XINGU-ARAGUAIA GROUPED REDD+ PROJECT

Document Prepared by Future Forest

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1 PROJECT DETAILS

1.1 Summary Description of the Project

In Brazil, 58.39% of its entire 851,034,553.8 ha territory[1] is covered by forests, representing almost 497 million hectares of forest area[2] and putting it in second place for nations with most forest area worldwide. Brazil has also been at times the country with the highest levels of deforestation in the world, having lost almost 15 million hectares of its forest area from 2010 to 2020[3]. The expansion of the agriculture frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The State of Mato Grosso is one of the main grain and meat producers in Brazil. Currently, the State is the 5th largest exporter, mainly with soy, cotton and beef[4]. Simultaneously, Mato Grosso also registers high deforestation rates, reaching in 2018 the highest in 10 years[5].

The primary objective of the Xingu-Araguaia Grouped REDD+ Project is to avoid the unplanned deforestation (AUD) in a 9,008.82-ha project area, consisting of 100% Amazon rainforest. The project area is in São José do Xingu and São Félix do Araguaia, in the State of Mato Grosso, Southern Amazon.

The project reduces the emission of greenhouse gases through activities that avoid deforestation and degradation of the forest area and, consequently, keep the forest standing and conserve carbon stocks. To achieve this objective, monitoring and surveillance actions are fundamental to ensure the forest will stand and for that, the project will implement actions such as frequent patrols, satellite images that help to identify actions such as encroachment attempts and fire outbreaks on the project area and surroundings.

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

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

The present REDD project is expected to avoid a predicted 4,183.34 ha of deforestation, equating to 1,984.673 tCO_2e in emissions reductions over the 30-year project lifetime (15-October-2020 to 14-October-2050), with an annual average of 66.15 tCO_2e.

1.2 Sectoral Scope and Project Type

Sectoral Scope: 14 - Agriculture, Forestry, Land Use

Project Category: Reduced Emissions from Deforestation and Degradation (REDD) through Avoided Unplanned Deforestation (AUD project activity).

This is a grouped project.

1.3 Project Eligibility

According to the VCS Methodology Requirements v4.2[6], 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 version 4.3[7], sections 3.2 and Appendix A1.5 – A1.8:

Table 1. Eligibility conditions

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1	The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in 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, noting the exception set out in Section 3.13.1	The applied methodology is VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1. Applicability conditions are detailed in section 3.2.

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

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	The project activity involves the conservation of native 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.

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline (i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project).	Not applicable. Project applies the VM0015 Methodology, in addition to the VT0001 for additionality assessment.
Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence	The project applies 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.

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

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
Where an implementation partner is acting in partnership with the project proponent, the implementation partner shall be identified in the project description. The implementation partner shall identify its roles and responsibilities with respect to the project, including but not limited to, implementation, management and monitoring of the project, over the project crediting period	Any implementation partners are described on the Project Description, in sections 1.5 and 1.6.
Activities that convert native ecosystems to generate GHG credits are not eligible under the VCS Program. Evidence shall be provided in the project description that any ARR, ALM, WRC or ACoGS project areas were not cleared of native ecosystems to create GHG credits (e.g., evidence indicating that clearing occurred due to natural disasters such as hurricanes or floods). Such proof is not required where such clearing or conversion took place at least 10 years prior to the proposed project start date.	This project does not convert native ecosystems to generate GHG. The project area only contains native forested 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	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
The project proponent shall demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design. Where no new project activities have been implemented during a verification period, project proponents shall demonstrate that previously implemented project activities continued to be implemented during the verification period (e.g., forest patrols or improved agricultural practices of community members).	PP will demonstrate that project activities that lead to the intended GHG benefit have been implemented during each verification period in accordance with the project design.
For all IFM, APDD (except where the agent is unknown), RWE, APWD, APC, and ALM project types, the project proponent shall, for the duration of the project, reassess the baseline every ten years and have this validated at the same time as the subsequent verification. For all AUDD, APDD (where the agent is unknown), AUC and AUWD project types, the project proponent shall, for the duration of the project, reassess the baseline every six years and have this validated at the same time as the subsequent verification.	The baseline reassessment will be conducted every six years as this is an AUDD project.
Where ARR, ALM, IFM or REDD project activities occur on wetlands, the project shall adhere to both the respective project category requirements and the WRC requirements, unless the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is deemed below de minimis or can be conservatively excluded as set out in the VCS Program document VCS Methodology	Not applicable. The project activity does not occur on wetlands.

