URUPIANGA GROUPED REDD PROJECT

Document Prepared by Future Forest

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CONTENTS

1 PROJECT DETAILS 4

1.1 Summary Description of the Project 4
1.2 Sectoral Scope and Project Type 4
1.3 Project Eligibility 5
1.4 Project Design 5
1.5 Project Proponent 13
1.6 Other Entities Involved in the Project 19
1.7 Ownership 19
1.8 Project Start Date 21
1.9 Project Crediting Period 21
1.10 Project Scale and Estimated GHG Emission Reductions or Removals 22
1.11 Description of the Project Activity 23
1.12 Project Location 23
1.13 Conditions Prior to Project Initiation 24
1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks 24
1.15 Participation under Other GHG Programs 36
1.16 Other Forms of Credit 36
1.17 Sustainable Development Contributions 36
1.18 Additional Information Relevant to the Project 40

2 SAFEGUARDS 41

2.1 No Net Harm 41
2.2 Local Stakeholder Consultation 41
2.3 Environmental Impact 46
2.4 Public Comments 46
2.5 AFOLU-Specific Safeguards 46

3 APPLICATION OF METHODOLOGY 46

3.1 Title and Reference of Methodology 52
3.2 Applicability of Methodology 52
3.3 Project Boundary 55
3.4 Baseline Scenario 55

3.5 Additionality 66
3.6 Methodology Deviations 90
4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS 94
4.1 Baseline Emissions 94
4.2 Project Emissions 94
4.3 Leakage 129
4.4 Net GHG Emission Reductions and Removals 134
5 MONITORING 147
5.1 Data and Parameters Available at Validation 147
5.2 Data and Parameters Monitored 147
5.3 Monitoring Plan 153
APPENDIX 173

1 PROJECT DETAILS

1.1 Summary Description of the Project

In Brazil, 58.39% of its entire 8,510,345,538 km² 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 Amazon rainforest experienced its worst year in a decade in 2021. From January to December, 10,362 km² of native forest were destroyed[4]. 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 Urupianga Grouped REDD Project has its properties located in the State of Mato Grosso, Brazil. 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[5]. Simultaneously, Mato Grosso also registers high deforestation rates, reaching in 2018 the highest in 10 years [6]; 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[7].

For several reasons, the area is a vulnerable target of invasions and illegal actions, such as fires and theft of wood. Thus, monitoring and vigilance actions are fundamental to guarantee the standing forest.

The main objective of the Urupianga Grouped REDD Project is to avoid unplanned deforestation (AUD) in a project area of 13,351 ha, inserted in an area of transition from Cerrado to Amazon biome.

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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] IMAZON – Instituto do Homem e do Meio Ambiente da Amazônia. Available at:< Desmatamento na Amazônia cresce 29% em 2021 e é o maior dos últimos 10 anos - Imazon>

[5] 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

[6] 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

[7] Available at: http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5465

The project area is located within 6 private properties, located in the municipality of Vila Rica, in the State of Mato Grosso. This project was conceived as a grouped project, in order to be able to increase its contribution to the standing forest with the addition of new instances of project activity in the future.

Beyond 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, and developing environmental education and other social activities.

The AUD REDD project is expected to avoid predicted deforestation of 6,214.13 ha of deforestation, equating to 2,309,793 tCO2e in emissions reductions over the 30-year project lifetime (01-February-2021 to 31-January-2051), with an annual average of 76,993 tCO2e.

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[8], 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[9], Sections 3.1, 3.2 and Appendix A1.5 – A1.8:

Eligibility Conditions	Justification of Eligibility
Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document.	The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in Applicability of Methodology.
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	The applied methodology is VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1. Applicability conditions are detailed in section 3.2.

[8] Available at <https://verra.org/wp-content/uploads/2022/06/VCS-Methodology-Requirements-v4.2.pdf>
[9] Available at <https://verra.org/wp-content/uploads/2022/12/vcs-standard-v4.4-final.pdf> Last visit on 10/January/2023

Eligibility Conditions	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 Tropical Rainforest, including sustainable forest management plan or not. These activities are 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. 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. Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment.
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	Not applicable. Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment.

Eligibility Conditions	Justification of Eligibility
(i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project).	
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 approved VCS methodology and tools. 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 approved VCS methodology and tools. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.
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	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).

Eligibility Conditions	Justification of Eligibility
shall be adhered to at project crediting period renewal.	
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	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 land 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	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 Requirements, in which case the project shall not be subject to the WRC requirements.	Not applicable. The project activity does not occur on wetlands.

Eligibility Conditions	Justification of Eligibility
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 most recent version of the VCS Program document *AFOLU Non-Permanence Risk Tool*, 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 host country 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 parameters at the start of the project. Forested wetlands, such as floodplain forests, peatland forests and mangrove forests, are also eligible	The Project Area is composed of 100% native forest. The area is considered forest as per the definition of forest adopted by FAO[10]: 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.

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

Eligibility Conditions	Justification of Eligibility
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 most recent version of the VCS Standard document.	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 stopping or reducing deforestation or degradation on forest lands that are legally authorized and documented for conversion.	The present Project Activity is within category AUDD: Avoided Unplanned Deforestation and/or Degradation.

Eligibility Conditions	Justification of Eligibility
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

This project has been designed as a grouped project activity.

Eligibility Criteria

A set of eligibility criteria for the inclusion of any new areas as instances willing to participate within the grouped project will be developed as per VCS Standard requirements.

Since Urupianga Grouped REDD Project is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15, 3.5.16 and the specific AFOLU Projects criteria (3.5.17 and 3.5.18) of VCS Standard. 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	Urupianga 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.	Instance 1 complies with this requirement because it adopts the Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012.

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, 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 grouped Project. Also, this instance is in the same reference region described on the VCS PD. Instance 1 applies one of the technologies or measures specified on the present Project Description: forest conservation by avoiding unplanned 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 grouped Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD.
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	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. 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.	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.

investment, technological and/or other barriers as the initial instances.	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 (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 Protected Areas. - 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 area 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	The project activity within the area referring to instance 1 is located within the project's reference region as described in section 3.3 of the VCS PD.

	risk rating for each area applies only to the GHG emissions reductions generated 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	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.

reducing or removing GHG emissions).		
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 1.9 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 Analyst Lyara Carolina Montone Amaral – Technical Coordinator Yara Fernandes da Silva – Technical Coordinator
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Email	forest@futurecarbon.com.br

1.6 Other Entities Involved in the Project

Organization name	Mário Alves Ribeiro
Role in the project	Instance 1
Contact person	-
Title	Fazenda Boa Esperança/Fazenda Santa Celina/ Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Tifla Empreendimentos E Participaçoes Ltda.
Role in the project	Instance 1
Contact person	Marcelo
Title	Fazenda Ouro Branco e Ouro Verde / Fazenda Marupiara
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Caio Mário Caldeira Brant Ribeiro
Role in the project	Instance
Contact person	-
Title	Fazenda Santa Celina/ Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Urupianga Agro Pecuaria S.A

Role in the project	Instance 1
Contact person	Marcelo
Title	Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Flavia Caldeira Brant Ribeiro de Figueiredo
Role in the project	Instance 1
Contact person	Flavia Caldeira Brant Ribeiro de Figueiredo
Title	Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Ana Beatriz Ribeiro de Queiroz
Role in the project	Instance 1
Contact person	Ana Beatriz Ribeiro de Queiroz
Title	Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

Organization name	Helena Caldeira Brant Ribeiro
Role in the project	Instance 1
Contact person	-

Title	Fazenda Urupianga
Address	-
Telephone	-
Email	urupianga@uol.com.br

1.7 Ownership

Instance 1 is located in Vila Rica municipality, State of Mato Grosso, and is composed by 6 properties that comprise the following areas:

Figure 1 Project Properties

Land Owner	Proprety	Registration Number	Area
MÁRIO ALVES RIBEIRO	Fazenda Boa Esperança	5773/5772	2.892,91
TIFLA EMPREENDIMENTOS E PARTICIPAÇOES LTDA	Fazenda Ouro Branco e Ouro Verde	2123/1492	1.452,59
TIFLA EMPREENDIMENTOS E PARTICIPAÇOES LTDA	Fazenda Marupiara	4836	2.889,22
MÁRIO ALVES RIBEIRO	Fazenda Santa Celina	7420	505,19
Caio Mário Caldeira Brant Ribeiro	Fazenda vista Alegre	1262/3145/633	1.561,54
URUPIANGA AGRO PECUARIA S.A Flavia Caldeira Brant Ribeiro de Figueiredo Ana Beatriz Ribeiro de Queiroz Caio Mário Caldeira Brant Ribeiro HELENA CALDEIRA BRANT RIBEIRO MÁRIO ALVES RIBEIRO	Fazenda Urupianga	4838/4837	13.912,05

The table above shows all the properties involved in the project, in addition to their respective owners, registration number and the number of areas. The legal documents proving the land title and ownership of the property will be made available to the auditors during the validation process.

As per the rules stated at Section 3.6 – Ownership of the VCS Standard, v.4, an enforceable and irrevocable agreement was set between the property owners – the holders 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. (hereafter, "Future Carbon Group" or "Future Carbon"), which vests project ownership in the Project Proponent. Evidence of such agreement will also be made available to the audit team.

1.8 Project Start Date

Due to a significant increase in fires in the state of Mato Grosso, Instance 1 property owners took the initiative to elaborate a forest conservation plan on February 1st, 2021, in order formalize

their commitment to protecting their area. From this point, some actions aiming the surveillance and protection of the forest were carried out, such as the purchase of a vehicle use to carry out periodic rounds in the boundaries of the properties and putting up fences to better demarcate the areas, making their borders clear to outsiders, avoiding doubts about their limits for possible invaders.

Thus, the Project Start Date of the Urupianga Grouped REDD Project is 01-February-2021.

1.9 Project Crediting Period

The REDD project has a crediting period of 30 years, from 01-February-2021 to 31-January-2051.

According to the VCS requirements[11], the AUD baseline must be reassessed every 6 years for ongoing unplanned deforestation because projections for deforestation are difficult to predict over the long term.

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_2e)
2021	91,638
2022	98,989
2023	97,937
2024	96,907
2025	95,899
2026	94,913
2027	91,445
2028	90,579
2029	89,732
2030	88,902
2031	86,025
2032	84,107
2033	80,022
2034	78,350

[11] Available at: <https://verra.org/wp-content/uploads/2022/06/VCS-Standard_v4.3.pdf>

2035	76,714
2036	75,111
2037	73,599
2038	72,087
2039	68,483
2040	67,095
2041	65,734
2042	64,401
2043	63,147
2044	61,890
2045	58,705
2046	57,552
2047	56,421
2048	55,313
2049	54,274
2050	53,230
2051	20,589
Total estimated ERs	**2,309,793**
Total number of crediting years	**30**
Average annual ERs	**76,993**

1.11 Description of the Project Activity

The Urupianga Grouped REDD Project is a grouped project that consists in the implementation of conservation measures for avoiding unplanned deforestation within the Project Area.

Instance 1 adopts forest conservation measures such as improvements of infrastructure, acquisition of vehicles, trainings and management of surveillance teams to monitor suspicious and/or illegal activities and control of invasions within the project area. Other mitigation actions proposed by the Project in order 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 providing benefits to surrounding communities, aiming to minimize invasions and illegal deforestation, offering alternative income, education and professional training.

Therefore, besides forest conservation, the present project aims to quantify its social and environmental activities that benefit the local communities in order to improve the 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 aforementioned measures are expected to result in 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.

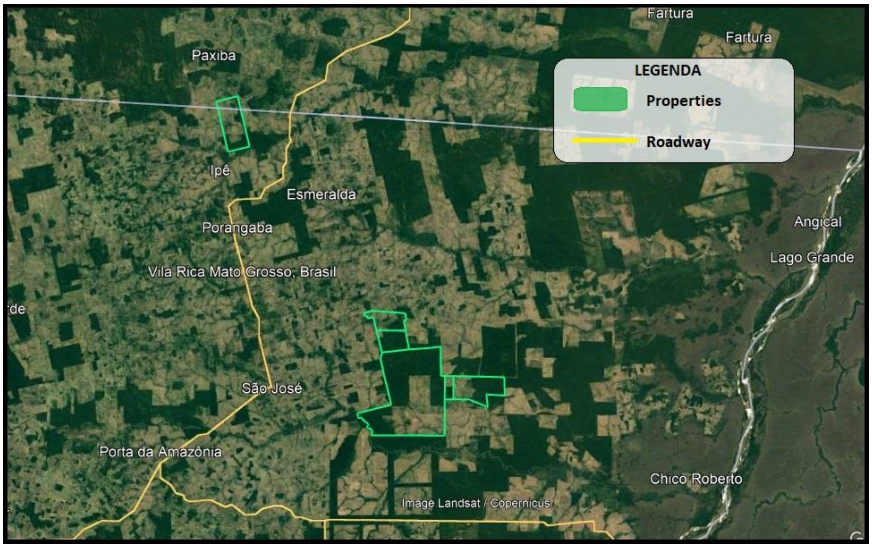
It is important to highlight that this project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

1.12 Project Location

The project area is mostly located in the municipality of Vila Rica, in the state of Mato Grosso and a small part in the municipality of Santana do Araguaia in the state of Pará, in the Midwest region and north of Brazil. The municipality of Vila Rica is located about 1,116 km from Cuiabá, capital of the State of Mato Grosso. The municipality of Santana do Araguaia is 1,303 km from Cuiabá-MT and 1,094 km from Belém, capital of the state of Pará. From the point of view of biodiversity, the project area is in a transition area from Cerrado to the Amazon Biome, however the project area has a greater predominance of the Amazon Forest biome.

The project location is close to other municipalities of Confresa/MT, Santa Terezinha/MT and Santana do Araguaia/PA, which belong to the State of Mato Grosso and State of Para. The region is in a region that has been the target of pressure from different segments such as loggers, cattle ranchers, and grain producers.

Figure 2. Properties location



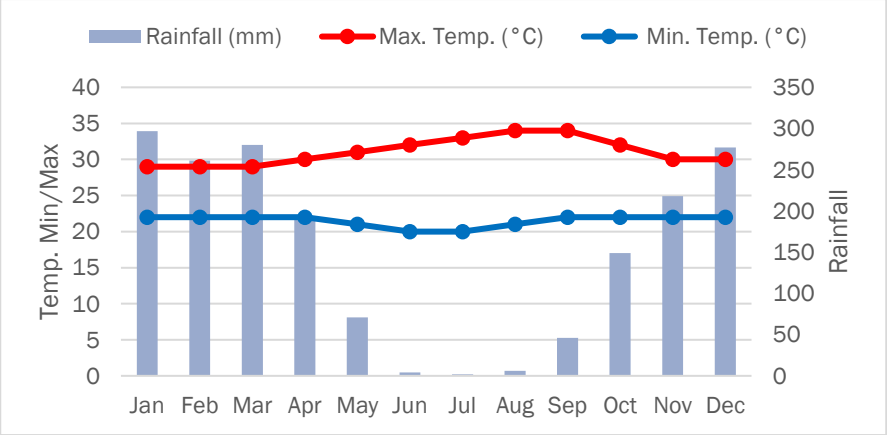
1.13 Conditions Prior to Project Initiation

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

Climate and Hydrography

The project region is classified as Tropical, dry climate type – Am category – according to the Köppen climate classification[12]. The dry season is defined between May and September[13]. Considering Vila Rica municipality climatology[14], the maximum temperature reaches 34ºC, and the minimum is 20ºC, while the average annual range is from 25ºC to 26. The biggest thermal differences (amplitude) are associated with the day and night cycle and not with the seasonal cycle. The daily thermal amplitude of this unit varies between 6º and 10º, while the annual amplitude is between 2ºC and 3ºC. The annual rainfall is around 1,800 mm. As stated before, the dry season occurs from May to September (5 months) with 130 mm of total water deficiency. Graphs below represents climatology for the municipality around Urupianga Grouped REDD Project.

Figure 3. Vila Rica climate graph

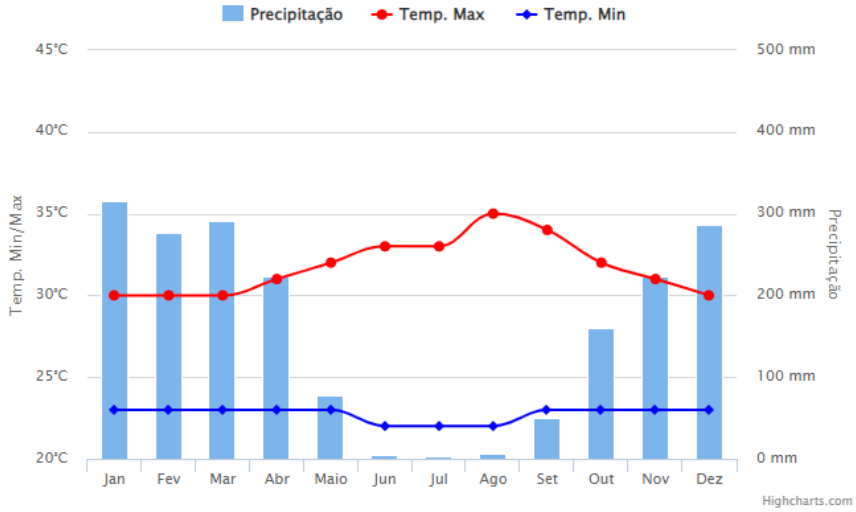


[12] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928. < https://en.wikipedia.org/wiki/K%C3%B6ppen_climate_classification>

[13] Availabe at: http://www.dados.mt.gov.br/publicacoes/dsee/climatologia/rt/DSEE-CL-RT-002.pdf. Last Visits on April 7th, 2022.

[14] Available at: < https://www.climatempo.com.br/climatologia/5127/vilarica-mt>

Figure 4. Santana do Araguaia climate graph



Part of the project area is located in the Mesoregion of Southeast Pará and the Microregion from Araguaia. Santana do Araguaia It is located at latitude 9°32'23.98" south and longitude 50°51'35.54" west, being at an altitude of 160 meters. Figure 3 has a climate that is Inserted in the super-humid equatorial category, type Ami, in the Köppen classification, the climate it is in the transition range to AW. It has an annual average temperature of 26.2o C, with the maximum average, around 32.0o C and, minimum, 20.4o C. The annual rainfall index is in around 2,000 mm, and the rainy season occurs notably, from November to May, while June to October is the driest period. The relative humidity is high, presenting oscillations between the wettest and the driest seasons, with the real average being 77%.[15] The graph below represents the climatology for the municipality surrounding the Urupianga Grouped REDD Project.

The project area is in the Tocantins Basin, specifically in the Araguaia sub-basin, downstream from Ilha do Bananal and Araguaia, part of Ilha do Bananal. The main rivers close to the Project Area are the Araguaia River, Crisóstomo river and Ribeirão Santana. The source of the Araguaia River is in the Serra dos Caiapós in the state of Goias and of the other rivers the sources are in

[15] CLIMATE-DATA.ORG; Clima: Available in: https://pt.climate-data.org/america-do-sul/brasil/para/placas-43940/ Last Visits on January 19th. Apud. Alves. Mariele Correia – Et Al. Available in: https://cointer.institutoidv.org/inscricao/pdvagro/uploadsAnais2020/EVAPOTRANSPIRA%C3%87%C3%83O-DE-REFERENCIA-ENTRE-OS-METODOS-DE-PENMAN-E-THORTHWAITE,-NOS-MUNICIPIOS-DE-NOVP-REPARTIMENTO-E-SANTANA-DO-ARAGUAIA,-PA.pdf

the state of Mato Grosso, but both cut through cities in the state of Goias, Mato Grosso, Tocantins to the State of Pará until it meets the Tocantins River in the far north of the state[16].

Figure 5. Sub-basin in the properties

Geology, Topography and Soils

In Mato Grosso, as in other parts of the Amazon, the altimetric variation is not expressive. The geomorphological unit in which the Project Area is inserted is the Araguaia Depression, Southern Dissected Plateau of Pará, Peripheral Depression of Pará-Serra do Matão[17], with slopes that vary from medium to steep.

The predominant soil types within the Project Area are Luvissols, Cambissols and Gleissols. The Luvissols are shallow soils, that is, they rarely exceed 1m in depth and usually present an abrupt textural change. The limitations of the use are related to the amount of stones in the surface horizon that can hinder the use of agricultural mechanization and the susceptibility to compaction. The Luvissols are poorly or moderately weathered soil, with clay accumulation on the B horizon. The Cambisol are heavily, even imperfectly, drained, shallow to deep soils. They are soils in the beginning of formation, with few characteristics. A large part of Cambisols is under natural vegetation[18]. Gleissolos are soils that are permanently or periodically saturated with

[16]Available at: https://brasilescola.uol.com.br/brasil/rio-araguaia.htm. Last visit in: January 2023

[17] Avaiable at: https://portalmatogrosso.com.br/geografia-de-vila-rica/. Last visit in: January 2023

[18] Lepsch, Igo. 2013. Formação e Conservação dos Solos, 2ª ed. Oficina de Textos. São Paulo.

water, characterized by strong gleation. They are defined as hydromorphic soils and constituted by mineral material[19].

Vegetation cover

According to the Brazilian Forests at a Glance 2019[20], the Brazilian Forest Service considers as forests the lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE), updated by the SIVAM project[21].

Mato Grosso is the only Brazilian state with three biomes: Amazon Forest, Cerrado and Pantanal. This makes the state's vegetation unique, with great diversity and importance for conservation. Of its 141 municipalities, 86 are covered by the Amazon rainforest. The Project Area of the Urupianga Grouped REDD Project is in a transition area through the Amazon Forest and Cerrado that is composed of 2 different phytophysiognomies.

The vegetation types that were found in the project area are Open Ombrophylous Forest and Submountain Open Ombrophylous Forest. The definition and profile of each vegetation class is detailed in Section 3.3.

Socio-economic conditions

Vila Rica

The municipality of Vila Rica has more than 7,436.383 km² of territorial extension. The population count, in the last census of 2010, was around 21,382 people and a population density of 2.88 inhab/km². The population estimate for 2021 is 26.946 people. In 2019, only 9.7% of the total population was considered economically active. Formal workers received, on average, 2.2 minimum wages[22]. This represents living with US$ 544.81 per month, considering that in 2019 the salary was R$ 998.00[23] and the average dollar rate, from June to December, was US$ 4.03[24].

The municipality also has the schooling rates around 94.3% of children aged 6 to 14 years attended schools in the period of the last census, 2010. The HDI of the municipality is low and in 2010 it was 0.688. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three

[19] Available at: < https://www.embrapa.br/en/agencia-de-informacao-tecnologica/tematicas/solos-tropicais/sibcs/chave-do-sibcs/gleissolos#:~:text=Apresenta%20baixa%20(distr%C3%B3ficos)%20fertilidade%20natural,mal%20drenados%2C%20em%20condi%C3%A7%C3%B5es%20naturais.>

[20] Available at: <https://www.florestal.gov.br/documentos/publicacoes/4262-brazilian-forests-at-a-glance-2019/file>

[21] As of 1996, through a contract signed between the Implementation Commission of the Airspace Control System - Ciscea, and 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/>.

