019 - July 2020).

In order to analyse the legality of such logging, 545 forest exploration permits issued by the State Secretariat for the Environment (Sema/MT) were verified. This assessment identified that 63% of the mapped logging area (173,381 hectares) was legally logged, that is, with valid permits and within the authorized area. Illegal exploitation, on the other hand, affected 103,668 hectares of forests in Mato Grosso. This corresponds to 37% of the total exploration mapped in 2021, consisting in a 17% increase in the area illegally explored in comparison to the previous year[87], representing 73% of the illegal logging in the Amazon region[88].

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[85] Available at <https://www.icv.org.br/website/wp-content/uploads/2022/10/infografico-simex-amazonia-ag2020-jul2021-en-2.pdf>

[86] Available at < https://www.icv.org.br/publicacao/mapeamento-da-exploracao-madeireira-em-mato-grosso-agosto-2020-a-julho-2021/>

[87] Available at <https://www.icv.org.br/publicacao/mapeamento-da-exploracao-madeireira-em-mato-grosso-agosto-2020-a-julho-2021/>

[88] Available at <https://www.icv.org.br/2022/09/mato-grosso-concentra-70-da-exploracao-ilegal-de-madeira-na-amazonia/>

The data comes from research published by *Simex*. The survey mapped 377 thousand hectares of timber harvested in the Amazon through satellite images between August 2020 and July 2021. And, in an unprecedented way, obtained access to public data on authorizations for this activity issued by environmental agencies in all analysed States.

Although most of the logging in Mato Grosso has been authorized, the area with the presence of illegal activity grew 17% compared to the previous survey, which analysed the period from August 2019 to July 2020. Only in the State's indigenous lands, there was a 70% increase in the illegal extraction of wood[89].

Also, according to the analysis, almost 40% of the area with recorded activity in the region did not have authorization from environmental agencies. And 15% of the unauthorized extraction took place within protected areas, such as indigenous lands and conservation units[90]. The survey showed for the first time the percentage of irregularity in logging throughout the Amazon.

Wood, timber and mostly firewood, represent a product with a much more attractive value compared to other types, being even more advantageous when combined with animal production afterwards, where there is no need for forest management.

Furthermore, according to the Methodology, after analysing the main deforestation agents acting within the Reference Region during the historical reference period, it is necessary to identify the main drivers affecting the amount of deforestation.

Some of the factors that characterize, and drive deforestation and subsequent cattle ranching are the low cost of the forested area; soil fertility and favorable weather; well-structured soil and mainly flat conditions of the area; tradition of farming existing in the municipalities and the meat market of the region.

a) **Driver variables explaining the quantity (hectares) of deforestation:**

1) **Population growth**

This deforestation driver is associated with the dynamics of the local cattle market, as well as with the increase of potential deforestation agents working in the region. Several studies for the Amazon biome[91,92,93] mention that deforestation rates may increase because of population growth and the need for more land for food, fuelwood,

[89] Available at <https://www.icv.org.br/2022/09/mato-grosso-concentra-70-da-exploracao-ilegal-de-madeira-na-amazonia/>
[90] Available at <https://www.icv.org.br/2022/09/mato-grosso-concentra-70-da-exploracao-ilegal-de-madeira-na-amazonia/>
[91] ANGELSEN; KAIMOWITZ. Rethinking the Causes of Deforestation: Lessons from Economic Models. The World Bank Research Observer, vol. 14, no. 1 (February 1999), pp. 73–98. Available at < https://www.researchgate.net/publication/11117669_Rethinking_the_Causes_of_Deforestation_Lessons_from_Economic_Models>
[92] ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997 Available at < https://doi.org/10.1300/J091v07n01_03>
[93] MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003 Available at < https://www.prb.org/resources/population-growth-and-deforestation-a-critical-and-complex-relationship/>

timber, or other forest products. The number of people and their socio-economic conditions both have a significant impact on deforestation. As agriculturally based population density increases near forested areas, the strongest relationship between population growth and deforestation occurs, as local people and young migrant families arrive at the forest frontier and clear the land to provide more area for subsistence farming. Therefore, besides addressing the population numbers, policies that impact the socio-economic conditions of the people are needed if deforestation is to be delayed or forests are to remain standing.

From the 2010 census and the 2021 estimate provided by IBGE[94], it is possible to note that the population has grown in all municipalities, and it is a very similar rate and trend:

Figure 11. Nova Olímpia, Denise, Barra do Bugres, Salto do Céu and Reserva do Cabaçal population (2010-2021)

City	Population - 2010 census	Population - 2021 estimate
Nova Olímpia	2,572	2,754
Denise	8,523	9,626
Barra do Bugres	31,793	35,642
Salto do Céu	3,908	3,226
Reserva do Cabaçal	2,572	2,754

2) **Prices of timber logs and livestock per arroba:**

As previously described on items a) Cattle ranching and b) Timber logging, the prices of timber logs and arroba (livestock) are the main reason why the cattle herd increased in the period. In addition, during the same period, firewood logging also increased, being the main produced product in the same municipalities.

As detailed on previous Sections and in the description of deforestation agents above, firewood and timber prices have much higher value than other products exploited in the region, as they are the only extraction activities carried out.

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[95]. Thus, this disparity promotes the purchase of newly forested areas, deforestation, and an increase in the creation of new pasturelands.

During 2021 in Mato Grosso, cattle prices were in a stable trend, varying between R$259 and R$293. An overvaluation of the "arroba" (unit use to count the animal's weight, around 15 kg) made the monthly average price soar in comparison to 2020 (R$260).

Figure 12. Average cattle price in Mato Grosso, in R$[96]
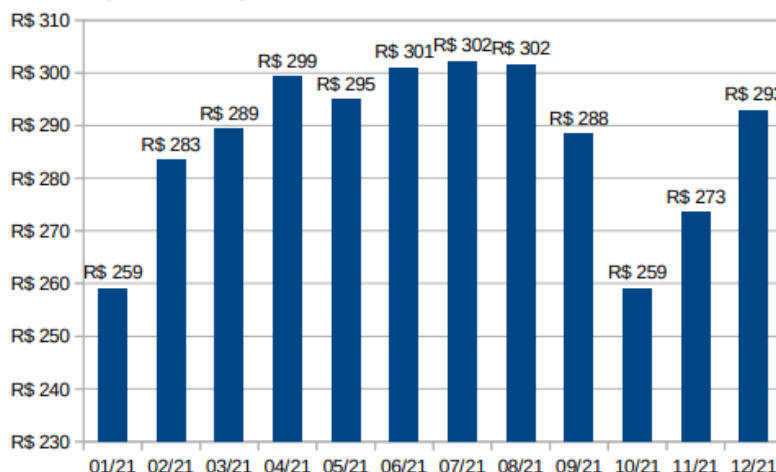
Thus, partly due to the expansion of globalization, deforestation rates in the Amazon Rainforest appear to be linked to the growth of the international market, especially of beef[97].

b) Driver variables explaining the location of deforestation:

The main drivers of deforestation related to the location of impact in the Project region are:

1) Distance from deforested areas

The presence of "non-forest" is a driver variable predicting quantity and location of future deforestation. Forested areas are influenced by their proximity to areas that have already been deforested. The distance from previously deforested areas is one of the major causes of forest degradation in the Amazon biome and their spatio-temporal dynamics are highly influenced by annual deforestation patterns. In

[95] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. Economia Verde: Desafios e Oportunidades, Campinas, v. 8, p.143-155, jun. 2011. Available at: < https://silo.tips/download/o-desmatamento-da-floresta-amazonica-causas-e-soluoes>
[96] Available at <https://www.conab.gov.br/info-agro/analises-do-mercado-agropecuario-e-extrativista/analise-regional-do-mercado-agropecuario/analise-regional-mt-pecuaria>. Monthly conjuncture of January 2022 (*Pecuária - Análise Janeiro/2022*).
[97] Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. **Conservation Biology** 19(3):680-688. Available at < https://www.jstor.org/stable/3591054>

addition, forest fragmentation results from deforestation and disturbance, with subsequent edge effects extending deep into remaining forest areas[98],[99]. This driver was also analysed for the deforestation projection model, as mentioned throughout the present VCS PD.

2) Roads, highways, access roads and navigable rivers

Access roads are means of communication, which influence the spatial distribution of the land-use. They have an influence on fragmentation, population densities, agriculture and pastureland. The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation[100],[101],[102]. It is broadly recognized that deforestation is accelerated in regions that have denser road networks[103].

Waterways remain the overwhelmingly predominant means of transport and access to forest products. The Reference Region is located in one of Brazil's richest areas in terms of waterways, which historically determined the locations of settlements in relation to extraction of non-timber forest products (NTFPs) and timber. Waterways remain the overwhelmingly predominant means of transport and access to forest products. Furthermore, the small sawmills to which timber is taken for processing are located on riverbanks. For these reasons, the great majority of the regional population is located in small settlements on the banks of the rivers.

The Reference Region holds a dense network of primary, secondary, and tertiary roads. The lands located near these roads are more likely to undergo deforestation, generating a progressive fishbone effect. This deforestation pattern may even increase exponentially in some cases, given that a single road may originate several other offshoot roads in the future, and so on.

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[98] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757 Available at <https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

[99] IMAZON. Carbon emissions from deforestation and forest fragmentation in the Brazilian Amazon. 2011. Available at: http://imazon.org.br/publicacoes/carbon-emissions-from-deforestation-and-forest-fragmentation-in-the-brazilian-amazon/?lang=en .

[100] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757. Available at <https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

[101] GENELETTI, D. Biodiversity Impact Assessment of roads: an approach based on ecosystem rarity. Environmental Impact Assessment Review, v.23, n.3, p.343-365, 2003 Available at <https://www.sciencedirect.com/science/article/abs/pii/S0195925502000999>

[102] Fearnside, P.M. e P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the Potential Impact of Linking the Arc of Deforestation to Central Amazonia. Environmental Management 38:705-716. Available at <https://www.researchgate.net/publication/6803490_BR-319_Brazil's_Manaus-Porto_Velho_Highway_and_the_Potential_Impact_of_Linking_the_Arc_of_Deforestation_to_Central_Amazonia>

[103] Available at <https://imazongeo.org.br/>

The Project Activity results in the increase in intensity of surveillance activities during the crediting period, in such a way that the main means of access to the Project Area will be continuously monitored and controlled, as a mitigation action.

3) Presence of protected areas, indigenous lands and settlements

There are several settlements around the Rerence Region. The ones closest to the Project Area are listed below:

- *Nova Conquista* Sustainable Development Project

- *Riozinho* Settlement Project

- *Triângulo* Settlement Project

- *Corgão* Settlement Project

The analysis of the contribution of settlements to deforestation in the Amazon was carried out from the 2016 reference[104], due to the lack of in-depth literature updated until 2021.

Agrarian reform settlements have emerged as one of the main focuses of deforestation in the Amazon between 2007 and 2014. The analysis indicates that deforestation seems to be closely linked to some of the main categories of existing settlement projects in the Amazon, as these classifications group together modalities with specific objectives, established to promote, either agricultural-based, or forest-based and extractive land uses[105].

Historically, a large part of deforestation since 1997 has occurred in PAs (*Projetos de Assentamento* – Settlement Projects). The contribution of settlements to total deforestation in the Amazon has increased progressively, from an average of 18% between 2003 and 2005, to an average of 30% between 2010 and 2014.

This pattern indicates that the processes that affect the dynamics of forest clearing outside the settlements have repercussions within them, and that the strategies to encourage the reduction of deforestation in these settlements cannot be treated as isolated cases, distant from the local context of the territory in which they are inserted. It should be considered, however, that punitive strategies must be treated

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[104] Available at < https://ipam.org.br/wp-content/uploads/2016/02/Desmatamento-nos-Assentamentos-da-Amaz%C3%B4nia.pdf>
[105] Settlements can be divided into two groups: I - those created through land acquisition by Incra, in the traditional way, called Settlement Projects (Projeto de Assentamento - PA), that include the environmentally differentiated ones and the Decentralized Sustainable Settlement Project (Projeto Descentralizado de Assentamento Sustentável - PDAS); II - those implemented by government institutions and recognized by Incra for access to some public policies of the National Agrarian Reform Program (Programa Nacional de Reforma Agrária - PNRA). More information available at < https://www.gov.br/incra/pt-br/assuntos/reforma-agraria/assentamentos#:~:text=Os%20assentamentos%20podem%20ser%20divididos,de%20Assentamento%20Sustent%C3%A1vel%20(PDAS)%3B>

cautiously and in a surgical and educational manner within them, taking into account the impact that these sanctions may have on the food security of the real beneficiaries of agrarian reform. Thus, the importance of this carbon project and the socio-environmental actions to be applied as a way of mitigating deforestation is highlighted. The strategy is to detach the need for illegal deforestation as alternative income is generated in these communities, creating other economically productive strategies.

In conclusion, in 2014, as well as in the previous three years, few settlements were responsible for a large part of deforestation in this land category, with deforestation in these settlements occurring mainly through large continuous blocks. These two results indicate that deforestation in Amazonian settlements is localized and possibly results from a process of land reconcentration. Thus, the deforestation that occurs within the settlements is not carried out solely by land reform clients. The analysis show that it is common to find consolidated farms consolidated in the settlements. Entrepreneurs, traders and other segments of local society, not clients of the agrarian reform, have acquired lots within the settlements, following a strategy that begins with the commercialization of the remaining wood in the forests of the lots, followed by the deforestation of the same, and the establishment of pasture to cattle ranching.

- **Identification of underlying causes of deforestation**

Underlying causes of deforestation include the political scenario related to the environment in the baseline period. The political instability would probably reflect in the increase of deforestation. There are no applicable mitigation actions for these causes, as they are political and determined through elections every 4 years. However, it is expected that the local actions developed by the project activity will help to reduce the impacts of these facts.

Due to being located in a region of large cattle ranchers, miners and settlements, the reference region has a considerable social conflict issue, primarily land conflict. Land is occasionally illegally occupied by squatters and illegal loggers[106],[107],[108]. Thus, the main underlying causes of deforestation within the reference region are associated with land conflicts (tenure issues), and the lack of public policies promoting sustainable alternatives to combat deforestation and degradation activities.

The continued lack of resolution of land tenure issues contributes to reducing legal production options and continues to promote the expansion of deforestation associated with cattle farming and land speculation in southern Amazonas. According to studies conducted in the region by Idesam, there is a pressing need for restructuring at a local

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[106] Available at <https://g1.globo.com/natureza/noticia/2019/09/04/invasoes-grilagem-e-queimadas-ameacam-areas-protegidas-na-amazonia.ghtml>

[107] Available at <https://acervo.socioambiental.org/sites/default/files/documents/prov0227_0.pdf>

[108] Available at https://www.bbc.com/portuguese/brasil-56211156

level, which is lacking investment in infrastructure, equipment, and human resources to attend to strong land-tenure demand. The low presence of Governance and lack of land-tenure documentation, with thousands of rural producers owning non-documented properties, promotes a scenario of forest destruction for exploration of natural resources and creation of pastureland, driving the tendency for the frontier to grow[109].

Environmental governance in Brazil can be divided into three major periods: pre-2005, a period with very poor governance and high rates of deforestation; 2005-2011, a period with improvements in environmental governance and effective results in reducing deforestation; and after 2012, when governance suffered a gradual erosion with the large amnesty granted to past illegal deforesters in the revision of the Forest Code and a return of deforestation rates to the peak levels of the last decade.

2012's political scenario, with the flexibilization of the forest code legislation and amnesty to deforesters, the interruption of the creation of protected areas, including the unprecedented reduction of several of these protected areas in the Amazon, among other actions, proved to be the beginning of a series of setbacks, which have continued over the past 5 years.

From 2016 onwards, the impeachment on Brazil's president Dilma Rousseff wide opened the dismantling policy of the environmental agenda created by the new government (Michel Temer, May 12, 2016 to December 31, 2018) to gain the support of the ruralist bench, constituted by a coalition of parliamentarians of the Brazilian National Congress with common interests, such as the advance of the livestock and agribusiness barrier in Brazil – and, consequently, the deforestation and the environmental policies that prevent it from occur. The Brazilian National Congress has approximately 500 parliamentarians, which means that obtaining support from the ruralist caucus (which has around 350 parliamentarians) guarantees a strategic advantage for the approval of provisional measures and decrees.

The 2017's federal government is marked by a series of acts against the environmental area, and such as Cutting budget and freezing investments in Brazilian science. The main ministries linked to Higher Education Institutions (Ministry of Education and Ministry of Science and Technology) suffered billionaire budget cuts, endangering scientific research and environmental monitoring bodies, as the largest network of biodiversity research in Brazil, the PPBio. Besides the budget cut, the Ministry of Science and Technology suffered another attack when it was merged with the Ministry of Communications, devaluing science by uniting two ministries with opposing goals and threatening the future of the country's scientific research. After the measure, which froze investments in education for the next 20 years, the National Council for Scientific and Technological Development

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[109] INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Reduções de Emissões do Desmatamento e Degradação Florestal (REDD+): Estudo de Oportunidades para a Região Sul do Amazonas. Manaus: Idesam, 2011. 45 p. (Relatórios Técnicos nº1). 141 Available in < https://idesam.org/publicacao/REDD_Estudo_de_Oportunidades_Sul_Amazonas.pdf>

(CNPq), the responsible body for financing most undergraduate and graduate research projects in the country, had a budget in 2017 lower than the equivalent of 2004. The scrapping of Brazilian scientific research bodies directly affects the monitoring and production of knowledge about the dynamics of deforestation and the influence of agribusiness in it.

In the Bolsonaro's pre-election period in 2018, the country was already discussing the threat of political bargaining to climate mitigation and the forest conservation in general. In exchange of political support, the government offered landholders to increase deforestation, and the signature of provisionary acts and decrees lowering environmental licensing requirements, suspending the ratification of indigenous lands, reducing the size of protected areas and facilitating land grabbers to obtain the deeds of illegally deforested areas[110].

In the beginning of 2019, the fusion of Environment and Agriculture Ministries was a clear attempt to obtain more rights for the expansion of agriculture and livestock. The decision was canceled a few days later, after pressure from environmentalists and others in the sector; however, major changes occurred in the ministerial office, limiting the reach and autonomy of the Environmental Ministry, with the absence of resources to combat deforestation[111].

In addition, the transference of policies and instruments of water resources, including the National Water Agency (ANA) to the Ministry of Regional Development[112] and the Brazilian Forest Service and the Rural Environmental Registry (main instrument for controlling the regularization of large and small properties in forest regions) to the Ministry of Agriculture, Livestock and Supply[113] demonstrated the dismantling of the Environment Ministry. Furthermore, the officialization of indigenous lands, in addition to other land tenure issues, such as the agrarian reform and land regularization in the legal Amazon and traditional territories have also been transferred to the Ministry of Agriculture, Livestock and Supply[114].

As a consequence, the deforestation in the Amazon Rainforest was widely reported in 2019, as it was the third largest in history, with an increase of 29.5% in comparison to 2018. In total, 9,762 km² were deforested during that year[115]. In August, during the peak of fire warnings in the forest, fact that caused climate effects in São Paulo, 2,790 km

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[110] Available in < https://epoca.oglobo.globo.com/ciencia-e-meio-ambiente/blog-do-planeta/noticia/2017/09/o-desmanche-ambiental-do-governo-temer.html>
[111] Available in <https://www.socioambiental.org/pt-br/blog/blog-do-isa/a-anatomia-do-desmonte-das-politicas-socioambientais>
[112] Available in <https://oeco.org.br/reportagens/ana-muda-de-pasta-e-atribuicao-mas-incertezas-continuam/>
[113] Available in <https://oglobo.globo.com/brasil/bolsonaro-transfere-concessao-de-florestas-publicas-para-ministerio-da-agricultura-24427684>
[114] Available in <https://politica.estadao.com.br/noticias/geral,ministerio-da-agricultura-sera-responsavel-por-reforma-agraria-terras-indigenas-e-quilombos,70002663895>
[115] Available in <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294>

away from the Amazon[116], the government tried to deviate attention from the fires, claiming they were fake news[117]. The number of fires in Brazilian forests increased 70% in 2019, the highest rate in 7 years. According to National Spatial Research Institute (INPE), the most affected biome was the Amazon, with 51.9%[118].

Also, during August, Germany and Norway announced the suspension of transfers to Amazon Programs after affirming that the Brazilian Government was not playing its part in fighting deforestation. The contribution to protecting the rainforest amounted to more than 133 million Brazilian reais, destined to the Amazon Fund[119].

Even though fire alerts increased in the period between 2019 and 2020, the Brazilian Government reduced the budget for forest fire prevention and control personnel. A reduction of 58% reached the brigade teams, with budget ranging from 23.78 million reais in 2019 to 9.99 million in 2020[120].