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
Requirements, in which case the project shall not be subject to the WRC requirements.	
Projects shall prepare a non-permanence risk report in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool at both validation and verification. In the case of projects that are not validated and verified simultaneously, having their initial risk assessments validated at the time of VCS project validation will assist VCU buyers and sellers by providing a more accurate early indication of the number of VCUs projects are expected to generate. The non-permanence risk report shall be prepared using the VCS Non-Permanence Risk Report Template, which may be included as an annex to the project description or monitoring report, as applicable, or provided as a stand-alone document.	The project has conducted a non-permanence risk analysis on validation, according to the VCS Program document *AFOLU Non-Permanence Risk Tool*, v4.0, and shall perform the same report during subsequent verifications.
Eligible REDD activities are those that reduce net GHG emissions by reducing deforestation and/or degradation of forests. The project area shall meet an internationally accepted definition of forest, such as those based on UNFCCC hostcountry thresholds or FAO definitions, and shall qualify as forest for a minimum of 10 years before the project start date. The definition of forest may include mature forests, secondary forests, and degraded forests. Under the VCS Program, secondary forests are considered to be forests that have been cleared and have recovered naturally and that are at least 10-years-old and meet the lower bound of the forest threshold	The Project Area is composed of 100% native forest. The area is considered forest as per the definition of forest adopted by FAO[8]: 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.

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

Eligibility Conditions	Xingu-Araguaia Grouped REDD+ Project Justification of Eligibility
parameters at the start of the project. Forested wetlands, such as floodplain forests, peatland forests and mangrove forests, are also eligible provided they meet the forest definition requirements mentioned above.	
Activities covered under the REDD project category are those that are designed to stop planned (designated and sanctioned) deforestation or unplanned (unsanctioned) deforestation and/or degradation. Avoided planned degradation is classified as IFM.	The project activity is designed to stop unplanned (unsanctioned) deforestation as described throughout the PD.
Activities that stop unsanctioned deforestation and/or illegal degradation (such as removal of fuelwood or timber extracted by non-concessionaires) on lands that are legally sanctioned for timber production are eligible as REDD activities. However, activities that reduce or stop logging only, followed by protection, on forest lands legally designated or sanctioned for forestry activities are included within IFM. Projects that include both avoided unplanned deforestation and/or degradation as well as stopping sanctioned logging activities, shall follow the REDD guidelines for the unplanned deforestation and/or degradation and the IFM guidelines for the sanctioned logging activities, and shall follow the requirements set out in Section 3.5.2.	In case future project activity instances have areas legally sanctioned for timber production, baseline and project activity shall comprehend unsanctioned deforestation and/or illegal degradation, not the reduction of logging.
Eligible REDD activities include: 1) Avoiding Planned Deforestation and/or Degradation (APDD): This category includes activities that reduce net GHG emissions by	The Xingu-Araguaia Grouped REDD+ Project is within category AUDD: Avoided Unplanned Deforestation and/or Degradation.

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

1.4 Project Design

The project is a grouped project

This project has been designed as an Avoided Unplanned Deforestation applying VM0015 methodology, Version 1.1 from December 3rd, 2012.

Eligibility Criteria

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

As Xingu-Araguaia REDD+ is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15 and 3.5.16 of VCS Standard v4.3.

Table 2. Grouped Project eligibility criteria

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Xingu-Araguaia Grouped REDD+ Project	Instance 1	Instance 2

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.	Instance 2 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 Xingu-Araguaia Grouped REDD+ Project. Also, this instance is in the same reference region described on the VCS PD. Instance 1 applies the same technologies or measures specified on the present Project Description: forest conservation by avoiding unplanned deforestation, without forest management in project scenario.	The Instance 2 project activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Xingu-Araguaia Grouped REDD+ Project. Also, this instance is in the same reference region described on the VCS PD. Instance 2 applies the same 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 Xingu-Araguaia Grouped REDD+ Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD.	The Instance 2 Project Activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Xingu-Araguaia Grouped REDD+ 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 investment, technological and/or other barriers as the initial instances.	All instances must be additional to be included in the Grouped Project. The project activity must be consistent with Grouped Project Description: forest conservation by avoiding unplanned deforestation. In this case, the project activity may or may not include Sustainable Forest Management Plan. In the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v 3.0 tool. 1) Instances may or may not include Sustainable Forest Management Plan. 2) In case the project activity does not involve Sustainable Forest Management Plan:	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.	Since the PD was developed based on the characteristics, reference region and activity of the initial instance, Instance 2 complies with this additionality criterion. The additionality analysis for Instance 2 was made according to Option I of VCS VT0001 v3.0, as detailed in section 3.5.