[22] Available at: < https://cidades.ibge.gov.br/brasil/mt/vila-rica/panorama>

[23] Available at: <http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D9661.htm>

[24] Available at: <https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes>

dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[25].

Brazil harbors 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 the main nation among the 17 countries with the highest biodiversity levels globally, containing over 70% of the planet's biodiversity[26].

Brazil has the greatest flora species richness in the world, 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[27].

The number of known species in Brazil is estimated to range from 170 to 210 thousand, while the total number of species that the country harbors is approximately 1.8 million, putting the known proportion of biodiversity at a mere 11%. New species are described every day in Brazil[28]. It is also estimated then that approximately 10% of the entire planet's biodiversity is found in the project region, including many threatened species and those which exist only in Amazonia, or endemic species[29].

Mato Grosso is a privileged state in terms of biodiversity. It is the only one in Brazil to have, alone, three of the main biomes in the country: Amazon, Cerrado and Pantanal[30]. The Mato Grosso ecosystem represents a representativeness of the biodiversity characteristic of the Amazon region, where more than two thousand species of fish, about 950 species of birds, 300 species of mammals and about 10% of all plant species on Earth have already been catalogued. And in the Cerrado environment, more than 1,500 species of animals are known so far, including vertebrates (mammals, birds, fish, reptiles and amphibians) and invertebrates (insects, molluscs, etc.). About 161 of the world's 524 mammal species are in the Cerrado. It features 837 species of birds, 150 species of amphibians and 120 species of reptiles[31].

[25] Available at: <https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html>. Last visit: Oct 2022.
[26] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). The Brazilian Biodiversity. Available at: <https://www.gov.br/mma/pt-br/assuntos/biodiversidade>. Last visit on: October 21st, 2021.
[27] Information System about the Brazilian Biodiversity (SiBBr). Available at: <https://regions.sibbr.gov.br/regions/Biomas%20Brasileiros/Amaz%25C3%25B4nia#group=ALL_SPECIES&subgroup=&guid=&from=1850&to=2021&tab=speciesTab&fq=>. Last visit on: October 21st, 2021.
[28] Information System about the Brazilian Biodiversity (SiBBr). Available at: <https://regions.sibbr.gov.br/regions/Biomas%20Brasileiros/Amaz%25C3%25B4nia#group=ALL_SPECIES&subgroup=&guid=&from=1850&to=2021&tab=speciesTab&fq=>. Last visit on: October 21st, 2021.
[29] Protected Areas Program of the Amazon - ARPA (Brasil) (Org.). Arpa Biodiversidade. Amazonas: WWF - Brasil, 2010. 34 p.

[30] Available at: http://www.mt.gov.br/geografia#:~:text=Mato%20Grosso%20%C3%A9%20um%20estado%20privilegiado%20em%20termos%20de%20biodiversidade,%3A%20Amaz%C3%B4nia%2C%20Cerrado%20e%20Pantanal.&text=Uma%20vegeta%C3%A7%C3%A3o%20riqu%C3%ADssima%20com%20uma,bioma%20do%20Centro%2DOeste%20brasileiro. Last Visit: January 2023.

[31] Available at: http://www.mt.gov.br/geografia#:~:text=Mato%20Grosso%20%C3%A9%20um%20estado%20privilegiado%20em%20termos%

The flora also features exotic species, such as the water lily and dozens of species of bromeliads. In the last decades, the concern with the future of the Amazonian ecosystem has been manifested inside and outside Brazil, by governmental and non-governmental institutions.

Several factors contribute to the destruction of flora and the accelerated process of extinction of animals in Mato Grosso territory. Among these factors, we highlight the selective exploitation of wood (which ends with natural reserves of hardwoods), extensive agriculture (responsible for cutting down the forest for transformation into pasture), the construction of hydroelectric plants (which alters the ecosystem of rivers and nearby areas), indiscriminate hunting aiming at the removal of leather for commercialization, overfishing and extraction of plants destined for the pharmaceutical industry.

In some areas, animals, such as the white-lipped peccary, the manatee, the pirarucu, the turtles and the curassows have already been greatly reduced.

The "Red book of Endangered Brazilian Fauna" was developed in 2008[32] and updated in 2018[33]. In 2008, the book reported that the Amazon biome presented 24 threatened species. On the 2018 update, of the total endangered species in Brazil, 15.3% are found in the Amazon, representing 180. Of this total, 124 species are endemic to this biome.

The Brazilian Government Ministry for the Environment classified the project region in its 2018 survey of Brazil's priority areas for conservation[34]. The surroundings of the project area are mainly classified within the "very high" priority category. This shows the importance of the present REDD project for the conservation of Brazilian biodiversity, creating an ecological corridor for preservation of the fauna and flora species. Thus, the conservation of these private lands contributes to the Brazilian Government's conservation proposal.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

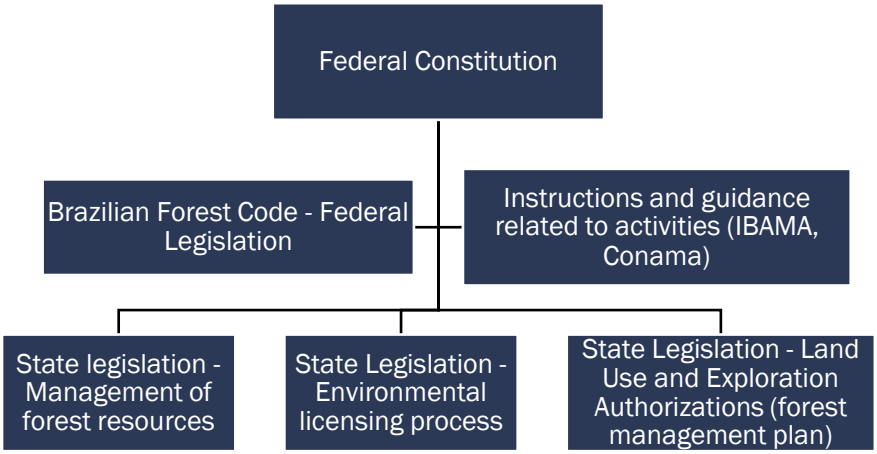
In a brief context of Brazilian legislation, the Federal Constitution determines that it is concurrent between the Union, Member States and the Federal District the competence to legislate on matters related to the protection of the environment, conservation of nature, defense of the soil, protection of landscape heritage and responsibility for damages to the environment. The same document establishes that municipalities are responsible for legislation at the local level[35].

20de%20biodiversidade,%3A%20Amaz%C3%B4nia%2C%20Cerrado%20e%20Pantanal.&text=Uma%20vegeta%C3%A7%C3%A3o%20riqu%C3%ADssima%20com%20uma,bioma%20do%20Centro%2DOeste%20brasileiro. Last Visit: January 2023.

[32] Available at < https://biodiversitas.org.br/wp-content/uploads/2021/06/Livro-Vermelho-BR-Vol-I.pdf> Last visit on: October 13th, 2021.
[33] Available at < https://www.icmbio.gov.br/portal/images/stories/comunicacao/publicacoes/publicacoes-diversas/livro_vermelho_2018_vol1.pdf> Last visit on: October 13th, 2021.
[34] Brazilian Government Ministry for the Environment (Ministério do Meio Ambiente – MMA). Brazilian priority areas for biodiversity conservation and sustainable use – 2nd update. Available at: <http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias>. Last visit on: October 8th, 2021.
[35] 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

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, 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[36]. 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 6. 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 Nº 12.651, 25/05/2012[37]), 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

[36] Available at http://pnla.mma.gov.br/competencias-para-o-licenciamento-ambiental
[37] 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>

native flora and fauna. In the Brazilian Legal Amazon[38], eighty percent (80%) of a rural property should be preserved.

It is important to highlight that the legal reserve applicable to the area of the properties included in the Canindé project is 80%, as registered in the land title and following the forest code. The 1934 version of the Brazilian Forest Code required the conservation of only 25% of the vegetation cover; the 1965 version increased the conservation area to 50% in the Amazon; and, finally, in the 2012 version, the conservation requirements increased even more, reaching 80% of the areas located in the Amazon biome[39].

However, 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[40]. 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

  Instances 1 and 2 do not have Sustainable Forest Management Plan activities. In the state of Mato Grosso, the Environmental Agency (SEMA/MT) is the body responsible for licensing and environmental inspection.

- 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

[38] 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.
[39] Available at https://oeco.org.br/dicionario-ambiental/28574-o-que-e-o-codigo-florestal/
[40] 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>

and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+[41].

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 to comply with mitigation commitments of other countries to the United Nations Framework Convention on Climate Change. It does not impose a 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 Canindé 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.	Instances 1 and 2 comply with current federal legislation, as evidenced by the regularity in the CAR and the absence of pending legal issues in 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.	Instances 1 and 2 do not carry out sustainable forest management in their forest area; therefore, this Decree does not apply.
State Legislation		

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

Complementary law 233	Provides information for the Forest Policy of the State of Mato Grosso and other provisions.	Instances 1 and 2 do not carry out sustainable forest management in their forest area; therefore, this Complementary Law does not apply.
Decree 1313	Regulates Forest Management in the State of Mato Grosso and makes other provisions.	Instances 1 and 2 do not perform sustainable forest management within its forest area; therefore, this Decree does not apply.
Complementary law 668[42]	Amends provisions of Complementary Law No. 592, of May 26, 2017, which provides for the Environmental Regularization Program - PRA, 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.	Instances 1 and 2 complies with the current State legislation and does not perform 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.	Instances 1 and 2 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.	Instances 1 and 2 do 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.	Instances 1 and 2 do 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	Instances 1 and 2 do not perform sustainable forest management within

[42] Available at https://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/b88b0eb8f863f223042585b2005f778a?OpenDocument

	mentioned in art. 19 of Law 4,771, of September 15, 1965	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	Instances 1 and 2 do 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	Instances 1 an 2 do 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 management plan - SFMP for timber purposes, for native forests and their forms of succession in the Amazon biome	Instances 1 and 2 do not perform sustainable forest management within its forest 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[43]	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

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

		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.

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 in 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 and 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 Urupianga Grouped REDD Project is to avoid the unplanned deforestation (AUD) of its instances, consisting of 100% Amazon rainforest. The Project also has

the function of establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Amazon 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)[44] 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[45]. The Commission is made up of eight government representatives (Government Secretariat of the Presidency of the 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[46] and by the IPEA reports[47]. 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 Mamuriá Grouped REDD Project main planned contributions to the Brazilian Priority Goals are listed below[48]. These contributions are monitored by the parameters defined by the REDD project, in addition to additional standards, if applicable:

- 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”;

[44] UN’s Sustainable Development Goals and targets available at: <https://sdgs.un.org/goals>
[45] More information on the CNODS available at: <http://www4.planalto.gov.br/ods/noticias/governanca-nacional-para-os-ods>
[46] Available at: < https://odsbrasil.gov.br/relatorio/sintese>
[47] Available at: < https://www.ipea.gov.br/ods/publicacoes.html>
[48] Available at: < https://odsbrasil.gov.br>

- 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 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 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 biome, 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 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[49].

The following components of the Brazilian commitments under the Convention are reinforced by the development of the Mamuriá 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

One area was included in the Leakage Management Area, as it is nearest communities to the Project Area. Further information about boundaries of the leakage management area is located at section 3.3, Project Boundaries, of the present VCS PD.

- Vila Rica Community.

More information on the relationship between the LMA and the Project, as well as the prospects for socio-environmental activities will be further discussed on the Social Carbon Report, which will be performed along with the 1st monitoring period.

[49] 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>

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 present REDD Project plans to implement a program regarding the extraction of NTFPs as a way of providing an alternative income source for the local communities that surround the project area.

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[50]. 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.

In this way, the owners are committed and add value to the carbon project with each action taken, encouraging long-term sustainable development and driving continuous improvement in the local community through prospects (at least one per Resource, totaling 6 improvement actions), on which the project proponent undertakes to implement them until the next monitoring period.

Commercially Sensitive Information

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

Further Information

No further information to disclose.

2 SAFEGUARDS

2.1 No Net Harm

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.

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

Table 2. Project Risks

Identify 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. Nevertheless, these risks will also be assessed.

2.2 Local Stakeholder Consultation

As preconized by the VCS Standard, the project proponent has conducted an assessment of the local stakeholders that are potentially impacted by the project. Information on the local stakeholders identified are discussed throughout this Section.

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 as well as set potential partnerships in the future.

Thus, the output list of stakeholders from this analysis is described below.

- Communities living within the Reference Region
- Municipality of Vila Rica
- Secretaria Estadual de Meio ambiente e Sustentabilidade
- Secretarias Municipais de Meio Ambiente
- Secretaria de Educação
- Instituto Nacional de Colonização e Reforma Agrária (INCRA)
- WWF – Brazil;
- Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais (IBAMA).
- Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio);
- Serviço Florestal Brasileiro
- Programa Municípios Verdes
- CEPAM
- UFRA

The justification for including the stakeholders list above is described below.

- *Public entities: 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.*

- *Unions: The participation of unions is important to spread knowledge of the carbon market and include the vision of local employees and workers in the development of the project.*

- *Universities: 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 activities, 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.*

- *Communities: The employees on the Instance 1 properties were included as stakeholders as it is considered that they are directly affected by the Project, since their work influence*

the Project development and activities. Therefore, their participation in the planning of activities, in addition to comments and suggestions, is essential.

- *Settlements: Some communities near the Instance 1 are located in settlements. 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 by the VCS Standard, "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 is further detailed as part of the Non-Permanence Risk analysis.

As also required by the VCS Standard, item 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, a communication channel was established for stakeholders to continually express their concerns and to solve eventual conflicts and grievances that arise during project planning, implementation, and monitoring. The main communication channel is the project's own email.

It is expected that this 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:

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).

Thus, the Stakeholder Consultation will be divided into two events: a remote meeting with entities that have access to internet; and an on-site consultation with local entities in the municipalities and the local community that resides near the project area, where the Leakage Management Area was defined.

Regarding the stakeholders located in urban areas, which are mostly government agencies, a letter will be sent, briefly presenting the project and inviting them to the remote consultation. This presentation is a detailed summary of the proposed activities regarding project implementation and monitoring.

In addition to the introduction of the forest conservation measures, the carbon project development process, deforestation monitoring and projection methods, as well as the delimitation of the Project Area, Reference Region, Leakage Belt, among other information that are also displayed.

Contact information of the Future Forest[51] team will be made available at the end of the meeting. Communication can be carried out via letter, email, or telephone. The presentation will be recorded, and a PDF version might be made available through e-mail should it be requested by any stakeholder. The participants will be informed that the period for requesting information and comments about the REDD Project will be open for 30 days starting from the presentation date.

The meetings will provide a simplified presentation about the Project, guided by a folder with the main project information. Maps will also be used to explain about the dynamics of historical deforestation and its projection into the future and where the project activities and its repercussions are and/or will be located, exposing the risks and benefits resulting from the project activities for the population, which will also be assessed.

A permanent communication channel with the local stakeholders was created in order to receive any comments or suggestions regarding the present REDD Project. Emails, phone numbers and addresses were made available through the folder aforementioned should they want to contact the Project Proponent. It is important to note that the same contact information made available is also part of the grievance mechanism, where all comments can be received, and outcomes will be documented and stored in digital format.

[51] Future Forest is the technical team dedicated towards forestry carbon projects at Future Carbon Group. Therefore, it is Future Carbon's team responsible for developing and monitoring such projects.

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[52]. 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[53]. 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[54].

Another benefit is that the Urupianga 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.

The SFMP conducted in the properties follows all the applicable legislation and comply with all the environmental rules requested for the approval of the licenses.

2.4 Public Comments

The PD is currently being written to be submitted for public consultation.

2.5 AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

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 were identified through research, as well as local knowledge from the Instance 1 landowners and management team. As detailed in Section 2.2, stakeholders were

[52] 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/

[53] 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 .

[54] 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 .

identified considering the communities, government agencies, educational and research entities, taking into consideration relevant Acre State and Amazon biome institutions, in addition to NGOs within the Reference Region. The list is available at section Local Stakeholders Consultation, above.

The Project and actions involving local communities will be monitored by Future Carbon's Social team in order to analyze the extent of alternative income generation sources and further programs, besides the applied methods for local stakeholders' consultation.

2. 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 landowners 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[55] and updated in 2016[56], with the objective of implementing a national policy especially directed at such communities.

The Decree No. 6,040 of February 7, 2007[57], 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[58].

The Policy is structured around four strategic axes:

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

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

form Brazilian society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[59].

The REDD methodology guarantees and is 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 was 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 was 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:

   No changes were identified among the stakeholders involved with the Project. 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:

   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.

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

6. The location of communities, local stakeholders and areas outside the project area that are predicted to be impacted by the project:
    - Vila Rica City: 10° 1'0.42"S ; 51° 7'19.70"O
7. The location of territories and resources which local stakeholders own or to which they have customary access.

    Territories and resources used or accessed by the communities are included on the Leakage Management Area and are, therefore, within the Reference Region.

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 3. Risks to Local Stakeholders

Aspect	Impact	Effect		Comments / Observation
		Beneficial	Adverse	
Land use	Reduced access to land and traditional areas due to the project activity		X	The baseline scenario activity of the project area will be maintained, i.e, no activity will be conducted in the Project Area. One of the objectives of the project is to benefit the local community with resources from the carbon credit sales, providing quality of life, sustainable development, and alternative income sources. Monitored by the Biodiversity Resource: • Non-timber forest products (NTFPs) Monitored by the Social resource: • Local traditional people assistance[60]
Resources	Withdrawal of natural, economic and cultural resources (water, food, alternative income, cultural		X	The Project's objective is to guarantee financial resources to expand the socio-environmental benefits for the communities around the Project Area. Monitored by the Biodiversity Resource: • Non-timber forest products (NTFPs) Monitored by the Financial Resource: • Alternative income sources Monitored by the Social Resource: • Additional Social Programs

[60] As there are no traditional communities surrounding the Project Area, this indicator will be adapted to comply with local communities

	events, etc.) from families			
Land use	Displacement of families due to Project Activity		X	Families will not be removed from any areas currently used, as they do not reside within the Project Area. Instance 1 landowners maintain a friendly relationship with the neighbors, and one of the objectives of the carbon project is to expand social and environmental benefits to local communities. The Project Activity understands the permanence and land use of the families in the surrounding areas. Monitored by the Carbon Resource: • Stakeholder Consultation Monitored by the Natural Resource: • Project efficiency in agents that fight deforestation/degradation
Food Security	Withdrawal of land used for food production or income generation		X	Communities access regions are not included within the Project Area and, therefore, they will not be affected by the maintenance of activities. The areas for planting/ranching for subsistence or for selling for income generation will not be included in the Project Activity nor the removal of these lands are planned. Monitored by the Biodiversity resource: • Non-timber forest products (NTFPs) Monitored by the Financial resource: • Alternative income sources
Climate change adaptation	Adaptations and impacts related to the climate crisis	X		The main objective of the project is forest conservation through the avoidance of unplanned deforestation. The maintenance of the standing forest is essential to mitigate the effects of the climate crisis and the maintenance of natural resources for the people. The Project also contributes to achieving climate justice, since the groups that suffer most from climate change are the vulnerable communities. Monitored by the Financial Resource: • Carbon Credit Benefits Monitored by the Social Resource: • Additional Social Programs Monitored by the Carbon Resource:

				• Project Performance

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 property or relocate people off their lands without consent. In the event there are any ongoing or unresolved conflicts over property rights, usage or resources, the project shall undertake no activity that could exacerbate the conflict or influence the outcome of an unresolved dispute.

No community member has been or will be removed from their land. In addition, the project did not introduce any invasive species or allow an invasive species to thrive through project 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. 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 were 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 communities has 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[61].

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[62];
- AFOLU Non-Permanence Risk Tool v4, published on 19-September-2019[63].

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. 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 expansion, such as waterways and roads.

[61] Available at https://verra.org/methodology/vm0015-methodology-for-avoided-unplanned-deforestation-v1-1/
[62] 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/
[63] Available at https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

	Therefore, in the baseline scenario, the Project Area would continue to be illegally 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 applied 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".	The forest classes composing the Project Area are named as per the Technical Manual for Brazilian Vegetation[64]. The area is considered forest as per the definition of adopted by FAO[65]: 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 over 10 years prior to the project start date – all of which according to the Brazilian definition of forest[66]. This was ascertained using satellite images, as described in the section Baseline Scenario of

[64] Avaliable at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf
[65] Available at < https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses>
[66] 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>.

	the present VCS PD.
e) The project area can include forested 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.	As described at Section 1.13 of the present VCS PD, the main soil type within the Project Area are Yellow Latosol, Lithosoil and Podzolic Soil. Therefore, no peat or peat swamp forests were found within the Project Area and Reference Region, 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	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.

methodologies shall ensure consistency between the determination of a baseline scenario and the determination of additionality of a project activity.	

3.3 Project Boundary

Spatial Boundaries

The Table below presents the Project Area, Reference Region, Leakage Belt and Leakage Management Areas:

Table 4. Project Area, Reference Region, Leakage Belt and Leakage Management Area

Name	Area (ha)
Reference Region	528,127
Project Area	13,351
Leakage Belt	58,418

Project Area

The Project Area comprises Instance 1.

Instance 1 is composed by 6 properties, which have a total area of 13,351 ha. 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.

In order to define the Project Area, areas deforested up to the Project Start Date, non-forest vegetation areas and areas containing water bodies were excluded from the properties' area. As a result, the Project Area was defined as 13,351 ha. Further characteristics of the Project Area until the Project Start Date are described in Section 1.13.

Figure 7. Project Area of the Urupianga REDD Project

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 geomorphology, 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 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats throughout the southern Amazon region. Thus, the analysis of the Reference Region definition includes these factors.

- **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[67], National Protected Areas[68]. No Indigenous Land or Protected Areas were included in the Reference Region.

- **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 20-40 times the size of the Project Area as the Reference Region.

[67] Available at <https://www.car.gov.br/publico/municipios/downloads>
[68] Available at <https://metadados.snirh.gov.br/geonetwork/srv/api/records/9407d38f-84d2-48ea-97dd-ee152c493043>

From the definition of this area, 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. The results are presented below:

Vegetation cover

The main Project Area's vegetation type, Open Tropical Rainforest (Da), occupies around 90% of the Reference Region.

Altitude

The altitude in the project area ranges from 169 to 254 m and these values are within 96.45% of the variation in the rest of the reference region.