In June 2020, investment funds that manage approximately 4 trillion US dollars in assets asked Brazilian government to suspend the deforestation in the Amazon Rainforest. In an open letter, they warned of the systematic, reputational, operation and regulatory risks of clients and projects in Brazil, in addition to the survival of the forest[121].

Government agencies such as INPE and IBAMA, responsible for deforestation monitoring have suffered funding cutoffs, dismissals and had their functions and increasing deforestation data publicly questioned and denied by the government[122].

The quantity of national parks protected areas and indigenous lands in the country was already questioned by Bolsonaro, that intended to extinguish those by decree[123], an unconstitutional action, after announcing the intention to review the protected areas' law (SNUC) and the existing units[124]. In addition, the Minister of the Environment speaks publicly, in a video released during investigations, of his intention to take advantage of

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[116] Available in <https://www.economist.com/the-americas/2019/08/22/forest-fires-in-the-amazon-blacken-the-sun-in-sao-paulo>

[117] Available in <https://www.theguardian.com/environment/2019/sep/09/amazon-fires-brazil-rainforest>

[118] Available in <https://noticias.uol.com.br/meio-ambiente/ultimas-noticias/redacao/2019/08/19/numero-de-queimadas-cresce-70-e-e-o-maior-desde-2013-amazonia-lidera.htm>

[119] Available in <https://brasil.elpais.com/brasil/2019/08/15/politica/1565898219_277747.html>

[120] Available in <https://g1.globo.com/natureza/noticia/2020/09/12/em-um-ano-governo-bolsonaro-corta-verba-para-brigadistas-em-58.ghtml>

[121] Available in <https://noticias.uol.com.br/ultimas-noticias/rfi/2020/06/23/fundos-de-investimentos-estrangeiros-cobram-de-bolsonaro-fim-do-desmatamento-da-amazonia.htm?cmpid=copiaecola>

[122] Available in <https://g1.globo.com/natureza/noticia/2019/08/02/cronologia-reacao-do-governo-ao-uso-de-dados-sobre-desmatamento-leva-a-exoneracao-de-diretor-do-inpe.ghtml>

[123] Available at <http://www.ihu.unisinos.br/78-noticias/589958-em-live-bolsonaro-reclama-que-nao-consegue-extinguir-parques-por-decreto>

[124] Available at <https://oeco.org.br/noticias/ricardo-salles-quer-rever-todas-as-unidades-de-conservacao-federais-do-pais-e-mudar-snuc/#:~:text=A%20lei%20do%20SNUC%20determina,extinguir%20uma%20unidade%20de%20conserva%C3%A7%C3%A3o>

the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and justice processes[125].

There are also several threats to the national environmental license process, which has existed since 1981, including from the Minister of the Economy, who wants to loosen the process to favor mining companies, even with the several recent cases of environmental crimes of breaches of poorly executed and maintained mining dams from companies in the country[126].

Specialists affirm that, with the current pace of dismantling of the inspection structure and environmental legislation demonstrated since the first 6 months of the current government, the forest destruction can reach an irreversible limit in 4 to 8 years. Recent scientific research shows that if an area of 40% of the original forest gets deforested, the rest cannot sustain the functioning of the tropical rainforest, and in this scenario, part of the forest may not be able to sustain itself. The Amazon has so far lost approximately 20% of its original coverage[127]

The development of REDD projects and a new culture of sustainable development and production, in addition to the profit from carbon credit sales, to encourage the maintenance of standing forest, goes against the non-environmental policy currently adopted by the country. Despite the National Commission for REDD+ being since 2015 established by decree, which is responsible for coordinating and monitoring the implementation of the National REDD+ Strategy in Brazil, it is noted that the main effort comes from landowners and project developers, since there is no guideline or effective planning from the government to amplify the development of new projects.

Although the Project is not able to change political and agricultural issues in Brazil, its position as a conservation agent will be used to try to reduce the inequalities that act as drivers of deforestation and expand forest monitoring actions, actions possible through the investment of proceeds from the sale of credits. More mitigation actions are detailed in the Monitoring Plan.

Another important underlying agent of deforestation is the poverty and wealth inequality, also influenced by the political situation. According to the statistics of the municipalities that make up the project area and reference region, the population with formal employment receives low wages, and the percentage of the people with formal work is very low, as shown in section 1.13 - Socioeconomic Conditions.

This key underlying cause has a major impact on deforestation decisions, as the main agents (cattle ranchers, operationally supported by loggers and land-grabbers) can easily recruit cheap manpower, consisting of workers seeking to sustain their families by means

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[125] Available at <https://g1.globo.com/politica/noticia/2020/05/22/ministro-do-meio-ambiente-defende-passar-a-boiada-e-mudar-regramento-e-simplificar-normas.ghtml>

[126] Available at <https://brasil.elpais.com/brasil/2019/01/27/opinion/1548547908_087976.html>

[127] Available at <https://www.bbc.com/portuguese/brasil-48805675>

of this profitable activity, despite it being illegal, due to the inconsistency of law enforcement.

Over the coming years, it is not expected that the poverty issue will be rapidly solved, as it is historically deeply rooted. Given this context, poverty can be assumed to be a constant underlying cause during the project lifetime.

Although the Project Activity cannot solve the poverty issue, it aims to provide new jobs for local agents, who will be able to generate alternative revenue to support their families by means of legal and sustainable initiatives.

ANALYSIS OF CHAIN OF EVENTS LEADING TO DEFORESTATION

Therefore, the analysis of chain events leading to deforestation within the Reference Region was based on the facts presented above, analysing the relations between main deforestation agents, drivers, and underlying causes that caused and most likely will lead to deforestation.

Most of the deforestation occurring in the Amazon and Cerrado regions is related to the implementation of infrastructure projects, population increase and agricultural and cattle ranching activities. Additionally, several other subjacent causes related to political, economic and social issues lead to an increased pressure over the region, mainly in the last few years.

The lack of enforcement of policies and laws also affects land tenure and property rights. This aspect stimulates the action of land grabbers and squatters. Ineffective legal land registration and documentation is also a barrier to official registration of timber production from natural forests. In this scenario, a great portion of harvested wood logs can be regarded as illegal and official registration is not technically feasible.

Those two land-use changes (timber harvesting and cattle ranching) are the main deforestation agents in the region, being possible to relate the deforestation curve to the increase in livestock and wood production, all of which are continuously growing. The profit from both products is also considerably higher than the production of other common products. The socioeconomic conditions of the population and the fact that the municipalities are predominantly dominated by large properties landowners (with political and historical contributions that made the region an important livestock producer), and the demographic growth implied by the need for new infrastructure projects, which stimulates the arrival of new habitants coming from other regions of the country attracted by the favourable conditions of production in low-cost forested areas, increase the pressure on the forest in the Project Area.

The recent history of polemics and anti-environmentalism actions of the Brazilian government, in addition to not tackling the direct causes, minimizing monitoring and restrictions in critical environmental areas, and no investments in sustainable management and farming methods end up influencing and even motivating deforestation, illegal occupation and non-compliance with environmental laws. The lack of strong environmental

policies causes Brazilian laws to have gaps that are taken in advantage of by landowners, intensified by weakened controlling mechanisms that have been dismantled by the Government, making the conservation of the extensive Brazilian biomes even more difficult.

All the above factors combine to result in uncontrolled land invasions and deforestation, followed by cattle ranching activities, a scenario which is substantiated by illegal trespassing events, and the fact that daily patrolling of the area is required by one or two employees, in order to refrain the constant deforestation pressure.

CONCLUSION

The conduction of the Step 3 and available evidence allows the analysis of the most likely future deforestation trend within the Reference Region and Project Area in a conclusive way. The hypothesized relationships between agent groups, driver variables, underlying causes and historical levels of deforestation can be verified at hand of statistical tests, literature studies, or other verifiable sources of information, such as documented information provided by local experts, communities, deforestation agents and other groups with deep knowledge of the Reference Region and Project Area. The increasing deforestation rate, added to the region's cattle ranching advancement, population increase, lack of effective governmental control and environmental planning are clear evidence that the overall trend in future baseline deforestation rates will be increasing, and this demonstrates the need for conservation measures that encourage a change in the business and production model in the region.

3.5 Additionality

The VCS Tool for the Demonstration and Assessment of Additionality in VCS Agricultural, Forestry and Other Land Use (AFOLU) Project Activities - VT0001 version 3.0[128] must be applied for all project activities instances.

On the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v. 3.0.

Instances may or may not include Sustainable Forest Management Plan, as described on the Grouped Project Eligibility Criteria in Section 1.4.

In case the project activity does not involve Sustainable Forest Management Plan:

- The instance shall have financial, technical and scale consistent with the described in this PD, facing similar investments, technological and/or other barriers as the initial

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[128] Available in <https://verra.org/wp-content/uploads/2017/11/VT0001v3.0.pdf>

instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied.

In case the project activity includes a Sustainable Forest Management Plan:

- A new additionality and AFOLU non-permanence risk analyses shall be provided. In this case, the investment comparison analysis (Option II) or the benchmark analysis (Option III) of the Tool shall be used.

This tool is applicable for this project activity because the following conditions have been met:

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

b) The applied baseline methodology provides a stepwise approach to justify determination of the most plausible baseline scenario, in accordance to VCS AFOLU Requirements.

Other instances shall perform the additionality analysis at the time of their inclusion in the monitoring report.

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

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

Credible alternative land use scenarios to the present AFOLU project activity are:

Instance 1

I. The continuation of the current (pre-project) land use scenario:

As there is no activity being held on Instance 1, the pre-project land use is the maintenance of the area as it is, without any activities and conservation measures, but still being accountable for the costs of taxes required to maintain the land tenure. Although no economic activities are carried out in the pre-project scenario, the area is exposed to invasions and illegal deforestation, precedents to cattle raising, a common practice in the region, for example, as detailed in section 3.4.

II.   Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project:

The application of the project activity could be carried out on the land within the project boundary, nevertheless performed without being registered as the VCS REDD project. This scenario would include avoiding deforestation through security and monitoring installation. Additionally, complementary activities to improve the monitoring of deforestation caused by the agents (identified in section 3.4 above) would have to be carried out, such as: increased surveillance, monitoring and control by satellite images, REDD+ technical studies, social and environmental activities, among others. These investments are usually not made by the Brazilian Government, nor are part of sustainable forest management plans, as they are financially unattractive and not

necessary to legally perform the timber harvest. Therefore, the economic feasibility of this scenario would be reduced without additional revenues from the sale of VCUs.

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

Scenario I - The pre-project activity consists of no activities to be developed within the area, which is in compliance with the Brazilian environmental laws.

Scenario II - The conservation of the forest, monitoring and surveillance are in compliance with the Brazilian environmental laws.

Sub-step 1c. Selection of the baseline scenario

The baseline scenario is the continuation of the pre project activity. The area holds no activity in the baseline scenario. There are no economic activities implemented in the area or other land use activities.

Therefore, the difficulty in monitoring the area makes it exposed to encroachment and illegal deforestation, and activities such as cattle raising and wood extraction, without any control of the activities carried out within the area.

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

Instance 1 and generates no financial or economic benefits other than VCS related income, then it was applied the Simple Cost Analysis (Option I).

Sub-step 2b. Simple Cost Analysis

The simple cost analysis was determined as the appropriate analysis method once the Project does not generate any financial or economic benefits other than VCUs related income. There is no for-profit sale of any products, as the NTFPs has not yet been implemented and as there is no timber production in the area as well.

In addition to the baseline yearly expenses of the landowner, the project activity will require investments in monitoring, security, socio-environmental activities and conservation of the area. These activities, without carrying out the carbon project, do not generate any income for the owner.

According to the additionality tool applied: If it is concluded that the proposed VCS AFOLU project produces no financial benefits other than VCS related income then proceed to Step 4 (Common Practice Analysis).

STEP 4. Common practice analysis

The practice of conservation of privately-owned forest areas in the Mato Grosso State is extremely rare. Conservation activities in larger areas are usually made in public areas, such as Conservation Units, Federal and State protected areas.

Although most of Brazil's agricultural output is deforestation-free, it is observed that a fraction of properties in the Amazon are responsible for 62% of all potentially illegal deforestation and that roughly 20% of soy exports and at least 17% of beef exports from both biomes to the EU may be contaminated with illegal deforestation[129]. As previously detailed, Mato Grosso is the main producer of cattle and agriculture in the country, and this sector represents most of the State and Brazil's GDP.

In addition to REDD projects, other forms of conservation of private areas are promoted in the country:

- **Private Reserve of Natural Heritage (RPPN)**[130]**:** it is a category of conservation unit created voluntarily by the landowner. When the area is categorized as RPPN, the owner is committed to nature conservation, without land expropriation. The benefits of the private reserve are preference in the analysis of applications to acquire rural credit, tax benefits and the possibility of cooperation with private and public entities in the protection and management of the land, but no revenue is generated as it is on REDD+ projects due to the sale of verified carbon units. In Mato Grosso State, there are 15 registered RPPNs, none in the Reference Region municipalities. RPPN management tends to be much more affordable than REDD+ projects due to its costless implementation.

- **Payment for Environmental Services (PES)**[131]**:** PES is a transaction of voluntary nature, through which a buyer of environmental services grants the provider of these services with financial resources or other form of payment, under the agreed conditions, in compliance with the relevant legal and regulatory provisions, so the provider can maintain, restore, or improve the environmental conditions of ecosystems. Regulation regarding this type of service in Brazil is at its early stages, as it has recently been approved, on January 13, 2021, when Law n° 14.119 was sanctioned. The law establishes the National Policy on Payment for Environmental Services and amends other laws to adapt to the new policy. However, the financial incentive is usually determined by the State, and it is commonly applied in taxes discounts, not representing an income to invest in other activities or in the maintenance of the area.

It is possible to note that, for the reasons, the project does not characterize as a common practice due to the presented barriers, such as lack of investment and opportunity cost of other land uses. During the attempt to identify similar projects, the essential distinctions between REDD+ projects compared in terms of area, challenges, monitoring costs, among other aspects, greatly diverge from the alternative initiatives identified.

The significant difference between the present REDD+ project and similar conservation practices on the region, regarding financial and opportunity obstacles, makes it possible to conclude that

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[129] Available at <https://www.gov.br/icmbio/pt-br/servicos/crie-sua-reserva/perguntas-e-respostas-sobre-rppn>.
[130] Available at <https://www.icmbio.gov.br/portal/images/stories/comunicacao/downloads/perguntaserespostasrppn.pdf>
[131] Available at <http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/L14119.htm>

the project is unable to support itself and its conservation activities without the revenues from the verified carbon units, as investment and capital costs for REDD+ projects are very high, which differ from other similar practices (RPPN and PES).

Besides, due to the context of the region, and the fact that the project is located in a reference area for both logging and cattle ranching of the State offer risks to the conservation of the Project Area.

Therefore, the present Instance depends on the revenue from the VCUs to support itself and hence, it is additional.

3.6 Methodology Deviations

Not applicable as no methodology deviations were performed.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Analysis of historical land-use and land-cover change

- **Collection of appropriate data sources**

  GIS MAPPING, REMOTE SENSING TECHNIQUES
  To carry out the assessment of land use and land cover (LU/LC) for the baseline period (2011-2021), remote sensing satellite analysis was carried out, which is described below.

  The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. The historical reference period for the present project during the assessment of the baseline period comprised analysis of images from 2011 - 2021. In accordance with the methodology, the analysis shall be made using the data obtained from monitoring LU/LC changes in the reference region during the historical reference period.

  To map the dynamics of land use in the reference region, images from 2011 to 2021 produced by MapBiomas (collection 5.0) were used, made available in raster format on the program's website (http: //mapbioma .org/) and supervised classifications using Google Earth Engine for the period of April 2021. This classifier is the same one used in MapBiomas, allowing a closer approximation of the methodology.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[132] promoted by the Climate Observatory. The MapBiomas creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomas series and direct collection by visual interpretation of Landsat images to classify as a single map per class. This classification then goes through the stages of the spatial filter, applying neighbourhood rules and temporal filters, in particular changes in coverage and use that are impossible or not allowed, to reduce spatial and temporal inconsistencies.

For the supervised classification of April 2021, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomas methodology. To obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 5% cloud cover limit were collected within the Reference Region and an average of these images was generated. Training samples were generated for each land use class (forest, water, and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. Then the spatial filter with the Majority Filter tool from ArcGIS was applied using an 8-pixel neighborhood. This filter is used in MapBiomas to avoid unwanted modifications on the edges of pixel groups (blobs).

- Definition of classes of land-use and land-cover (LU/LC)

Following the VM0015 Methodology requirements, the LU/LC maps have been conducted using satellite images. There are 2 surveys available in Brazil for deforestation and forest mapping: INPE (PRODES) and Mapbiomas. However, none of them separates by forest classes.

Land-use change analyses have been conducted through MapBiomas images, which is a new platform that produces maps through a pixel-by-pixel classification from Landsat satellite images. The entire process is done with extensive machine learning algorithms through the Google Earth Engine system that offers more detailed, precise and available information. MapBiomas presents a higher temporal frequency than the official data from Prodes, and thus it is recommended as image reference for regions with high cloud cover throughout the whole year.

Thus, definition of classes of land-use and land-cover was performed through MapBiomas' classification, which identifies forest, non-forest vegetation, anthropic uses (categorized as

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[132] SEEG website. Available at: http://seeg.eco.br/en/ Last visited on 19/04/2021

deforestation) and hydrography (lakes and rivers). For this map, the accuracy assessment has been conducted, which meets the methodology requirements.

Furthermore, the official map for all vegetation types of the country, which was elaborated by IBGE (Brazilian Institute of Geography and Statistics), was used to check the vegetation types present within the RR, PA and LK. The vegetation type map was created by IBGE considering several aspects that are able to differentiate one type of vegetation to the other, such as species composition, elevation and climate variation, soil type, among others. The accuracy assessment of this mapping would be unfeasible, since the IBGE map was generated considering characteristics such as soil type, elevation, species composition, etc. For the correct accuracy of this information, a field survey would be necessary, which is costly and complicated to be carried out in the timeline of a carbon project.

Table 6. Vegetation types found in the project boundaries

IDct	Name - Initial	Trend in carbon stock[1]	Presence in	Activity in the baseline case			Name - Final	Trend in carbon stock	Presence in	Activity in the project case		
				LG	FW	CP				LG	FW	CP
I1/F1	Forest	constant	RR, PA, LK	yes	no	no	Forest	constant	RR, PA, LK	yes	no	no
I1/F2	Forest	constant	RR, PA, LK	yes	no	no	Non Forest	constant	RR, PA, LK	yes	no	no
I2/F2	Non Forest	constant	RR, LK	no	no	no	Non Forest	constant	RR, PA, LK	no	no	no

Thus, the classes of LU/LC were defined as "forest" and "non-forest" in accordance with the procedures described above. These classes are the minimum classes to be considered in the present REDD project as stipulated by the Methodology. As such, degradation was not a factor.

The LU/LC classes present in the project area, reference region and leakage belt at the project start date are listed in Table below, which specifies whether logging, fuel wood collection or charcoal production are occurring in the baseline case.

Table 7. List of land use and land cover change categories

Class identifier		Trend in carbon stock[1]	Presence in[2]	Baseline activity[3]			Description (including criteria for unambiguous boundary definition)
IDcl	Name			LG	FW	CP	
1	Forest	constant	RR, PA, LK	yes	no	no	According to official classification of the types of vegetation of Brazil (SIVAM), no stratification in different forest classes was conducted. In addition, carbon density is not expected to undergo significant changes due to degradation in the baseline case. According to the significance test, carbon stock change due to logging activities in the baseline case is considered insignificant and therefore, trend in carbon stock could be deemed as constant.
2	No forest	constant	RR, PA, LK	no	no	no	Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification.
3	Hydrography	constant	RR, PA, LK	no	no	no	Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA.

An analysis in the Amazon region[133] between 2007-2020 shows that there is no trend in degradation, although it affects an area larger than deforestation. It was concluded that degradation can serve as a warning that the region will soon be the target of deforestation practices. As the degradation has low local recurrence over the years, i.e., on average the same area is classified as degraded only once during the analyzed period, it is very unusual that the same area will suffer another degradation, since the valuable woods have already been harvested. Thus, it is very likely that carbon stocks after degradation might increase. Therefore, it is conservatively assumed that the trend in carbon stocks in the baseline case is constant.

The main forest type present in RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[134]:

● <u>Definition of categories of land-use and land-cover change (LU/LC-change)</u>

The LU/LC-change categories that could occur within the project area and leakage belt during the first baseline period, in both the baseline and project case, are identified in the potential LU/LC-change matrix and the list of LU/LC-change categories during the project crediting period are shown in the Tables below.

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[133] Available at https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/DQ-Degradacao-Florestal-Amazonia.pdf
[134] Available at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf

It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map comparing 2011 with 2021. It is important to note that while the latter shows only deforestation from 2011–2021, the Tables below display deforestation across the whole crediting period.