	- 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 Conservation Units. - As per the VCS Standard, new *AFOLU Non-Permanence Risk* assessments shall be carried out for each geographic area specified in the project description (for requirements related to geographic areas of grouped projects, see the VCS Standard). Where risks are relevant to only a portion of	The project activity within the area referring to instance 1 is located in the project's reference region as described in section 3.3 of the VCS PD.	The project activity within the area referring to instance 2 is located in the project's reference region as described in section 3.3 of the VCS PD.

	each geographic area, the geographic area shall be further divided such that a single total risk rating can be determined for each geographic area. Where a project is divided into more than one geographic areas for the purpose of risk analysis, the project's monitoring and verification reports shall list the total risk rating for each area and the corresponding net change in the project's carbon stocks in the same area, and the risk rating for each area applies only to the GHG emissions reductions generated 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.	Instance 2 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	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.	Instance 2 complies with this criterion, as it is included in this Joint PD as the first Project Activity Instance.

validation/verification body.			
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.	Instance 2 complies with this criterion, as it is included in this Joint PD as the first Project Activity Instance.
New Project Activity Instances must have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).	All Project Activity instances must provide evidence of Project ownership (land title and related documents) and Project start date (agreements, protection or management plan, or others in accordance with the applicable VCS Standard definitions).	Instance 1 is in accordance with this criterion. The evidence of Project ownership and Project start date were provided, as described in Sections 1.7 and 1.8 of the VCS PD.	Instance 2 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.
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.	Instance 2 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	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 1 project activity's crediting period has the same start and end dates of the grouped	Instance 2 project activity's crediting period has the same start and end dates of the grouped

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.	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.	Project, as described in section 1.8 of the VCS PD.	Project, as described in section 1.8 of the VCS PD.

1.5 Project Proponent

Organization name	FUTURE Forest (Future Carbon Consultoria e Projetos Florestais LTDA)
Contact person	Bárbara Silva e Souza Carolina Chiarello de Andrade Carolina Pendl Abinajm Eliane Seiko Maffi Yamada Gabriella Hita Marangom Cesilio Gabriel de Toledo Piza Laura Cristina Pantaleão Letícia Morais Teixeira Lyara Carolina Montone Amaral Yara Fernandes da Silva

Title	Bárbara Silva e Souza - Technical Analyst Carolina Chiarello de Andrade - Technical Analyst Carolina Pendl Abinajm – Technical Coordinator Eliane Seiko Maffi Yamada – Technical Coordinator Gabriella Hita Marangom Cesilio - Technical Analyst Gabriel de Toledo Piza – Technical Coordinator Laura Cristina Pantaleão – Technical Analyst Letícia Morais Teixeira - Technical Analyst Lyara Carolina Montone Amaral – Technical Coordinator Yara Fernandes da Silva – Technical Coordinator
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1.6 Other Entities Involved in the Project

Organization name	FUTURE Forest (Future Carbon Consultoria e Projetos Florestais LTDA)
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1.7 Ownership

Instance 1 is located within the municipality of São José do Xingu and Instance 2 is located within the municipality of São Félix do Araguaia, both in the State of Mato Grosso, Brazil. The project area is composed by the following properties:

- Instance 1: Fazenda Marcélia
- Instance 2: Fazenda Luciano

The property composing Instance 1 (hereafter "Instance 1" or "Fazenda Marcélia) and the property composing Instance 2 (hereafter "Instance 2" or "Fazenda Luciano"), therefore the project area, are owned by Célia Regina da Costa.

As per the rules stated at Section 3.6 Ownership of the VCS Standard v.4.3, an enforceable and irrevocable agreement was set between, Célia Regina da Costa – the holder of the statutory, property and contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions or removals –, and Future Carbon Holding S.A., which vests project ownership in the project proponent (Future Forest[9]). Evidence of such agreement will also be made available at the audit.

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

1.8 Project Start Date

Faced with the scenario of deforestation in the region to place areas for pasture, the owner of Fazenda Marcélia (Instance 1) noticed that the risk of fire outbreaks on the property could increase and that it would be necessary to act to prevent it. Thus, the project owner decided to take action and increase the monitoring and surveillance of the property limits, making a firebreak and hiring a company to inspect the property

Therefore, the project start date is December 14, 2020. This date marked the first action implemented by the project owner of Instance 1 to carry out activities to mitigate deforestation and conserve the forest.