Slope

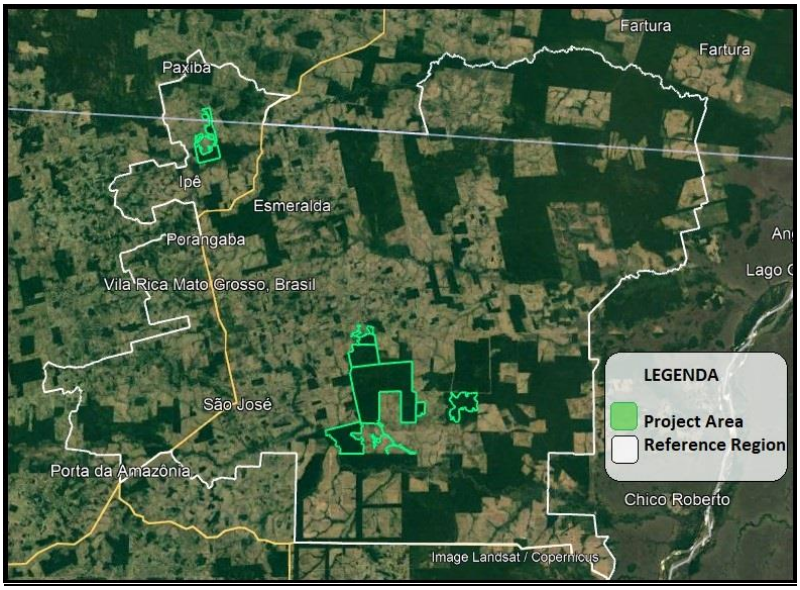
The average slope in the Project Area is 4.16 degrees, while in the rest of the Reference Region it is 3.82. Therefore, the average value of 100% of the Project Area is within the range of ± 10% of the average in this region, which is between 3.44 and 4.20 degrees.

Rainfall

The annual rainfall in the project area is, on average, 1,950 mm, while in the rest of the reference region it is 1,835 mm. Thus, it is verified that the amount of rainfall in the project area remains within the variation of ± 10% of 100% of the average of the rest of the reference region, which varies between 1,702.15 and 2,105 mm.

Based on the criteria related to the type of vegetation, elevation, slope and precipitation above, the reference region was defined, which has 1,626,009 ha (26.8 times the Project Area). The map showing the RR and PA is presented below:

Figure 8. Location of the Reference Region



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 behaviour 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. The table in Annex II of the aforementioned 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_l: 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

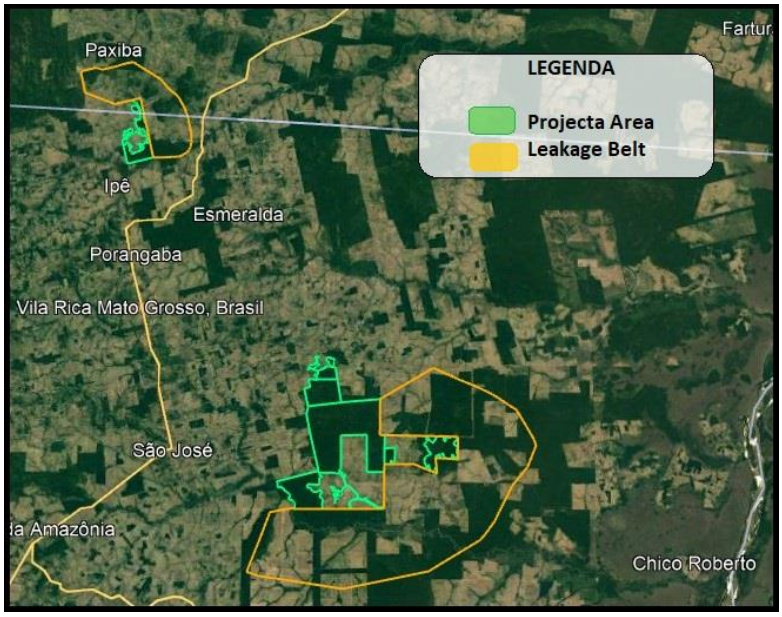
V: 1, 2, 3...V, surface type on which transportation occurs; dimensionless

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 20km, 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 roads and other deforested areas.

Finally, by overlapping the Project Area buffer with the areas with the highest profitability potential, an area of 248,409.45 ha was defined as the Leakage Belt. The Figure below illustrates its location. In summary, the Leakage Belt was composed by areas within a 20km radius from the Project Area boundaries, which present forestlands areas and higher economic viability for cattle ranching, i.e., where deforestation could be displaced from the project area.

Figure 9. Leakage Belt location

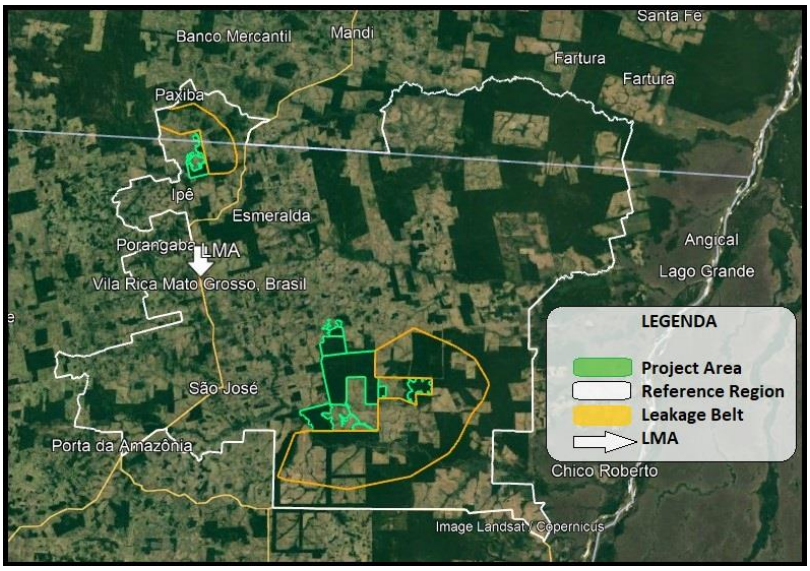


Leakage Management Area

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 in order 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, with a total area of 696.02 ha, and their locations are represented in the Figures below:

Figure 10. Leakage Management Area



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)[69], updated by the SIVAM project[70]. 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[71]. 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

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

[70] 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/>

[71] 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 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.

Temporal Boundaries

- **Starting date and end date of the historical reference period**

  The adopted historical reference period is January 2011 to December 2021.

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

  The project has a crediting period of 30 years, from 01-February-2021 until 31-January-2051.

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

  The first baseline period is from 01-February-2021 to 31-January-2027.

Carbon Pools

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:

Table 5. 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: Included	Included 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. Not a significant carbon pool.
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.

According to the applied methodology, harvested wood products must be included if removal of timber is associated with significantly more carbon stored in long-term wood products in the baseline case compared to the project scenario. The significance criterion shall apply.

According to the most common species harvested by illegal agents in the project region[72], relating the species with the highest commercial value and their presence in the region (according to a forest inventory conducted close to the project region in the State of Pará), it can be concluded that the potential volume of wood harvested by illegal loggers during the baseline would be of 17 m^3/ha.

In addition, logging in the baseline case occurred through planned and unplanned activities. In both cases, harvesting targeted the most commercially valuable species[73], without the use of proper machinery and planning, i.e., the same species were harvested using low efficiency methods without any criteria regarding the number of remaining trees per species. In addition, in both scenarios, after harvesting the most valuable species, the area was abandoned for illegal deforestation.

Thus, it can be concluded that logging in the baseline scenario, both by planned and unplanned activities, harvested the same species and volumes per hectare[74].

After the conclusions reported above, a significance test was performed following the "Tool for testing significance of GHG emissions in A/R CDM project activities", according to the applied methodology. According to the Tool, the sum of decreases in carbon pools and increases in emissions that may be neglected shall be less than 5% of the total decreases in carbon pools and increases in emissions, or less than 5% of net anthropogenic removals by sinks, whichever is lower.

This analysis was conducted for baseline logging activities (both planned and unplanned), and it was found that the sum of decreases in carbon pools and increases in emissions represents less

[72] Term of apprehension of illegal wood from SEMA-PA. The document gathers information on wood species seized without documentation during the surveillance operation in the project area and its surroundings, originated from reports of illegal deforestation. From this, it is possible to evaluate the most sought-after species, usually for having greater commercial value.
[73] The comparison of the SEMA-PA apprehension term, literature and the post-exploratory report of the management plan executed before the project start date allowed to conclude that around 90% of the harvested volume carried out by baseline planned activities are composed by the same species illegally logged in the baseline.
[74] Information available at Apprehension Report by SEMA-PA – 2019 and EXPLORAÇÃO E VALORAÇÃO EM TORA DE 10 ESPÉCIES FLORESTAIS NO BAIXO AMAZONAS, ESTADO DO PARÁ, ENTRE 2006 – 2016 <https://periodicoscientificos.ufmt.br/ojs/index.php/biodiversidade/article/view/9999 >

than 5% of the total decrease in carbon pools and increase in emissions and less than 5% of net anthropogenic removals by sinks (i.e., 1.85%).

As per VM0015: If logging activities are present in the baseline, the harvested wood product carbon pool must be estimated and, if significantly higher in the baseline compared to the project scenario, it will have to be accounted. As harvested wood product carbon pool is not significant, harvested wood products was excluded in the baseline scenario, according to the methodology requirements.

Furthermore, in accordance with the applied 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:

Table 6. Sources and 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.
	Livestock emissions	CO_2	Excluded	Not a significant source
		CH_4	Excluded	No livestock agriculture increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		N_2O	Excluded	No livestock agriculture increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		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 essential to maintain this area as standing forest, as described under the Additionality of the Project (Section 3.5), and 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 historical land-use and land-cover change

- Collection of appropriate data sources

  GIS MAPPING, REMOTE SENSING TECHNIQUES

  The assessment of land use and land cover (LU/LC) for the baseline period shall be made using the data obtained from monitoring LU/LC changes in the Reference Region during the historical reference period. The historical reference period for the present Project comprised image analysis from 2011 to 2021.

  In order to map land use dynamics within the Reference Region, remote sensing satellite analysis was carried out with MapBiomas[75] (collection 6.0) from 2011 to 2021, using images that are available in raster format on the program's website. Supervised classifications from

[75] Available at <http://mapbiomas.org/>

Google Earth Engine were also used. This classifier is the same used in MapBiomas, allowing a closer adequacy to the Methodology.

One Landsat scene per year from the reference period was required to compose the entire Reference Region. The final mapping resolution was 30 m pixel.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[76] promoted by the Climate Observatory. Its creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology uses, 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 to 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 land cover change and other impossible or prohibited kinds of use, in order to reduce spatial and temporal inconsistencies.

For the supervised classification, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomas methodology. In order to obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 15% 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. The spatial filter was then applied with the Majority Filter tool from ArcGIS, using 8-pixel neighborhood. This filter is used in MapBiomas in order to avoid unwanted modifications on the edges of pixel groups (blobs).

[76] Available at <SEEG - http://seeg.eco.br/en/>

Table 7. Satellite images used on the historical LU/LC change analysis

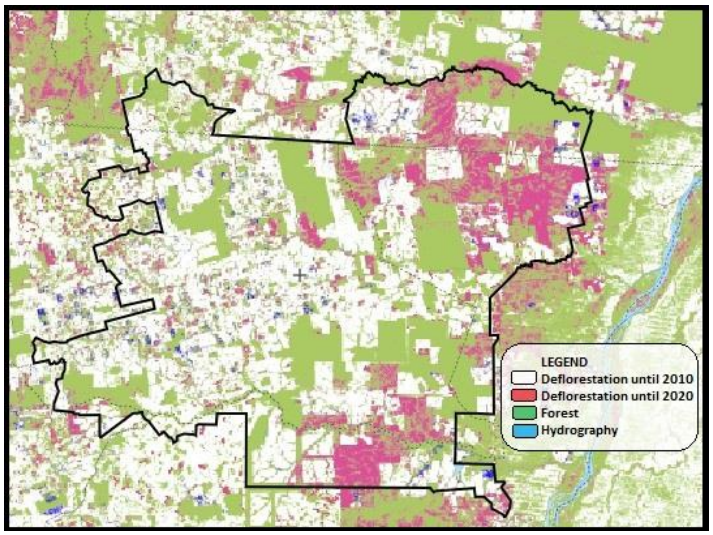
Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (μm)	(Km²)	DD/MM/YY	Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	223	67
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	224	67

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

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.

Stratification was not carried out in either class, and therefore the categories "forest" and "non-forest" have homogenous carbon stocks. Satellite images were used to generate the land-use and land-cover map in 2020, shown on the Figure below:

Figure 11. Land use and land cover dynamics between 2010 and 2020 within the Reference Region



Following the VM00015 Methodology requirements, the LU/LC maps have been conducted using satellite images. There are two surveys available in Brazil for deforestation and forest mapping: INPE (PRODES) and Mapbiomas. However, none of them separates deforestation by forest classes.

As aforementioned, 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 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.

Three vegetation types were found, and, according to this analysis, the Open Tropical Rainforest is the main forest type present within the project area, with around 90% of the total forest cover. Thus, after verifying that most of the project boundaries were composed of only one phytophysiognomy, the mapping and modeling of the project proceeded without stratification.

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 8. 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) and the high representativeness of the main forest type within the project area, 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[77] between 2009-2016 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 around 90% of the RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[78]:

- Contact between savannah and seasonal forest

  This area is classified as Ecotono, or transitional system. Between two or more phytoecological regions or types of vegetation, there are always, or at least most of the time, undifferentiated communities, where the floras interpenetrate, constituting floristic transitions or edaphic contacts. Thus, this area has characteristics of both Cerrado and Open Ombrophylous Forest.

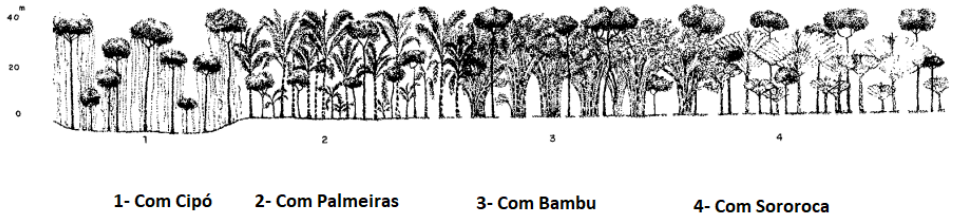
- Open Ombrophylous Forest

  It is considered a type of transition from the dense Ombrophylous Forest, characterized by climatic gradients with more than 60 dry days. It has four floristic faciations: with vine, in the areas of circular depressions of the Precambrian basement; with palm trees, on sandstone terrain that occurs throughout the Amazon and even outside of it; with bamboo, it occurs from the western part of the Amazon to the southern plateau of the State of Paraná (generally occupying areas where noble species were exploited); with sororoca (Phenakosperma guyanensis) in the south of the Amazon basin, in the middle Xingu river, occurring in depressions that are temporarily flooded and in small areas where soils of the Red-Yellow Latosol type predominate[79].

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

[79] Available at https://www.cnpf.embrapa.br/pesquisa/efb/aspec.htm. Last Visit: January 2023.

Figure 12. Open Ombrophylous Forestprofile[80]



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

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.

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.

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

[80] Available at: https://jbb.ibict.br/bitstream/1/397/1/1991_classificacaovegetal_Velloso1991.pdf. Last Visit: January 2023.

Table 9. Land use change matrix between 2011 and 2021

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

BASELINE SCENARIO

	PA	Initial LU/LC class	
	IDcl	Forest	Non Forest in the PA
Final Class	Forest	7,136.87	0.00
	Non Forest in the PA	6,214.13	0.00

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	154,803.49	0.00
	Non Forest in the LK	11,205.80	54,990.71

PROJECT SCENARIO

	PA	Initial LU/LC class	
	IDcl	Forest	Non Forest in the PA
Final Class	Forest	13,011.02	0.00
	Non Forest in the PA	339.98	0.00

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	153,871.37	0.00
	Non Forest in the LK	12,137.92	54,990.71

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

Table 10. List of land use and land cover change categories

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

- Analysis of historical land-use and land-cover change

According to the GIS analysis, between 2011 and 2021, there was a deforestation of 70,700 ha within the Reference Region, with an average oscillation of approximately 7,070 ha/year. The location where the deforestation occurred may be observed in the Figure below:

Figure 13. Variation in the deforestation rate within the reference region between 2011 and 2021

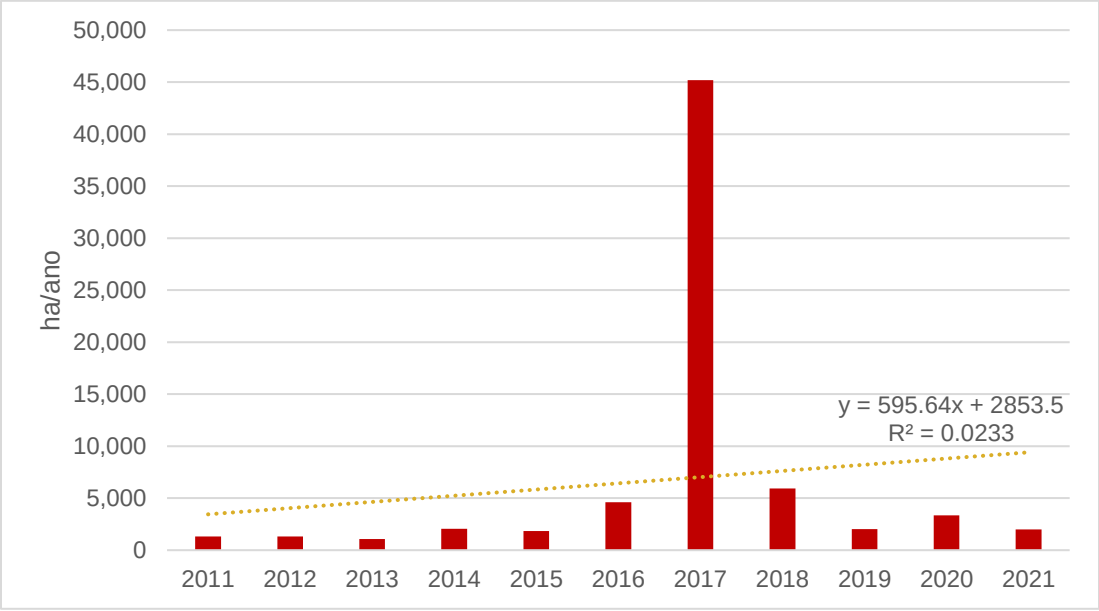


Table 11. Annual deforestation in the Reference Region between 2011 and 2021

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2011	60,100	1,320
2012	67,410	1,310
2013	68,480	1,070
2014	70,530	2,050
2015	72,370	1,840
2016	76,990	4,620
2017	122,190	45,200
2018	128,110	5,920
2019	130,120	2,010
2020	133,480	3,360
2021	133,650	2,000

- Map accuracy assessment

  The MapBiomas results undergo an accuracy assessment, which for the entire Amazon Biome is on average 95%. However, to meet the particularities of the project region, an independent evaluation was carried out for the reference region between 2010-2020.

  In order 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, 300 random points were drawn over the RR, 100 in each of the classes (forest, hydrography and deforestation).

Table 12. Summary of confusion matrices from the evaluation of MapBiomas during the historical reference period

	Producer accuracy				User accuracy			
Year	Forest	Hydrography	Pioneer vegetation	Deforestation	Forest	Hydrography	Pioneer vegetation	Deforestation
2011	94.81%	94.81%	80.23%	88.75%	91.25%	91.25%	86.25%	88.75%
2012	94.94%	93.75%	82.50%	91.36%	93.75%	93.75%	82.50%	92.50%
2013	92.94%	97.30%	79.31%	91.89%	98.75%	90.00%	86.25%	85.00%
2014	94.81%	95.00%	79.52%	91.25%	91.25%	95.00%	82.50%	91.25%
2015	96.20%	100.00%	79.55%	87.65%	95.00%	90.00%	87.50%	88.75%
2016	97.47%	100.00%	80.00%	86.25%	96.25%	95.00%	85.00%	86.25%
2017	97.40%	100.00%	87.80%	90.36%	93.75%	97.50%	90.00%	93.75%
2018	93.98%	97.40%	88.31%	90.36%	97.50%	93.75%	85.00%	93.75%
2019	86.52%	94.74%	81.48%	94.59%	96.25%	90.00%	82.50%	87.50%
2020	97.26%	90.24%	79.76%	90.12%	88.75%	92.50%	83.75%	91.25%
2021	96.20%	100.00%	98.44%	94.12%	95.00%	95.00%	96.75%	100.00%

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 measures78.

- Database organization and pre-processing

The forest dynamics data, deforestation vectors and other base information fromthe region under analysis, which were used to build the Project Baseline, were organized in a spatialized database, in the File Geodatabase formatof ArcGIS 10.8. The data comefrom different sources and have different cartographic scales (Tablebelow). The files are stored in vector and matrix (raster) format. In order to standardize the spatial references, all data were reprojected to the WGS 1984 UTM Zone 21S projection.

At first, several layers were pre-selected, whichmay 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,

where deforestation agentscanencroachthe territorytoextracttimber andotherdeforestationbyproducts.

Table 13. 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

- <u>Identification of agents of deforestation</u>

  In the past few years, the project region has been the subject of news and studies, mainly due to the advancement of the arc of deforestation in the Amazon biome. This pressure

is expected to continue, given the globalization of markets in the amazon region and international development policies planned for the region[81].

The main deforestation agents identified in the region are timber harvesting, acting both legally and illegally.

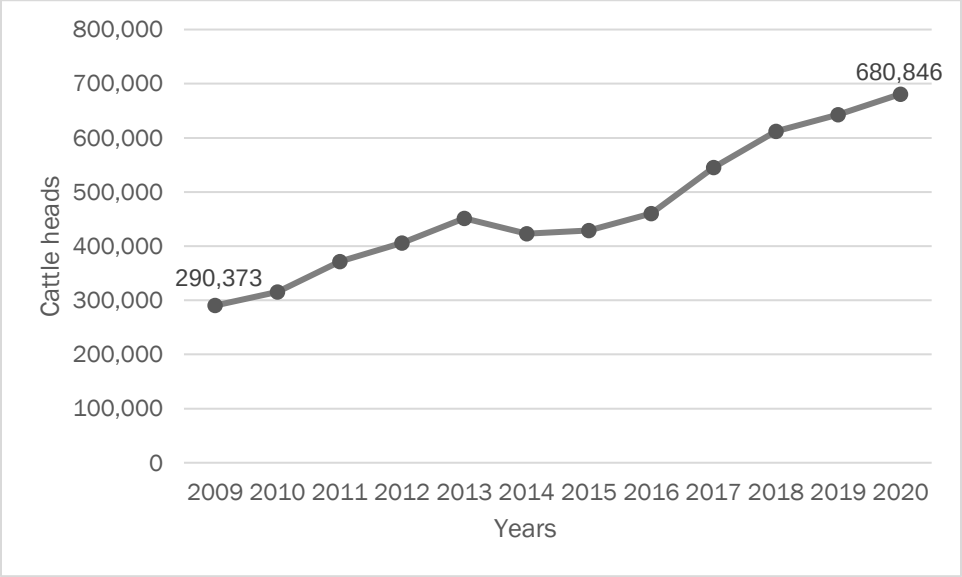
a) Cattle Ranchers

Description of the main features of the main agent of deforestation: 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). Thus, it can be affirmed that the deforestation agent group is composed by large and small-scale cattle ranchers supported by land-grabbers and loggers in the initial stage of deforestation. This group is composed by private owners and itinerant land-grabbers. It can also be affirmed that this group of deforestation agents is culturally and economically adapted to this "business cycle" of deforestation, whose results are clearly demonstrated in the Reference Region during the reference period.