As shown in tables below, degradation was not considered in any of the LU/LC classes.

Table 8. Land use change matrix in the reference region between 2010 and 2020

	IDcl	Initial LU/LC class	
		Forest	No forest
Final Class	Forest	I1/F1	0
Final Class	No forest	I1/F2	I2/F2

BASELINE SCENARIO

PA	IDcl	Initial LU/LC class	
		Forest	Non Forest in the PA
Final Class	Forest	17,568.90	0.00
Final Class	Non Forest in the PA	5,184.46	0.00

LB	IDcl	Initial LU/LC class	
		Forest	Non Forest in the LK
Final Class	Forest	13,644.16	0.00
Final Class	Non Forest in the LK	4,456.84	4,999.00

PROJECT SCENARIO

PA	IDcl	Initial LU/LC class	
		Forest	Non Forest in the PA
Final	Forest	22,469.71	0.00

LB	IDcl	Initial LU/LC class	
		Forest	Non Forest in the LK
Final	Forest	12,866.49	0.00

Non Forest in the PA	283.65	0.00		Non Forest in the LK	5,234.51	4,999.00	

The Table below also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

Table 9. List of land use and land cover change categories

Class identifier		Trend in carbon stock[1]	Presence in[2]	Baseline activity[3]			Description (including criteria for unambiguous boundary definition)
IDcl	Name			LG	FW	CP	
1	Forest	constant	RR, PA, LK	yes	no	no	According to official classification of the types of vegetation of Brazil (SIVAM), no stratification in different forest classes was conducted. In addition, carbon density is not expected to undergo significant changes due to degradation in the baseline case. According to the significance test, carbon stock change due to logging activities in the baseline case is considered insignificant and therefore, trend in carbon stock could be deemed as constant.
2	No forest	constant	RR, PA, LK	no	no	no	Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification.
3	Hydrography	constant	RR, PA, LK	no	no	no	Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA.

The annual deforestation dynamics in the Reference Region during the historical reference period can be seen in the figure and tables below.

- **Map accuracy assessment**

  To meet the particularities of the region, an independent evaluation was carried out for the reference region from the years 2011 to 2021.

  To assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated by calculating the user's and producer's percentage of correct answers, errors of omission and commission. For that, 200 sample points were randomly drawn on the reference region, 50 in each class (forest, hydrography and deforestation), and the degree of correctness classification was verified. As a reference, high resolution Landsat images were used, where it was possible to visually determine the land use of the sample points drawn.

For the supervised classification in April 2021, 300 random points were drawn over the RR, 100 in each of the classes (forest, hydrography and deforestation). It is noteworthy that for this year only deforestation classification information was considered.

The table below shows the accuracy analysis carried out for each year and each land use class.

Table 10. Summary of confusion matrices from the evaluation of MapBiomas from 2011 to 2021

Year	Producer accuracy				User accuracy			
	Forest	Hydrography	Pioneer vegetation	Deforestation	Forest	Hydrography	Pioneer vegetation	Deforestation
2011	82.11%	97.22%	96.97%	88.51%	97.50%	87.50%	80.00%	96.25%
2012	85.87%	98.61%	95.59%	86.36%	98.75%	88.75%	81.25%	95.00%
2013	83.87%	97.26%	90.14%	91.57%	97.50%	88.75%	80.00%	95.00%
2014	82.11%	98.57%	92.86%	89.41%	97.50%	86.25%	81.25%	95.00%
2015	89.89%	100.00%	95.52%	85.39%	100.00%	93.75%	80.00%	95.00%
2016	85.56%	95.77%	92.86%	86.52%	96.25%	85.00%	81.25%	96.25%
2017	86.67%	97.33%	94.25%	87.80%	97.50%	91.25%	86.25%	90.00%
2018	86.81%	98.68%	98.48%	86.21%	98.75%	93.75%	81.25%	93.75%
2019	89.66%	97.47%	98.51%	85.06%	97.50%	96.25%	82.50%	92.50%
2020	85.11%	100.00%	95.95%	93.75%	100.00%	90.00%	88.75%	93.75%
2021	85.87%	98.65%	95.59%	86.05%	98.75%	91.25%	81.25%	92.50%

PROJECTION OF FUTURE DEFORESTATION

As the Methodology stipulates, the aim of this step is to locate in space and time the baseline deforestation in the project area, reference region and leakage belt.

- **Selection of Baseline Approach**

    The Historical Average (Approach A from the applied methodology) was chosen as Baseline Approach, since deforestation rates measured in different historical sub-periods in the reference region reveal a low increasing trend and therefore, in order to be conservative, a constant historical average deforestation rate trend was utilized to project future deforestation.

The analysis of presented evidence related to deforestation agents and drivers, in addition to underlying causes, allows to conclude that the deforestation rate trend is likely to continue in the future.

- **Quantitative projection of future deforestation**

For the deforestation baseline, the average deforestation rate during the 2011-2021 period (0.85%/year).

- **Projection of the annual areas of baseline deforestation in the reference region, leakage belt and project area:**

Based on the selection of baseline approach, using the historical average approach, tables below show the results of the projection in reference region, leakage belt and project area.

Table 11. Annual areas of baseline deforestation in the reference region

Project year t	Stratum i in the reference region (ha)	Total (ha)	
	ABSLRR	annual ABSLRR$_t$	cumulative ABSLRR
2022	4,038.88	4,038.88	4,038.88
2023	4,038.88	4,038.88	8,077.75
2024	4,038.88	4,038.88	12,116.63
2025	4,038.88	4,038.88	16,155.50
2026	4,038.88	4,038.88	20,194.38
2027	4,038.88	4,038.88	24,233.25
2028	3,634.99	3,634.99	27,868.24
2029	3,634.99	3,634.99	31,503.23
2030	3,634.99	3,634.99	35,138.22
2031	3,634.99	3,634.99	38,773.20
2032	3,634.99	3,634.99	42,408.19
2033	3,634.99	3,634.99	46,043.18
2034	3,271.49	3,271.49	49,314.67
2035	3,271.49	3,271.49	52,586.16
2036	3,271.49	3,271.49	55,857.65
2037	3,271.49	3,271.49	59,129.14
2038	3,271.49	3,271.49	62,400.63
2039	3,271.49	3,271.49	65,672.11

2040	2,944.34	2,944.34	68,616.45
2041	2,944.34	2,944.34	71,560.80
2042	2,944.34	2,944.34	74,505.14
2043	2,944.34	2,944.34	77,449.48
2044	2,944.34	2,944.34	80,393.82
2045	2,944.34	2,944.34	83,338.16
2046	2,649.91	2,649.91	85,988.06
2047	2,649.91	2,649.91	88,637.97
2048	2,649.91	2,649.91	91,287.87
2049	2,649.91	2,649.91	93,937.78
2050	2,649.91	2,649.91	96,587.69
2051	2,649.91	2,649.91	99,237.59

Table 12. Annual areas of baseline deforestation in the project area

| Project year t | Stratum i in the project area (ha) | Total (ha) | |
	ABSLPA	annual $ABSLPA_t$	cumulative ABSLPA
2022	211.00	211.00	211.00
2023	211.00	211.00	422.01
2024	211.00	211.00	633.01
2025	211.00	211.00	844.01
2026	211.00	211.00	1,055.01
2027	211.00	211.00	1,266.02
2028	189.90	189.90	1,455.92
2029	189.90	189.90	1,645.82
2030	189.90	189.90	1,835.72
2031	189.90	189.90	2,025.63
2032	189.90	189.90	2,215.53
2033	189.90	189.90	2,405.43
2034	170.91	170.91	2,576.34
2035	170.91	170.91	2,747.25
2036	170.91	170.91	2,918.17
2037	170.91	170.91	3,089.08
2038	170.91	170.91	3,259.99
2039	170.91	170.91	3,430.90
2040	153.82	153.82	3,584.72
2041	153.82	153.82	3,738.55
2042	153.82	153.82	3,892.37

2043	153.82	153.82	4,046.19
2044	153.82	153.82	4,200.01
2045	153.82	153.82	4,353.83
2046	138.44	138.44	4,492.27
2047	138.44	138.44	4,630.71
2048	138.44	138.44	4,769.15
2049	138.44	138.44	4,907.58
2050	138.44	138.44	5,046.02
2051	138.44	138.44	5,184.46

Table 13. Annual areas of baseline deforestation in the leakage belt

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	ABSLLK	annual ABSLLK$_t$	cumulative ABSLLK
2022	181.39	181.39	181.39
2023	181.39	181.39	362.78
2024	181.39	181.39	544.17
2025	181.39	181.39	725.56
2026	181.39	181.39	906.95
2027	181.39	181.39	1,088.33
2028	163.25	163.25	1,251.58
2029	163.25	163.25	1,414.84
2030	163.25	163.25	1,578.09
2031	163.25	163.25	1,741.34
2032	163.25	163.25	1,904.59
2033	163.25	163.25	2,067.84
2034	146.93	146.93	2,214.76
2035	146.93	146.93	2,361.69
2036	146.93	146.93	2,508.61
2037	146.93	146.93	2,655.54
2038	146.93	146.93	2,802.46
2039	146.93	146.93	2,949.39
2040	132.23	132.23	3,081.62
2041	132.23	132.23	3,213.85
2042	132.23	132.23	3,346.09
2043	132.23	132.23	3,478.32
2044	132.23	132.23	3,610.55
2045	132.23	132.23	3,742.78
2046	119.01	119.01	3,861.79
2047	119.01	119.01	3,980.80
2048	119.01	119.01	4,099.81

2049	119.01	119.01	4,218.82
2050	119.01	119.01	4,337.83
2051	119.01	119.01	4,456.84

Projection of the location of future deforestation

The projection of the future deforestation within the reference region followed four steps:

(i) Definition of the model assumptions, which consists of defining the modelled deforestation;

(ii) Organization of the spatial and non-spatial database that represents the selection and standardization of the variables used;

(iii) Calibration and validation of the model, which consist of the combination of variables and evaluation of the adjustments of the models; and

(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2008 to 2017) through the Business-as-usual scenario.

Assigning weightings to change agents

The predictive variables considered to have the potential to influence the risk of deforestation in the region are the proximity to roads, proximity to cities, slope, altitude, presence of settlements, presence of strictly protected and sustainable use protection areas, presence of indigenous lands, proximity to rivers and the proximity to large rivers.

Regarding the proximity factor of roads, in addition to the official roads of the IBGE database, the most recent Imazon mappings were used, which contains the new roads that are being opened in the region, roads visibly opened by satellite images and information obtained in field (Figure below).

Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created using Dinamica EGO Software[135], which modeling techniques are used for calibrating, running and validating space-time models.

Dinamica EGO is an environmental platform for land use change modeling. Dinamica EGO allows the design of a model by simply dragging and connecting operators that perform calculations upon various types of data, such as constants, matrices, tables and raster maps. In this way, it is possible to set up a model by establishing a sequence of operators involving an ample range of analytical and simulation algorithms.

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[135] Dinamica Ego Software. Available at: <https://csr.ufmg.br/dinamica/>. Last visited on august 5th, 2021.

In addition, Dinamica EGO holds multiple transitions that can be calibrated employing the Weights of Evidence. This method calculates the influence of spatial determinants on the changes, producing as a result an integrated transition potential map, also known as the transition probability map.

The result of the application of Dinamica EGO is a transition potential map that identifies areas that present favorable conditions for deforestation to occur in areas classified as forest. This map is the starting point for spatialization of future areas of deforestation, from which annual rates are allocated in conjunction with dynamic variables.

The flowchart below illustrates the modelling steps, showing how the risk map was generated and how the projection of future deforestation was carried out.

Figure 13. Modelling steps focusing on the creation of the deforestation risk map and the projection of future deforestation
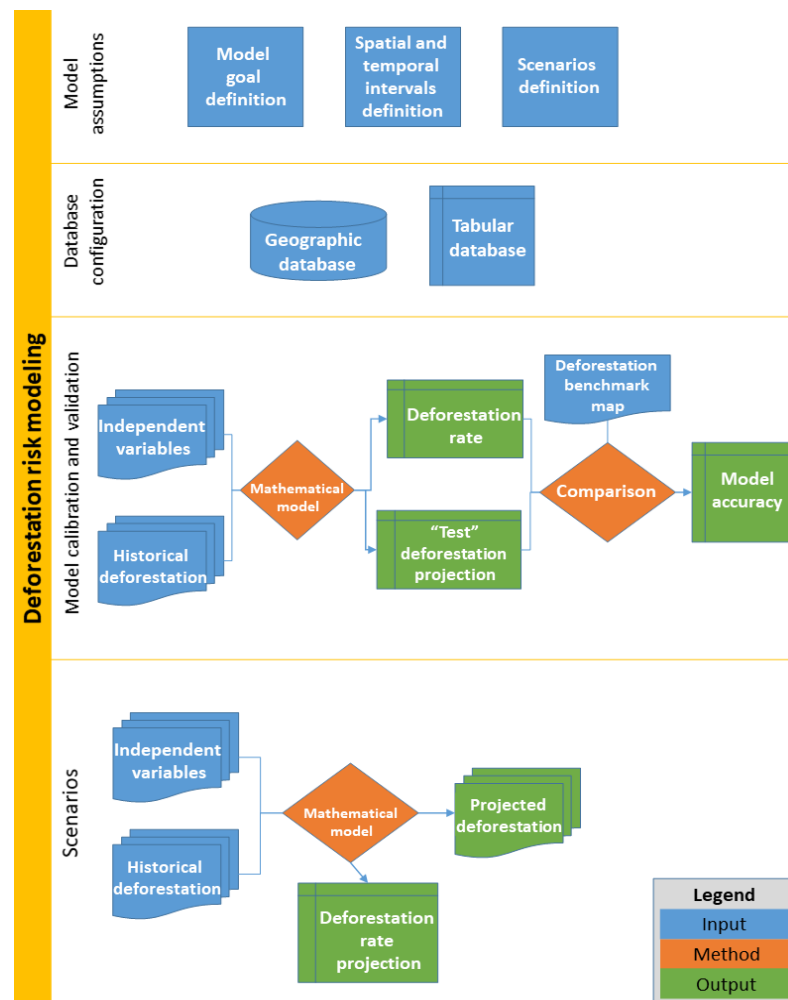
The spatial variables that most likely represent the patterns of baseline deforestation in the reference region were identified, and the digital maps representing the spatial features of each variable were created. The list of variables, maps and factor maps is presented below:

Table 14. List of variables, maps and factor maps

Factor Map		Source	Variable represented		Meaning of categories or pixel value		Other maps or variables used to create the Factor Map		Algorithm or equation used	Comments
ID	File Name		Unit	Description	Range	Meaning	ID	File Name		
1	d_estradas_edited_v2.tif	IBGE/Imazon	Meter	Distance from paved and unpaved roads	0-15,017.7	Lower values mean more proximity		Merge_IBGE_Imazon_edited_v2	Euclidean Distance (ArcGis 10.6)	Quantitative variable
2	UCs.tif	MMA		Sustainable Use Protected Areas						Categoric variable
3	Tis.tif	FUNAI		Indigenous lands						Categoric variable
4	Assentamentos.tif	INCRA		Rural Settlements						Categoric variable
5	d_rios_g.tif	ANA	Meter	Distance from water bodies	0 – 33,354	Lower values mean more proximity		RiosGrandes_ANA	Euclidean Distance (ArcGis10.6)	Quantitative variable
6	d_rios_mbiomas.tif	MapBiomas	Meter	Distance from water bodies	0-17,197.6	Lower values mean more proximity		Rios_MapBiomas	Euclidean Distance (ArcGis10.6)	Quantitative variable
7	d_rios.tif	ANA	Meter	Distance from rivers	0-11,370.4	Lower values mean more proximity		Rios_ANA	Euclidean Distance (ArcGis10.6)	Quantitative variable
8	d_urbana.tif	IBGE	Meter	Distance from urban centers	10,441.6-101,033	Lower values mean more proximity		AreasUrbanas_IBGE	Euclidean Distance (ArcGis10.6)	Quantitative variable
9	dem.tif	SRTM	Meter	Average altitude variation	0-139	Lower values mean lower altitude				Quantitative variable
10	slope_perc.tif	SRTM	Degrees	Average slope variation	0-97.1825	Lower values mean lower slope			Slope (ArcGis 10.6)	Quantitative variable

The weights of evidence are calculated in Dinamica EGO based on the predictor variables and also on the deforestation maps. The weights of evidence are defined by a Bayesian method, which considers the joint probability of deforestation a posteriori within each class of all explanatory variables. These values represent how much each of the different ranges that compose each predictor variable is related to deforestation. Positive values indicate a correlation with deforestation and negative values indicate ranges that have suffered little deforestation in the past and, therefore, should be less likely to be deforested in the future. Higher values, whether positive or negative, indicate greater weight to positively or negatively influence the calculation of the probability of deforestation in an area.

Based on the weights of the evidence, the transition probability of each forest pixel to become other types of anthropic use is calculated. This probability is calculated based on the sum of all the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps[136].

The variables and deforestation patterns presented in the Table above were analyzed together to produce the risk map. Factor maps were created using the empirical approach, in which the deforestation likelihood was estimated as the percentage of pixels that were deforested during the period of analysis. Tables below describe the rule used to build classes and the deforestation likelihood assigned to each distance class.

Table 15. Variation of the weights of evidence according to deforestation distance ranges

Distance to deforestation		Weight of evidence
0	100	0.723
100	200	-0.162
200	300	-0.563
300	400	-1.192
400	500	-1.966
500	600	-3.737
600	1800	-4.313

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[136] Soares-Filho, B., Nepstad, D., Curran, L. et al. Modelling conservation in the Amazon basin. Nature 440, 520–523 (2006). <https://doi.org/10.1038/nature04389>.

Table 16. Variation of the weights of evidence according to the distance from roads

Distance to roads		Weight of evidence
0	1000	0.273
1000	3000	-0.056
3000	4000	-1.756
4000	5000	-0.896

Table 17. Variation of the weights of evidence according to the distance from rivers

Distance from rivers		Weight of evidence
0	2000	-0.269
2000	4000	0.960
4000	6000	0.304

Table 18.Variation of the weights of evidence according to slope

Slope		Weight of evidence
0	2	-0.137
2	34	0.017

Table 19. Variation of the weights of evidence according to altitude

Altitude		Weight of evidence	Altitude		Weight of evidence
0	291	-2.141	307	309	-0.350

Altitude		Weight of evidence
291	292	-0.400
292	295	0.344
295	296	0.699
296	297	0.247
297	298	-0.514
298	299	-0.882
299	300	0.260
300	301	-0.571
301	302	0.083
302	303	0.657
303	304	-1.282
304	305	-0.367
305	306	0.157
306	307	-0.116

Altitude		Weight of evidence
309	310	-1.022
310	311	-0.304
311	324	-0.123
324	353	0.057
353	354	0.632
354	356	0.354
356	384	0.158
384	385	-0.127
385	386	-0.637
386	425	-0.453
425	426	1.042
426	427	1.639
427	430	2.584
430	434	6.383

Table 20. Variation of the weights of evidence according to distance from urban areas

Distance from urban areas		Weight of evidence
0	20000	-0.502
20000	40000	0.173

Table 21. Variation of the weights of evidence according to the distance from settlements

Distance from settlements		Weight of evidence
0	2000	1.513
2000	3000	1.104
3000	4000	-0.917
4000	6000	-0.971
6000	7000	0.650
7000	8000	0.141
8000	9000	-1.011
9000	11000	-0.334
11000	12000	-0.033
12000	13000	0.198
13000	14000	-0.053
14000	15000	0.634
15000	16000	0.906
16000	17000	-0.333
17000	18000	-0.840
18000	19000	0.229
19000	24000	0.043
24000	25000	-0.557
25000	26000	0.336
26000	28000	-0.148

- **Selection of most accurate deforestation risk map**

As previously noted, the historical average approach was chosen to project the quantity of future deforestation, given the tendency to increase over time. In addition, to validate which are the best models to allocate where the deforestation happens, the calibration and confirmation methodology was applied, dividing the deforestation period in two.

For that, simulations of the deforestation projection were made, taking three dates as reference: 2011, 2015 and 2021. The period of 2011-2015 was used to generate the correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the models. After that a projection from 2016 to 2021 was made, developing a reference region scenario for this date. Therefore, the deforestation map for the period of 2016 to 2021 and two 2021 scenarios, real and projected, were developed. These scenarios were compared regarding the degree of similarity considering the exponential decay. The higher the similarity, the better the prediction of the model. This index ranges from 0 (no overlapping) to 1 (completely overlapped), and the closer to 1, the more similar is the simulated scenario in relation to the real. Two values are calculated for the indices, the comparison of the simulated map in relation to the real deforestation map and, the opposite, the real map in relation to the simulated map. Thus, to define the most accurate map, the average of these two values was used.