1.9 Project Crediting Period

The project has a crediting period of 30 years, from 14-December-2020 until 13-Decemberr-2050.

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)
2020 (Starting on October 15)	71,732
2021	72,755

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

Year	Estimated GHG emission reductions or removals (tCO_2e)
2022	73,777
2023	74,800
2024	75,823
2025	76,845
2026	70,695
2027	71,615
2028	72,535
2029	73,456
2030	72,773
2031	72,671
2032	66,113
2033	65,918
2034	65,724
2035	65,530
2036	65,496
2037	65,404
2038	59,501
2039	59,326
2040	59,152

Year	Estimated GHG emission reductions or removals (tCO_2e)
2041	58,977
2042	58,946
2043	58,863
2044	53,551
2045	53,394
2046	53,236
2047	53,079
2048	53,051
2049	52,977
2050 (Ending on October 14)	36,958
Total estimated ERs	**1,984,673**
Total number of crediting years	30
Average annual ERs	66,155

1.11 Description of the Project Activity

The main objective of Xingu-Araguaia Grouped REDD+ Project (hereafter "the project") is the conservation of Amazon rainforest area located within the municipalities of São José do Xingu and São Félix do Araguaia, both in the Mato Grosso State. This will be achieved through avoidance of unplanned deforestation.

The first instance of this Grouped Project presents 6,906.15 ha of forest area in the Fazenda Marcélia property. The second instance presents 2,104.02 ha of forest area in the Fazenda Luciano property. In the future, new instances may be added to the project.

The main deforestation agents within the Xingu-Araguaia Grouped REDD+ Project region are cattle ranching, mainly producing beef, and timber harvesters, acting both legally and illegally.

This REDD+ project is expected to avoid deforestation, equating to 1,984,673 tCO_2e in emissions reductions over the 30-year project lifetime (15-October-2020 to 14-October-2050), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

The main mitigation action of the project is to avoid unplanned deforestation through the expansion of monitoring the area, mapping of deforestation, partnerships with education and research institutions and the insertion of the surrounding communities in the project activities, aiming to minimize invasions and illegal deforestation, offering alternative income, education and professional training.

Therefore, besides forest conservation, the present project aims to improve and quantify its social and environmental activities that benefit the local communities, through application of the SOCIALCARBON® Methodology. This methodology measures the contribution of carbon projects towards sustainable development. The SOCIALCARBON® Methodology is based on six main indicators: Biodiversity; Natural; Financial; Human; Social and Carbon Resources and aims to deliver high-integrity benefits in each in order to improve social and environmental conditions in the project region.

The implementation of REDD + SOCIALCARBON mechanisms promotes sustainable forest use, as it carries on forest conservation and storage of carbon stocks in forests while reducing pressure for timber from other conserved areas. In this way, biodiversity conservation and development of the local economy can be achieved simultaneously.

All the measures above aid in achieving the net GHG emission reductions by preventing legal deforestation agents from advancing with their activities and retrieving their practices and, therefore, protecting and even restoring the carbon pools.

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

1.12 Project Location

Instance 1

The Fazenda Marcélia is located in the municipality of São José do Xingu, in the State of Mato Grosso, a region known as Southern Amazon. The municipality is located around 950 km from Cuiabá, capital city of the State of Mato Grosso.

The closest access road is through MT-322 leading to highway BR-163 called Cuiabá-Santarém, which connects Brazilian states of Rio Grande do Sul to Pará.