Assessment of the most likely development of the population size of the deforestation agent group in the Reference Region, Project Area and Leakage Belt: As the main deforestation agent in the region, cattle ranching (pasture) is expected to increase in the project region. This increase is inferred from official IBGE data on cattle livestock in the municipalities of Vila Rica/MT, as shown in the following figure below.

[81] 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

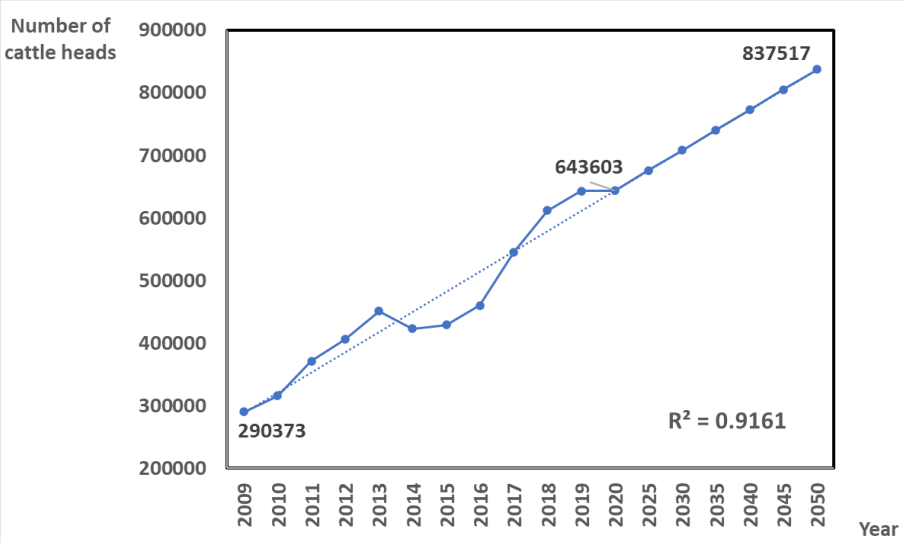
Figure 14. Historical growth of livestock numbers in the municipality of Vila Rica, Mato Grosso: number of cattle heads per year (IBGE, 2021)[82]



Given these dynamics, the herd size in Vila Rica is expected to increase by up to 30% (837,517 heads) during the project lifetime (up to 2050, see Figure 15), according to statistical projections conducted with official IBGE data from the 10 years prior to the project start date. This significant pace of growth in cattle-related land uses will certainly impose considerable deforestation pressures in the future.

[82]https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9107-producao-da-pecuaria-municipal.html?=&t=resultados

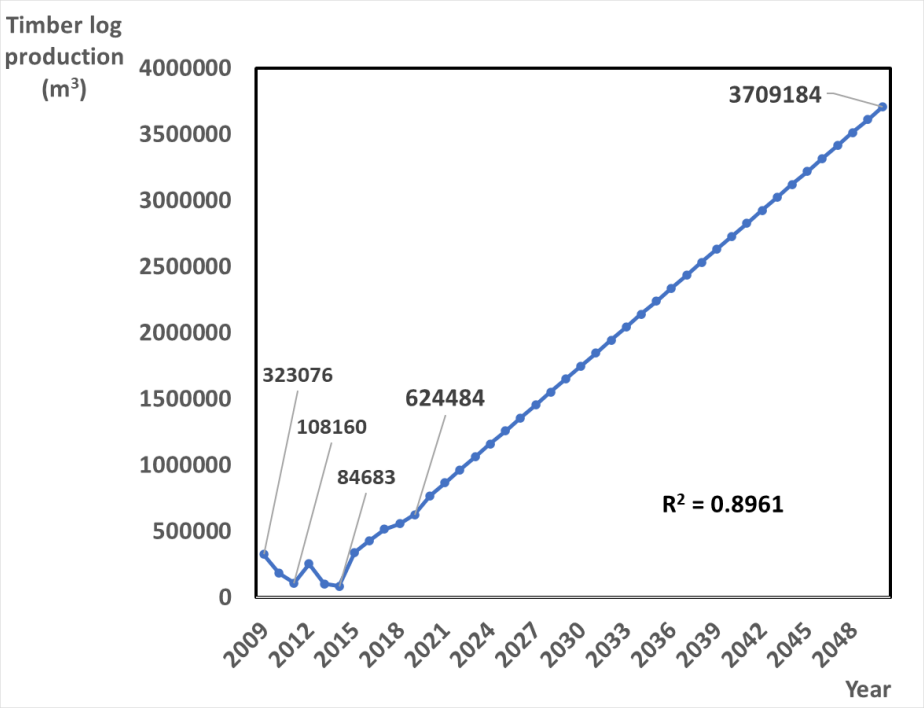
Figure 15. Projected growth of livestock numbers in the municipality of Vila Rica, State of Mato Grosso, within project lifetime (adapted from IBGE, 2021)



b) Timber harvesting

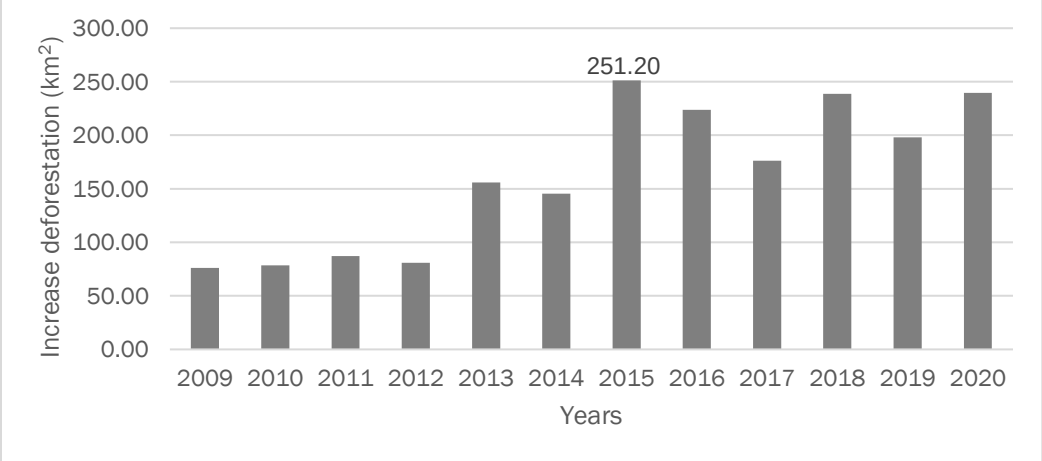
Timber harvesting can be regarded as the initial approach in a series of activities by deforestation agents, as it is the precursor of cattle ranching implementation. Official registration of formally documented logging for sale to sawmills has been volatile over the last 10 years, according to official IBGE data. As shown in Figure 16, production of legal timber in Vila Rica presented a significant decrease in years 2011 (108,160 m3) and 2014 (84,683 m3). From that year afterwards, the supply of legal wood only continued to increase, reaching in 2019 624,484 m3. Based on official data from the last 6 years, it is projected that the production tends to increase during the project lifetime, reaching 3,709,184 m3 in 2050, which also points to a significant increase in timber demand for the following years of project.

Figure 16. Historical production and future projection of legally registered logs in the municipality of Vila Rica, State of Mato Grosso (adapted from IBGE, 2021)



Statistics on historical deforestation attributable to the agent group: in Vila Rica, the highest deforestation rates for the last ten years occurred in 2015 (251.20 km2), totaling deforested area of 4,331.0. During the historical reference period (2009 – 2020), the lowest deforestation occurred in 2009 (76.10 km2). However, in the following years, the increase in deforestation increased in the municipality, as shown in the following image:

Figure 17. Historical deforestation – Vila Rica/MT[83]



[83] PRODES - http://www.dpi.inpe.br/prodesdigital/prodesmunicipal.php

Identification of drivers of deforestation

In the State of Mato Grosso there is a particularity in deforestation where the highest rates occur in vacant land and rural settlement projects. All related to population increase and cattle herd84. In this step, the factors that drive the land-use decisions of the agent group are analyzed to identify the immediate causes of deforestation. For this analysis, two sets of driver variables are distinguished:

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

Cattle prices:

According to CEPEA (2021)85, the price of cattle increased 245% over the 2010 (R$ 88.51 per arroba) to 2021 (R$ 305.46 per arroba) period. This economic phenomenon can be observed throughout the country. Young (1998) as cited in Rivero et al. (2009)86, evaluating the mechanisms that cause deforestation in the Legal Amazon, found a positive relation between the expansion of agricultural areas and the variation of prices of agricultural products. For Margulis (2001) as cited in Rivero et al. (2009), the higher the agricultural prices, the higher is the migration to rural lands, which results in deforestation.

This key driver variable is likely to have a major impact on cattle ranchers' decision to deforest. Considering that the higher is the cattle price, the higher are the profits obtained with pasture for cattle ranching, instead of maintaining standing forests. This driver also plays an important role on the definition of economic radius for cattle activities, which also influences the distances of deforestation from consumption poles.

China's demand for beef is still a reflection of swine flu, which has decimated between 40% and 60% of the country's pig stock (about one third of the world's pork production). In addition to this conjuncture factor, China also contributed to the growth of imports, since it was the only major economy in the world to record economic growth in 2020, even amid the coronavirus pandemic, and a more long-term factor, which is the gradual increase in income of the Chinese population, which results in higher consumption of more expensive proteins, such as beef. Analysts estimate that the price of beef should remain under pressure for the next few years, due to the livestock cycle: the low supply of ox is not something that can be solved immediately, because cattle is a multi-year production, as it begins to produce today to deliver animals in two, three, or four years87.

84 http://www.journals.ufrpe.br/index.php/JEAP/article/view/2790/482483315

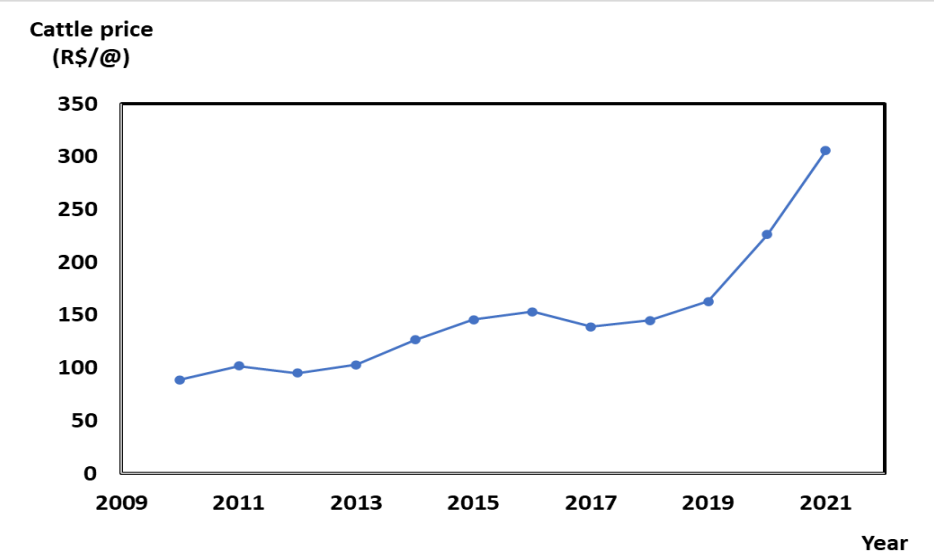
85 https://www.cepea.esalq.usp.br/br/consultas-ao-banco-de-dados-do-site.aspx

86 https://www.scielo.br/j/neco/a/jZHjd9B8ZghY7tG9G7qchTk/?format=pdf&lang=pt

87 https://www.bbc.com/portuguese/brasil-55664305

In 2020, Brazil broke its beef export record, with more than 2 million tons sold (8% more than in 2019). For 2021, the projection indicates an increase of 5% over the value of 202088, indicating a strong trend of increased in exports for the coming years. Beef exports have continued increased, growing by almost 7% in 2020 and close to 8% in 2021, increasing by more than 15% in the biennium 2020/202189. Chinese importers have increased the purchases of Brazilian beef by more than 150% in 202090. The dynamics of cattle prices are regulated by micro and macroeconomic scenario throughout the country and abroad, and there are no applicable measures that can be implemented to address this driver.

Figure 18. Cattle prices in Brazil (CEPEA, 2021) [91]



Population density:

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 authors include population density as a prediction variable in deforestation models,

[88] https://revistagloborural.globo.com/Noticias/Criacao/Boi/noticia/2021/01/apos-recorde-brasil-projeta-alta-de-5-nas-exportacoes-de-carne-bovina-em-2021.html#:~:text=Segundo%20Abrafrigo%2C%20pa%C3%ADs%20alcan%C3%A7ou%20marca,em%20rela%C3%A7%C3%A3o%20ao%20ano%20anterior&text=As%20exports%C3%A7%C3%B5es%20de%20carne%20bovine,by%20fortes%20shipments%20%C3%A0%20China

[89] https://www.avisite.com.br/index.php?page=noticias&id=21284

[90] https://www2.safras.com.br/eng/2020/09/23/meat-exports-in-brazil-will-be-an-important-differential-in-2021/

[91] https://www.cepea.esalq.usp.br/br/consultas-ao-banco-de-dados-do-site.aspx

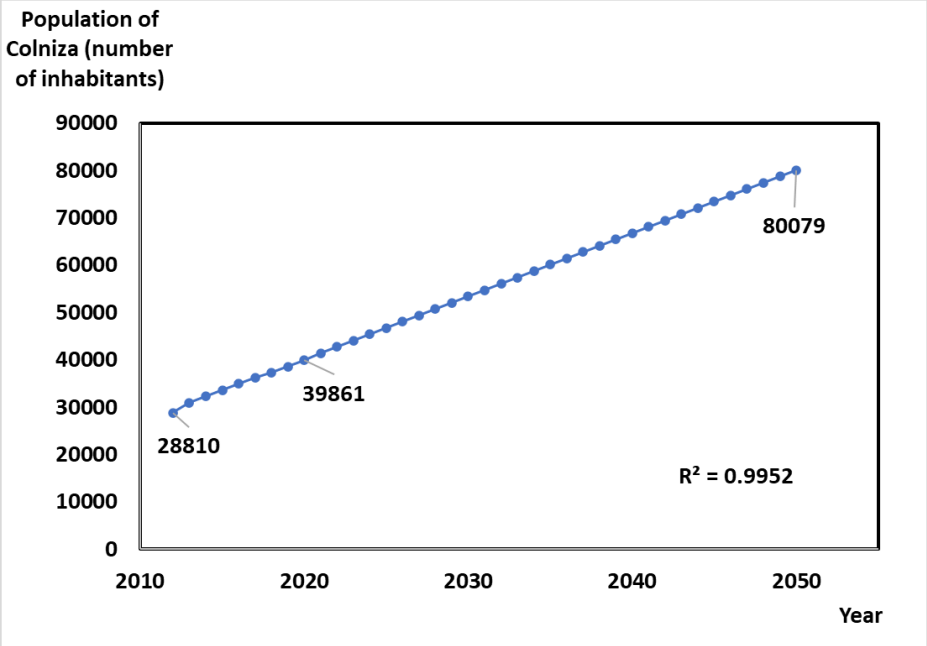
which demonstrates that this driver has important impact on deforestation trends (Reis and Margulis, 1991; Reis, 1996; Andersen and Reis, 1997 as cited in Rivero et al. 2009).

This key driver variable provides an increasing pressure of deforestation by cattle ranchers, avid for mitigating poverty by means of a profitable business.

The population of Vila Rica (municipality where the Project Area is located) is expected to virtually double (i.e., 101% approximate growth) during the project period (Figure 19). This estimate was made by means of a linear regression based on the past 10 years of official data on population, according to official IBGE data92. This population growth rate could represent a major driver to increase the deforestation in the region over upcoming decades.

Considering that the project activity cannot regulate the population density, there will be no project measures to address this driver.

Figure 19. Projected population growth in the municipality of Vila Rica, Mato Grosso, Brazil



b) Driver variables explaining the location of deforestation:

These driver variables were used in deforestation projection modelling, the results of which show that such variables can predict the location of deforestation variables explaining the quantity (hectares) of deforestation:

[92] https://ftp.ibge.gov.br/Estimativas_de_Populacao/ (accessed in 31/05/2021)

Access to forests (existing roads and navigable rivers):

Studies on historical location of deforestation in the Reference Region can evidence that this factor has been a driver for deforestation during the historical reference period. It is broadly recognized that deforestation is accelerated in regions that have denser road networks (IMAZON, 202193);

The presence of roads and navigable rivers is a logical deforestation driver, since it facilitates the flow of wood and other products harvested from the forest. The capacity to transport wood logs, rapidly clear the land for pasture and place wood logs in sawmills, quickly obtaining revenues, certainly has a major impact on cattle ranchers' decision to deforest the most accessible forest areas;

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. In a brief analysis of deforestation location, the existence of the fishbone deforestation patterns can be noted, which indicates the creation of secondary and tertiary roads in the Reference Region. Barber et al. (2014), in their study on deforestation drivers in the Amazon, conclude that proximity to transportation networks, particularly the rapidly growing unofficial road network, is a major driver of deforestation in the Amazon. Thus, it can be expected that the growth of the unofficial road network will increasingly affect the dynamics of deforestation over the project lifetime.

The project activity will result in the increase of the 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.

Proximity to forest edges:

Studies on historical location of deforestation in the Reference Region provide evidence that this has also been a driver for deforestation over the historical reference period. Similar to the proximity to roads and navigable rivers, the effect of this driver on deforestation decisions is related to easier logistics when clearing areas and easier and quicker revenue from logging. Proximity to forest edges has been similarly utilized by other REDD projects, including the "Serenity Valley Grouped REDD Project", the "Xingu-Araguaia Grouped REDD Project", the "Rio Manito Grouped REDD Project" and others. Furthermore, this deforestation vector has been used to explain the dynamics of deforestation in similar analyzes (LAURANCE et al. 2009; ROSA et al. 2013). According to

[93] https://imazongeo.org.br/ (accessed in 31/05/2021)

ROSA et al. (2013), deforestation is contagious, so that local deforestation rates increase over time if adjacent sites are deforested.

The impact of this driver on cattle ranchers' decision to deforest is similar to that explained for roads and navigable rivers: this proximity facilitates the logistics of wood and other products extracted from the forest;

This key driver variable will have increased impact during next years, owing to the advance of deforestation in the region, which will bring deforestation pressures gradually closer to the boundaries of the Project Area. As stated in several parts of this PD, deforestation for logging and cattle ranching is a common practice in the project region, and this behavior tends to continue in the future. Thus, it is expected that deforested areas will attract deforestation agents continuously, in a growing deforestation trend, provoked by a "contagious" process, as stated by ROSA et al. (2013);

The project measures that will be implemented to address this driver are the same measures that are being adopted to manage leakage in this project. These measures are described in detail in "1.17 Additional Information Relevant to the Project", subtopic "Leakage Management", of this PD, and involve surveillance, replication of project concepts to other areas (divulgation), engagement of local communities in inhibiting illegal occupation, and others.

- **Identification of underlying causes of deforestation**

  According to literature surveys and local interviews, it is concluded that the underlying causes of deforestation are as follows:

Land-use policies and their enforcement:

As previously mentioned in this PD, in spite of the legal provisions intended to preserve at least 80% of the Amazon's Forest cover, the lack of law enforcement by local authorities along with the increase in production and prices of cattle has 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. Accordingly, policies implemented to address illegal deforestation only by means of command-and-control approaches have proven to be ineffective so far.

This key underlying cause has a strong effect on the decisions of the main deforestation agents, as they are at liberty to continue their illegal business activities with very low probability of being detained by authorities. There are several indications of loosening of environmental legislation in recent years, with emphasis on the following subfactors:

Greater conveniences for obtaining “forest clearing authorization”: An example of this fact can be observed in the state of Goiás, which reported a 1,100% increase in the number of permits for deforestation in 202094. The new environmental licensing in Goiás, plus technologies that facilitate the inspection work of the Secretariat of Environment and Sustainable Development (Semad), in addition to effort in the analysis of applications, are responsible for increasing the number of deforestation permits in the State. According to data from Semad's Environmental Licensing Superintendence, there was an increase of area suppressed by 673%: 6.5 km2 in 2019, to 43.8 km² in 2020. Thus, as occurred in the State of Goiás, the facilitation of the issuance of authorization for the suppression of native vegetation can occur at any time in the Amazon Biome. In fact, attempts at facilitation have been sought recently (in 2020), as indicated in the next topic.

Granting of tacit (or automatic) environmental licensing, in case of delay of the environmental agency: The controversial automatic release of environmental permits and permits by maturity of term, that is, after a period stipulated for the government agency to manifest (120 days), was voted on 29/04/2020, by a virtual plenary. Provisional Measure 915 originally referred to the so-called "Economic Freedom Law" edited by the government, but ended up bringing, within the texts, changes that directly affect the rite of environmental licensing throughout the country. The change could lead to the automatic authorization of forest suppression in the Amazon and Atlantic Forest enforced by delay, and without analysis of the environmental agency. This means that, once the 120-day period is expired, the request would be automatically granted with a tacit license95. Fortunately, environmentalists have reedited the Provisional Measure 915, to prevent deforestation licensing for term expiration96.

Loosening legislation for timber exports: As reported by Reuters, during 2019 Brazil exported "thousands of cargoes of wood from an Amazonian port without authorization from the federal environmental agency, increasing the risk that they have been extracted from illegally deforested land". The rule change scrapping IBAMA's authorizations for most timber exports came after five cargoes of wood arrived in US and European ports without these mandatory documents. Foreign authorities contacted Brazil to ask about the missing authorizations, with the head of IBAMA in Mato Grosso then retroactively granting the authorizations. The problem, however, is much more widespread than just the five shipments. In Mato Grosso state, more than half of the roughly 3,000 officially

94 https://www.meioambiente.go.gov.br/noticias/2089-emiss%C3%A3o-de-licen%C3%A7as-para-supress%C3%A3o-de-vegeta%C3%A7%C3%A3o-tem-aumento-de-1-100-in-a-year-in-goi%C3%A1s.html

95 https://www.correiobraziliense.com.br/app/noticia/brasil/2020/04/29/interna-brasil,849652/camara-pode-aprovar-hoje-licenciamento-ambiental-automatico.shtml

96 https://epbr.com.br/ambientalistas-alteram-mp-915-para-prevent-licensing-environmental-by-course-of-time/

registered shipments in the past year, containing an estimated 54,000 m3 of wood that left one port, did not have authorization. Companies had requested authorizations from IBAMA for those shipments but exported them before the agency had time to respond. Beyond that, many shipments were exported without seeking approval from IBAMA. Shipments went to the US, the Netherlands, France, Germany, Belgium, and possibly other countries. Before the rules changed, IBAMA was required to give authorization to all wood exports before they leave port. Even though, most of the shipments needed only the proper paperwork to be given the green light, but only certain cargoes would be randomly selected for physical inspection97. Arbitrarily, the president of IBAMA ensured that all future unauthorized exports of wood, previously classified as illegal, became legal: he took advantage of the inattention of the press to the theme during Carnival, at the end of February 2020, to quietly revoke a 2011 IBAMA policy that required an authorization from the agency before forest products could receive export licenses. From that date on, such permits would be required only for endangered tree species or in other special circumstances. With the repeal, the way was opened for large shipments of illegal timber from the Brazilian Amazon to go abroad98. It was also revealed that in February 2020, loggers from Mato Grosso asked IBAMA to change that rule: the companies wanted to sell wood abroad presenting only the Document of Forest Origin (or "DOF – Documento de Origem Florestal" in Portuguese), made by the companies themselves and that originally only serves to allow the transport of the goods to the port. This change has been immediately accepted by the president of IBAMA[99].