The first tested model was the one with all the predictor variables of deforestation (m00); next, the models were tested by removing each factor separately and measuring the degree of correctness of the model (m01 to m06). Therefore, the most important variables were those in which their absence caused a greater drop in the degree of similarity between the real and projected deforestation maps.

Next, the inverse combinations were made, that is, the models were analyzed only with the deforestation proximity variable (dynamic variable) and the static variables with the greatest impact on the degree of similarity, adding one by one in order of impact (m07 to m11). Through this procedure it is possible to guarantee that all the best models could be assessed. Only the dynamic variable "Proximity to Deforestation" was used in all models, as there is evidence that proximity to deforested areas is one of the most important variables to predict deforestation.

The best model was m09, with an average similarity of 0.217. This model applies three variables: distance from settlements, distance from urban areas and distance from rivers. Thus, it was selected to project the future deforestation.

Definition of the Land-Use and Land-Cover Change Component of the Baseline

Now that the area and location of future deforestation are both known, pre-deforestation carbon stocks can be determined by matching the predicted location of deforestation with the location of forest classes with known carbon stocks. The goal of this step is to calculate activity data of the initial forest classes (icl) that will be deforested and activity data of the post-deforestation classes (fcl) that will replace them in the baseline case.

In accordance with analysis achieved through the procedure described above, the quantity of baseline LU/LC-change was projected throughout the 1st baseline period, in the reference region,

project area and leakage belt in each stratum. This is in accordance with step 5 of the methodology "Definition of the land-use and land-cover change component of the baseline".

Calculation of baseline activity data per forest class

The following is in accordance with step 5.1 Calculation of baseline activity data per forest class", in which is stipulated that the previously created maps of annual baseline deforestation and LU/LC map can be combined, producing a map showing deforestation per class in the baseline case.

The LU/LC-change within the project crediting period, caused by baseline deforestation consisted of initial forest classes being converted to the final LU/LC class of 'non-forest'.

Table 22. Annual areas deforested per forest class icl within the reference region in the baseline case (baseline activity data per forest class)

Area deforested per forest class *icl* within the reference region		Total baseline deforestation in the reference region	
IDicl	1		
Name	Forest	annual ABSLRRt (ha)	ABSLRR cumulative (ha)
Project year *t*	ha		
2022	4,038.88	4,038.88	4,038.88
2023	4,038.88	4,038.88	8,077.75
2024	4,038.88	4,038.88	12,116.63
2025	4,038.88	4,038.88	16,155.50
2026	4,038.88	4,038.88	20,194.38
2027	4,038.88	4,038.88	24,233.25
2028	3,634.99	3,634.99	27,868.24
2029	3,634.99	3,634.99	31,503.23
2030	3,634.99	3,634.99	35,138.22
2031	3,634.99	3,634.99	38,773.20
2032	3,634.99	3,634.99	42,408.19
2033	3,634.99	3,634.99	46,043.18
2034	3,271.49	3,271.49	49,314.67
2035	3,271.49	3,271.49	52,586.16
2036	3,271.49	3,271.49	55,857.65
2037	3,271.49	3,271.49	59,129.14
2038	3,271.49	3,271.49	62,400.63
2039	3,271.49	3,271.49	65,672.11
2040	2,944.34	2,944.34	68,616.45

Year			
2041	2,944.34	2,944.34	71,560.80
2042	2,944.34	2,944.34	74,505.14
2043	2,944.34	2,944.34	77,449.48
2044	2,944.34	2,944.34	80,393.82
2045	2,944.34	2,944.34	83,338.16
2046	2,649.91	2,649.91	85,988.06
2047	2,649.91	2,649.91	88,637.97
2048	2,649.91	2,649.91	91,287.87
2049	2,649.91	2,649.91	93,937.78
2050	2,649.91	2,649.91	96,587.69
2051	2,649.91	2,649.91	99,237.59

Table 23. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)

	Area (ha) forest class	Total forest area (ha)
IDicl	1	
Name	Forest	
Project year *t*	ha	
2022	22,542.36	22,542.36
2023	22,331.35	22,331.35
2024	22,120.35	22,120.35
2025	21,909.35	21,909.35
2026	21,698.35	21,698.35
2027	21,487.34	21,487.34
2028	21,297.44	21,297.44
2029	21,107.54	21,107.54
2030	20,917.64	20,917.64
2031	20,727.73	20,727.73
2032	20,537.83	20,537.83
2033	20,347.93	20,347.93
2034	20,177.02	20,177.02
2035	20,006.11	20,006.11
2036	19,835.19	19,835.19
2037	19,664.28	19,664.28
2038	19,493.37	19,493.37
2039	19,322.46	19,322.46
2040	19,168.64	19,168.64
2041	19,014.81	19,014.81

2042	18,860.99	18,860.99
2043	18,707.17	18,707.17
2044	18,553.35	18,553.35
2045	18,399.53	18,399.53
2046	18,261.09	18,261.09
2047	18,122.65	18,122.65
2048	17,984.21	17,984.21
2049	17,845.78	17,845.78
2050	17,707.34	17,707.34
2051	17,568.90	17,568.90

Table 24. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

	Area (ha) forest class	Total forest area (ha)
IDicl	1	
Name	Forest	
Project year *t*	ha	
2022	17,919.61	17,919.61
2023	17,738.22	17,738.22
2024	17,556.83	17,556.83
2025	17,375.44	17,375.44
2026	17,194.05	17,194.05
2027	17,012.67	17,012.67
2028	16,849.42	16,849.42
2029	16,686.16	16,686.16
2030	16,522.91	16,522.91
2031	16,359.66	16,359.66
2032	16,196.41	16,196.41
2033	16,033.16	16,033.16
2034	15,886.24	15,886.24
2035	15,739.31	15,739.31
2036	15,592.39	15,592.39
2037	15,445.46	15,445.46
2038	15,298.54	15,298.54
2039	15,151.61	15,151.61
2040	15,019.38	15,019.38
2041	14,887.15	14,887.15
2042	14,754.91	14,754.91
2043	14,622.68	14,622.68
2044	14,490.45	14,490.45
2045	14,358.22	14,358.22

2046	14,239.21	14,239.21
2047	14,120.20	14,120.20
2048	14,001.19	14,001.19
2049	13,882.18	13,882.18
2050	13,763.17	13,763.17
2051	13,644.16	13,644.16

Table 25. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

	Area (ha) forest class	Total forest area (ha)
IDicl	1	
Name	Forest	
Project year *t*	ha	
2022	17,919.61	17,919.61
2023	17,738.22	17,738.22
2024	17,556.83	17,556.83
2025	17,375.44	17,375.44
2026	17,194.05	17,194.05
2027	17,012.67	17,012.67
2028	16,849.42	16,849.42
2029	16,686.16	16,686.16
2030	16,522.91	16,522.91
2031	16,359.66	16,359.66
2032	16,196.41	16,196.41
2033	16,033.16	16,033.16
2034	15,886.24	15,886.24
2035	15,739.31	15,739.31
2036	15,592.39	15,592.39
2037	15,445.46	15,445.46
2038	15,298.54	15,298.54
2039	15,151.61	15,151.61
2040	15,019.38	15,019.38
2041	14,887.15	14,887.15
2042	14,754.91	14,754.91
2043	14,622.68	14,622.68
2044	14,490.45	14,490.45
2045	14,358.22	14,358.22
2046	14,239.21	14,239.21
2047	14,120.20	14,120.20
2048	14,001.19	14,001.19
2049	13,882.18	13,882.18

2050	13,763.17	13,763.17
2051	13,644.16	13,644.16

Calculation of baseline activity data per post-deforestation forest class

The following is in accordance with step 5.2 of the methodology: "Calculation of baseline activity data per post-deforestation forest class". As all of the initial classes represented in the tables above were transformed into non-forest (final post-deforestation class) in the considered baseline, the annual values corresponding to the final classes are the same as those of the initial classes.

According to the methodology VM0145, the Historical LU/LC-change (Method 1) was used to calculate the LU/LC class that will replace the forest cover in the baseline scenario. The table below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region.

Tables below depict the annual areas deforested in each zone in the baseline case within the reference region, project area and leakage belt, respectively:

Table 26. Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data per zone)

Zone		Name		Total area of each zone	
		Non-forest			
		ID_{fcl}	1		
		Area	% of zone	Area	% of zone
IDz	Name	ha	%	ha	%
1	Reference region	99,237.59	19%	99,237.59	19%
Total area of each class *fcl*		99,237.59	19%	99,237.59	19%

Table 27. Annual areas deforested in each zone within the project area in the baseline case (baseline activity data per zone)

Area established after deforestation per zone within the reference region		Total baseline deforestation in the reference region	
ID_{fcl}	1	$ABSLRR_t$	$ABSLRR$
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2022	4,038.88	4,038.88	4,038.88
2023	4,038.88	4,038.88	8,077.75
2024	4,038.88	4,038.88	12,116.63

2025	4,038.88	4,038.88	16,155.50
2026	4,038.88	4,038.88	20,194.38
2027	4,038.88	4,038.88	24,233.25
2028	3,634.99	3,634.99	27,868.24
2029	3,634.99	3,634.99	31,503.23
2030	3,634.99	3,634.99	35,138.22
2031	3,634.99	3,634.99	38,773.20
2032	3,634.99	3,634.99	42,408.19
2033	3,634.99	3,634.99	46,043.18
2034	3,271.49	3,271.49	49,314.67
2035	3,271.49	3,271.49	52,586.16
2036	3,271.49	3,271.49	55,857.65
2037	3,271.49	3,271.49	59,129.14
2038	3,271.49	3,271.49	62,400.63
2039	3,271.49	3,271.49	65,672.11
2040	2,944.34	2,944.34	68,616.45
2041	2,944.34	2,944.34	71,560.80
2042	2,944.34	2,944.34	74,505.14
2043	2,944.34	2,944.34	77,449.48
2044	2,944.34	2,944.34	80,393.82
2045	2,944.34	2,944.34	83,338.16
2046	2,649.91	2,649.91	85,988.06
2047	2,649.91	2,649.91	88,637.97
2048	2,649.91	2,649.91	91,287.87
2049	2,649.91	2,649.91	93,937.78
2050	2,649.91	2,649.91	96,587.69
2051	2,649.91	2,649.91	99,237.59

Table 28. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

Leakage Belt			
Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	$ABSLLK_t$	$ABSLLK$
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2022	181.39	181.39	181.39
2023	181.39	181.39	362.78

2024	181.39	181.39	544.17
2025	181.39	181.39	725.56
2026	181.39	181.39	906.95
2027	181.39	181.39	1,088.33
2028	163.25	163.25	1,251.58
2029	163.25	163.25	1,414.84
2030	163.25	163.25	1,578.09
2031	163.25	163.25	1,741.34
2032	163.25	163.25	1,904.59
2033	163.25	163.25	2,067.84
2034	146.93	146.93	2,214.76
2035	146.93	146.93	2,361.69
2036	146.93	146.93	2,508.61
2037	146.93	146.93	2,655.54
2038	146.93	146.93	2,802.46
2039	146.93	146.93	2,949.39
2040	132.23	132.23	3,081.62
2041	132.23	132.23	3,213.85
2042	132.23	132.23	3,346.09
2043	132.23	132.23	3,478.32
2044	132.23	132.23	3,610.55
2045	132.23	132.23	3,742.78
2046	119.01	119.01	3,861.79
2047	119.01	119.01	3,980.80
2048	119.01	119.01	4,099.81
2049	119.01	119.01	4,218.82
2050	119.01	119.01	4,337.83
2051	119.01	119.01	4,456.84

Calculation of Baseline Emissions

The total average biomass stock per hectare (Mg ha^{-1}) was converted to tCO$_2$e using the following equations:

$$Cab_{icl} = ab \times CF \times 44/12$$

Where,

Cabicl — Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class icl; tCO2e ha^{-1}

ab — Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl; Mg ha^{-1}

CF — Default value of carbon fraction in biomass

44/12 — Ratio converting C to CO2e

$$Cbb_{icl} = bb \times CF \times 44/12$$

Where,

Cbbicl	Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class icl; tCO2e ha^{-1}
bb	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl; Mg ha^{-1}
CF	Default value of carbon fraction in biomass
44/12	Ratio converting C to CO2e

The total baseline carbon stock change in the project area at year t is calculated as follows:

$$\Delta CBSLPA_t = \Delta CabBSLPA_{icl,t} + \Delta CbbBSLPA_{icl,t}$$

Where,

ΔCBSLPAt	Total baseline carbon stock changes in the project area at year t; tCO2e
ΔCabBSLPAicl,t	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e
ΔCbbBSLPAicl,t	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO2e

$$\Delta CabBSLPA_{icl,t} = ABSLPA_{icl,t} * \Delta Cab_{icl}$$

Where,

ΔCabBSLPAicl,t	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e
ABSLPAicl,t	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCabicl	Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class icl; tCO2e ha^{-1}

$$\Delta CbbBSLPA_{icl,t} = ABSLPA_{icl,t} * \Delta Cbb_{icl}$$

Where,

ΔCbbBSLPAicl,t	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO2e
ABSLPAicl,t	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCbbicl	Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category icl; tCO2e ha^{-1}

Estimation of the average carbon stocks of each LU/LC class

According to the applied methodology, average carbon stocks must be estimated for the forest classes existing within the project area. This information must be collected from existing carbon stock data for these classes from local published studies and existing forest and carbon inventories, according to the following criteria:

- The data is less than 10 years old;

- The data are derived from multiple measurement plots;

- All species above a minimum diameter are included in the inventories;

- The minimum diameter for trees included is 30 cm or less at breast height (DBH);

- Data is sampled from good coverage of the classes over which they will be extrapolated.

Project carbon stocks were calculated on the basis of biomass values from the study from Lunardelli, 2016[137].The data will be updated and may be stratified if new and more updated references for each phytophysiognomy are published. It is also important to note that revenues from carbon credits will be an important factor in encouraging specific studies in the project area, which would produce direct data on the region's carbon dynamics.

The methodology of the study summarized below:

LUNARDELLI, Caroline. Influence of environmental and anthropic factors seon Above-ground biomass estimate in the south of Amazon. Universidade Federal do Mato Grosso (UFMT), 2016.

The study was carried out in three areas located in the South of the Amazon, in the municipality of Cláudia, Mato Grosso. The areas were considered as modules.

The modules have different exploration histories and post-exploratory fallow time, being explored in 1981, 1995 and 2002 (module III, II and I, respectively). Modules I and II were explored according to the legislation, with a Sustainable Forest Management Plan (PMFS – Decree No. 1282/1994), where management operations lasted two years, and were carried out by the same

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[137] LUNARDELLI, Caroline. Influência de fatores ambientais e antrópico na estimativa de biomassa arbórea acima do solo no sul da Amazônia. UFMT, 2016. Available at https://ppbio.inpa.gov.br/sites/default/files/Lunardelli_C_Dissertacao_2016.pdf

exploration team. Module III has no evidence of major disturbances. This area had restricted logging, with Swietenia macrophylla King (Mahogany) being the only species explored.

The vegetation of the three modules is classified as Evergreen Seasonal Forest (IBGE, 2012), with species characteristic of the Amazon-Cerrado transitional forest.

Modules I and II (12 plots each) form a 1x5 km trail system, totaling 5 km². Module III (eight plots) is composed of a 1x3 km trail system, totaling 3 km², due to the smaller size of the area. A permanent plot (40x250 m) was installed at each intersection of trails, 1 km apart, following the altimetric quota to minimize variations in altitude, type and soil characteristics.

Within each plot, trees were marked and had their diameter at breast height (DBH) measured, to later be used to estimate tree biomass. This measurement was performed according to the Vegetation Structure Manual for measuring and marking trees in RAPELD grids and modules (PPBio, 2014). The trees were sampled in three bands, according to their size. In the first strip, trees with DBH ≥ 1 cm were sampled in an area of 0.1 ha (4 x 250 m); in the second, trees with DBH ≥ 10 cm in an area of 0.5 ha (20 x 250 m); and in the third, trees with DBH ≥ 30 cm, totaling 1 ha (40 x 250 m).

The aboveground tree biomass was estimated for each of the 32 plots belonging to the three modules, from the measurement of the diameter at breast height (DBH, corresponding to 1.30 m above the ground) of trees with diameter ≥ 5 cm. The measurement of diameters was performed according to the size of the trees.

Individuals with DBH < 6 cm were measured with a caliper, positioning it towards the largest diameter. For individuals with DBH > 6 cm, a diametric tape (Forestry Suppliers, model 283D) was used. In trees with buttresses, the diameter was measured about 50 cm above the buttress end. In trunks with irregularities, the measurement point was shifted upwards, looking for more cylindrical sections of the stem.

The allometric equation used to estimate aboveground tree biomass was developed by Nogueira et al. (2008), for the southern region of the Amazon with data collected from individuals with DBH ≥ 5 cm, in four localities with similar forest characteristics: Carlinda, Cotriguaçu and Juruena in Mato Grosso, and Novo Progresso in Pará.

This equation adopts only DBH as the input variable, in a simple model that calculates the aboveground dry biomass of each individual, in Kg ha-1 (Equation 1).

$$Biomass = \exp(-1.716 + 2.413 * \ln(DBH)) \quad \text{(Equation 1)}$$

Where

Biomass	Dry weight of biomass (kg)
ln	natural logarithm
DBH	Diameter at breast height

To verify the influence of forest exploitation on the biomass estimate, the explored basal area (ABE) was used. From a sweep inside each plot, the base of the trees explored (stumps) was measured with the aid of a diametric tape. Stumps that were in an advanced stage of decomposition were not measured (only 5% of the stumps were found in this condition), as they did not allow recognition of their original shape. From the base diameter of these individuals, it was possible to calculate the basal area explored.

$$ABE = \frac{\sum (\pi * d^2)}{4} \qquad \text{(Equation 2)}$$

Where

ABE	Basal area explored (Área basal explorada)
π	3.141593
d	Diameter at base height

Analysis of Variance (ANOVA) was used to verify the existence of average differences in the estimation of tree biomass between the three modules. The Shapiro Wilk test was used to verify the normality of the data. Only the variables estimated tree biomass and explored basal area did not show normal distribution and were logarithmized.

The Mantel test was used to verify the spatial autocorrelation between the location of the plots and the biomass estimate values. This procedure is often used to correlate the variable 'distance' with any other variable, which in this case was biomass. Tree biomass estimates were related to environmental variables, human disturbance and soil through multiple regression analysis.

The average tree biomass estimated in the three modules was 155.40 Mg ha-1 ± 13.29 CI (95% confidence interval) per plot, ranging from 87.18 to 320.34 Mg ha-1. Module III had the highest estimated average tree biomass (168.88 Mg ha-1, followed by modules I and II. However, module I had the highest estimated total tree biomass (1,885.26 Mg ha-1), followed by modules II and III. The average tree biomass was Applied in the Project case.

In addition, average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha.

In order to convert biomass into carbon, and carbon into carbon-dioxide, the conversion factors defined in table below were used.

Table 29. Biomass to CO2 conversion factors[138]

Conversion Factors***	
Biomass to Carbon	0.5
C to CO_2	3.6667

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[138] IPCC, 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Table 30. Biomass values used for the "forest" classes within the reference region.

REFERENCE REGION									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{lcl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{lcl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{lcl}$ (tCO$_2$/ha)
Evergreen seasonal forest	155.40	77.70	284.90	37.30	18.65	68.38	192.70	96.35	353.28

Table 31. Biomass values used for the "forest" classes within the project area.

PROJECT AREA									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{lcl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{lcl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{lcl}$ (tCO$_2$/ha)
Evergreen seasonal forest	155.40	77.70	284.90	37.30	18.65	68.38	192.70	96.35	353.28

Table 32. Biomass values used for the "forest" classes within the leakage belt.

LEAKAGE BELT									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{lcl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{lcl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{lcl}$ (tCO$_2$/ha)
Evergreen seasonal forest	155.40	77.70	284.90	37.30	18.65	68.38	192.70	96.35	353.28

Average carbon stocks of post-deforestation classes

Fearnside (1996)[139] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual

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[139] FEARNSIDE, Philip M. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. Forest Ecology And Management, Manaus, v. 80, p.21-34, 1996 Available at < https://www.jstor.org/stable/3591054>

transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO2e/ha. It is important to note that no sampling was applied to calculate this data.

Table 33. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Post deforestation class *fcl*	
Name	Non forest
ID_{fcl}	1
Average carbon stock per hectare ±90% CI	
$Ctot_{fcl}$	
tCO_2e/ha	
46.93	

Following a literature review, the use of Fearnside (1996) value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory[140], the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used.

<u>Uncertainty assessment</u>

According to the applied methodology, if the uncertainty of the total average carbon stock is less than 10% of the average value, the average value, the average carbon stock value can be used. Otherwise, the lower boundary of the 90% confidence interval must be considered in the calculations if the class is an initial forest class in the project area or a final non-forest class in the leakage belt, and the higher boundary of the 90% confidence interval if the class is an initial forest class in the leakage belt or a final non-forest class in the project area.