Legislation favoring landgrabbers. An analysis conducted by IPAM (Environmental Research Institute of the Amazon) showed that 35% of deforestation occurred in the Amazon between August 2018 and July 2019 was recorded in non-designated areas without information. About land regularization, environmental NGOs warn about two ongoing projects. While, in the Senate is presented Bill 510/21, in the House of Representatives it is considered to vote the Bill 2633/20100. Commonly, both derive from the original text of Provisional Measure 910, known as "MP da Grilagem" (Landgrabbers' Provisional Measure), for changing the law to favor large occupants of recently invaded public lands. Bill 510/21 once again changes the deadline for public land invasions to be legalized (from 2011 to 2014) and allows large areas (up to 2500 hectares) to be titrated without the need for inspection. Indeed, given that the land grabbing of undesignated public lands is responsible for more than 1/3 of the

[97] https://www.businesslive.co.za/bd/world/americas/2020-03-04-brazil-may-be-exporting-illegally-deforested-wood/

[98] https://brasil.mongabay.com/2020/04/ao-afrouxar-leis-de-exportacao-brasil-permite-saida-de-madeira-ilegal-da-amazonia/

[99] https://g1.globo.com/natureza/noticia/2020/11/17/documentos-mostram-que-ibama-facilitou-exportacao-de-madeira-extraida-ilegalmente.ghtml

[100] https://ipam.org.br/35-do-desmatamento-na-amazonia-e-grilagem-indica-analise-do-ipam/

deforestation in the country, it is to be expected that amnesty for landgrabbers and illegal deforesters will be an incentive to intensify this practice in the coming years. Bill 2633/20 has a loophole that would allow to legalize, via bidding, public areas invaded after the deadline for occupation provided for by law (i.e., 2014). Of the 49.8 million hectares of forests under state and federal responsibility, but not yet allocated to any category of use, 11.6 million hectares, or 23%, were irregularly declared as rural properties of particular use, in the National System of Rural Environmental Registration (CAR). If the entire area registered to date as private property was legalized, 2.2 to 5.5 million hectares could be deforested in the coming years, according to the deforestation limits defined by the Forest Code and considering that deforestation is often greater than allowed. In recent years, grabbing of non-destined public forests has increased: in 2019, it was the land category where the most forest felled in the Amazon, according to data from the deforestation alert system of INPE (National Institute of Space Research), Deter. The trend continued in 2020. Among the conditions defined by Provisional Measure 910, for appropriation of public lands by individuals, are: i) the area must be registered in the Rural Environmental Registry (CAR, "Cadastro Ambiental Rural"): as it is known, any information can be imputed in the "CAR" system until the current moment without any veracity checking, and ii) the claimant must be performing agricultural activities in the territory (i.e., should have preferably deforested the area)101. The Provisional Measure defines that for areas that meet the requirements and have up to 15 fiscal modules (areas with up to 1,650 hectares), the title will be granted without the need for inspection. Before the Provisional Measure, the exemption from inspection was granted to areas with up to four fiscal modules (maximum 440 hectares). The exemption from the inspection may allow large illegally deforested areas to be taken over by individuals. This is because the Provisional Measure only prohibits the regularization of areas that have been subject to fines or environmental embargoes, and not all environmental violations are known and fined by the government102. Given that the Project Area is surrounded by public lands and that cases of land-grabbing can be evidenced in the Reference Region, an abnormal increase in deforestation in that region is expected in the coming years, because Brazilian legislation increasingly gives all indications that it is very inviting to land-grabbing acts, granting amnesty to landgrabbers and agents of illegal deforestation.

The problem of lack of command-and-control measures to contain deforestation in the Amazon Biome is a widespread issue, which has been getting worse and worse every year, due to lack of personnel and infrastructure of legal authorities, in addition to schemes of corruption and violence established by illegal agents to maintain the status

[101] https://ipam.org.br/cientistas-mapeiam-grilagem-em-florestas-publicas-na-amazonia/#:~:text=O%20impact%20da%20grilagem%20se,main%20g%C3%A1s%20%20effect%20estufa

[102] https://amazonia.org.br/como-a-mp-da-grilagem-pode-mudar-o-mapa-de-regioes-da-amazonia/

quo. In this context, the lack of law enforcement can be assumed to be a constant underlying cause of deforestation during the project lifetime.

Although the project activity cannot solve the problem of lack of enforcement in Brazil, it can serve as a case of success, to encourage neighbors to adopt sustainable practices as a profitable land-use alternative.

Poverty and wealth:

According to statistics on the municipality of Vila Rica (IBGE, 2021)[103], in 2018, the average monthly salary was 1.9 minimum wages. The proportion of occupied people in relation to the total population was 8.4%. In comparison with other municipalities in the state, it ranked 40 out of 22, while in comparison with cities nationwide, it ranked 1505 out of 5570. Considering households with monthly incomes of up to half a minimum wage per person, it had 45.7% of the population in these conditions. These data show that the region faces poverty issues.

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 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 region will rapidly solve the poverty issue, as it is historically deeply rooted in the region. 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 revenues for their families by means of a legal and sustainable initiative.

- **Analysis of chain of events leading to deforestation**

Based on the historical evidence collected, it is concluded that the implementation of the BAU activity (pasture) is usually financed by means of initial capital obtained through timber logging.

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.

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

[103] https://cidades.ibge.gov.br/brasil/mt/colniza/panorama

the fact that daily patrolling of the area is required by one or two employees on motorbikes, in order to combat the constant deforestation pressure.

- **Conclusion**

Available evidence about the most likely future deforestation trend within the Reference Region and Project Area is deemed to be "Conclusive". Meaning that the hypothesized relationships between agent groups, driver variables, underlying causes, and historical levels of deforestation have been verified via literature studies and other verifiable local sources of information.

The weight of the available evidence conservatively suggests that the overall trend in future baseline deforestation rates will be "Increasing". During the reference period, the deforestation rate in the Reference Region has consistently increased. In this context, the deforestation rate used in the projections was the Modelling ("c") approach (see step 4.1.1 of the VM0015 methodology: Selection of Baseline Approach).

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[104] 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.

Project instances must not be mandated by any law, statute, or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute, or other regulatory framework.

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 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.

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

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, as they are not mandatory. 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 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.

Table below provides an estimate of yearly expenses for the landowner, without considering the costs of the present REDD project:

Table 14. Estimated annual costs for the REDD Project[105]

Estimated Annual Costs of Conservation (R$/year)	
Surveillance and security of the area	R$ 38,668.50
Proposed socio-environmental activities	R$ 175,000.00[106]
TOTAL	**R$ 213,668.50**

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).

[105] Costs were estimated based on the quotes provided by the respective service providers, according to the available cashflow.
[106] The cost with socio-environmental activities was calculated based on other REDD projects, which have implemented similar measures.

STEP 4. Common practice analysis

Given that no financial benefits were found in the results of the Simple Cost Analysis, the following step according to the VCS additionality tool is the Common Practice Analysis.

The practice of conservation of privately-owned forest areas in the States of Mato Grosso and Pará as a whole 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 and Cerrado 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[107]. As previously detailed, Pará is one of the main producers of cattle in the country, and this sector represents most of the State'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)[108]:** 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 Pará, there are 6 registered RPPNs and none of them are located in the municipalities of the reference region[109].

  RPPN management tends to be much more affordable than REDD+ projects due to its costless implementation.

- **Payment for Environmental Services (PES)[110]:** 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 aforementioned law establishes the National Policy on Payment for Environmental

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

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 aforementioned 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 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

This project activity does not apply any methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

According to the Section 3.4 – Baseline Scenario above, between 2011 and 2021, there was a deforestation of 70,700 ha within the Reference Region, with an average oscillation of approximately 7,070 ha/year and a low increasing trend (R^2 = 0.02).

Therefore, 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 (0.91%/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 of the annual areas of baseline deforestation in reference region, leakage belt and project area.

Table 15. 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
2021	3,907.34	3,907.34	3,907.34
2022	4,178.37	4,178.37	8,085.72
2023	4,088.85	4,088.85	12,174.57
2024	4,001.25	4,001.25	16,175.82
2025	3,915.53	3,915.53	20,091.35
2026	3,831.64	3,831.64	23,923.00
2027	3,642.83	3,642.83	27,565.82
2028	3,210.30	3,210.30	30,776.13
2029	3,150.16	3,150.16	33,926.29
2030	3,091.15	3,091.15	37,017.44
2031	3,033.25	3,033.25	40,050.69

2032	2,976.42	2,976.42	43,027.11
2033	2,865.62	2,865.62	45,892.73
2034	2,531.65	2,531.65	48,424.38
2035	2,489.77	2,489.77	50,914.15
2036	2,448.59	2,448.59	53,362.74
2037	2,408.08	2,408.08	55,770.83
2038	2,368.25	2,368.25	58,139.08
2039	2,266.79	2,266.79	60,405.87
2040	2,007.27	2,007.27	62,413.14
2041	1,978.19	1,978.19	64,391.33
2042	1,949.52	1,949.52	66,340.85
2043	1,921.27	1,921.27	68,262.13
2044	1,893.44	1,893.44	70,155.56
2045	1,802.47	1,802.47	71,958.04
2046	1,599.52	1,599.52	73,557.56
2047	1,579.37	1,579.37	75,136.93
2048	1,559.48	1,559.48	76,696.40
2049	1,539.83	1,539.83	78,236.24
2050	1,520.44	1,520.44	79,756.67
2051	1,501.04	1,501.04	81,257.71

Table 16. 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
2021	261.71	261.71	261.71
2022	279.91	279.91	541.62
2023	273.91	273.91	815.53
2024	268.04	268.04	1,083.57
2025	262.30	262.30	1,345.87
2026	256.68	256.68	1,602.55
2027	244.03	244.03	1,846.58
2028	238.95	238.95	2,085.53
2029	233.98	233.98	2,319.51
2030	229.11	229.11	2,548.62
2031	224.34	224.34	2,772.96
2032	219.67	219.67	2,992.62
2033	208.51	208.51	3,201.14

2034	204.30	204.30	3,405.44
2035	200.18	200.18	3,605.62
2036	196.14	196.14	3,801.77
2037	192.19	192.19	3,993.95
2038	188.31	188.31	4,182.26
2039	178.45	178.45	4,360.70
2040	174.96	174.96	4,535.67
2041	171.55	171.55	4,707.22
2042	168.20	168.20	4,875.42
2043	164.92	164.92	5,040.34
2044	161.70	161.70	5,202.04
2045	152.97	152.97	5,355.00
2046	150.09	150.09	5,505.09
2047	147.26	147.26	5,652.35
2048	144.49	144.49	5,796.84
2049	141.77	141.77	5,938.61
2050	139.10	139.10	6,077.70
2051	136.43	136.43	6,214.13

Table 17. 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
2021	472.18	472.18	472.18
2022	504.74	504.74	976.91
2023	493.92	493.92	1,470.84
2024	483.34	483.34	1,954.18
2025	472.99	472.99	2,427.17
2026	462.85	462.85	2,890.02
2027	440.05	440.05	3,330.07
2028	430.89	430.89	3,760.95
2029	421.92	421.92	4,182.87
2030	413.14	413.14	4,596.01
2031	404.54	404.54	5,000.54
2032	396.12	396.12	5,396.66
2033	376.00	376.00	5,772.65
2034	368.41	368.41	6,141.06
2035	360.98	360.98	6,502.04
2036	353.69	353.69	6,855.73
2037	346.56	346.56	7,202.29

2038	339.56	339.56	7,541.85
2039	321.78	321.78	7,863.63
2040	315.50	315.50	8,179.13
2041	309.34	309.34	8,488.47
2042	303.31	303.31	8,791.78
2043	297.39	297.39	9,089.16
2044	291.58	291.58	9,380.75
2045	275.83	275.83	9,656.58
2046	270.64	270.64	9,927.22
2047	265.55	265.55	10,192.77
2048	260.55	260.55	10,453.32
2049	255.64	255.64	10,708.96
2050	250.83	250.83	10,959.79
2051	246.01	246.01	11,205.80

- 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 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, proximity to settlements and proximity rivers.

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[111], 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.

[111] Dinamica Ego Software. Available at: https://csr.ufmg.br/dinamica/ .

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.

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 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.

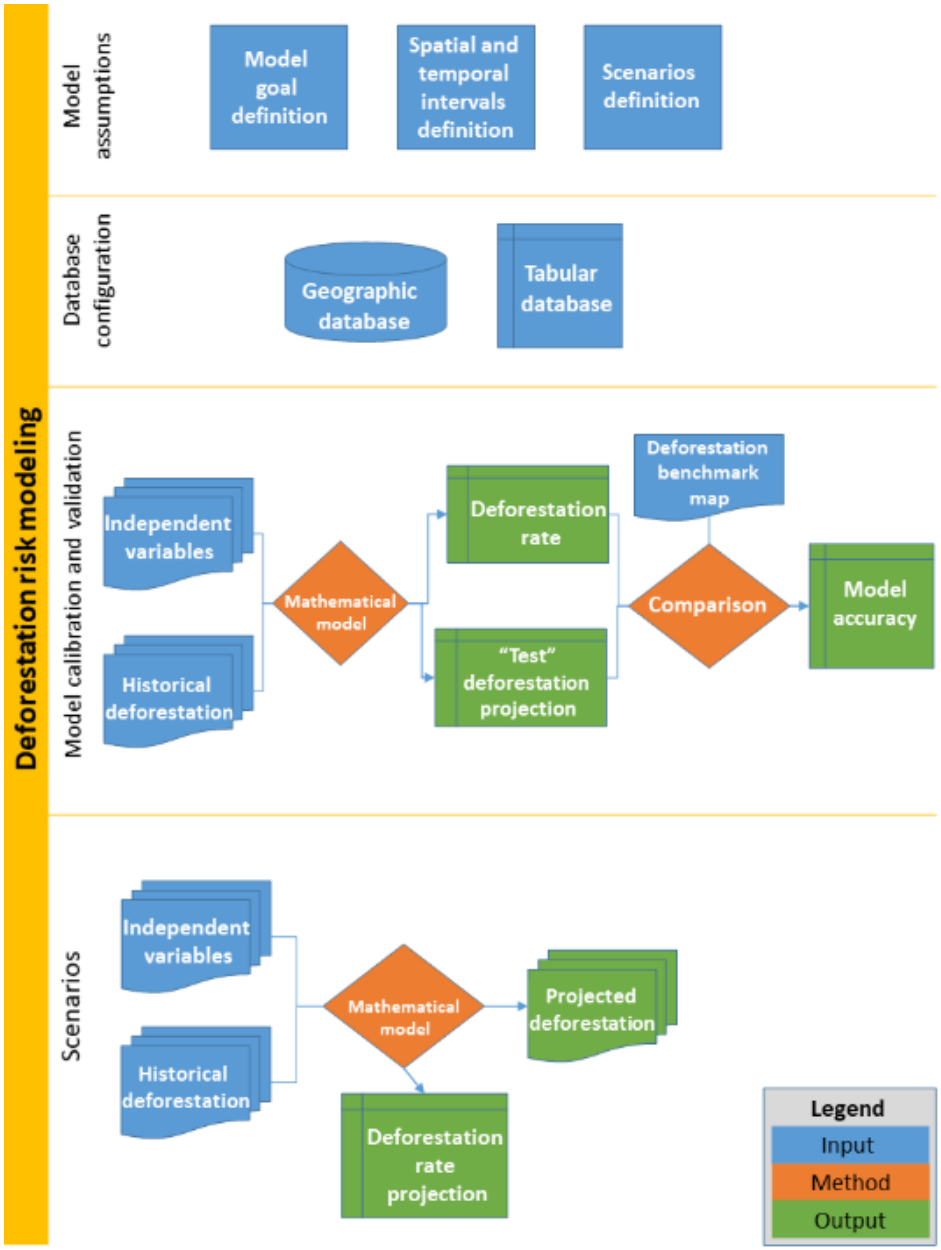
Based on the weights of the evidence, the transition probability of each forest pixel to become other types of anthropic use is calculated. This probability is calculated based on the sum of all the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps[112].

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.

[112] 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>

Figure 20. 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 18. 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/ABC Norte data	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 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.

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

  According to the methodology, "The Prediction Map" with the best fit is the map that best reproduced actual deforestation in the confirmation period. The best fit must be assessed using appropriate statistical techniques. Most peer reviewed modeling tools, such as Geomod, Idrisi Taiga, Land Use Change Modeler, and Dinamica Ego, include in the software package appropriate assessment techniques, which can be used under this methodology. Preference should be given to techniques that assess the accuracy of the prediction at the polygon level, such as the predicted quantity of total deforestation within the project area as compared to the observed one."

  For that, simulations of the deforestation projection were made, taking three dates as reference: 2011, 2016 and 2021. The period from 2011 to 2016 was used to generate the correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the model. After that, a projection from 2017 to 2021 was developing a reference region scenario for this date. Therefore, the deforestation maps for the period from 2017 to 2021 and two scenarios for 2021, real and projected, were developed. These scenarios were compared regarding the degree of similarity considering exponential decay. The higher the similarity, the better the prediction of the model. 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.

Table 19. Best deforestation projection models from 2017 to 2021. Each line corresponds to a model and was evaluated by the degree of Similarity.

Model	Similarity 1	Similarity 2	Average	Distance from deforestation	Settlement	Distance from rivers	Distance from roads	Distance from urban areas	Slope	Altitude
m00	0.335	0.354	0.345	1	1	1	1	1	1	1
m01	0.322	0.35	0.336	0	1	1	1	1	1	1
m02	0.308	0.324	0.316	1	0	1	1	1	1	1
m03	0.484	0.501	0.493	1	1	0	1	1	1	1
m04	0.355	0.387	0.371	1	1	1	0	1	1	1
m05	0.383	0.415	0.399	1	1	1	1	0	1	1

m06	0.584	0.592	0.588	1	1	0	1	0	0	1
m07	0.371	0.395	0.383	1	1	1	1	1	1	0
m08	0.428	0.458	0.476	1	1	1	1	1	0	1
m09	0.476	0.489	0.483	1	1	0	0	1	0	1
m10	0.411	0.437	0.424	1	0	1	1	0	1	0
m11	0.512	0.536	0.524	1	1	0	1	0	1	1

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 m08). 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. Through this procedure it is possible to guarantee that all the best models could be assessed. During this second round of analysis, 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 m06, with an average similarity of 0.588. This model applies four variables: distance from deforestation, distance from settlements, distance from roads, and altitude. Thus, it was selected to project the future deforestation.

In addition, the AUC (Area Under the Curve), which is the area under the ROC curve (Receiver Operating Characteristic) was calculated. This represents the accuracy of the probability maps, that is, it shows whether the actual deforestation is indicated with the deforestation probabilities by the models (deforestation risk map). Regarding the AUC values, the best model presented a value of 0.78[113].

- **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 crediting period, in the reference

[113] According to KHATAMI, Reza; MOUNTRAKIS, Giorgos; STEHMAN, Stephen V. **Mapping per-pixel predicted accuracy of classified remote sensing images.** Remote Sensing of Environment, v. 191, p. 156-167, 2017., models that present values over 0.5 may be used.

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 20. 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	annual ABSLRRt (ha)	ABSLRR cumulative (ha)
Name	Forest		
Project year *t*	ha		
2021	3,907.34	3,907.34	3,907.34
2022	4,178.37	4,178.37	8,085.72
2023	4,088.85	4,088.85	12,174.57
2024	4,001.25	4,001.25	16,175.82
2025	3,915.53	3,915.53	20,091.35
2026	3,831.64	3,831.64	23,923.00
2027	3,642.83	3,642.83	27,565.82
2028	3,210.30	3,210.30	30,776.13
2029	3,150.16	3,150.16	33,926.29
2030	3,091.15	3,091.15	37,017.44
2031	3,033.25	3,033.25	40,050.69
2032	2,976.42	2,976.42	43,027.11
2033	2,865.62	2,865.62	45,892.73
2034	2,531.65	2,531.65	48,424.38
2035	2,489.77	2,489.77	50,914.15
2036	2,448.59	2,448.59	53,362.74
2037	2,408.08	2,408.08	55,770.83
2038	2,368.25	2,368.25	58,139.08
2039	2,266.79	2,266.79	60,405.87
2040	2,007.27	2,007.27	62,413.14
2041	1,978.19	1,978.19	64,391.33
2042	1,949.52	1,949.52	66,340.85
2043	1,921.27	1,921.27	68,262.13
2044	1,893.44	1,893.44	70,155.56
2045	1,802.47	1,802.47	71,958.04
2046	1,599.52	1,599.52	73,557.56
2047	1,579.37	1,579.37	75,136.93
2048	1,559.48	1,559.48	76,696.40
2049	1,539.83	1,539.83	78,236.24
2050	1,520.44	1,520.44	79,756.67
2051	1,501.04	1,501.04	81,257.71

Table 21. Annual areas deforested per forest class icl within the Project Area in the baseline case (baseline activity data per forest class)

Area deforested per forest class icl within the project area		Total baseline deforestation in the project area	
IDicl	1	annual ABSLPAt (ha)	ABSLPA cumulative (ha)
Name	Forest		
Project year *t*	ha		
2021	261.71	261.71	261.71
2022	279.91	279.91	541.62
2023	273.91	273.91	815.53
2024	268.04	268.04	1,083.57
2025	262.30	262.30	1,345.87
2026	256.68	256.68	1,602.55
2027	244.03	244.03	1,846.58
2028	238.95	238.95	2,085.53
2029	233.98	233.98	2,319.51
2030	229.11	229.11	2,548.62
2031	224.34	224.34	2,772.96
2032	219.67	219.67	2,992.62
2033	208.51	208.51	3,201.14
2034	204.30	204.30	3,405.44
2035	200.18	200.18	3,605.62
2036	196.14	196.14	3,801.77
2037	192.19	192.19	3,993.95
2038	188.31	188.31	4,182.26
2039	178.45	178.45	4,360.70
2040	174.96	174.96	4,535.67
2041	171.55	171.55	4,707.22
2042	168.20	168.20	4,875.42
2043	164.92	164.92	5,040.34
2044	161.70	161.70	5,202.04
2045	152.97	152.97	5,355.00
2046	150.09	150.09	5,505.09
2047	147.26	147.26	5,652.35
2048	144.49	144.49	5,796.84
2049	141.77	141.77	5,938.61
2050	139.10	139.10	6,077.70
2051	136.43	136.43	6,214.13

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

Area deforested per forest class icl within the leakage belt		Total baseline deforestation in the leakage belt	
IDicl	1	annual ABSLLKt (ha)	ABSLLK cumulative (ha)
Name	Forest		
Project year *t*	ha		
2021	472.18	472.18	472.18
2022	504.74	504.74	976.91
2023	493.92	493.92	1,470.84
2024	483.34	483.34	1,954.18
2025	472.99	472.99	2,427.17
2026	462.85	462.85	2,890.02
2027	440.05	440.05	3,330.07
2028	430.89	430.89	3,760.95
2029	421.92	421.92	4,182.87
2030	413.14	413.14	4,596.01
2031	404.54	404.54	5,000.54
2032	396.12	396.12	5,396.66
2033	376.00	376.00	5,772.65
2034	368.41	368.41	6,141.06
2035	360.98	360.98	6,502.04
2036	353.69	353.69	6,855.73
2037	346.56	346.56	7,202.29
2038	339.56	339.56	7,541.85
2039	321.78	321.78	7,863.63
2040	315.50	315.50	8,179.13
2041	309.34	309.34	8,488.47
2042	303.31	303.31	8,791.78
2043	297.39	297.39	9,089.16
2044	291.58	291.58	9,380.75
2045	275.83	275.83	9,656.58
2046	270.64	270.64	9,927.22
2047	265.55	265.55	10,192.77
2048	260.55	260.55	10,453.32
2049	255.64	255.64	10,708.96
2050	250.83	250.83	10,959.79
2051	246.01	246.01	11,205.80

- **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 VM00145, 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.

Table 23. Zone of the reference region encompassing potential post-deforestation LU/LC class

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	81,257.71	9%	81,257.71	9%
Total area of each class *fcl*		81,257.71	9%	81,257.71	9%

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 24. Annual areas deforested in each zone within the reference region 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
2021	3,907.34	3,907.34	3,907.34
2022	4,178.37	4,178.37	8,085.72
2023	4,088.85	4,088.85	12,174.57
2024	4,001.25	4,001.25	16,175.82
2025	3,915.53	3,915.53	20,091.35
2026	3,831.64	3,831.64	23,923.00
2027	3,642.83	3,642.83	27,565.82
2028	3,210.30	3,210.30	30,776.13
2029	3,150.16	3,150.16	33,926.29
2030	3,091.15	3,091.15	37,017.44
2031	3,033.25	3,033.25	40,050.69
2032	2,976.42	2,976.42	43,027.11
2033	2,865.62	2,865.62	45,892.73
2034	2,531.65	2,531.65	48,424.38
2035	2,489.77	2,489.77	50,914.15
2036	2,448.59	2,448.59	53,362.74
2037	2,408.08	2,408.08	55,770.83
2038	2,368.25	2,368.25	58,139.08
2039	2,266.79	2,266.79	60,405.87
2040	2,007.27	2,007.27	62,413.14
2041	1,978.19	1,978.19	64,391.33
2042	1,949.52	1,949.52	66,340.85
2043	1,921.27	1,921.27	68,262.13
2044	1,893.44	1,893.44	70,155.56
2045	1,802.47	1,802.47	71,958.04
2046	1,599.52	1,599.52	73,557.56
2047	1,579.37	1,579.37	75,136.93
2048	1,559.48	1,559.48	76,696.40
2049	1,539.83	1,539.83	78,236.24
2050	1,520.44	1,520.44	79,756.67
2051	1,501.04	1,501.04	81,257.71

Table 25. 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 project area		Total baseline deforestation in the project area	
ID_{fcl}	1	$ABSLPA_t$	$ABSLPA$
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2021	261.71	261.71	261.71
2022	279.91	279.91	541.62
2023	273.91	273.91	815.53
2024	268.04	268.04	1,083.57
2025	262.30	262.30	1,345.87
2026	256.68	256.68	1,602.55
2027	244.03	244.03	1,846.58
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2031	224.34	224.34	2,772.96
2032	219.67	219.67	2,992.62
2033	208.51	208.51	3,201.14
2034	204.30	204.30	3,405.44
2035	200.18	200.18	3,605.62
2036	196.14	196.14	3,801.77
2037	192.19	192.19	3,993.95
2038	188.31	188.31	4,182.26
2039	178.45	178.45	4,360.70
2040	174.96	174.96	4,535.67
2041	171.55	171.55	4,707.22
2042	168.20	168.20	4,875.42
2043	164.92	164.92	5,040.34
2044	161.70	161.70	5,202.04
2045	152.97	152.97	5,355.00
2046	150.09	150.09	5,505.09
2047	147.26	147.26	5,652.35
2048	144.49	144.49	5,796.84
2049	141.77	141.77	5,938.61
2050	139.10	139.10	6,077.70
2051	136.43	136.43	6,214.13

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

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
2021	472.18	472.18	472.18
2022	504.74	504.74	976.91
2023	493.92	493.92	1,470.84
2024	483.34	483.34	1,954.18
2025	472.99	472.99	2,427.17
2026	462.85	462.85	2,890.02
2027	440.05	440.05	3,330.07
2028	430.89	430.89	3,760.95
2029	421.92	421.92	4,182.87
2030	413.14	413.14	4,596.01
2031	404.54	404.54	5,000.54
2032	396.12	396.12	5,396.66
2033	376.00	376.00	5,772.65
2034	368.41	368.41	6,141.06
2035	360.98	360.98	6,502.04
2036	353.69	353.69	6,855.73
2037	346.56	346.56	7,202.29
2038	339.56	339.56	7,541.85
2039	321.78	321.78	7,863.63
2040	315.50	315.50	8,179.13
2041	309.34	309.34	8,488.47
2042	303.31	303.31	8,791.78
2043	297.39	297.39	9,089.16
2044	291.58	291.58	9,380.75
2045	275.83	275.83	9,656.58
2046	270.64	270.64	9,927.22
2047	265.55	265.55	10,192.77
2048	260.55	260.55	10,453.32
2049	255.64	255.64	10,708.96
2050	250.83	250.83	10,959.79
2051	246.01	246.01	11,205.80

Calculation of Baseline Emissions

The total average biomass stock per hectare (Mg ha^{-1}) was converted to tCO_2e using the following equations:

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

Where,

Cab_{icl}	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,

Cbb_{icl}	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,

$\Delta CBSLPA_t$	Total baseline carbon stock changes in the project area at year t; tCO2e
$\Delta CabBSLPA_{icl,t}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e
$\Delta CbbBSLPA_{icl,t}$	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,

$\Delta CabBSLPA_{icl,t}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t; tCO2e
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCab_{icl}	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,

$\Delta CbbBSLPA_{icl,t}$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO2e
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCbb_{icl}	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, VM0015 v1.1, 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 are 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 are sampled from good coverage of the classes over which they will be extrapolated.

As previously described, Open Tropical Rainforest is the main forest type present within the project area, with around 90% of the total forest cover. Thus, due to the high representativeness of this forest type within the project area, the forest class was not stratified, i.e., the “Forest” class includes just one strata due to the low difference in average carbon stocks within the project area.

The estimation of the average carbon stocks for Open Tropical Rainforest was based on FAO (2020)[114], which fulfil the criteria mentioned above.

FAO has been monitoring the world's forests at 5 to 10 year intervals since 1946. The Global Forest Resources Assessments (FRA) are produced every five years in an attempt to provide a consistent approach to describing the world's forests and how they are changing. The FRA is a country-driven process and the assessments are based on reports prepared by officially nominated National Correspondents. If a report is not available, the FRA Secretariat prepares a desk study using reports, existing information and/or remote sensing-based analysis.

The data used for estimating volume stocks were obtained from Brazil's National Forest Inventory (NFI) collected until and available by December 2018. The NFI is based on a systematic sampling design, with clusters of four sub unities of 20m x 50m each, distributed in a national grid of 20 km x 20 km. Data of all living trees over 10 cm DBH were processed for calculating average stocks of volume (m3/ha) for each biome and for each forest type within each biome, using available and published volume equation fitted for forest types. For the vegetation types with low number of clusters in the considered biome, the total samples (clusters) for all biomes of that specific forest type were used instead. To retrieve field data for forest type, the same vegetation map used for forest extension was utilized, and to achieve the total growing stock, each forest type stock (m3/ha) was multiplied by its correspondent area given by the vegetation map. The same procedure for Forest and Other Wooded Land categories.

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.

Values presented in tables below were chosen after a literature search revealed that these studies had the most accurate biomass values for the vegetation-cover of the Project's reference region.

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 27. Biomass to CO2 conversion factors[115]

[114] FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020, Report, Rome, 2020. Available at: https://snif.florestal.gov.br/pt-br/ultimas-noticias/659-avaliacao-global-do-recursos-florestais-fra-2020. Last visited on December 07th, 2021.

[115] 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

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

Therefore, the carbon stocks values for above and belowground biomass for this project activity are described below.

Table 28. Biomass values used for the "forest" classes within the Project area.

Forest class	Aboveground			Belowground			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Open Tropical Rainforest	225.46	112.73	413.34	54.11	27.06	99.20	279.57	139.79	512.55

Average carbon stocks of post-deforestation classes

Fearnside (1996)[116] 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 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 tCO_2e/ha. It is important to note that no sampling was applied to calculate this data.

Table 29. 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 tCO_2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory[117], the weighted average for carbon stocks in other land uses (mainly agriculture and

[116] 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>

[117] Available at https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/arquivos/LIVRORESULTADOINVENTARIO30062021WEB.pdf

pasturelands) was 32.99 tCO_2e. Therefore, the most conservative value between these two data was used.

Uncertainty assessment

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.

FAO (2020) study was conducted at a 90% confidence interval and present an uncertainty level less than 10% of the average carbon stock value for Open Tropical Rainforest.

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.

Table 30. Biomass to CO2 conversion factors[118]

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

Table 31. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt

Initial forest class *icl*						
Boundaries	Average carbon stock 90% CI					
	Name	Forest				
	ID_{icl}	1				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock tCO2e/ha	±90% CI tCO2e/ha	C stock tCO2e/ha	±90% CI tCO2e/ha	C stock tCO2e/ha	±90% CI tCO2e/ha
Project Area	413.34	29.37	99.20	7.05	512.55	36.42
Leakage Belt	413.34	29.37	99.20	7.05	512.55	36.42

[118] 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 32. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties

	Initial forest class *icl*						
	Boundaries	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	Project Area	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55
Initial forest class	Leakage Belt	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55

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*+10 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*+10 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 33. Carbon stock change factors for initial forest classes (icl) in the reference region (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-413.34	-9.92
2	t*+1	0	-9.92
3	t*+2	0	-9.92
4	t*+3	0	-9.92
5	t*+4	0	-9.92
6	t*+5	0	-9.92
7	t*+6	0	-9.92
8	t*+7	0	-9.92
9	t*+8	0	-9.92
10	t*+9	0	-9.92
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 34. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-413.34	-9.92
2	t*+1	0	-9.92
3	t*+2	0	-9.92
4	t*+3	0	-9.92
5	t*+4	0	-9.92
6	t*+5	0	-9.92
7	t*+6	0	-9.92
8	t*+7	0	-9.92
9	t*+8	0	-9.92
10	t*+9	0	-9.92
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 35. Carbon stock change factors for initial forest classes (icl) in the Leakage Belt (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-413.34	-9.92
2	t*+1	0	-9.92
3	t*+2	0	-9.92
4	t*+3	0	-9.92
5	t*+4	0	-9.92
6	t*+5	0	-9.92
7	t*+6	0	-9.92
8	t*+7	0	-9.92
9	t*+8	0	-9.92
10	t*+9	0	-9.92
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 36. Carbon stock change factors for final classes fcl or zones z (Method 1)

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/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 37. 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	
ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	1,615,074	1,615,074	1,615,074
2022	1,727,103	1,727,103	3,342,177
2023	1,690,101	1,690,101	5,032,277
2024	1,653,892	1,653,892	6,686,169
2025	1,618,458	1,618,458	8,304,628
2026	1,583,784	1,583,784	9,888,412
2027	1,505,738	1,505,738	11,394,149
2028	1,326,957	1,326,957	12,721,107
2029	1,302,099	1,302,099	14,023,206
2030	1,277,707	1,277,707	15,300,913
2031	1,253,772	1,253,772	16,554,685
2032	1,230,285	1,230,285	17,784,969
2033	1,184,484	1,184,484	18,969,453
2034	1,046,442	1,046,442	20,015,895
2035	1,029,132	1,029,132	21,045,026
2036	1,012,108	1,012,108	22,057,134
2037	995,366	995,366	23,052,500
2038	978,900	978,900	24,031,400
2039	936,965	936,965	24,968,365
2040	829,692	829,692	25,798,056
2041	817,670	817,670	26,615,726
2042	805,822	805,822	27,421,549
2043	794,146	794,146	28,215,695
2044	782,639	782,639	28,998,334
2045	745,040	745,040	29,743,374
2046	661,151	661,151	30,404,525
2047	652,823	652,823	31,057,348
2048	644,599	644,599	31,701,947
2049	636,480	636,480	32,338,427
2050	628,462	628,462	32,966,889
2051	620,444	620,444	33,587,333

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	
ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	38,762	38,762	38,762
2022	80,212	80,212	118,974
2023	120,775	120,775	239,749
2024	160,468	160,468	400,217
2025	199,311	199,311	599,528
2026	237,322	237,322	836,850
2027	273,460	273,460	1,110,309
2028	305,307	305,307	1,415,616
2029	336,557	336,557	1,752,173
2030	367,222	367,222	2,119,395
2031	358,551	358,551	2,477,945
2032	346,627	346,627	2,824,572
2033	334,492	334,492	3,159,065
2034	319,913	319,913	3,478,978
2035	305,770	305,770	3,784,748
2036	292,049	292,049	4,076,797
2037	279,800	279,800	4,356,597
2038	271,447	271,447	4,628,044
2039	262,684	262,684	4,890,728
2040	251,931	251,931	5,142,660
2041	241,465	241,465	5,384,125
2042	231,278	231,278	5,615,403
2043	221,910	221,910	5,837,312
2044	215,579	215,579	6,052,891
2045	208,760	208,760	6,261,651
2046	200,337	200,337	6,461,989
2047	192,116	192,116	6,654,105
2048	184,093	184,093	6,838,198
2049	176,881	176,881	7,015,080
2050	172,052	172,052	7,187,132
2051	167,319	167,319	7,354,450

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region	
ID_{lz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	0	0	0
2022	20,376	20,376	20,376
2023	42,166	42,166	62,542
2024	63,488	63,488	126,030
2025	84,354	84,354	210,384
2026	104,773	104,773	315,156
2027	124,754	124,754	439,910
2028	143,751	143,751	583,661
2029	160,492	160,492	744,153
2030	176,919	176,919	921,072
2031	193,039	193,039	1,114,111
2032	188,481	188,481	1,302,592
2033	182,213	182,213	1,484,805
2034	175,834	175,834	1,660,639
2035	168,170	168,170	1,828,809
2036	160,735	160,735	1,989,544
2037	153,523	153,523	2,143,067
2038	147,084	147,084	2,290,151
2039	142,693	142,693	2,432,844
2040	138,086	138,086	2,570,930
2041	132,434	132,434	2,703,364
2042	126,932	126,932	2,830,296
2043	121,577	121,577	2,951,873
2044	116,652	116,652	3,068,525
2045	113,324	113,324	3,181,849
2046	109,740	109,740	3,291,589
2047	105,312	105,312	3,396,901
2048	100,991	100,991	3,497,892
2049	96,773	96,773	3,594,665
2050	92,982	92,982	3,687,647
2051	90,443	90,443	3,778,090

Total net carbon stock change in the reference region	
$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
annual	cumulative
tCO_2e	tCO_2e
1,653,836	1,653,836
1,786,939	3,440,775
1,768,710	5,209,485
1,750,872	6,960,356
1,733,415	8,693,772
1,716,333	10,410,105
1,654,443	12,064,548
1,488,513	13,553,061
1,478,164	15,031,226
1,468,010	16,499,235
1,419,283	17,918,519
1,388,431	19,306,950
1,336,763	20,643,713
1,190,521	21,834,234
1,166,731	23,000,965
1,143,422	24,144,387
1,121,643	25,266,030
1,103,263	26,369,293
1,056,956	27,426,249
943,537	28,369,786
926,701	29,296,487
910,168	30,206,655
894,479	31,101,135
881,566	31,982,700
840,476	32,823,176
751,749	33,574,925
739,627	34,314,552
727,702	35,042,254
716,588	35,758,842
707,532	36,466,374
697,320	37,163,693

Table 38. 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	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	108,176	108,176	108,176
2022	115,698	115,698	223,874
2023	113,219	113,219	337,093
2024	110,793	110,793	447,886
2025	108,420	108,420	556,306
2026	106,097	106,097	662,402
2027	100,869	100,869	763,271
2028	98,769	98,769	862,040
2029	96,713	96,713	958,753
2030	94,700	94,700	1,053,453
2031	92,729	92,729	1,146,182
2032	90,799	90,799	1,236,981
2033	86,187	86,187	1,323,168
2034	84,448	84,448	1,407,616
2035	82,744	82,744	1,490,360
2036	81,074	81,074	1,571,435
2037	79,439	79,439	1,650,873
2038	77,836	77,836	1,728,709
2039	73,759	73,759	1,802,468
2040	72,320	72,320	1,874,788
2041	70,909	70,909	1,945,696
2042	69,525	69,525	2,015,221
2043	68,168	68,168	2,083,389
2044	66,838	66,838	2,150,227
2045	63,228	63,228	2,213,455
2046	62,037	62,037	2,275,492
2047	60,869	60,869	2,336,361
2048	59,723	59,723	2,396,084
2049	58,599	58,599	2,454,683
2050	57,496	57,496	2,512,179
2051	56,392	56,392	2,568,571

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	
ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	2,596	2,596	2,596
2022	5,373	5,373	7,969
2023	8,090	8,090	16,059
2024	10,749	10,749	26,809
2025	13,351	13,351	40,160
2026	15,898	15,898	56,058
2027	18,319	18,319	74,376
2028	20,689	20,689	95,065
2029	23,010	23,010	118,075
2030	25,283	25,283	143,358
2031	24,912	24,912	168,270
2032	24,315	24,315	192,585
2033	23,666	23,666	216,251
2034	23,034	23,034	239,284
2035	22,417	22,417	261,701
2036	21,817	21,817	283,518
2037	21,302	21,302	304,821
2038	20,800	20,800	325,621
2039	20,249	20,249	345,870
2040	19,712	19,712	365,582
2041	19,188	19,188	384,770
2042	18,678	18,678	403,448
2043	18,245	18,245	421,693
2044	17,823	17,823	439,516
2045	17,354	17,354	456,870
2046	16,897	16,897	473,768
2047	16,452	16,452	490,219
2048	16,017	16,017	506,236
2049	15,653	15,653	521,889
2050	15,297	15,297	537,187
2051	14,949	14,949	552,136

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area	
ID_{lz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	0	0	0
2022	1,365	1,365	1,365
2023	2,824	2,824	4,189
2024	4,253	4,253	8,442
2025	5,651	5,651	14,093
2026	7,018	7,018	21,111
2027	8,357	8,357	29,468
2028	9,630	9,630	39,098
2029	10,876	10,876	49,973
2030	12,096	12,096	62,069
2031	13,291	13,291	75,360
2032	13,096	13,096	88,455
2033	12,782	12,782	101,237
2034	12,441	12,441	113,677
2035	12,108	12,108	125,786
2036	11,784	11,784	137,570
2037	11,469	11,469	149,038
2038	11,198	11,198	160,236
2039	10,934	10,934	171,170
2040	10,644	10,644	181,815
2041	10,362	10,362	192,177
2042	10,087	10,087	202,264
2043	9,818	9,818	212,082
2044	9,591	9,591	221,673
2045	9,369	9,369	231,042
2046	9,123	9,123	240,165
2047	8,883	8,883	249,047
2048	8,648	8,648	257,696
2049	8,420	8,420	266,115
2050	8,228	8,228	274,344
2051	8,041	8,041	282,385

Total net carbon stock change in the project area	
$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
annual	cumulative
tCO_2e	tCO_2e
110,772	110,772
119,706	230,478
118,485	348,963
117,290	466,253
116,120	582,373
114,976	697,349
110,830	808,179
109,828	918,007
108,848	1,026,855
107,887	1,134,742
104,351	1,239,093
102,018	1,341,111
97,071	1,438,182
95,041	1,533,223
93,053	1,626,276
91,107	1,717,383
89,272	1,806,656
87,438	1,894,093
83,074	1,977,167
81,387	2,058,555
79,735	2,138,289
78,116	2,216,405
76,595	2,293,000
75,069	2,368,069
71,213	2,439,283
69,812	2,509,094
68,438	2,577,533
67,092	2,644,625
65,832	2,710,457
64,564	2,775,022
63,300	2,838,322

Table 39. 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	
ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	195,171	195,171	195,171
2022	208,630	208,630	403,801
2023	204,160	204,160	607,961
2024	199,786	199,786	807,748
2025	195,506	195,506	1,003,254
2026	191,318	191,318	1,194,571
2027	181,890	181,890	1,376,461
2028	178,104	178,104	1,554,565
2029	174,397	174,397	1,728,962
2030	170,767	170,767	1,899,729
2031	167,212	167,212	2,066,941
2032	163,732	163,732	2,230,673
2033	155,415	155,415	2,386,088
2034	152,279	152,279	2,538,368
2035	149,207	149,207	2,687,574
2036	146,196	146,196	2,833,771
2037	143,246	143,246	2,977,017
2038	140,356	140,356	3,117,373
2039	133,005	133,005	3,250,378
2040	130,410	130,410	3,380,788
2041	127,865	127,865	3,508,653
2042	125,370	125,370	3,634,022
2043	122,923	122,923	3,756,945
2044	120,524	120,524	3,877,470
2045	114,014	114,014	3,991,484
2046	111,868	111,868	4,103,352
2047	109,762	109,762	4,213,114
2048	107,695	107,695	4,320,809
2049	105,667	105,667	4,426,476
2050	103,678	103,678	4,530,154
2051	101,689	101,689	4,631,843

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	
ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	4,684	4,684	4,684
2022	9,691	9,691	14,375
2023	14,591	14,591	28,966
2024	19,386	19,386	48,352
2025	24,078	24,078	72,430
2026	28,670	28,670	101,100
2027	33,035	33,035	134,135
2028	37,310	37,310	171,445
2029	41,495	41,495	212,940
2030	45,593	45,593	258,533
2031	44,922	44,922	303,456
2032	43,845	43,845	347,301
2033	42,675	42,675	389,976
2034	41,535	41,535	431,511
2035	40,424	40,424	471,934
2036	39,341	39,341	511,275
2037	38,413	38,413	549,689
2038	37,507	37,507	587,196
2039	36,514	36,514	623,710
2040	35,545	35,545	659,255
2041	34,601	34,601	693,856
2042	33,680	33,680	727,537
2043	32,901	32,901	760,437
2044	32,138	32,138	792,576
2045	31,294	31,294	823,870
2046	30,470	30,470	854,340
2047	29,666	29,666	884,006
2048	28,882	28,882	912,888
2049	28,226	28,226	941,115
2050	27,585	27,585	968,699
2051	26,957	26,957	995,656

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt	
ID_{lz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	0	0	0
2022	2,462	2,462	2,462
2023	5,094	5,094	7,557
2024	7,670	7,670	15,227
2025	10,191	10,191	25,418
2026	12,657	12,657	38,075
2027	15,071	15,071	53,146
2028	17,366	17,366	70,511
2029	19,613	19,613	90,124
2030	21,813	21,813	111,937
2031	23,967	23,967	135,904
2032	23,615	23,615	159,519
2033	23,048	23,048	182,567
2034	22,433	22,433	205,000
2035	21,834	21,834	226,834
2036	21,250	21,250	248,084
2037	20,680	20,680	268,764
2038	20,193	20,193	288,957
2039	19,717	19,717	308,674
2040	19,194	19,194	327,868
2041	18,685	18,685	346,554
2042	18,189	18,189	364,742
2043	17,705	17,705	382,447
2044	17,295	17,295	399,742
2045	16,894	16,894	416,637
2046	16,450	16,450	433,087
2047	16,017	16,017	449,104
2048	15,595	15,595	464,699
2049	15,183	15,183	479,882
2050	14,838	14,838	494,720
2051	14,501	14,501	509,220

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulative
tCO_2e	tCO_2e
199,855	199,855
215,859	415,714
213,657	629,371
211,502	840,873
209,394	1,050,267
207,330	1,257,597
199,854	1,457,451
198,048	1,655,498
196,279	1,851,778
194,547	2,046,325
188,168	2,234,493
183,962	2,418,455
175,042	2,593,497
171,381	2,764,878
167,797	2,932,675
164,287	3,096,962
160,979	3,257,941
157,671	3,415,612
149,802	3,565,414
146,761	3,712,175
143,781	3,855,955
140,861	3,996,817
138,119	4,134,935
135,368	4,270,303
128,414	4,398,717
125,887	4,524,604
123,411	4,648,015
120,983	4,768,998
118,711	4,887,709
116,425	5,004,134
114,145	5,118,279

Baseline non-CO_2 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 CO_2 emissions is counted in the estimation of carbon stock changes; therefore, CO_2 emissions from biomass burning were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) 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_2O 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_2O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N_2O (IPCC default value)[119]

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

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)

[119] According to the VCS Standard 4.3, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for N_2O = 298).