Lunardelli, for the Evegreen vegetation type, was conducted at a 95% confidence interval and present an uncertainty level less than 10% of the average carbon stock value.

Therefore, tables below present carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt, uncertainties at confidence interval of 90%, and final values after discounts for uncertainties, if applicable:

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[140] Available at <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/estimativas-anuais-de-emissoes-gee>

Table 34. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt

Boundaries	Initial forest class *icl*					
	Average carbon stock 90% CI					
	Name	Forest				
	ID$_{icl}$	1				
	Cab$_{icl}$		Cbb$_{icl}$		Ctot$_{icl}$	
	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI
	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
Project Area	284.90	20.45	68.38	4.91	353.28	25.36
Leakage Belt	284.90	20.45	68.38	4.91	353.28	25.36

Table 35. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties

	Boundaries	Initial forest class *icl*					
		Average carbon stock 90% CI					
		Name	Forest				
		ID$_{icl}$	1				
		Cab$_{icl}$		Cbb$_{icl}$		Ctot$_{icl}$	
		C stock	C stock change	C stock	C stock change	C stock	C stock change
		tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
Initial forest class Final forest class	Project Area	284.90	284.90	68.38	68.38	353.28	353.28
		284.90	284.90	68.38	68.38	353.28	353.28
Initial forest class Final forest class	Leakage Belt	284.90	284.90	68.38	68.38	353.28	353.28
		284.90	284.90	68.38	68.38	353.28	353.28

Carbon stock change factors

The VM0015 methodology v1.1 applies default linear functions to account for the decay of carbon stock in initial forest classes (icl) and increase of carbon stocks in post-deforestation classes. In addition, the methodology stipulates that various change factors must be applied to the baseline case initial and post-deforestation classes in above-ground and below ground biomass:

a) Above-ground biomass:

- Initial forest classes (icl): immediate release of 100% of the carbon stock is assumed to happen during year $t = t^*$ (year in which deforestation occurs).

- Post-deforestation classes (fcl): linear increase from 0 tCO_2e/ha in year $t = t^*$ to 100% of the long-term average carbon stock in year $t = t^*+9$ is assumed to happen in the 10-years period following deforestation (i.e. $1/10^{th}$ of the final carbon stock is accumulated each year).

b) Below-ground biomass:

- Initial forest classes (icl): an annual release of $1/10^{th}$ of the initial carbon stock is assumed to happen each year between $t = t^*$ and $t = t^*+9$.

- Post-deforestation classes (fcl): linear increase from 0 tCO_2e/ha in year $t = t^*$ to 100% of the long-term average carbon stock in year $t = t^*+9$ is assumed to happen in the 10 years period following deforestation (i.e. $1/10^{th}$ of the final carbon stock is accumulated each year).

As such, the tables below show carbon stock change factors for initial and final forest classes in above and below-ground carbon pools, which were then applied to calculate baseline carbon stock changes.

Table 36. Carbon stock change factors for initial forest classes (icl) in the reference region (Method 1)

		Forest	
Year after deforestation		$\Delta Cab_{icl,t}$ tCO_2/ha	$\Delta Cbb_{icl,t}$ tCO_2/ha
1	t^*	-284.90	-6.84
2	t^*+1	0	-6.84
3	t^*+2	0	-6.84
4	t^*+3	0	-6.84
5	t^*+4	0	-6.84
6	t^*+5	0	-6.84
7	t^*+6	0	-6.84
8	t^*+7	0	-6.84
9	t^*+8	0	-6.84
10	t^*+9	0	-6.84
11	t^*+10	0	0
12	t^*+11	0	0
13	t^*+12	0	0
14	t^*+13	0	0
15	t^*+14	0	0
16	t^*+15	0	0
17	t^*+16	0	0
18	t^*+17	0	0

19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Table 37. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method1)

	Forest		
Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-284.90	-6.84
2	t*+1	0	-6.84
3	t*+2	0	-6.84
4	t*+3	0	-6.84
5	t*+4	0	-6.84
6	t*+5	0	-6.84
7	t*+6	0	-6.84
8	t*+7	0	-6.84
9	t*+8	0	-6.84
10	t*+9	0	-6.84
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Table 38. Carbon stock change factors for initial forest classes (icl) in the Leakage Belt (Method 1)

	Forest		
Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-284.90	-6.84
2	t*+1	0	-6.84
3	t*+2	0	-6.84
4	t*+3	0	-6.84
5	t*+4	0	-6.84
6	t*+5	0	-6.84

7	t*+6	0	-6.84
8	t*+7	0	-6.84
9	t*+8	0	-6.84
10	t*+9	0	-6.84
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Table 39. Carbon stock change factors for final classes fcl or zones z (Method 1)

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO$_2$e/ha)
1	t*	0.00
2	t*+1	5.21
3	t*+2	5.21
4	t*+3	5.21
5	t*+4	5.21
6	t*+5	5.21
7	t*+6	5.21
8	t*+7	5.21
9	t*+8	5.21
10	t*+9	5.21
11	t*+10	0
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0
16	t*+15	0
17	t*+16	0
18	t*+17	0
19	t*+18	0
20	t*+19	0
21-T	t*+20...	0

Calculation of baseline carbon stock changes

The resulting changes in carbon stock for initial forest classes for the reference region, project area and leakage belt are shown in tables below.

Table 40. Baseline carbon stock change in the Reference Region

Carbon stock change in the above-ground biomass per initial forest class icl		Total carbon stock change in the above-ground biomass of initial forest class in the reference region		Carbon stock change in the below-ground biomass per initial forest class icl		Total carbon stock change in the below-ground biomass of initial forest class in the reference region		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region		Total net carbon stock change in the reference region	
ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$	ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$	ID_{lz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$	$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e	Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e	Project year	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e
2022	1,150,676	1,150,676	1,150,676	2022	27,616	27,616	27,616	2022	0	0	0	1,178,292	1,178,292
2023	1,150,676	1,150,676	2,301,351	2023	55,232	55,232	82,849	2023	21,062	21,062	21,062	1,184,846	2,363,138
2024	1,150,676	1,150,676	3,452,027	2024	82,849	82,849	165,697	2024	42,124	42,124	63,186	1,191,400	3,554,538
2025	1,150,676	1,150,676	4,602,702	2025	110,465	110,465	276,162	2025	63,186	63,186	126,372	1,197,955	4,752,493
2026	1,150,676	1,150,676	5,753,378	2026	138,081	138,081	414,243	2026	84,248	84,248	210,620	1,204,509	5,957,001
2027	1,150,676	1,150,676	6,904,054	2027	165,697	165,697	579,941	2027	105,310	105,310	315,930	1,211,063	7,168,064
2028	1,035,608	1,035,608	7,939,662	2028	190,552	190,552	770,492	2028	126,372	126,372	442,302	1,099,788	8,267,852
2029	1,035,608	1,035,608	8,975,270	2029	215,406	215,406	985,899	2029	145,328	145,328	587,629	1,105,687	9,373,539
2030	1,035,608	1,035,608	10,010,878	2030	240,261	240,261	1,226,160	2030	164,284	164,284	751,913	1,111,586	10,485,125
2031	1,035,608	1,035,608	11,046,486	2031	265,116	265,116	1,491,276	2031	183,239	183,239	935,152	1,117,484	11,602,609
2032	1,035,608	1,035,608	12,082,094	2032	262,354	262,354	1,753,630	2032	202,195	202,195	1,137,347	1,095,767	12,698,376
2033	1,035,608	1,035,608	13,117,702	2033	259,592	259,592	2,013,222	2033	200,089	200,089	1,337,436	1,095,112	13,793,488
2034	932,047	932,047	14,049,749	2034	254,345	254,345	2,267,567	2034	197,983	197,983	1,535,419	988,410	14,781,898
2035	932,047	932,047	14,981,797	2035	249,098	249,098	2,516,666	2035	193,981	193,981	1,729,400	987,165	15,769,062
2036	932,047	932,047	15,913,844	2036	243,851	243,851	2,760,517	2036	189,979	189,979	1,919,379	985,919	16,754,982
2037	932,047	932,047	16,845,891	2037	238,604	238,604	2,999,121	2037	185,977	185,977	2,105,356	984,674	17,739,656
2038	932,047	932,047	17,777,938	2038	236,119	236,119	3,235,240	2038	181,976	181,976	2,287,332	986,190	18,725,846
2039	932,047	932,047	18,709,985	2039	233,633	233,633	3,468,873	2039	180,080	180,080	2,467,412	985,600	19,711,446
2040	838,843	838,843	19,548,828	2040	228,911	228,911	3,697,784	2040	178,184	178,184	2,645,596	889,569	20,601,015
2041	838,843	838,843	20,387,671	2041	224,188	224,188	3,921,972	2041	174,583	174,583	2,820,179	888,448	21,489,463
2042	838,843	838,843	21,226,513	2042	219,466	219,466	4,141,438	2042	170,981	170,981	2,991,160	887,327	22,376,791
2043	838,843	838,843	22,065,356	2043	214,744	214,744	4,356,182	2043	167,380	167,380	3,158,540	886,207	23,262,997
2044	838,843	838,843	22,904,198	2044	212,507	212,507	4,568,688	2044	163,778	163,778	3,322,318	887,571	24,150,569
2045	838,843	838,843	23,743,041	2045	210,270	210,270	4,778,958	2045	162,072	162,072	3,484,390	887,040	25,037,609
2046	754,958	754,958	24,497,999	2046	206,020	206,020	4,984,978	2046	160,366	160,366	3,644,756	800,612	25,838,221
2047	754,958	754,958	25,252,957	2047	201,770	201,770	5,186,748	2047	157,125	157,125	3,801,880	799,603	26,637,824
2048	754,958	754,958	26,007,915	2048	197,519	197,519	5,384,267	2048	153,883	153,883	3,955,764	798,595	27,436,419
2049	754,958	754,958	26,762,874	2049	193,269	193,269	5,577,536	2049	150,642	150,642	4,106,405	797,586	28,234,005
2050	754,958	754,958	27,517,832	2050	191,256	191,256	5,768,793	2050	147,400	147,400	4,253,805	798,814	29,032,819
2051	754,958	754,958	28,272,790	2051	189,243	189,243	5,958,035	2051	145,865	145,865	4,399,670	798,336	29,831,155

Table 41. Baseline carbon stock change in the Project Area

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the project area		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area		Total net carbon stock change in the project area	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$	ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$	ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_z$	$\Delta CBSLPA_t$	$\Delta CBSLPA$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2022	60,115	60,115	60,115	2022	1,443	1,443	1,443	2022	0	0	0	61,557	61,557
2023	60,115	60,115	120,229	2023	2,886	2,886	4,328	2023	1,100	1,100	1,100	61,900	123,457
2024	60,115	60,115	180,344	2024	4,328	4,328	8,657	2024	2,201	2,201	3,301	62,242	185,699
2025	60,115	60,115	240,459	2025	5,771	5,771	14,428	2025	3,301	3,301	6,602	62,585	248,284
2026	60,115	60,115	300,573	2026	7,214	7,214	21,641	2026	4,401	4,401	11,003	62,927	311,211
2027	60,115	60,115	360,688	2027	8,657	8,657	30,298	2027	5,502	5,502	16,505	63,269	374,481
2028	54,103	54,103	414,791	2028	9,955	9,955	40,253	2028	6,602	6,602	23,107	57,456	431,937
2029	54,103	54,103	468,894	2029	11,253	11,253	51,506	2029	7,592	7,592	30,699	57,764	489,701
2030	54,103	54,103	522,998	2030	12,552	12,552	64,058	2030	8,583	8,583	39,282	58,072	547,774
2031	54,103	54,103	577,101	2031	13,850	13,850	77,909	2031	9,573	9,573	48,855	58,381	606,154
2032	54,103	54,103	631,204	2032	13,706	13,706	91,615	2032	10,563	10,563	59,418	57,246	663,400
2033	54,103	54,103	685,307	2033	13,562	13,562	105,177	2033	10,453	10,453	69,872	57,212	720,612
2034	48,693	48,693	734,000	2034	13,288	13,288	118,464	2034	10,343	10,343	80,215	51,637	772,250
2035	48,693	48,693	782,693	2035	13,014	13,014	131,478	2035	10,134	10,134	90,349	51,572	823,822
2036	48,693	48,693	831,386	2036	12,739	12,739	144,217	2036	9,925	9,925	100,274	51,507	875,329
2037	48,693	48,693	880,079	2037	12,465	12,465	156,683	2037	9,716	9,716	109,990	51,442	926,771
2038	48,693	48,693	928,771	2038	12,336	12,336	169,018	2038	9,507	9,507	119,497	51,521	978,293
2039	48,693	48,693	977,464	2039	12,206	12,206	181,224	2039	9,408	9,408	128,905	51,491	1,029,784
2040	43,824	43,824	1,021,288	2040	11,959	11,959	193,183	2040	9,309	9,309	138,214	46,474	1,076,257
2041	43,824	43,824	1,065,111	2041	11,712	11,712	204,895	2041	9,121	9,121	147,334	46,415	1,122,672
2042	43,824	43,824	1,108,935	2042	11,466	11,466	216,361	2042	8,933	8,933	156,267	46,357	1,169,029
2043	43,824	43,824	1,152,759	2043	11,219	11,219	227,580	2043	8,744	8,744	165,011	46,298	1,215,327
2044	43,824	43,824	1,196,582	2044	11,102	11,102	238,682	2044	8,556	8,556	173,568	46,369	1,261,696
2045	43,824	43,824	1,240,406	2045	10,985	10,985	249,667	2045	8,467	8,467	182,035	46,342	1,308,038
2046	39,441	39,441	1,279,847	2046	10,763	10,763	260,430	2046	8,378	8,378	190,413	41,826	1,349,864
2047	39,441	39,441	1,319,288	2047	10,541	10,541	270,971	2047	8,209	8,209	198,621	41,774	1,391,638
2048	39,441	39,441	1,358,730	2048	10,319	10,319	281,290	2048	8,039	8,039	206,661	41,721	1,433,359
2049	39,441	39,441	1,398,171	2049	10,097	10,097	291,387	2049	7,870	7,870	214,531	41,668	1,475,027
2050	39,441	39,441	1,437,612	2050	9,992	9,992	301,379	2050	7,701	7,701	222,231	41,732	1,516,759
2051	39,441	39,441	1,477,053	2051	9,887	9,887	311,265	2051	7,620	7,620	229,852	41,707	1,558,467

Table 42. Baseline carbon stock change in the Leakage Belt

Carbon stock change in the above-ground biomass per initial forest class icl		Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt		Carbon stock change in the below-ground biomass per initial forest class icl		Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt		Total net carbon stock change in the leakage belt	
ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$	ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$	ID_{lz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$	$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2022	51,678	51,678	51,678	2022	1,240	1,240	1,240	2022	0	0	0	52,918	52,918
2023	51,678	51,678	103,356	2023	2,481	2,481	3,721	2023	946	946	946	53,212	106,130
2024	51,678	51,678	155,033	2024	3,721	3,721	7,442	2024	1,892	1,892	2,838	53,507	159,637
2025	51,678	51,678	206,711	2025	4,961	4,961	12,403	2025	2,838	2,838	5,675	53,801	213,438
2026	51,678	51,678	258,389	2026	6,201	6,201	18,604	2026	3,784	3,784	9,459	54,095	267,534
2027	51,678	51,678	310,067	2027	7,442	7,442	26,046	2027	4,730	4,730	14,189	54,390	321,923
2028	46,510	46,510	356,577	2028	8,558	8,558	34,603	2028	5,675	5,675	19,864	49,392	371,316
2029	46,510	46,510	403,087	2029	9,674	9,674	44,278	2029	6,527	6,527	26,391	49,657	420,973
2030	46,510	46,510	449,597	2030	10,790	10,790	55,068	2030	7,378	7,378	33,769	49,922	470,895
2031	46,510	46,510	496,107	2031	11,907	11,907	66,974	2031	8,229	8,229	41,998	50,187	521,082
2032	46,510	46,510	542,616	2032	11,783	11,783	78,757	2032	9,081	9,081	51,079	49,212	570,294
2033	46,510	46,510	589,126	2033	11,659	11,659	90,415	2033	8,986	8,986	60,065	49,182	619,477
2034	41,859	41,859	630,985	2034	11,423	11,423	101,838	2034	8,892	8,892	68,957	44,390	663,867
2035	41,859	41,859	672,844	2035	11,187	11,187	113,025	2035	8,712	8,712	77,669	44,334	708,201
2036	41,859	41,859	714,703	2036	10,952	10,952	123,977	2036	8,532	8,532	86,201	44,278	752,480
2037	41,859	41,859	756,562	2037	10,716	10,716	134,693	2037	8,352	8,352	94,553	44,222	796,702
2038	41,859	41,859	798,421	2038	10,604	10,604	145,297	2038	8,173	8,173	102,726	44,291	840,993
2039	41,859	41,859	840,280	2039	10,493	10,493	155,790	2039	8,088	8,088	110,813	44,264	885,257
2040	37,673	37,673	877,953	2040	10,281	10,281	166,070	2040	8,002	8,002	118,816	39,951	925,208
2041	37,673	37,673	915,627	2041	10,068	10,068	176,139	2041	7,841	7,841	126,656	39,901	965,109
2042	37,673	37,673	953,300	2042	9,856	9,856	185,995	2042	7,679	7,679	134,335	39,851	1,004,960
2043	37,673	37,673	990,973	2043	9,644	9,644	195,640	2043	7,517	7,517	141,853	39,800	1,044,760
2044	37,673	37,673	1,028,646	2044	9,544	9,544	205,183	2044	7,355	7,355	149,208	39,862	1,084,621
2045	37,673	37,673	1,066,319	2045	9,443	9,443	214,627	2045	7,279	7,279	156,487	39,838	1,124,459
2046	33,906	33,906	1,100,225	2046	9,253	9,253	223,879	2046	7,202	7,202	163,689	35,956	1,160,415
2047	33,906	33,906	1,134,130	2047	9,062	9,062	232,941	2047	7,057	7,057	170,745	35,911	1,196,326
2048	33,906	33,906	1,168,036	2048	8,871	8,871	241,812	2048	6,911	6,911	177,656	35,866	1,232,191
2049	33,906	33,906	1,201,942	2049	8,680	8,680	250,492	2049	6,765	6,765	184,422	35,820	1,268,012
2050	33,906	33,906	1,235,848	2050	8,589	8,589	259,081	2050	6,620	6,620	191,042	35,875	1,303,887
2051	33,906	33,906	1,269,754	2051	8,499	8,499	267,580	2051	6,551	6,551	197,593	35,854	1,339,741

Baseline non-CO2 emissions from forest fires

As described in baseline scenario, slash-and-burn deforestation to clear the area is carried out for cattle ranching, which is the main cause of deforestation within the project area.

Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. It is worth mentioning that the effect of fire on CO2 emissions is counted in the estimation of carbon stock changes; therefore, CO2 emissions from biomass burning were ignored to avoid double counting. However, non-CO2 emissions (CH4 and N2O) from forest fires (EBBBSLPAt) were quantified and included as baseline emissions, as follows.

$$EBBtot_{icl,t} = EBBN_2O_{icl,t} + EBBCH_{4icl,t}$$

Where,

$EBBtot_{icl,t}$	Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBN_2O_{icl,t}$	N$_2$O emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBCH_{4icl,t}$	CH$_4$ emission from biomass burning in forest class icl at year t; tCO_2e/ha

$$EBBN_2O_{icl,t} = EBBCO_{2icl,t} * 12/44 * NCR * ER_{N2O} * 44/28 * GWP_{N2O}$$

Where,

$EBBCO_{2icl,t}$	Per hectare CO$_2$ emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
NCR	Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
ER_{N2O}	Emission ratio for N$_2$O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N$_2$O (IPCC default value)[141]

$$EBBCH_{4icl,t} = EBBCO_{2icl,t} * 12/44 * ER_{CH4} * 16/12 * GWP_{CH4}$$

Where,

$EBBCO_{2icl,t}$	Per hectare CO$_2$ emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
ER_{CH4}	Emission ratio for CH$_4$ (IPCC default value = 0.012)

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[141] According to the VCS Standard, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fifth Assessment Report (GWP for N2O = 265).

GWP_{CH4} Global Warming Potential for CH_4 (IPCC default value) [142]

$$EBBCO_{2icl,t} = Fburnt_{icl} * \sum_{p=1}^{P} (C_{picl,t} * Pburnt_{p,icl} * CE_{p,icl})$$

Where,

$EBBCO_{2icl,t}$ Per hectare CO_2 emission from biomass burning in the forest class icl at year t; tCO_2e/ha

$Fburnt_{icl}$ Proportion of forest area burned during the historical reference period in the forest class icl; %

$C_{picl,t}$ Average carbon stock per hectare in the carbon pool p burnt in the forest class icl at year t; tCO_2e/ha

$Pburnt_{p,icl}$ Average proportion of mass burnt in the carbon pool p in the forest class icl; %

$CE_{p,icl}$ Average combustion efficiency of the carbon pool p in the forest class icl; dimensionless (IPCC default of 0.5)

p   Carbon pool that could burn, above-ground biomass

The proportion of forest burned during the historical reference period used is the value of "Biomass combustion factors by phytophysiognomies group in the Amazon biome" for Seasonal semideciduous forest available at the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change[143]. The Fburnt estimated was 46.40%.