GWP_{CH4}	Global Warming Potential for CH_4 (IPCC default value) [120]

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

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 Fburnt analysis was carried out on the municipalities of the reference region, as it is where the Project Area is fully inserted in. Hot spots were considered during the period from historical reference period (prior to 2014, the data has no fire risk classification, and therefore, was not taken into account). For the assessed years, the fire risk predicted for the day of detection of the outbreak was considered, contemplating only outbreaks with a fire risk of >= 0.5 as, according to INPE's methodology, fire risk higher than 0.4 is considered as medium to critical (=1). By overlapping these fire outbreaks with the deforestation mapping of the same time period, it was possible to verify the tendency of fire outbreaks being directly related to areas with recent and/or consolidated deforestation. This can also be verified by the proximity of deforestation detection dates by satellite and the close or overlapping heat spots. Thus, it is possible to assume that these outbreaks are related to anthropic actions to open pastures/crops. Thereby, there was an overlap of 89.44% of the pixels analysed during the reference period where the project is located.

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 m^3/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

[120] According to the VCS Standard v4.3, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for CH_4 = 25).

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.

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

Initial Forest Class		Parameters								
IDcl	Name	$Fburnt_{icl}$	Cab	$Pburnt_{ab,icl}$	$CE_{ab,icl}$	ECO2-ab	EBBCO2-tot	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
		%	tCO2e/ha	%	%	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
1	Forest	89%	413.34	78%	50%	144.19	144.19	1.29	15.73	17.02

Table 41. 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
	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	EBBBSLPA
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2021	261.71	17.02	4,453.94	4,453.94
2022	279.91	17.02	4,763.64	9,217.58
2023	273.91	17.02	4,661.58	13,879.16
2024	268.04	17.02	4,561.71	18,440.87
2025	262.30	17.02	4,463.98	22,904.85
2026	256.68	17.02	4,368.34	27,273.19
2027	244.03	17.02	4,153.08	31,426.26
2028	238.95	17.02	4,066.63	35,492.89
2029	233.98	17.02	3,981.99	39,474.88
2030	229.11	17.02	3,899.10	43,373.99
2031	224.34	17.02	3,817.95	47,191.93
2032	219.67	17.02	3,738.48	50,930.41
2033	208.51	17.02	3,548.58	54,478.99
2034	204.30	17.02	3,476.98	57,955.98
2035	200.18	17.02	3,406.83	61,362.81
2036	196.14	17.02	3,338.09	64,700.89
2037	192.19	17.02	3,270.73	67,971.63
2038	188.31	17.02	3,204.74	71,176.37
2039	178.45	17.02	3,036.89	74,213.26
2040	174.96	17.02	2,977.63	77,190.90
2041	171.55	17.02	2,919.53	80,110.42
2042	168.20	17.02	2,862.55	82,972.97
2043	164.92	17.02	2,806.69	85,779.67
2044	161.70	17.02	2,751.92	88,531.59
2045	152.97	17.02	2,603.28	91,134.88
2046	150.09	17.02	2,554.27	93,689.15
2047	147.26	17.02	2,506.18	96,195.32
2048	144.49	17.02	2,458.99	98,654.32
2049	141.77	17.02	2,412.70	101,067.02
2050	139.10	17.02	2,367.27	103,434.29
2051	136.43	17.02	2,321.85	105,756.14

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 94.53%. This percentage was calculated based on the effectiveness of other VM0015 REDD projects located in Brazil in containing deforestation, comparing the project versus the baseline scenarios in verified monitoring reports.

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 42. 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_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	6,060.48	6,060.48	6,060.48	6,060.48
2022	0.00	0.00	0.00	0.00	6,549.25	12,609.73	6,549.25	12,609.73
2023	0.00	0.00	0.00	0.00	6,482.44	19,092.17	6,482.44	19,092.17
2024	0.00	0.00	0.00	0.00	6,417.06	25,509.24	6,417.06	25,509.24
2025	0.00	0.00	0.00	0.00	6,353.09	31,862.33	6,353.09	31,862.33
2026	0.00	0.00	0.00	0.00	6,290.48	38,152.80	6,290.48	38,152.80
2027	0.00	0.00	0.00	0.00	6,063.65	44,216.45	6,063.65	44,216.45
2028	0.00	0.00	0.00	0.00	6,008.85	50,225.30	6,008.85	50,225.30
2029	0.00	0.00	0.00	0.00	5,955.19	56,180.49	5,955.19	56,180.49
2030	0.00	0.00	0.00	0.00	5,902.64	62,083.13	5,902.64	62,083.13
2031	0.00	0.00	0.00	0.00	5,709.15	67,792.28	5,709.15	67,792.28
2032	0.00	0.00	0.00	0.00	5,581.52	73,373.80	5,581.52	73,373.80
2033	0.00	0.00	0.00	0.00	5,310.88	78,684.68	5,310.88	78,684.68
2034	0.00	0.00	0.00	0.00	5,199.80	83,884.48	5,199.80	83,884.48
2035	0.00	0.00	0.00	0.00	5,091.05	88,975.53	5,091.05	88,975.53
2036	0.00	0.00	0.00	0.00	4,984.57	93,960.10	4,984.57	93,960.10
2037	0.00	0.00	0.00	0.00	4,884.21	98,844.31	4,884.21	98,844.31
2038	0.00	0.00	0.00	0.00	4,783.82	103,628.13	4,783.82	103,628.13
2039	0.00	0.00	0.00	0.00	4,545.09	108,173.22	4,545.09	108,173.22
2040	0.00	0.00	0.00	0.00	4,452.80	112,626.02	4,452.80	112,626.02
2041	0.00	0.00	0.00	0.00	4,362.38	116,988.40	4,362.38	116,988.40
2042	0.00	0.00	0.00	0.00	4,273.81	121,262.21	4,273.81	121,262.21
2043	0.00	0.00	0.00	0.00	4,190.60	125,452.81	4,190.60	125,452.81
2044	0.00	0.00	0.00	0.00	4,107.14	129,559.95	4,107.14	129,559.95
2045	0.00	0.00	0.00	0.00	3,896.15	133,456.10	3,896.15	133,456.10
2046	0.00	0.00	0.00	0.00	3,819.50	137,275.60	3,819.50	137,275.60
2047	0.00	0.00	0.00	0.00	3,744.35	141,019.95	3,744.35	141,019.95
2048	0.00	0.00	0.00	0.00	3,670.69	144,690.64	3,670.69	144,690.64
2049	0.00	0.00	0.00	0.00	3,601.76	148,292.40	3,601.76	148,292.40
2050	0.00	0.00	0.00	0.00	3,532.40	151,824.80	3,532.40	151,824.80
2051	0.00	0.00	0.00	0.00	3,463.21	155,288.01	3,463.21	155,288.01

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_2e/ha
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
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 43. 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-CO_2 emissions from forest fires in the Project area	
	$EBBPSPA_t$ annual	EBBPSPA cumulative
	tCO_2e	tCO_2e
2021	243.68	243.68
2022	260.62	504.30
2023	255.04	759.35
2024	249.58	1,008.92
2025	244.23	1,253.15
2026	239.00	1,492.15
2027	227.22	1,719.37
2028	222.49	1,941.86
2029	217.86	2,159.72
2030	213.32	2,373.04
2031	208.88	2,581.93
2032	204.54	2,786.46
2033	194.15	2,980.61
2034	190.23	3,170.84

2035	186.39	3,357.23
2036	182.63	3,539.86
2037	178.95	3,718.81
2038	175.34	3,894.15
2039	166.15	4,060.30
2040	162.91	4,223.21
2041	159.73	4,382.94
2042	156.61	4,539.55
2043	153.56	4,693.11
2044	150.56	4,843.67
2045	142.43	4,986.10
2046	139.75	5,125.85
2047	137.12	5,262.96
2048	134.53	5,397.50
2049	132.00	5,529.50
2050	129.52	5,659.02
2051	127.03	5,786.05

Total *ex ante* estimations for the project area

The expected *ex ante* net carbon stock changes and non-CO_2 emissions in the Project area is summarized in the table below.

Table 44. 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-CO_2 emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	6,060.48	6,060.48	6,060.48	6,060.48	243.68	243.68
2022	0.00	0.00	0.00	0.00	6,549.25	12,609.73	6,549.25	12,609.73	260.62	504.30
2023	0.00	0.00	0.00	0.00	6,482.44	19,092.17	6,482.44	19,092.17	255.04	759.35
2024	0.00	0.00	0.00	0.00	6,417.06	25,509.24	6,417.06	25,509.24	249.58	1,008.92
2025	0.00	0.00	0.00	0.00	6,353.09	31,862.33	6,353.09	31,862.33	244.23	1,253.15
2026	0.00	0.00	0.00	0.00	6,290.48	38,152.80	6,290.48	38,152.80	239.00	1,492.15
2027	0.00	0.00	0.00	0.00	6,063.65	44,216.45	6,063.65	44,216.45	227.22	1,719.37
2028	0.00	0.00	0.00	0.00	6,008.85	50,225.30	6,008.85	50,225.30	222.49	1,941.86
2029	0.00	0.00	0.00	0.00	5,955.19	56,180.49	5,955.19	56,180.49	217.86	2,159.72
2030	0.00	0.00	0.00	0.00	5,902.64	62,083.13	5,902.64	62,083.13	213.32	2,373.04
2031	0.00	0.00	0.00	0.00	5,709.15	67,792.28	5,709.15	67,792.28	208.88	2,581.93
2032	0.00	0.00	0.00	0.00	5,581.52	73,373.80	5,581.52	73,373.80	204.54	2,786.46
2033	0.00	0.00	0.00	0.00	5,310.88	78,684.68	5,310.88	78,684.68	194.15	2,980.61
2034	0.00	0.00	0.00	0.00	5,199.80	83,884.48	5,199.80	83,884.48	190.23	3,170.84
2035	0.00	0.00	0.00	0.00	5,091.05	88,975.53	5,091.05	88,975.53	186.39	3,357.23
2036	0.00	0.00	0.00	0.00	4,984.57	93,960.10	4,984.57	93,960.10	182.63	3,539.86
2037	0.00	0.00	0.00	0.00	4,884.21	98,844.31	4,884.21	98,844.31	178.95	3,718.81
2038	0.00	0.00	0.00	0.00	4,783.82	103,628.13	4,783.82	103,628.13	175.34	3,894.15
2039	0.00	0.00	0.00	0.00	4,545.09	108,173.22	4,545.09	108,173.22	166.15	4,060.30
2040	0.00	0.00	0.00	0.00	4,452.80	112,626.02	4,452.80	112,626.02	162.91	4,223.21
2041	0.00	0.00	0.00	0.00	4,362.38	116,988.40	4,362.38	116,988.40	159.73	4,382.94
2042	0.00	0.00	0.00	0.00	4,273.81	121,262.21	4,273.81	121,262.21	156.61	4,539.55
2043	0.00	0.00	0.00	0.00	4,190.60	125,452.81	4,190.60	125,452.81	153.56	4,693.11
2044	0.00	0.00	0.00	0.00	4,107.14	129,559.95	4,107.14	129,559.95	150.56	4,843.67
2045	0.00	0.00	0.00	0.00	3,896.15	133,456.10	3,896.15	133,456.10	142.43	4,986.10
2046	0.00	0.00	0.00	0.00	3,819.50	137,275.60	3,819.50	137,275.60	139.75	5,125.85
2047	0.00	0.00	0.00	0.00	3,744.35	141,019.95	3,744.35	141,019.95	137.12	5,262.96
2048	0.00	0.00	0.00	0.00	3,670.69	144,690.64	3,670.69	144,690.64	134.53	5,397.50
2049	0.00	0.00	0.00	0.00	3,601.76	148,292.40	3,601.76	148,292.40	132.00	5,529.50
2050	0.00	0.00	0.00	0.00	3,532.40	151,824.80	3,532.40	151,824.80	129.52	5,659.02
2051	0.00	0.00	0.00	0.00	3,463.21	155,288.01	3,463.21	155,288.01	127.03	5,786.05

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.

According to the planned interventions proposed by present project activity, 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. 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

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

Project year	Total carbon stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual	cumulatve	annual	cumulatve	annual	cumulatve
	$\Delta CBSLLK_t$	$\Delta CBSLLK$	$\Delta CPSLK_t$	$\Delta CPSLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	0.00	0.00
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

No livestock agriculture increase resulting from activities developed by the 1st Instance is predicted to occur in the project scenario compared to the baseline case. However, in case any

future instance includes any activity that might result in such increase, in order to estimate the increase in emissions of methane and nitrous oxide from grazing animals in leakage management areas, the GHG emissions are estimated as follows, according to Appendix 4 of the applied Methodology and default values from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 – AFOLU, Chapter 10[121]:

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

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

The leakage prevention measures proposed by the 1st instance project activity does not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas.

[121] Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf

Table 46. Ex ante estimation of leakage emissions above the baseline from 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
2021	0.00	0.00	0.00	0.00	0.00	0.00
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

***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. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted ex-ante would indicate displacement of deforestation activities due to the project.

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.

$$\Delta CADLK_t = \Delta CBSLPA_t * DLF$$

Where,

$\Delta CADLK_t$	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.

To reduce the risk of activity displacement leakage, baseline deforestation agents mapped may participate in activities within the project area and leakage management area, so that deforestation will be reduced, and the risk of displacement minimized. This is monitored by social reports, which analyzes education and training programs, alternative income sources and the extent of social activities to local communities.

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[122] used to estimate the decrease in carbon stocks, as follows.

$$EADLKt_t = EBBBSPA_t * DLF$$

[122] If deforestation agents do not participate in leakage prevention activities and project activities, the Displacement Factor shall be 100%. 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.

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

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

Table 47. 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_2e	tCO_2e	tCO_2e	tCO_2e
2021	16,615.82	16,615.82	668.09	668.09
2022	17,955.88	34,571.70	714.55	1,382.64
2023	17,772.71	52,344.41	699.24	2,081.87
2024	17,593.46	69,937.88	684.26	2,766.13
2025	17,418.06	87,355.93	669.60	3,435.73
2026	17,246.41	104,602.34	655.25	4,090.98
2027	16,624.51	121,226.85	622.96	4,713.94
2028	16,474.27	137,701.12	609.99	5,323.93
2029	16,327.15	154,028.27	597.30	5,921.23
2030	16,183.09	170,211.36	584.87	6,506.10
2031	15,652.60	185,863.96	572.69	7,078.79
2032	15,302.68	201,166.64	560.77	7,639.56
2033	14,560.67	215,727.31	532.29	8,171.85
2034	14,256.13	229,983.44	521.55	8,693.40
2035	13,957.97	243,941.41	511.02	9,204.42
2036	13,666.05	257,607.45	500.71	9,705.13
2037	13,390.87	270,998.33	490.61	10,195.74
2038	13,115.64	284,113.97	480.71	10,676.46
2039	12,461.13	296,575.10	455.53	11,131.99
2040	12,208.10	308,783.20	446.64	11,578.63
2041	11,960.21	320,743.41	437.93	12,016.56
2042	11,717.36	332,460.76	429.38	12,445.95

2043	11,489.24	343,950.01	421.00	12,866.95
2044	11,260.41	355,210.42	412.79	13,279.74
2045	10,681.96	365,892.38	390.49	13,670.23
2046	10,471.80	376,364.17	383.14	14,053.37
2047	10,265.77	386,629.95	375.93	14,429.30
2048	10,063.81	396,693.75	368.85	14,798.15
2049	9,874.84	406,568.59	361.90	15,160.05
2050	9,684.67	416,253.26	355.09	15,515.14
2051	9,494.98	425,748.24	348.28	15,863.42

Ex ante estimation of total leakage

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

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

Where,

ΔCLKt	Total decrease in carbon stocks within the leakage belt at year t; tCO_2e
ΔCADLKt	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
ΔCLPMLKt	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 (ΔCLPMLKt) 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 fertilizer or fuel use.

Table 48. 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
2021	0.00	0.00	668.09	668.09	16,615.82	16,615.82	0.00	0.00	16,615.82	16,615.82	668.09	668.09
2022	0.00	0.00	714.55	1,382.64	17,955.88	34,571.70	0.00	0.00	17,955.88	34,571.70	714.55	1,382.64
2023	0.00	0.00	699.24	2,081.87	17,772.71	52,344.41	0.00	0.00	17,772.71	52,344.41	699.24	2,081.87
2024	0.00	0.00	684.26	2,766.13	17,593.46	69,937.88	0.00	0.00	17,593.46	69,937.88	684.26	2,766.13
2025	0.00	0.00	669.60	3,435.73	17,418.06	87,355.93	0.00	0.00	17,418.06	87,355.93	669.60	3,435.73
2026	0.00	0.00	655.25	4,090.98	17,246.41	104,602.34	0.00	0.00	17,246.41	104,602.34	655.25	4,090.98
2027	0.00	0.00	622.96	4,713.94	16,624.51	121,226.85	0.00	0.00	16,624.51	121,226.85	622.96	4,713.94
2028	0.00	0.00	609.99	5,323.93	16,474.27	137,701.12	0.00	0.00	16,474.27	137,701.12	609.99	5,323.93
2029	0.00	0.00	597.30	5,921.23	16,327.15	154,028.27	0.00	0.00	16,327.15	154,028.27	597.30	5,921.23
2030	0.00	0.00	584.87	6,506.10	16,183.09	170,211.36	0.00	0.00	16,183.09	170,211.36	584.87	6,506.10
2031	0.00	0.00	572.69	7,078.79	15,652.60	185,863.96	0.00	0.00	15,652.60	185,863.96	572.69	7,078.79
2032	0.00	0.00	560.77	7,639.56	15,302.68	201,166.64	0.00	0.00	15,302.68	201,166.64	560.77	7,639.56
2033	0.00	0.00	532.29	8,171.85	14,560.67	215,727.31	0.00	0.00	14,560.67	215,727.31	532.29	8,171.85
2034	0.00	0.00	521.55	8,693.40	14,256.13	229,983.44	0.00	0.00	14,256.13	229,983.44	521.55	8,693.40
2035	0.00	0.00	511.02	9,204.42	13,957.97	243,941.41	0.00	0.00	13,957.97	243,941.41	511.02	9,204.42
2036	0.00	0.00	500.71	9,705.13	13,666.05	257,607.45	0.00	0.00	13,666.05	257,607.45	500.71	9,705.13
2037	0.00	0.00	490.61	10,195.74	13,390.87	270,998.33	0.00	0.00	13,390.87	270,998.33	490.61	10,195.74
2038	0.00	0.00	480.71	10,676.46	13,115.64	284,113.97	0.00	0.00	13,115.64	284,113.97	480.71	10,676.46
2039	0.00	0.00	455.53	11,131.99	12,461.13	296,575.10	0.00	0.00	12,461.13	296,575.10	455.53	11,131.99
2040	0.00	0.00	446.64	11,578.63	12,208.10	308,783.20	0.00	0.00	12,208.10	308,783.20	446.64	11,578.63
2041	0.00	0.00	437.93	12,016.56	11,960.21	320,743.41	0.00	0.00	11,960.21	320,743.41	437.93	12,016.56
2042	0.00	0.00	429.38	12,445.95	11,717.36	332,460.76	0.00	0.00	11,717.36	332,460.76	429.38	12,445.95
2043	0.00	0.00	421.00	12,866.95	11,489.24	343,950.01	0.00	0.00	11,489.24	343,950.01	421.00	12,866.95
2044	0.00	0.00	412.79	13,279.74	11,260.41	355,210.42	0.00	0.00	11,260.41	355,210.42	412.79	13,279.74
2045	0.00	0.00	390.49	13,670.23	10,681.96	365,892.38	0.00	0.00	10,681.96	365,892.38	390.49	13,670.23
2046	0.00	0.00	383.14	14,053.37	10,471.80	376,364.17	0.00	0.00	10,471.80	376,364.17	383.14	14,053.37
2047	0.00	0.00	375.93	14,429.30	10,265.77	386,629.95	0.00	0.00	10,265.77	386,629.95	375.93	14,429.30
2048	0.00	0.00	368.85	14,798.15	10,063.81	396,693.75	0.00	0.00	10,063.81	396,693.75	368.85	14,798.15
2049	0.00	0.00	361.90	15,160.05	9,874.84	406,568.59	0.00	0.00	9,874.84	406,568.59	361.90	15,160.05
2050	0.00	0.00	355.09	15,515.14	9,684.67	416,253.26	0.00	0.00	9,684.67	416,253.26	355.09	15,515.14
2051	0.00	0.00	348.28	15,863.42	9,494.98	425,748.24	0.00	0.00	9,494.98	425,748.24	348.28	15,863.42

4.4 Net GHG Emission Reductions and Removals

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

$$\Delta REDD_t = (\Delta CBSLPA_t + EBBBSLPA_t) - (\Delta CPSPA_t + EBBPSPA_t) - (\Delta CLK_t + ELK_t)$$

Where:

$\Delta REDD_t$	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO_2e
$\Delta CBSLPA_t$	Sum of baseline carbon stock changes in the project area at year t; tCO_2e
$EBBBSLPA_t$	Sum of baseline emissions from biomass burning in the project area at year t; tCO_2e
$\Delta CPSPA_t$	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO_2e Note: If $\Delta CPSPA_t$ represents a net increase in carbon stocks, a negative sign before the absolute value of $\Delta CPSPA_t$ shall be used. If $\Delta CPSPA_t$ represents a net decrease, the positive sign shall be used.
$EBBPSPA_t$	Sum of (ex ante estimated) actual emissions from biomass burning in the project area at year t; tCO_2e
ΔCLK_t	Sum of ex ante estimated leakage net carbon stock changes at year t; tCO_2e Note: If the cumulative sum of ΔCLK_t within a fixed baseline period is > 0, ΔCLK_t shall be set to zero.
ELK_t	Sum of ex ante estimated leakage emissions at year t; tCO_2e
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:

$$VCU_t = \Delta REDD_t - VBC_t$$

$$VBC_t = (\Delta CBSLPA_t - \Delta CPSPA_t) * RF_t$$

Where:

VCU_t	Number of Verified Carbon Units that can be traded at time t; t CO_2e
$\Delta REDD_t$	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO_2e

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 was 15%.