The Pburnt estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m³/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%.

However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation.

The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.

It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be

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[142] According to the VCS Standard, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fifth Assessment Report (GWP for CH_4 = 28).
[143] Available at Volume 3, Table A2.4, page 305
<http://www.ccst.inpe.br/publicacao/terceira-comunicacao-nacional-do-brasil-a-convencao-quadro-das-nacoes-unidas-sobre-mudanca-do-clima-portugues/>

a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.

Thus, the total actual non-CO_2 emissions from forest fire at year t in the project area at the baseline scenario (EBBBSLPA$_t$) were calculated as follows.

$$EBBBSLPA_t = ABSLPA_{icl,t} * EBBtot_{icl,t}$$

Where,

EBBBSLPA$_t$ Total actual non-CO_2 emissions from forest fire at year t in the project area in the baseline scenario; tCO_2e/ha

ABSLPA$_{icl,t}$ Annual area of deforestation of initial forest classes icl in the project area at year t; ha

EBBtot$_{icl,t}$ Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha

Values of all estimated parameters are reported in the following table.

Table 43. Parameters used to calculate non-CO2 emissions from forest fires

Initial Forest Class		Parameters								
		Fburnt$_{icl}$	Cab	Pburnt$_{ab,icl}$	CE$_{ab,icl}$	ECO2-ab	EBBCO2-tot	EBBN2O$_{icl}$	EBBCH4$_{icl}$	EBBtot$_{icl}$
IDcl	Name	%	tCO_2e/ha	%	%	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha
1	Forest	46.4%	284.90	78%	50%	51.56	51.56	0.46	5.62	6.09

Table 44. Baseline non-CO2 emissions from forest fires in the project area

Project year t	Emissions of non-CO_2 gasses from baseline forest fires		Total baseline non-CO_2 emissions from forest fires in the project area	
	ID_{cl} = 1 Forest		annual	cumulative
	$ABSLPA_{lcl,t}$	$EBBBSLtot_{lcl}$	$EBBBSLPA_t$	$EBBBSLPA$
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2022	211.00	6.09	1,283.98	1,283.98
2023	211.00	6.09	1,283.98	2,567.96
2024	211.00	6.09	1,283.98	3,851.94
2025	211.00	6.09	1,283.98	5,135.93
2026	211.00	6.09	1,283.98	6,419.91
2027	211.00	6.09	1,283.98	7,703.89
2028	189.90	6.09	1,155.58	8,859.47
2029	189.90	6.09	1,155.58	10,015.05
2030	189.90	6.09	1,155.58	11,170.64
2031	189.90	6.09	1,155.58	12,326.22
2032	189.90	6.09	1,155.58	13,481.80
2033	189.90	6.09	1,155.58	14,637.39
2034	170.91	6.09	1,040.02	15,677.41
2035	170.91	6.09	1,040.02	16,717.44
2036	170.91	6.09	1,040.02	17,757.46
2037	170.91	6.09	1,040.02	18,797.49
2038	170.91	6.09	1,040.02	19,837.51
2039	170.91	6.09	1,040.02	20,877.54
2040	153.82	6.09	936.02	21,813.56
2041	153.82	6.09	936.02	22,749.58
2042	153.82	6.09	936.02	23,685.60
2043	153.82	6.09	936.02	24,621.63
2044	153.82	6.09	936.02	25,557.65
2045	153.82	6.09	936.02	26,493.67
2046	138.44	6.09	842.42	27,336.09
2047	138.44	6.09	842.42	28,178.51
2048	138.44	6.09	842.42	29,020.93
2049	138.44	6.09	842.42	29,863.35
2050	138.44	6.09	842.42	30,705.77
2051	138.44	6.09	842.42	31,548.19

4.2   Project Emissions

The present activity instance does not include planned deforestation and planned logging activities within the project area. In case future instances include Sustainable Forest Management Plan, the respective parameters and calculation must be included in this section.

Nevertheless, some unplanned deforestation may happen in the project area despite the implemented REDD project activity. The level at which deforestation will actually be reduced in the project case depends on the effectiveness of the proposed activities, which cannot be measured *ex ante*. *Ex post* measurements of the project results will be important to determine actual emission reductions.

To allow ex ante projections to be made, a conservative assumption was made about the effectiveness of the proposed project activities in order to define the Effectiveness Index (EI). The estimated value of EI is used to multiply the baseline projections by the factor (1 - EI) and the result was considered to be the *ex ante* estimated emissions from unplanned deforestation in the project case. This is calculated as follows:

$$\Delta CUDdPA_t = \Delta CBSLPA_t * (1 - EI)$$

Where,

$\Delta CUDdPA_t$	Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e
$\Delta CBSLPA_t$	Total baseline carbon stock change in the project area at year t; tCO_2e
EI	*Ex ante* estimated Effectiveness Index; %
t	1, 2, 3 ... T, a year of the proposed project crediting period; dimensionless

$$\Delta CPSPA_t = \Delta CPAdPA_t + \Delta CUDdPA_t - \Delta CPAiPA_t$$

Where,

$\Delta CPSPA_t$	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO_2e
$\Delta CPAdPA_t$	Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_2e
$\Delta CUDdPA_t$	Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e
$\Delta CPAiPA_t$	Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

Due to the importance of project activities, which is expected to generate improvements in the local economy and employment generation, the Effectiveness Index (EI) was conservatively assumed as 92.07%. This percentage was calculated based on verified reports of other VM0015 REDD projects located in Brazil.

It was then applied to the ex-ante estimate of net carbon stock change in the project area under the project scenario, shown in Table below:

Table 45. Ex ante estimated net carbon stock change in the project area under the project scenario

Project year t	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e
2022	0.00	0.00	0.00	0.00	3,367.88	3,367.88	3,367.88	3,367.88
2023	0.00	0.00	0.00	0.00	3,386.61	6,754.49	3,386.61	6,754.49
2024	0.00	0.00	0.00	0.00	3,405.35	10,159.84	3,405.35	10,159.84
2025	0.00	0.00	0.00	0.00	3,424.08	13,583.92	3,424.08	13,583.92
2026	0.00	0.00	0.00	0.00	3,442.82	17,026.74	3,442.82	17,026.74
2027	0.00	0.00	0.00	0.00	3,461.55	20,488.29	3,461.55	20,488.29
2028	0.00	0.00	0.00	0.00	3,143.49	23,631.78	3,143.49	23,631.78
2029	0.00	0.00	0.00	0.00	3,160.36	26,792.14	3,160.36	26,792.14
2030	0.00	0.00	0.00	0.00	3,177.22	29,969.35	3,177.22	29,969.35
2031	0.00	0.00	0.00	0.00	3,194.08	33,163.43	3,194.08	33,163.43
2032	0.00	0.00	0.00	0.00	3,132.00	36,295.43	3,132.00	36,295.43
2033	0.00	0.00	0.00	0.00	3,130.13	39,425.56	3,130.13	39,425.56
2034	0.00	0.00	0.00	0.00	2,825.15	42,250.71	2,825.15	42,250.71
2035	0.00	0.00	0.00	0.00	2,821.59	45,072.29	2,821.59	45,072.29
2036	0.00	0.00	0.00	0.00	2,818.03	47,890.32	2,818.03	47,890.32
2037	0.00	0.00	0.00	0.00	2,814.47	50,704.79	2,814.47	50,704.79
2038	0.00	0.00	0.00	0.00	2,818.80	53,523.59	2,818.80	53,523.59
2039	0.00	0.00	0.00	0.00	2,817.12	56,340.71	2,817.12	56,340.71
2040	0.00	0.00	0.00	0.00	2,542.63	58,883.34	2,542.63	58,883.34
2041	0.00	0.00	0.00	0.00	2,539.43	61,422.76	2,539.43	61,422.76
2042	0.00	0.00	0.00	0.00	2,536.22	63,958.99	2,536.22	63,958.99
2043	0.00	0.00	0.00	0.00	2,533.02	66,492.01	2,533.02	66,492.01
2044	0.00	0.00	0.00	0.00	2,536.92	69,028.93	2,536.92	69,028.93
2045	0.00	0.00	0.00	0.00	2,535.40	71,564.34	2,535.40	71,564.34
2046	0.00	0.00	0.00	0.00	2,288.37	73,852.70	2,288.37	73,852.70
2047	0.00	0.00	0.00	0.00	2,285.49	76,138.19	2,285.49	76,138.19
2048	0.00	0.00	0.00	0.00	2,282.60	78,420.79	2,282.60	78,420.79
2049	0.00	0.00	0.00	0.00	2,279.72	80,700.51	2,279.72	80,700.51
2050	0.00	0.00	0.00	0.00	2,283.23	82,983.74	2,283.23	82,983.74
2051	0.00	0.00	0.00	0.00	2,281.86	85,265.60	2,281.86	85,265.60

As forest fires were included in the baseline scenario, non-CO_2 emissions from biomass burning should also be included in the project scenario. This is done by multiplying the baseline emissions by the factor (1 – EI), as follows.

$$EBBPSPA_t = EBBBSPA_t * (1 - EI)$$

Where,

EBBPSPA$_t$ Total *ex ante* actual non-CO_2 emissions from forest fire due to unavoided unplanned deforestationat at year t in the project area; tCO$_2$e/ha

EBBBSPA$_t$ Total non-CO_2 emissions from forest fire at year t in the project area; tCO$_2$e

EI   *Ex ante* estimated Effectiveness Index; %

t   1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

Furthermore, it is conservatively assumed that all unplanned deforestation within the project area will involve fire and all above ground biomass will be burnt. It is worth mentioning that the effect of fire on CO_2 emissions is counted in the estimation of carbon stock changes in the parameter ΔCUDdPAt; therefore, CO_2 emissions from forest fires should be ignored to avoid double counting.

Table 46. Total ex ante estimated actual emissions of non-CO₂ gases due to forest fires in the project area

Project year t	Total ex ante estimated actual non-CO₂ emissions from forest fires in the Project area	
	EBBPSPA$_t$	EBBPSPA
	annual	cumulative
	tCO₂e	tCO₂e
2022	70.25	70.25
2023	70.25	140.50
2024	70.25	210.74
2025	70.25	280.99
2026	70.25	351.24
2027	70.25	421.49
2028	63.22	484.71
2029	63.22	547.94
2030	63.22	611.16
2031	63.22	674.38
2032	63.22	737.61
2033	63.22	800.83
2034	56.90	857.73
2035	56.90	914.63
2036	56.90	971.53
2037	56.90	1,028.43
2038	56.90	1,085.33
2039	56.90	1,142.24
2040	51.21	1,193.45
2041	51.21	1,244.66
2042	51.21	1,295.87
2043	51.21	1,347.08
2044	51.21	1,398.29
2045	51.21	1,449.50
2046	46.09	1,495.59
2047	46.09	1,541.68
2048	46.09	1,587.77
2049	46.09	1,633.86
2050	46.09	1,679.95
2051	46.09	1,726.04

<u>Total *ex ante* estimations for the project area</u>

The expected *ex ante* net carbon stock changes and non-CO₂ emissions in the Project area is summarized in the table below:

Table 47. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area

Project year t	Total *ex ante* carbon stock decrease due to planned activities		Total *ex ante* carbon stock increase due to planned activities		Total *ex ante* carbon stock decrease due to unavoided unplanned deforestation		Total *ex ante* carbon stock change		Total *ex ante* estimated actual non-CO₂ emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCPAdPAt	ΔCPAdPA	ΔCPAiPAt	ΔCPAiPA	ΔCUDdPAt	ΔCUDdPA	ΔCPSPAt	ΔCPSPA	EBBPSPAt	EBBPSPA
	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e	tCO₂e
2022	0.00	0.00	0.00	0.00	3,367.88	3,367.88	3,367.88	3,367.88	70.25	70.25
2023	0.00	0.00	0.00	0.00	3,386.61	6,754.49	3,386.61	6,754.49	70.25	140.50
2024	0.00	0.00	0.00	0.00	3,405.35	10,159.84	3,405.35	10,159.84	70.25	210.74
2025	0.00	0.00	0.00	0.00	3,424.08	13,583.92	3,424.08	13,583.92	70.25	280.99
2026	0.00	0.00	0.00	0.00	3,442.82	17,026.74	3,442.82	17,026.74	70.25	351.24
2027	0.00	0.00	0.00	0.00	3,461.55	20,488.29	3,461.55	20,488.29	70.25	421.49
2028	0.00	0.00	0.00	0.00	3,143.49	23,631.78	3,143.49	23,631.78	63.22	484.71
2029	0.00	0.00	0.00	0.00	3,160.36	26,792.14	3,160.36	26,792.14	63.22	547.94
2030	0.00	0.00	0.00	0.00	3,177.22	29,969.35	3,177.22	29,969.35	63.22	611.16
2031	0.00	0.00	0.00	0.00	3,194.08	33,163.43	3,194.08	33,163.43	63.22	674.38
2032	0.00	0.00	0.00	0.00	3,132.00	36,295.43	3,132.00	36,295.43	63.22	737.61
2033	0.00	0.00	0.00	0.00	3,130.13	39,425.56	3,130.13	39,425.56	63.22	800.83
2034	0.00	0.00	0.00	0.00	2,825.15	42,250.71	2,825.15	42,250.71	56.90	857.73
2035	0.00	0.00	0.00	0.00	2,821.59	45,072.29	2,821.59	45,072.29	56.90	914.63
2036	0.00	0.00	0.00	0.00	2,818.03	47,890.32	2,818.03	47,890.32	56.90	971.53
2037	0.00	0.00	0.00	0.00	2,814.47	50,704.79	2,814.47	50,704.79	56.90	1,028.43
2038	0.00	0.00	0.00	0.00	2,818.80	53,523.59	2,818.80	53,523.59	56.90	1,085.33
2039	0.00	0.00	0.00	0.00	2,817.12	56,340.71	2,817.12	56,340.71	56.90	1,142.24
2040	0.00	0.00	0.00	0.00	2,542.63	58,883.34	2,542.63	58,883.34	51.21	1,193.45
2041	0.00	0.00	0.00	0.00	2,539.43	61,422.76	2,539.43	61,422.76	51.21	1,244.66
2042	0.00	0.00	0.00	0.00	2,536.22	63,958.99	2,536.22	63,958.99	51.21	1,295.87
2043	0.00	0.00	0.00	0.00	2,533.02	66,492.01	2,533.02	66,492.01	51.21	1,347.08
2044	0.00	0.00	0.00	0.00	2,536.92	69,028.93	2,536.92	69,028.93	51.21	1,398.29
2045	0.00	0.00	0.00	0.00	2,535.40	71,564.34	2,535.40	71,564.34	51.21	1,449.50
2046	0.00	0.00	0.00	0.00	2,288.37	73,852.70	2,288.37	73,852.70	46.09	1,495.59
2047	0.00	0.00	0.00	0.00	2,285.49	76,138.19	2,285.49	76,138.19	46.09	1,541.68
2048	0.00	0.00	0.00	0.00	2,282.60	78,420.79	2,282.60	78,420.79	46.09	1,587.77
2049	0.00	0.00	0.00	0.00	2,279.72	80,700.51	2,279.72	80,700.51	46.09	1,633.86
2050	0.00	0.00	0.00	0.00	2,283.23	82,983.74	2,283.23	82,983.74	46.09	1,679.95
2051	0.00	0.00	0.00	0.00	2,281.86	85,265.60	2,281.86	85,265.60	46.09	1,726.04

4.3 Leakage

This step provides an *ex ante* estimate of the possible decrease in carbon stock and increase in GHG emissions (other than carbon stock change) due to leakage. According to the applied methodology, two sources of leakage are considered: a) decrease in carbon stocks and increase in GHG emissions associated with leakage prevention measures; and b) decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage.

Ex ante estimation of decrease in carbon stocks and increase in GHG emissions due to leakage prevention measures

To reduce the risk of activity displacement leakage, baseline deforestation agents could participate in activities within the project area and leakage management area that together will replace baseline income, product generation and livelihood of the agents as much as possible, so that deforestation will be reduced and the risk of displacement minimized. As such, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. If this decrease in carbon stock or increase in GHG emission is significant, it must be accounted, and ex post monitoring will be required.

Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. In order to calculate the net carbon stock changes that the planned leakage prevention measures are expected to occasion during the project crediting period, the projected carbon stocks shall be estimated in the leakage management area under the baseline case and project scenario.

The following activities in leakage management areas could occasion a decrease in carbon stocks or an increase in GHG emissions:

- Carbon stock changes due to activities implemented in leakage management areas;

- Methane (CH_4) and nitrous oxide (N_2O) emissions from livestock intensification (involving a change in the animal diet and/or animal numbers).

$$\Delta CLPMLKt = \Delta CBSLLKt - \Delta CPSLKt$$

Where,

$\Delta CLPMLKt$ Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

$\Delta CBSLLKt$ Annual carbon stock changes in leakage management areas in the baseline case at year t; tCO_2e

$\Delta CPSLKt$ Annual carbon stock change in leakage management areas in the project case; tCO_2e

If the net sum of carbon stock changes within a monitoring period is more than zero, leakage prevention measures are not causing any carbon stock decrease. The net increase shall

conservatively be ignored in the calculation of net GHG emission reductions of the project activity. Nevertheless, if the net sum is negative, it must be accounted if significant.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

$EgLK_t$ Emissions from grazing animals in leakage management areas at year t; tCO_2e/year

ECH_4ferm_t CH_4 emissions from enteric fermentation in leakage management areas at year t; tCO_2e/year

ECH_4man_t CH_4 emissions from manure management in leakage management areas year t; tCO_2e/year

EN_2Oman_t N_2O emissions from manure management in leakage management areas at year t; tCO_2e/year

t   1, 2, 3, … T years of the project crediting period; dimensionless

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

$ELPMLK_t$ Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_2e

No decrease in carbon stocks and/or increase in GHG emissions due to activities implemented in the leakage management area were identified. The leakage prevention measures proposed by the present project do not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. However, if such activities are implemented in the future, changes in carbon stock will be monitored, and if significant, will be accounted.

Therefore, the total *ex ante* estimated carbon stock changes and increases in GHG emissions due to leakage prevention measures are shown in the table below.

Table 48. Ex ante estimated net carbon stock change in leakage management areas

Project year t	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e
2022	0.00	0.00	0.00	0.00	3,367.88	3,367.88	3,367.88	3,367.88
2023	0.00	0.00	0.00	0.00	3,386.61	6,754.49	3,386.61	6,754.49
2024	0.00	0.00	0.00	0.00	3,405.35	10,159.84	3,405.35	10,159.84
2025	0.00	0.00	0.00	0.00	3,424.08	13,583.92	3,424.08	13,583.92
2026	0.00	0.00	0.00	0.00	3,442.82	17,026.74	3,442.82	17,026.74
2027	0.00	0.00	0.00	0.00	3,461.55	20,488.29	3,461.55	20,488.29
2028	0.00	0.00	0.00	0.00	3,143.49	23,631.78	3,143.49	23,631.78
2029	0.00	0.00	0.00	0.00	3,160.36	26,792.14	3,160.36	26,792.14
2030	0.00	0.00	0.00	0.00	3,177.22	29,969.35	3,177.22	29,969.35
2031	0.00	0.00	0.00	0.00	3,194.08	33,163.43	3,194.08	33,163.43
2032	0.00	0.00	0.00	0.00	3,132.00	36,295.43	3,132.00	36,295.43
2033	0.00	0.00	0.00	0.00	3,130.13	39,425.56	3,130.13	39,425.56
2034	0.00	0.00	0.00	0.00	2,825.15	42,250.71	2,825.15	42,250.71
2035	0.00	0.00	0.00	0.00	2,821.59	45,072.29	2,821.59	45,072.29
2036	0.00	0.00	0.00	0.00	2,818.03	47,890.32	2,818.03	47,890.32
2037	0.00	0.00	0.00	0.00	2,814.47	50,704.79	2,814.47	50,704.79
2038	0.00	0.00	0.00	0.00	2,818.80	53,523.59	2,818.80	53,523.59
2039	0.00	0.00	0.00	0.00	2,817.12	56,340.71	2,817.12	56,340.71
2040	0.00	0.00	0.00	0.00	2,542.63	58,883.34	2,542.63	58,883.34
2041	0.00	0.00	0.00	0.00	2,539.43	61,422.76	2,539.43	61,422.76
2042	0.00	0.00	0.00	0.00	2,536.22	63,958.99	2,536.22	63,958.99
2043	0.00	0.00	0.00	0.00	2,533.02	66,492.01	2,533.02	66,492.01
2044	0.00	0.00	0.00	0.00	2,536.92	69,028.93	2,536.92	69,028.93
2045	0.00	0.00	0.00	0.00	2,535.40	71,564.34	2,535.40	71,564.34
2046	0.00	0.00	0.00	0.00	2,288.37	73,852.70	2,288.37	73,852.70
2047	0.00	0.00	0.00	0.00	2,285.49	76,138.19	2,285.49	76,138.19
2048	0.00	0.00	0.00	0.00	2,282.60	78,420.79	2,282.60	78,420.79
2049	0.00	0.00	0.00	0.00	2,279.72	80,700.51	2,279.72	80,700.51
2050	0.00	0.00	0.00	0.00	2,283.23	82,983.74	2,283.23	82,983.74
2051	0.00	0.00	0.00	0.00	2,281.86	85,265.60	2,281.86	85,265.60

In addition, it is important to note that consumption of fossil fuels is considered insignificant in avoided unplanned deforestation project activities and shall not be considered.