The specific summary of GHG reductions and removals by this project activity 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).

The present REDD project is expected to avoid a predicted 6,214.13 ha of deforestation, equating to 2,309,793 tCO2e in emissions reductions over the 30-year project lifetime (01-February-2021 to 31-January-2051), with an annual average of 76,993 tCO2e.

Table 49. Ex ante estimated net anthropogenic GHG emission reductions ($\Delta REDD_t$) and Verified Carbon Units (VCU_t)

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
2021	110,772	110,772	4,454	4,454	6,060	6,060	244	244	16,616	16,616	668	668	91,638	91,638	75,931	75,931	15,707	15,707
2022	119,706	230,478	4,764	9,218	6,549	12,610	261	504	17,956	34,572	715	1,383	98,989	190,627	82,015	157,946	16,973	32,680
2023	118,485	348,963	4,662	13,879	6,482	19,092	255	759	17,773	52,344	699	2,082	97,937	288,564	81,136	239,082	16,800	49,481
2024	117,290	466,253	4,562	18,441	6,417	25,509	250	1,009	17,593	69,938	684	2,766	96,907	385,471	80,276	319,358	16,631	66,111
2025	116,120	582,373	4,464	22,905	6,353	31,862	244	1,253	17,418	87,356	670	3,436	95,899	481,371	79,434	398,792	16,465	82,577
2026	114,976	697,349	4,368	27,273	6,290	38,153	239	1,492	17,246	104,602	655	4,091	94,913	576,284	78,610	477,402	16,303	98,879
2027	110,830	808,179	4,153	31,426	6,064	44,216	227	1,719	16,625	121,227	623	4,714	91,445	667,729	75,729	553,131	15,715	114,594
2028	109,828	918,007	4,067	35,493	6,009	50,225	222	1,942	16,474	137,701	610	5,324	90,579	758,308	75,006	628,137	15,573	130,167
2029	108,848	1,026,855	3,982	39,475	5,955	56,180	218	2,160	16,327	154,028	597	5,921	89,732	848,040	74,298	702,435	15,434	145,601
2030	107,887	1,134,742	3,899	43,374	5,903	62,083	213	2,373	16,183	170,211	585	6,506	88,902	936,943	73,604	776,039	15,298	160,899
2031	104,351	1,239,093	3,818	47,192	5,709	67,792	209	2,582	15,653	185,864	573	7,079	86,025	1,022,968	71,229	847,268	14,796	175,695
2032	102,018	1,341,111	3,738	50,930	5,582	73,374	205	2,786	15,303	201,167	561	7,640	84,107	1,107,075	69,641	916,909	14,465	190,161
2033	97,071	1,438,182	3,549	54,479	5,311	78,685	194	2,981	14,561	215,727	532	8,172	80,022	1,187,097	66,257	983,166	13,764	203,925
2034	95,041	1,533,223	3,477	57,956	5,200	83,884	190	3,171	14,256	229,983	522	8,693	78,350	1,265,447	64,873	1,048,039	13,476	217,401
2035	93,053	1,626,276	3,407	61,363	5,091	88,976	186	3,357	13,958	243,941	511	9,204	76,714	1,342,160	63,519	1,111,558	13,194	230,595
2036	91,107	1,717,383	3,338	64,701	4,985	93,960	183	3,540	13,666	257,607	501	9,705	75,111	1,417,271	62,192	1,173,750	12,918	243,513
2037	89,272	1,806,656	3,271	67,972	4,884	98,844	179	3,719	13,391	270,998	491	10,196	73,599	1,490,870	60,940	1,234,690	12,658	256,172
2038	87,438	1,894,093	3,205	71,176	4,784	103,628	175	3,894	13,116	284,114	481	10,676	72,087	1,562,957	59,688	1,294,378	12,398	268,570
2039	83,074	1,977,167	3,037	74,213	4,545	108,173	166	4,060	12,461	296,575	456	11,132	68,483	1,631,440	56,703	1,351,081	11,779	280,349
2040	81,387	2,058,555	2,978	77,191	4,453	112,626	163	4,223	12,208	308,783	447	11,579	67,095	1,698,534	55,554	1,406,635	11,540	291,889
2041	79,735	2,138,289	2,920	80,110	4,362	116,988	160	4,383	11,960	320,743	438	12,017	65,734	1,764,268	54,428	1,461,063	11,306	303,195
2042	78,116	2,216,405	2,863	82,973	4,274	121,262	157	4,540	11,717	332,461	429	12,446	64,401	1,828,670	53,324	1,514,387	11,076	314,271
2043	76,595	2,293,000	2,807	85,780	4,191	125,453	154	4,693	11,489	343,950	421	12,867	63,147	1,891,817	52,286	1,566,673	10,861	325,132
2044	75,069	2,368,069	2,752	88,532	4,107	129,560	151	4,844	11,260	355,210	413	13,280	61,890	1,953,707	51,246	1,617,919	10,644	335,776
2045	71,213	2,439,283	2,603	91,135	3,896	133,456	142	4,986	10,682	365,892	390	13,670	58,705	2,012,413	48,607	1,666,526	10,098	345,874
2046	69,812	2,509,094	2,554	93,689	3,819	137,276	140	5,126	10,472	376,364	383	14,053	57,552	2,069,965	47,653	1,714,179	9,899	355,773
2047	68,438	2,577,533	2,506	96,195	3,744	141,020	137	5,263	10,266	386,630	376	14,429	56,421	2,126,386	46,717	1,760,896	9,704	365,477
2048	67,092	2,644,625	2,459	98,654	3,671	144,691	135	5,397	10,064	396,694	369	14,798	55,313	2,181,699	45,799	1,806,695	9,513	374,990
2049	65,832	2,710,457	2,413	101,067	3,602	148,292	132	5,529	9,875	406,569	362	15,160	54,274	2,235,974	44,939	1,851,634	9,335	384,325
2050	64,564	2,775,022	2,367	103,434	3,532	151,825	130	5,659	9,685	416,253	355	15,515	53,230	2,289,204	44,075	1,895,709	9,155	393,480
2051	24,973	2,799,995	916	104,350	1,366	153,191	50	5,709	3,746	419,999	137	15,653	20,589	2,309,793	17,048	1,912,757	3,541	397,021

Table 50. Summary of net GHG Emission Reduction and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	*Ex ante* buffer credits (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2021	115,226	6,304	17,284	15,707	75,931
2022	124,470	6,810	18,670	16,973	82,015
2023	123,146	6,737	18,472	16,800	81,136
2024	121,851	6,667	18,278	16,631	80,276
2025	120,584	6,597	18,088	16,465	79,434
2026	119,344	6,529	17,902	16,303	78,610
2027	114,983	6,291	17,247	15,715	75,729
2028	113,895	6,231	17,084	15,573	75,006
2029	112,830	6,173	16,924	15,434	74,298
2030	111,786	6,116	16,768	15,298	73,604
2031	108,169	5,918	16,225	14,796	71,229
2032	105,756	5,786	15,863	14,465	69,641
2033	100,620	5,505	15,093	13,764	66,257
2034	98,518	5,390	14,778	13,476	64,873
2035	96,460	5,277	14,469	13,194	63,519
2036	94,445	5,167	14,167	12,918	62,192
2037	92,543	5,063	13,881	12,658	60,940
2038	90,642	4,959	13,596	12,398	59,688
2039	86,111	4,711	12,917	11,779	56,703
2040	84,365	4,616	12,655	11,540	55,554
2041	82,654	4,522	12,398	11,306	54,428
2042	80,978	4,430	12,147	11,076	53,324
2043	79,402	4,344	11,910	10,861	52,286
2044	77,821	4,258	11,673	10,644	51,246
2045	73,816	4,039	11,072	10,098	48,607
2046	72,366	3,959	10,855	9,899	47,653
2047	70,945	3,881	10,642	9,704	46,717
2048	69,551	3,805	10,433	9,513	45,799
2049	68,245	3,734	10,237	9,335	44,939
2050	66,932	3,662	10,040	9,155	44,075
2051	25,889	1,416	3,883	3,541	17,048
Total	**2,904,345**	**158,900**	**435,652**	**397,021**	**1,912,757**

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	15%
Justification of choice of data or description of	According to VCS requirements, where the applied methodology requires the quantification of activity-shifting leakage, projects may apply the optional default activity-shifting leakage deduction

measurement methods and procedures applied	of 15 percent to the gross GHG emission reductions and/or removals.
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	3,411.49 (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:* - Heat spots: Data from the municipalities within the reference region during the historical reference period. <https://queimadas.dgi.inpe.br/queimadas/bdqueimadas> - Deforestation: - <http://terrabrasilis.dpi.inpe.br/downloads/>
Value applied	89.94
Justification of choice of data or description of measurement methods and procedures applied	The Fburnt analysis was carried out on the municipalities of the reference region, as it is where the Project Area is fully inserted in. Heat spots were considered during the historical reference period (prior to 2014, the data has no fire risk classification, and therefore, was not taken into account). For the assessed years, the fire risk predicted for the day of detection of the outbreak was considered, contemplating only outbreaks with a fire risk of >= 0.5 as, according to INPE's methodology, fire risk higher than 0.4 is considered as medium to critical (=1). By overlapping these fire outbreaks with the deforestation mapping of the same time period, it was possible to verify the tendency of fire outbreaks being directly related to areas with recent and/or consolidated deforestation. This can also be verified by the proximity of deforestation detection dates by satellite and the close or overlapping heat spots. Thus, it is possible to assume that these outbreaks are related to anthropic actions to open pastures/crops. Thereby, there was an overlap of 89.94% of the pixels analysed during the reference period in the municipalities.
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>. Last visited on August 2022.
Value applied	78.00
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 m^3/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 REDD projects verified in Brazil up to date. Available in VERRA database.
Value applied	94.53%
Justification of choice of data or description of measurement methods and procedures applied	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.
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 studies: HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015.

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) **Vegetation** | **Reference Region** | **Project Area** | **Leakage Belt** Forest | 225.46 | 225.46 | 225.46
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) **Vegetation** | **Reference Region** | **Project Area** | **Leakage Belt** Forest | 54.11 | 54.11 | 54.11
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	$ACPA_t$
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, the following sources will also be monitored: - INMET[123] - INPE[124]

[123] INMET. Instituto Nacional de Meteorologia. Available at: <https://portal.inmet.gov.br/>.
[124] INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://www.inpe.br/>.

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
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	361.48 (annual average deforestation projected 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 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	200.456 (annual average projected deforestation in 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 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	2,621.2 (annual average projected deforestation within the reference region 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 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	13,733.8 (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	$\Delta CPSLK_t$
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	5,009.29 (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	511.72 (annual average)
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	186.65 (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	17.02
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
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 – Mamuriá 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 any additional Standards 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)[125] 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.

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.

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 present 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.

- **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

[125] Available at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>

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), MapBiomas data, and 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. 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 project area. Related parameters shall be monitored and reassessed at every verification and revalidation point.

- 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.

- 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 landowner shall notify Future Carbon so that it can include the related impacts in the carbon project reports, updating the related parameters, including the non-permanence risk 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 51. 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.

APPENDIX I – METHODOLOGICAL PROCEDURES FOR LU/LC CHANGE ANALYSIS

According to the applied methodology, in order to achieve a consistent time-series of LU/LC-change data over the crediting period, the detailed methodological procedures used in pre-processing, classification, post classification processing, and accuracy assessment of the remotely sensed data shall be carefully documented in the VCS PD. Therefore, the information below describes the methodological procedures applied during the current monitored period.

Data sources and pre-processing

The historic deforestation of the reference region should be analyzed through maps from MapBiomas (version 5.0, which was the last available version), available in raster format, which can be downloaded from the *http://mapbiomas.org/* website. MapBiomas is a multi-institutional initiative of the Greenhouse Gas Emissions Estimation System (SEEG - http://seeg.eco.br/en/) promoted by the Climate Observatory. MapBiomas co-creation involves NGO's, universities and technology companies.

Table 52. Source of the remotely sense data used for historical reference period

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	DD/MM/YY	Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	223	67
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	224	67

The forest dynamics data, the deforestation vectors and other base data from the studied region, which were used for the project's baseline construction, should be organized in a spatialized database. For this purpose, the software used in this baseline reassessment was the File Geodatabase format from ArcGIS 10.6. The files are stored in vector and matrix format (raster). In order to standardize spatial references, all data has been projected for the UTM and Datum WGS84, Zone 22S projection.

The MapBiomas methodology for land use classification uses 105 input variables, including the original Landsat bands, indexes, fractional and textural information derived from these bands, which are detailed in the Figure below:

Figure 21. List, description and reference of bands, fractions and indexes available in the feature space

			Reducer						
	band or index name	formula	median	median_dry	median_wet	amplitude	std Dev	min	Reference
bands	blue	B1 (L5 e L7); B2 (L8)	■	■	■		■	■	■
	green	B2 (L5 e L7); B3 (L8)	■	■	■		■	■	■
	red	B3 (L5 e L7); B4 (L8)	■	■	■		■	■	■
	nir	B4 (L5 e L7); B5 (L8)	■	■	■		■	■	■
	swir1	B5 (L5 e L7); B6 (L8)	■	■	■		■	■	■
	swir2	B7 (L5); B8 (L7); B7 (L8)	■	■	■		■	■	■
	temp	B6 (L5 e L7); B10 (L8)	■				■	■	■
index	ndvi	(nir - red)/(nir + red)	■	■	■	■	■		
	evi2	(2.5 * (nir - red)/(nir + 2.4 * red + 1)	■	■	■	■	■		
	cai	(swir2 / swir1)	■	■	■		■		
	ndwi	(nir - swir1)/(nir +	■	■	■	■	■		
		swir1)	■	■	■	■	■		
	gcvi	(nir / green - 1)	■	■	■		■		
	hall_cover	(-red*0.017 - nir*0.007 - swir2*0.079 + 5.22)	■				■		
	pri	(blue - green)/(blue + green)	■	■	■		■		
	savi	(1 + L) * (nir - red)/(nir + red + 0,5)	■	■	■		■		
	textG	('median_green') .entropy(ee.Kernel .square({radius: 5}))	■						
fraction	gv	fractional abundance of green vegetation within the pixel	■			■	■		
	npv	fractional abundance of non-photosynthetic vegetation within the pixel	■			■	■		
	soil	fractional abundance of soil within the pixel	■				■		
	cloud	fractional abundance of cloud within the pixel	■			■	■		
	shade	100 - (gv + npv + soil + cloud)	■				■		
MEM index	gvs	gv / (gv + npv + soil + cloud)	■	■	■		■		
	ndfi	(gvs - (npv + soil))/(gvs + (npv + soil))	■	■	■	■	■		
	sefi	(gv+npv_s - soil)/(gv+npv_s + soil)	■	■	■	■	■		
	wefi	((gv+npv) - (soil+shade)) /((gv+npv) + (soil+shade))	■	■	■	■	■		
	fns	((gv+shade) - soil) / ((gv+shade) + soil)	■	■	■		■		
slope		ALOS DSM: Global 30m	■						

Where,

Median - Median of the pixel values of the best mapping period defined by each biome.

Median_dry = median of the quartile of the lowest pixel NDVI values.

Median_wet = median of the quartile of the highest pixel NDVI values.

Amplitude = amplitude of variation of the index considering all the images of each year.

stdDev = standard deviation of all pixel values of all images of each year.

Min = lower annual value of the pixels of each band.

In addition, Landsat Images used in MapBiomas were accessible via Google Earth Engine, and most of them are composed by the Collection 1 Tier 1 from USGS. This is the highest quality Level-1 products suitable for pixel-level time series analysis. These images are radiometrically calibrated and orthorectified using ground control points (GCPs) and digital elevation model (DEM) data to correct for relief displacement.

Data classification and post-processing

The LU/LC classes defined for this project activity were: Forest, Non-Forest and Hydrography. In addition, the established LU/LC-change categories were:

a) Forested areas that remains as forested areas (Conservation);

b) Forest that are converted to non-forested areas (Deforestation); or

c) Non-forested areas that remains as non-forested areas.

The image classification methodology for each year involves all Landsat images available for each period (Landsat 5 [L5], Landsat 7 [L7] and Landsat 8 [L8]) or other sensor available) with a cloud cover less than or equal to 50%, and in accordance with its 30m resolution, the minimum mapping unit was defined at 30x30m (0.09ha), therefore falling easily to the methodology requirement that the MMU cannot be larger than 1ha. Thus, a representative mosaic of each year could be generated, selecting cloud free pixels from the available images. Metrics should be extracted for each pixel that describes its behavior during the year and could contain up to 105 layers of information. The mapping should be done with an artificial intelligence classifier, such as the Randon Forest. The Landsat images acquisition could be made through Google Earth Engine, with data from NASA and USGS (U.S. Geological Survey).

The algorithm may use samples obtained by reference maps, stable collections from previous MapBiomas series and/or direct collection by visual interpretation of Landsat images in order to classify a single map per class. This classification should then go through spatial filter, applying neighborhood rules and temporal filters to reduce spatial and temporal inconsistencies. The software used in this baseline reassessment was the ArcGIS 10.6. In addition, high resolution images from Google Earth software (https://earth.google.com/) were also utilized to perform some LU/LC-change analysis.

Due to the pixel-based classification method and the long temporal series, the MapBiomas applies a chain of post-classification filters. The first post-classification action involves the application of temporal filters. Then, a spatial filter was applied followed by a gap fill filter. The application of these filters removes classification noises. These post-classification procedures were implemented in the Google Earth Engine platform and are described below:

Gap Fill

The Gap fill is a temporal filter used to fill possible no-data values. In a long time series of severely cloud-affected regions, it is expected that no-data values may populate some of the resultant median composite pixels. In this filter, no-data values ("gaps") are theoretically not allowed and are replaced by the temporally nearest valid classification

Spatial Filter

Spatial filter was applied to avoid unwanted modifications to the edges of the pixel groups (blobs), a spatial filter was built based on the "connectedPixelCount" function. This function locates connected components (neighbours) that share the same pixel value.

Temporal Filter

The temporal filter uses sequential classifications in a three-to-five-years unidirectional moving window to identify temporally non-permitted transitions. Based on generic rules (GR), the temporal filter inspects the central positions of three to five consecutive years, and if the extremities of the consecutive years are identical but the centre position is not, then the central pixels are reclassified to match its temporal neighbor class.

Frequency Filter

This filter takes into consideration the occurrence frequency throughout the entire time series. Thus, all class occurrence with less than given percentage of temporal persistence (eg. 3 years or fewer out of 33) are filtered out. This mechanism decreasing the number of false positives and preserving consolidated trajectories.

Incident Filter

An incident filter was applied to remove pixels that changed too many times during the analyzed period. All pixels that changed more than eight times and are connected to less than 6 pixels were replaced by the MODE value of that given pixel position in the stack of years.

Classification accuracy assessment

The MapBiomas results go through an accuracy evaluation, which remains 95% for the entire Amazon Biome. However, to meet the particularities of the project's region, an independent evaluation was carried out for the reference region.

Thus, in order to assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated calculating the percentages of user and producer correctness, as well as omission and commission errors.

A total of 300 random points was drawn on the reference region (100 points for each land use class – Forest, Non-Forest and Hydrography) and the degree of correctness of the classification

was verified. High resolution images from Google Earth should also be used as reference, in which land use was visually possible at the drawn points.

The table below shows the final accuracy analysis carried out for each year and each land use class during the analyzed monitoring period.

Table 53. Summary of confusion matrices from the evaluation of MapBiomas

	Producer Accuracy				User Accuracy			
Year	Forest	Hydrography	Pioneer Formation	Deforestation	Forest	Hydrography	Pioneer Formation	Deforestation
2011	94.81%	94.81%	80.23%	88.75%	91.25%	91.25%	86.25%	88.75%
2012	94.94%	93.75%	82.50%	91.36%	93.75%	93.75%	82.50%	92.50%
2013	92.94%	97.30%	79.31%	91.89%	98.75%	90.00%	86.25%	85.00%
2014	94.81%	95.00%	79.52%	91.25%	91.25%	95.00%	82.50%	91.25%
2015	96.20%	100.00%	79.55%	87.65%	95.00%	90.00%	87.50%	88.75%
2016	97.47%	100.00%	80.00%	86.25%	96.25%	95.00%	85.00%	86.25%
2017	97.40%	100.00%	87.80%	90.36%	93.75%	97.50%	90.00%	93.75%
2018	93.98%	97.40%	88.31%	90.36%	97.50%	93.75%	85.00%	93.75%
2019	86.52%	94.74%	81.48%	94.59%	96.25%	90.00%	82.50%	87.50%
2020	97.26%	90.24%	79.76%	90.12%	88.75%	92.50%	83.75%	91.25%
2021	96.20%	100.00%	98.44%	94.12%	95.00%	95.00%	96.75%	100.00%