Table 49. Ex ante estimated total emissions above the baseline from leakage prevention activities

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total *ex ante* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00
2048	0.00	0.00	0.00	0.00	0.00	0.00
2049	0.00	0.00	0.00	0.00	0.00	0.00
2050	0.00	0.00	0.00	0.00	0.00	0.00
2051	0.00	0.00	0.00	0.00	0.00	0.00

Ex ante estimation of the decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. The ex-ante activity displacement leakage is calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This is done by multiplying the estimated baseline carbon stock changes for the project area by a "Displacement Leakage Factor" (DLF) representing the percent of deforestation expected to be displaced outside the project boundary.

The baseline rate of deforestation within the leakage belt is shown in the variable ABSLLK. The ex ante activity displacement leakage is calculated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities. This is done by multiplying the estimated baseline carbon stock changes for the project area by a "Displacement Leakage Factor" (DLF) representing the percent of deforestation expected to be displaced outside the project boundary. It is calculated as follows:

$$\Delta CADLKt = \Delta CBSLPAt * DLF$$

Where,

$\Delta CADLKt$ Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e

DLF   Displacement leakage factor; %

As per the methodology, where leakage prevention activities are implemented, the factor shall be equal to the proportion of the baseline agents estimated to be given the opportunity to participate in leakage prevention activities and project activities.

For this project, the default activity-shifting leakage deduction of 15 percent to the gross GHG emission reductions and/or removals was considered, as per VCS Standard.

Furthermore, the _ex ante_ emissions from forest fires due to activity displacement leakage was calculated by multiplying baseline forest fire emissions in the project area by the same DLF used to estimate the decrease in carbon stocks, as follows.

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

$EADLKt_t$ Total _ex ante_ estimated increase in GHG emissions due to displaced forest fires; tCO_2e

$EBBBSPA_t$ Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e

DLF   Displacement leakage factor; %

t   1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

$$DLF = \frac{Project\ scenario\ leakage\ (ha)}{Total\ deforestation\ within\ the\ project\ area\ (ha)}$$

The actual calculated values for ex ante estimated leakage due to activity displacement, annually and cumulatively, are shown in the table below.

Table 50. Ex ante estimated leakage due to activity displacement

Project year	Total ex ante estimated decrease in carbon stocks due to displaced deforestation		Total ex ante estimated increase in GHG emissions due to displaced forest fires	
	annual	cumulative	annual	cumulative
	$\Delta CADLK_t$	$\Delta CADLK$	$EADLK_t$	$EADLK$
	tCO$_2$e	tCO$_2$e	tCO$_2$e	tCO$_2$e
2022	9,233.61	9,233.61	192.60	192.60
2023	9,284.97	18,518.58	192.60	385.19
2024	9,336.33	27,854.92	192.60	577.79
2025	9,387.70	37,242.62	192.60	770.39
2026	9,439.06	46,681.67	192.60	962.99
2027	9,490.42	56,172.09	192.60	1,155.58
2028	8,618.42	64,790.52	173.34	1,328.92
2029	8,664.65	73,455.16	173.34	1,502.26
2030	8,710.87	82,166.03	173.34	1,675.60
2031	8,757.10	90,923.13	173.34	1,848.93
2032	8,586.91	99,510.04	173.34	2,022.27
2033	8,581.77	108,091.82	173.34	2,195.61
2034	7,745.61	115,837.43	156.00	2,351.61
2035	7,735.85	123,573.29	156.00	2,507.62
2036	7,726.10	131,299.38	156.00	2,663.62
2037	7,716.34	139,015.72	156.00	2,819.62
2038	7,728.22	146,743.94	156.00	2,975.63
2039	7,723.60	154,467.53	156.00	3,131.63
2040	6,971.05	161,438.59	140.40	3,272.03
2041	6,962.27	168,400.86	140.40	3,412.44
2042	6,953.49	175,354.34	140.40	3,552.84
2043	6,944.70	182,299.05	140.40	3,693.24
2044	6,955.40	189,254.44	140.40	3,833.65
2045	6,951.24	196,205.68	140.40	3,974.05
2046	6,273.95	202,479.63	126.36	4,100.41
2047	6,266.04	208,745.67	126.36	4,226.78
2048	6,258.14	215,003.81	126.36	4,353.14
2049	6,250.23	221,254.04	126.36	4,479.50
2050	6,259.86	227,513.90	126.36	4,605.87
2051	6,256.11	233,770.01	126.36	4,732.23

Ex ante estimation of total leakage

The result of all sources of leakage is calculated as follows:

$$\Delta CLKt = \Delta CADLKt + \Delta CLPMLKt$$

Where,

$\Delta CLKt$ Total decrease in carbon stocks within the leakage belt at year t; tCO_2e

$\Delta CADLKt$ Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e

$\Delta CLPMLKt$ Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

To reduce the risk of activity displacement leakage, baseline deforestation agents shall participate in activities within the project area and leakage management area, so that deforestation will be reduced, and the risk of displacement minimized.

If leakage prevention activities include measures to enhance cropland and grazing land areas, a reduction in carbon stocks and/or an increase in GHG emissions may occur compared to the baseline case. The reduction in carbon stocks ($\Delta CLPMLKt$) shall be calculated as explained above. However, leakage emissions due to leakage prevention measures implemented by the project activity shall be calculated as follows:

$$ELK_t = EgLK_t + EADLK_t$$

Where,

ELK_t Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_2e

$EgLK_t$ Emissions from grazing animals in leakage management areas at year t; tCO_2e

$EADLK_t$ Total ex ante increase in GHG emissions due to displaced forest fires at year t; tCO_2e

No displaced forest fires nor increase in GHG emissions due to activities implemented in the leakage management area are expected to occur, such as emissions from grazing animals, fertilizer or fuel use.

Table 51. Ex ante estimated total leakage

Project year	Total ex ante GHG emissions from increased grazing activities		Total ex ante increase in GHG emissions due to displaced forest fires		Total ex ante decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	$EgLK$	$EADLk_t$	$EADLK$	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2022	0.00	0.00	192.60	192.60	9,233.61	9,233.61	0.00	0.00	9,233.61	9,233.61	192.60	192.60
2023	0.00	0.00	192.60	385.19	9,284.97	18,518.58	0.00	0.00	9,284.97	18,518.58	192.60	385.19
2024	0.00	0.00	192.60	577.79	9,336.33	27,854.92	0.00	0.00	9,336.33	27,854.92	192.60	577.79
2025	0.00	0.00	192.60	770.39	9,387.70	37,242.62	0.00	0.00	9,387.70	37,242.62	192.60	770.39
2026	0.00	0.00	192.60	962.99	9,439.06	46,681.67	0.00	0.00	9,439.06	46,681.67	192.60	962.99
2027	0.00	0.00	192.60	1,155.58	9,490.42	56,172.09	0.00	0.00	9,490.42	56,172.09	192.60	1,155.58
2028	0.00	0.00	173.34	1,328.92	8,618.42	64,790.52	0.00	0.00	8,618.42	64,790.52	173.34	1,328.92
2029	0.00	0.00	173.34	1,502.26	8,664.65	73,455.16	0.00	0.00	8,664.65	73,455.16	173.34	1,502.26
2030	0.00	0.00	173.34	1,675.60	8,710.87	82,166.03	0.00	0.00	8,710.87	82,166.03	173.34	1,675.60
2031	0.00	0.00	173.34	1,848.93	8,757.10	90,923.13	0.00	0.00	8,757.10	90,923.13	173.34	1,848.93
2032	0.00	0.00	173.34	2,022.27	8,586.91	99,510.04	0.00	0.00	8,586.91	99,510.04	173.34	2,022.27
2033	0.00	0.00	173.34	2,195.61	8,581.77	108,091.82	0.00	0.00	8,581.77	108,091.82	173.34	2,195.61
2034	0.00	0.00	156.00	2,351.61	7,745.61	115,837.43	0.00	0.00	7,745.61	115,837.43	156.00	2,351.61
2035	0.00	0.00	156.00	2,507.62	7,735.85	123,573.29	0.00	0.00	7,735.85	123,573.29	156.00	2,507.62
2036	0.00	0.00	156.00	2,663.62	7,726.10	131,299.38	0.00	0.00	7,726.10	131,299.38	156.00	2,663.62
2037	0.00	0.00	156.00	2,819.62	7,716.34	139,015.72	0.00	0.00	7,716.34	139,015.72	156.00	2,819.62
2038	0.00	0.00	156.00	2,975.63	7,728.22	146,743.94	0.00	0.00	7,728.22	146,743.94	156.00	2,975.63
2039	0.00	0.00	156.00	3,131.63	7,723.60	154,467.53	0.00	0.00	7,723.60	154,467.53	156.00	3,131.63
2040	0.00	0.00	140.40	3,272.03	6,971.05	161,438.59	0.00	0.00	6,971.05	161,438.59	140.40	3,272.03
2041	0.00	0.00	140.40	3,412.44	6,962.27	168,400.86	0.00	0.00	6,962.27	168,400.86	140.40	3,412.44
2042	0.00	0.00	140.40	3,552.84	6,953.49	175,354.34	0.00	0.00	6,953.49	175,354.34	140.40	3,552.84
2043	0.00	0.00	140.40	3,693.24	6,944.70	182,299.05	0.00	0.00	6,944.70	182,299.05	140.40	3,693.24
2044	0.00	0.00	140.40	3,833.65	6,955.40	189,254.44	0.00	0.00	6,955.40	189,254.44	140.40	3,833.65
2045	0.00	0.00	140.40	3,974.05	6,951.24	196,205.68	0.00	0.00	6,951.24	196,205.68	140.40	3,974.05
2046	0.00	0.00	126.36	4,100.41	6,273.95	202,479.63	0.00	0.00	6,273.95	202,479.63	126.36	4,100.41
2047	0.00	0.00	126.36	4,226.78	6,266.04	208,745.67	0.00	0.00	6,266.04	208,745.67	126.36	4,226.78
2048	0.00	0.00	126.36	4,353.14	6,258.14	215,003.81	0.00	0.00	6,258.14	215,003.81	126.36	4,353.14
2049	0.00	0.00	126.36	4,479.50	6,250.23	221,254.04	0.00	0.00	6,250.23	221,254.04	126.36	4,479.50
2050	0.00	0.00	126.36	4,605.87	6,259.86	227,513.90	0.00	0.00	6,259.86	227,513.90	126.36	4,605.87
2051	0.00	0.00	126.36	4,732.23	6,256.11	233,770.01	0.00	0.00	6,256.11	233,770.01	126.36	4,732.23

4.4   Net GHG Emission Reductions and Removals

The net anthropogenic GHG emission reduction of the proposed AUD project activity is calculated as follows:

$$\Delta REDDt = (\Delta CBSLPAt + EBBBSLPAt) - (\Delta CPSPAt + EBBPSPAt) - (\Delta CLKt + ELKt)$$

Where:

$\Delta REDDt$ Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e

$\Delta CBSLPAt$ Sum of baseline carbon stock changes in the project area at year t; tCO2e

$EBBBSLPAt$ Sum of baseline emissions from biomass burning in the project area at year t; tCO2e

$\Delta CPSPAt$ Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e

Note: If $\Delta CPSPAt$ represents a net increase in carbon stocks, a negative sign before the absolute value of $\Delta CPSPAt$ shall be used. If $\Delta CPSPAt$ represents a net decrease, the positive sign shall be used.

$EBBPSPAt$ Sum of (ex ante estimated) actual emissions from biomass burning in the project area at year t; tCO2e

$\Delta CLKt$ Sum of ex ante estimated leakage net carbon stock changes at year t; tCO2e

Note: If the cumulative sum of $\Delta CLKt$ within a fixed baseline period is > 0, $\Delta CLKt$ shall be set to zero.

$ELKt$ Sum of ex ante estimated leakage emissions at year t; tCO2e

t   1, 2, 3 … t, a year of the proposed project crediting period; dimensionless.

The number of Verified Carbon Units (VCUs) to be generated through the proposed AUD project activity at each year is calculated as follows:

$$VCUt = \Delta REDDt - VBCt$$

$$VBCt = (\Delta CBSLPAt - \Delta CPSPAt) * RFt$$

Where:

$VCUt$ Number of Verified Carbon Units that can be traded at time t; t CO2e

$\Delta REDDt$ Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e

$VBCt$ Number of Buffer Credits deposited in the VCS Buffer at time t; t CO2e

ΔCBSLPAt Sum of baseline carbon stock changes in the project area at year t; tCO2e

ΔCPSPAt Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e ha-1

Ft Risk factor used to calculate VCS buffer credits; %

t 1, 2, 3 … T, a year of the proposed project crediting period; dimensionless.

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value of RFt for the first project instance activity was 15%.

The net GHG emission reductions and removals by the project activity of Itamarati Grouped REDD Project are summarized in the table below.

Table 52. Summary of net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO$_2$e)	Estimated project emissions or removals (tCO$_2$e)	Estimated leakage emissions (tCO$_2$e)	*Ex ante* buffer credits (tCO$_2$e)	Estimated net GHG emission reductions or removals (tCO$_2$e)
2022	62,841	3,438	9,426	8,728	41,248
2023	63,184	3,457	9,478	8,777	41,472
2024	63,526	3,476	9,529	8,826	41,696
2025	63,869	3,494	9,580	8,874	41,919
2026	64,211	3,513	9,632	8,923	42,143
2027	64,553	3,532	9,683	8,971	42,367
2028	58,612	3,207	8,792	8,147	38,466
2029	58,920	3,224	8,838	8,191	38,667
2030	59,228	3,240	8,884	8,234	38,869
2031	59,536	3,257	8,930	8,278	39,070
2032	58,402	3,195	8,760	8,117	38,329
2033	58,367	3,193	8,755	8,112	38,306
2034	52,677	2,882	7,902	7,322	34,571
2035	52,612	2,878	7,892	7,313	34,529
2036	52,547	2,875	7,882	7,303	34,486
2037	52,482	2,871	7,872	7,294	34,444
2038	52,561	2,876	7,884	7,305	34,496
2039	52,531	2,874	7,880	7,301	34,476
2040	47,410	2,594	7,111	6,590	31,114
2041	47,351	2,591	7,103	6,581	31,076
2042	47,293	2,587	7,094	6,573	31,038
2043	47,234	2,584	7,085	6,565	30,999
2044	47,305	2,588	7,096	6,575	31,046
2045	47,278	2,587	7,092	6,571	31,028
2046	42,669	2,334	6,400	5,931	28,003
2047	42,616	2,332	6,392	5,923	27,968
2048	42,563	2,329	6,385	5,916	27,934
2049	42,511	2,326	6,377	5,908	27,899
2050	42,575	2,329	6,386	5,917	27,941
2051	42,550	2,328	6,382	5,914	27,925
Total	1,590,015	86,992	238,502	220,980	1,043,525

The specific summary of GHG reductions and removals in the Itamarati Grouped REDD project is included in the table below, which includes estimates of GHG emissions reduction (REDDt), calculations of buffer and leakage, and the calculation of tradable Verified Carbon Units (VCUt).

Table 53. Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and verified carbon units (VCUt)

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex ante project carbon stock changes		Ex ante project GHG emissions from biomass burning		Ex ante leakage carbon stock changes		Ex ante leakage GHG emissions		Ex ante net anthropogenic GHG emission reductions		Ex ante VCUs tradable		Ex ante buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2022	61,557	61,557	1,284	1,284	3,368	3,368	70	70	9,234	9,234	193	193	49,977	49,977	41,248	41,248	8,728	8,728
2023	61,900	123,457	1,284	2,568	3,387	6,754	70	140	9,285	18,519	193	385	50,249	100,226	41,472	82,720	8,777	17,505
2024	62,242	185,699	1,284	3,852	3,405	10,160	70	211	9,336	27,855	193	578	50,522	150,748	41,696	124,416	8,826	26,331
2025	62,585	248,284	1,284	5,136	3,424	13,584	70	281	9,388	37,243	193	770	50,794	201,542	41,919	166,335	8,874	35,205
2026	62,927	311,211	1,284	6,420	3,443	17,027	70	351	9,439	46,682	193	963	51,066	252,608	42,143	208,478	8,923	44,128
2027	63,269	374,481	1,284	7,704	3,462	20,488	70	421	9,490	56,172	193	1,156	51,339	303,947	42,367	250,845	8,971	53,099
2028	57,456	431,937	1,156	8,859	3,143	23,632	63	485	8,618	64,791	173	1,329	46,613	350,560	38,466	289,311	8,147	61,246
2029	57,764	489,701	1,156	10,015	3,160	26,792	63	548	8,665	73,455	173	1,502	46,858	397,419	38,667	327,978	8,191	69,436
2030	58,072	547,774	1,156	11,171	3,177	29,969	63	611	8,711	82,166	173	1,676	47,103	444,522	38,869	366,847	8,234	77,671
2031	58,381	606,154	1,156	12,326	3,194	33,163	63	674	8,757	90,923	173	1,849	47,349	491,871	39,070	405,917	8,278	85,949
2032	57,246	663,400	1,156	13,482	3,132	36,295	63	738	8,587	99,510	173	2,022	46,446	538,317	38,329	444,246	8,117	94,066
2033	57,212	720,612	1,156	14,637	3,130	39,426	63	801	8,582	108,092	173	2,196	46,419	584,736	38,306	482,552	8,112	102,178
2034	51,637	772,250	1,040	15,677	2,825	42,251	57	858	7,746	115,837	156	2,352	41,894	626,629	34,571	517,123	7,322	109,500
2035	51,572	823,822	1,040	16,717	2,822	45,072	57	915	7,736	123,573	156	2,508	41,842	668,472	34,529	551,652	7,313	116,812
2036	51,507	875,329	1,040	17,757	2,818	47,890	57	972	7,726	131,299	156	2,664	41,790	710,262	34,486	586,138	7,303	124,116
2037	51,442	926,771	1,040	18,797	2,814	50,705	57	1,028	7,716	139,016	156	2,820	41,739	752,000	34,444	620,582	7,294	131,410
2038	51,521	978,293	1,040	19,838	2,819	53,524	57	1,085	7,728	146,744	156	2,976	41,802	793,802	34,496	655,078	7,305	138,715
2039	51,491	1,029,784	1,040	20,878	2,817	56,341	57	1,142	7,724	154,468	156	3,132	41,777	835,579	34,476	689,554	7,301	146,016
2040	46,474	1,076,257	936	21,814	2,543	58,883	51	1,193	6,971	161,439	140	3,272	37,704	873,283	31,114	720,668	6,590	152,606
2041	46,415	1,122,672	936	22,750	2,539	61,423	51	1,245	6,962	168,401	140	3,412	37,658	910,941	31,076	751,744	6,581	159,187
2042	46,357	1,169,029	936	23,686	2,536	63,959	51	1,296	6,953	175,354	140	3,553	37,611	948,553	31,038	782,782	6,573	165,760
2043	46,298	1,215,327	936	24,622	2,533	66,492	51	1,347	6,945	182,299	140	3,693	37,565	986,117	30,999	813,781	6,565	172,325
2044	46,369	1,261,696	936	25,558	2,537	69,029	51	1,398	6,955	189,254	140	3,834	37,621	1,023,739	31,046	844,827	6,575	178,900
2045	46,342	1,308,038	936	26,494	2,535	71,564	51	1,450	6,951	196,206	140	3,974	37,599	1,061,338	31,028	875,855	6,571	185,471
2046	41,826	1,349,864	842	27,336	2,288	73,853	46	1,496	6,274	202,480	126	4,100	33,934	1,095,272	28,003	903,858	5,931	191,402
2047	41,774	1,391,638	842	28,179	2,285	76,138	46	1,542	6,266	208,746	126	4,227	33,892	1,129,164	27,968	931,826	5,923	197,325
2048	41,721	1,433,359	842	29,021	2,283	78,421	46	1,588	6,258	215,004	126	4,353	33,850	1,163,014	27,934	959,760	5,916	203,241
2049	41,668	1,475,027	842	29,863	2,280	80,701	46	1,634	6,250	221,254	126	4,480	33,808	1,196,822	27,899	987,659	5,908	209,149
2050	41,732	1,516,759	842	30,706	2,283	82,984	46	1,680	6,260	227,514	126	4,606	33,859	1,230,682	27,941	1,015,600	5,917	215,066
2051	41,707	1,558,467	842	31,548	2,282	85,266	46	1,726	6,256	233,770	126	4,732	33,839	1,264,521	27,925	1,043,525	5,914	220,980

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	CF
Data unit	tC/tdm
Description	Default value of carbon fraction in biomass
Source of data	Values from the literature, e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default IPCC value was used.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an estimate of the carbon content of the vegetation biomass within the project reference region.
Comments	If new and more accurate carbon fraction data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	$Ctot_{fcl}$
Data unit	tCO_2e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in tCO_2e/ha
Source of data	Long-term average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region were taken from the following study: FEARNSIDE, Philip M. Amazonian

	deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management**, Manaus, v. 80, p.21-34, 1996.
Value applied	46.93
Justification of choice of data or description of measurement methods and procedures applied	Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. Following a literature review, the use of Fearnside value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory from 2019, the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used.
Purpose of Data	This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	DLF was adopted as an average of displaced leakage in the Monitoring Reports of VM0015 projects developed in Brazil. An assessment of 15 verified projects located in Brazil was conducted, comparing leakage due to displaced deforestation on baseline and project scenarios.
Value applied	0.71%
Justification of choice of data or description of measurement methods and procedures applied	The DLF was estimated as 0.71%, based on other REDD project activities and taking into account the project situation.

Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$\Delta CBSLLK_t$
Data unit	tCO_2e
Description	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data	- Planned interventions proposed by the project proponent. - Remote sensing and GIS.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.
Purpose of Data	This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented.
Comments	*Ex post* monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$EBBBSLPA_t$

Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO2 emissions from forest fire at year t in the project area
Source of data	Remote sensing data and GIS, supervisor reports.
Value applied	208.80 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Justification of choice of data or description of measurement methods and procedures applied	Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt.
	Non-CO_2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case.
	Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t).
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an ex-ante estimation.
Comments	Ex post monitoring of forest fires and non-CO_2 emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$Fburnt_{icl}$
Data unit	%

Description	Proportion of forest area burned during the historical reference period in the forest class.
Source of data	Measured or estimated from literature. *Fburnt data source:* VThird National Communication from Brazil to the United Nations Framework Convention on Climate Change - Volume 3, Table A2.4, page 305 <http://www.ccst.inpe.br/publicacao/terceira-comunicacao-nacional-do-brasil-a-convencao-quadro-das-nacoes-unidas-sobre-mudanca-do-clima-portugues/>
Value applied	46.40
Justification of choice of data or description of measurement methods and procedures applied	Value of "Biomass combustion factors by phytophysiognomies group in the Amazon biome" for Seasonal semideciduous forest available at the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change.
Purpose of data	This parameter is the average percentage of the area within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	$Pburnt_{p,icl}$
Data unit	%
Description	Average proportion of mass burnt in the carbon pool in the forest class
Source of data	Measured or estimated from literature. *Pburnt data source:* Anderson LO, Aragão LE, Gloor M, et al. **Disentangling the contribution of multiple land covers to fire-mediated carbon emissions in Amazonia during the 2010 drought.** Global Biogeochem Cycles. 2015; 29 (10):1739-1753. Doi: 10.1002/2014GB005008. Available at <https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014GB005008>.

Value applied	78
Justification of choice of data or description of measurement methods and procedures applied	Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m³/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%. However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation. The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%. It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.
Purpose of data	This parameter is the average of biomass that has commercial value, and could be removed prior to clear cutting and burning, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	Estimate from project proponent based on verified reports of similar VM0015 REDD projects in Brazil up to date. Available in VERRA database.
Value applied	92.07%
Justification of choice of data or description of	Based on the comparison between *ex post* and *ex ante* deforestation of similar REDD projects developed in Brazil, available in verified reports in VERRA database up to date.

measurement methods and procedures applied	
Purpose of Data	This parameter is used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation.
Comments	*Ex post* monitoring of the project area will be done to determine deforestation rate and the project emissions. This parameter will be updated at each renewal of fixed baseline period.

5.2   Data and Parameters Monitored

Data / Parameter	ab_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the above-ground biomass were taken from the following study: LUNARDELLI, Caroline. Influência de fatores ambientais e antrópico na estimativa de biomassa arbórea acima do solo no sul da Amazônia. UFMT, 2016. Available at https://ppbio.inpa.gov.br/sites/default/files/Lunardelli_C_Dissertacao_2016.pdf
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	

Above-ground biomass
ab_{icl} (Mg/ha)

	Forest class	Reference Region	Project Area	Leakage Belt
	Forest class	155.40	155.40	155.40

Monitoring equipment	No monitoring equipment is used to determine this parameter.
QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements
Purpose of data	This parameter is used to calculate baseline emissions, project emissions and leakage emissions in both baseline and project scenarios.
Calculation method	Following a literature search the above-ground biomass values of these studies were used as they were determined to accurately represent the values of vegetation within the project reference region.
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.

Data / Parameter	bb_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	

Below-ground biomass			
bb_{icl} (Mg/ha)			
Forest class	Reference Region	Project Area	Leakage Belt

	Forest class	37.30	37.30	37.30	
Monitoring equipment	No monitoring equipment is used to determine this parameter.				
QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements				
Purpose of data	This parameter is used to calculate baseline, project and leakage emissions in the baseline and project scenarios.				
Calculation method	Calculation according to the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.				
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.				
Data / Parameter	ACPAt				
Data unit	Ha				
Description	Annual area within the Project Area affected by catastrophic events at year t.				
Source of data	- Remote sensing data and GIS, - Forest management team and other field data.				
Description of measurement methods and procedures to be applied	In addition to field data from the management team, he following sources will also be monitored: - INMET144 - INPE145				
Frequency of monitoring/recording	At each time a catastrophic event occurs.				
Value applied	The value will be calculated ex-post at each time a catastrophic event occurs, when significant.				
Monitoring equipment	Remote sensing and GIS				
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Field data from the management team				

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[144] INMET. Instituto Nacional de Meteorologia. Available at: <https://portal.inmet.gov.br/>.
[145] INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://www.inpe.br/>.

Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an ex post estimation of the area affected by catastrophic events within the project area.
Calculation method	Remote sensing and GIS
Comments	Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$ABSLLK_t$
Data unit	Ha
Description	Annual area of deforestation within the leakage belt at year t.
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	148.56 (estimated annual average)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	ABSLPAt
Data unit	Ha
Description	Annual area of deforestation in the project area at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	172.82 (estimated annual average)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the ex ante and ex post values of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$ABSLRR_t$
Data unit	Ha
Description	Annual area of deforestation in the reference region at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the reference region.
Frequency of monitoring/recording	Annually
Value applied	3,307.92 (estimated annual average)

Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the reference region.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	7,792.33 (Annual average projected decrease in carbon stocks due to displaced deforestation in the leakage belt during the crediting period)
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.

Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	ΔCPAdPAt
Data unit	tCO2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Source of data	Documents, remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0.00 (Annual average decrease in carbon stocks due to all planned activities within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS SFMP reports, including the post-harvesting annual report.
QA/QC procedures to be applied	- Best practices in remote sensing. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing and GIS
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Source of data	- Remote sensing and GIS - Field reports.

Description of measurement methods and procedures to be applied	Forest cover change due to unplanned deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	2,842.19 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project area.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	N/A

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex post* increase in GHG emissions due to displaced forest fires at year t.
Source of data	Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	Forest fires in the leakage belt area may be considered activity displacement leakage. GHG emissions due displaced forest fires will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	157.74
Monitoring equipment	Remote sensing and GIS

QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate leakage emissions in the baseline and project scenario. Provides the *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt.
Calculation method	GHG emissions from deforestation are estimated by multiplying the detected area of forest loss in the leakage belt times the average forest carbon stock per unit area.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) of actual non-CO_2 emissions from forest fire at year t in the project area
Source of data	- Remote sensing data and GIS, - Forest management team and field data.
Description of measurement methods and procedures to be applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, the forest management team could also confirm the obtained data. No forest fire will be used by the project owner for conducting planned deforestation or timber harvesting activities. However, it is expected that some unplanned deforestation within the project area will occur during the crediting period, which conversion of forest to non-forest may involve fire. The effect of fire on carbon emissions is counted in the estimation of carbon stock changes in the parameter *$\Delta CUDdPA_t$*; therefore CO_2 emissions from forest fires were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest fires must be counted in the project scenario, when they are significant.

	In order to be conservative, it will be assumed that all unplanned deforestation within the project area will involve fire. Therefore, non-CO_2 emissions from forest fires will be quantified and deducted from emission reductions.
Frequency of monitoring/recording	Annually
Value applied	57.53 (annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate *non-CO_2* emissions due to forest fires within the project area in the project scenario, providing an estimate of the *ex post* value for each vegetation type.
Calculation method	If forest fires occur, *non-CO_2* emissions from biomass burning will calculated according to requirements of methodology VM0015 v1.1. Therefore, this parameter will be calculated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the project scenario times the total GHG emission from biomass burning in initial forest classes (*EBBtot$_{icl,t}$*), when significant.
Comments	N/A

Data / Parameter	EBBtot$_{icl,t}$
Data unit	tCO2e/ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Source of data	Calculated according to methodology VM0015 v1.1.
Description of measurement methods and procedures to be applied	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project

	case. These average percentage values are assumed to remain the same in the future, according to the applied methodology
Frequency of monitoring/recording	Annually
Value applied	6.09
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter is used to calculate the baseline, project and leakage non-CO_2 emissions from biomass burning occurred in the baseline and project scenarios
Calculation method	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology.
Comments	GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0 (annual average for the crediting period)
Monitoring equipment	Remote sensing and GIS Field assessment data
QA/QC procedures to be applied	Best practices in remote sensing and GIS.

Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	The community living within the leakage management area practices grazing activities. Therefore, this shall be monitored during the crediting period. GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report – Itamarati Grouped REDD Project; - Remote sensing data and GIS; - SFMP data; - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	15
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event.
Purpose of data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors

	described in the VCS Non-Permanence Risk Report will be assessed.
Comments	N/A

5.3   Monitoring Plan

This monitoring plan has been developed according to the VCS Methodology VM0015 version 1.1.

Organizational structure

According to the contract stipulated between Future Carbon and the landowner, the landowner is responsible for the costing and implementation and/or maintenance of the project's forest management and activities to reduce deforestation and degradation, surveillance, fire prevention, illegal extraction of wood, prevention of invasions, among others, implementation and maintenance of social and environmental activities to reduce leakage, decrease the risks of non-permanence of carbon and improve the results of SOCIALCARBON, or other Standard for the assessment of social and environmental co-benefits.

In addition, it is responsible for keeping all documentation required by the project in order, as well as project maintenance expenses; Execute, monitor and maintain in full operation the structure that authorizes and serves as the basis for the development of the Project, ensuring the reduction of deforestation and degradation, the implementation and maintenance of social and environmental activities (or designating and hiring third parties responsible for the activities).

The owner is responsible for establishing prospects in each Social Carbon report, as well as complying with at least 50% of the proposed actions, under penalty of losing the Social Carbon standard.

Future Carbon is responsible for the development of the project documents, assessment of the mapping files for application of the methodology, and internal auditing.

- **Revision of the baseline**

The current baseline is valid for 6 years. The baseline will be reassessed every 6 years, and it will be validated at the same time as the subsequent verification.

Technical description of the monitoring task

The baseline scenario will be monitored through the assessment of agents and drivers variables and satellite images to project expected deforestation. Information on agents, drivers and underlying causes of deforestation in the reference region will be collected at the end of each fixed baseline period, as these are essential for improving future deforestation projections and

the design of the project activity. In addition, in the same frequency, the projected annual areas of baseline deforestation for the reference region will be revisited and eventually adjusted for the subsequent fixed baseline period.

The location of the projected baseline deforestation will be reassessed using the adjusted projections for annual areas of baseline deforestation and spatial data. All areas credited for avoided deforestation in past fixed baseline periods will be excluded from the revisited baseline projections as these areas cannot be credited again.

Baseline monitoring task will be done in accordance with the applied methodology, VM0015, version 1.1 or the most recent.

Data to be collected

Data will be collected to comply with the parameters used in the VM0015 v1.1, listed in Appendix 5, or the most recent.

Overview of data collection procedures

Data will be collected according to measurement methods and procedures described in section 5.1 and 5.2 above. All *ex ante* and *ex post* parameters will be reassessed at the moment of revision of the baseline.

Quality control and quality assurance procedures

QA/QC will be done according to best practices in remote sensing and as stated by VM0015 methodology.

Data archiving

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by the instance owner. Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the first monitoring period, as well as further monitoring reports in case it participates in the development of subsequent monitoring periods in the future.

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 converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VVBs 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.

Organization and responsibilities of the parties involved in all the above

Future Carbon is responsible for the development of the Project Design Document and the first Monitoring Report. Therefore, it is responsible for the organization and calculation of items related to the methodology.

The instance owner is responsible for the development of the project activity, monitoring of the required parameters in section 5.2 above, and for the development of subsequent monitoring reports. In addition, it is also responsible for forest surveillance and generation of socioenvironmental activities to local communities.

Future Carbon and/or a related partner is responsible for all GIS related information.

- **Monitoring of actual carbon stock changes and GHG emissions within the project area**

  - **Monitoring of project implementation**

The instance owner is responsible for the implementation of the project activity. The monitoring of the sustainable management plan is carried out by the municipal and state secretariats.

Information from the sustainable forest management plan and post-exploratory reports will be used to update parameters related to planned deforestation and will be verified during the validation and verification of the carbon project.

Updating Forest Carbon Stocks Estimates

If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction, provided that these data are in accordance to the requirements established by the applied methodology VM0015. New data on carbon stocks will only be used if they are validated by an accredited VVB.

Methods for generating, recording, aggregating, collating and reporting data on monitored parameters

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by Future Carbon.

Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the subsequent baseline reports and monitoring periods.

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 converted to a format accessible to future software applications, as needed.

All maps and records generated during 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 will be Future Carbon Ltda. Monitored parameters are described in Section 5.2 and will be monitored with the frequency described further below.

Quality Assurance/Quality Control

To ensure consistency and quality of results, spatial analysts carrying out the image processing, interpretation, and change detection procedures will strictly adhere to the steps detailed in the Methodology.

All of this reliable data, which will be 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 realities. Project activities implemented within the project area must be consistent with the management plan of the PD.

The implementation of the project activity will be monitored by continuous monitoring activities using remote sensing techniques. Additionally, field studies will also be used. The land-use monitoring will be carried out with remote sensing methods, using images generated by Mapbiomas, INPE (PRODES)[146] and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

The management structure will also rely on the local community to help monitor the area. All the monitored parameters will be checked with the frequency detailed in the Section 5.2 above, as requested in the VCS Methodology VM0015, version 1.1.

With the carbon credits income, in order to complement the monitoring of the project area and its surroundings, the project proponent intends to improve the remote sensing methods and data used, which meet the accuracy assessment requirements laid out in the methodology.

The present REDD project will also implement the sustainability report following the SOCIALCARBON methodology, which was developed by *Instituto Ecológica* and focus on implementing environmental and social activities within the project area. This methodology follows the SOCIALCARBON Guidelines available at: http://www.socialcarbon.org/documents/.

In addition, the SOCIALCARBON Reports will be available on the VCS Registry once the project is registered.

Procedures for handling internal auditing and non-conformities

The procedures for handling internal auditing and non-conformities are going to be established by both project developer and project proponent. All the necessary taskforce and procedures will be in place to meet the highest levels of control.

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[146] Available at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>

A project information quality management system will be implemented, the main purpose of which is to minimize the risk of error, obtaining reliable data on which to base the monitoring results, and thus, minimizing non-conformities. It includes the training of general staff in the different roles to play within the framework of the Itamarati Grouped REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of Future Carbon.

If non-conformities exist during the internal or external auditing processes, the data should be reviewed, and the non-conformities addressed.

o **Monitoring of land-use and land-cover change within the project area**

Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

The project boundary, as set out in the PD, will serve as the initial "forest cover benchmark map" against which changes in forest cover will be assessed over the interval of the monitoring period.

The entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event.

The increase or decrease in carbon stocks due to planned activities in the project area will also be monitored through documents and periodic assessment of classified satellite imagery covering the project area. In case of planned deforestation, emissions are estimated by multiplying the area of forest loss by the average forest carbon stock per unit area.

The results of monitoring shall be reported by creating *ex post* tables of activity data per stratum; per initial forest class *icl*; and per post-deforestation zone *z*, for the reference region, project area and leakage belt.

In addition, a map showing Cumulative Areas Credited within the project area shall be updated and presented to VCS verifiers at each verification event. The cumulative area cannot generate additional VCUs in future periods.

Other applied methodologies for monitoring of deforestation are listed below:

Monitoring bases

The instance owner is responsible for the implementation of monitoring bases, if necessary, to guarantee the standing forest and carbon stock.

Satellite images and remote sensing monitoring

The land use and land use cover change will be analyzed through remote sensing methods, using data from INPE (PRODES – deforestation; Queimadas – fire monitoring; TerraClass – qualification of Amazon deforestation), satellite images (LANDSAT, Sentinel, CBRES).

All reliable data 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 periodic meetings to review the Action Plan – that will be developed as part of the SocialCarbon Methodology. On these occasions, the design of the Monitoring Plan will be analyzed according to its efficiency in generating reliable feedback and all the necessary information. If any changes in the Monitoring Plan or management actions are identified, a corrective action will be designed and implemented.

Security procedures

The instance owner is responsible for the security procedures and reporting illegal activity to responsible authorities.

These actions are planned to avoid unplanned deforestation and carbon stock changes in the area. Related parameters shall be monitored and reassessed at every verification and revalidation point.

SOCIALCARBON Report will also monitor the relationship between the company and the communities, and its evolution on mitigating unplanned deforestation caused by these agents.

- o **Monitoring of carbon stock changes and non-CO2 emissions from fires**

In addition to the mentioned above, the instance owner is responsible for training monitoring, management, safety and health personnel. This may include periodic fire brigade training, including first aid, fire procedures, training of new monitoring personnel and those responsible for management during harvests.

If forest fires occur, these non-CO2 emissions will be subject to monitoring and accounting, when significant.

- o **Monitoring of impacts of natural disturbances and other catastrophic events**

The monitoring of natural impacts and other catastrophic events is responsibility of the instance owner. The company must notify Future Carbon so that it can include the related impacts in the carbon project reports, updating the related parameters, including the buffer report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, flooding, drought, fires or storms) or

man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring, when significant. If the area (or a sub-set of it) affected by natural disturbances or man-made events generated VCUs in past verifications, the total net change in carbon stocks and GHG emissions in the area(s) that generated VCUs will be estimated, and an equivalent amount of VCUs will be cancelled from the VCS buffer. No VCUs can be issued for the project until all carbon stock losses and increases in GHG emissions have been offset.

- **Monitoring of Leakage**

Monitoring of the leakage belt and leakage management area will be carried out as in the project area and reference region.

The most recent VCS guidelines on this subject matter shall be applied. Furthermore, as the leakage belt was determined using Option 1 (Opportunity cost analysis), the boundary of the leakage belt will have to be reassessed at the end of each fixed baseline period using the same methodological approaches used in the previous period. The calculation procedure for estimating leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

- Carbon stock changes and GHG emissions associated with leakage prevention activities.

The carbon stock decrease or increase in GHG emissions due to leakage prevention measures, which will probably take place inside the leakage management area, will be monitored through documents and field assessment. In areas undergoing carbon stock enhancement, the project conservatively assumes stable stocks and no biomass monitoring is conducted.

- Carbon stock decrease and increases in GHG emissions due to activity displacement leakage

Deforestation in the leakage belt area above the baseline may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

- **Organizational structure, responsibilities and competencies**

Monitoring will be done by the project proponent and outsourced to a third party having sufficient capacities to perform the monitoring tasks. To ensure the operation of the monitoring activities, the operational and managerial structure will be established according to the table below.

For all aspects of project monitoring, the project proponent will ensure that data collection, processing, analysis, management and archiving are conducted in accordance with the monitoring plan. The authority for the registration, monitoring, measurement and reporting will be Future Carbon.

Table 54. Type of Monitoring and Party Responsible

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Future Carbon and external institutions qualified for the GIS analysis and monitoring	Every 6 years
Monitoring Deforestation and Project Emissions	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring Leakage emissions	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of Natural Disturbance and catastrophic events	Instance owner and Future Carbon	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Future Carbon	At least, every 10 years, only if necessary.