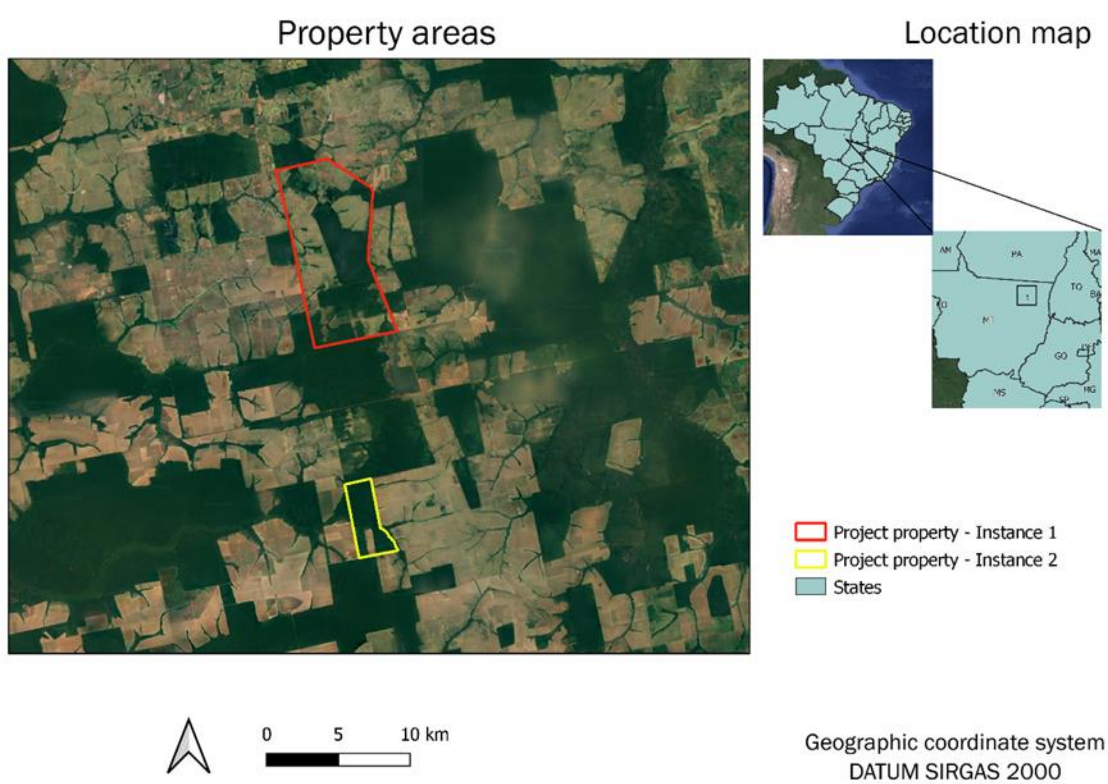
Instance 2

The Fazenda Luciano is located in the municipality of São Félix do Araguaia, in the State of Mato Grosso, a region known as Southern Amazon. The municipality is located around 1,159 km from Cuiabá, capital city of the State of Mato Grosso.

The closest access road is also through MT-322.

Geodetic coordinates of the project location have been submitted separately as a KML file.

Figure 1. Project 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

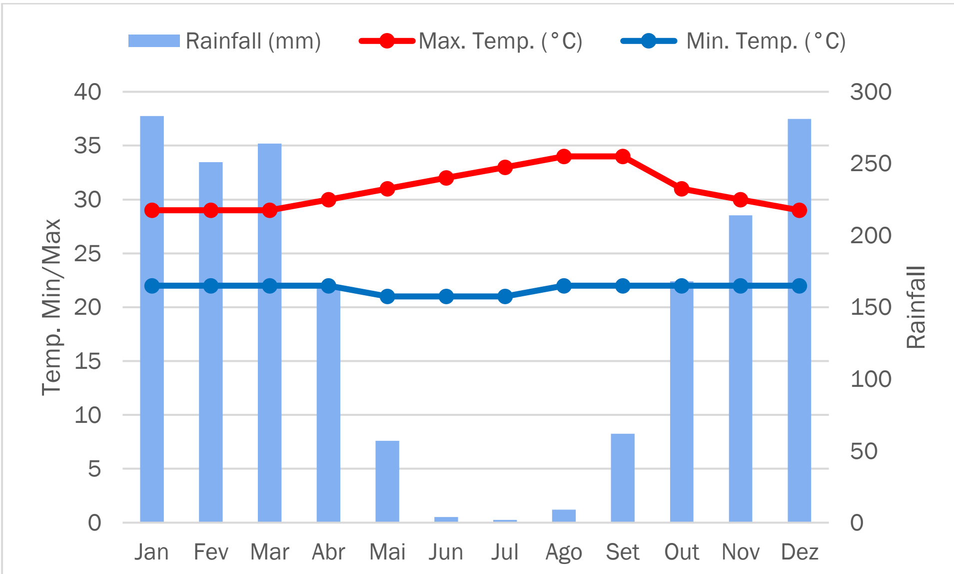
The project region is classified as Tropical, dry winter climate type – Aw category – according to the Köppen climate classification[10]. This means that it has a rainy season in summer, from

[10] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928.

November to April, and a distinct dry season in winter, from May to October (July is the driest month). The average temperature of the coldest month is above 18ºC[11]. Annual precipitation in the project area is on average 1,968.9 mm.

The graph below presents the temperature and rainfall pattern in São José do Xingu[12].

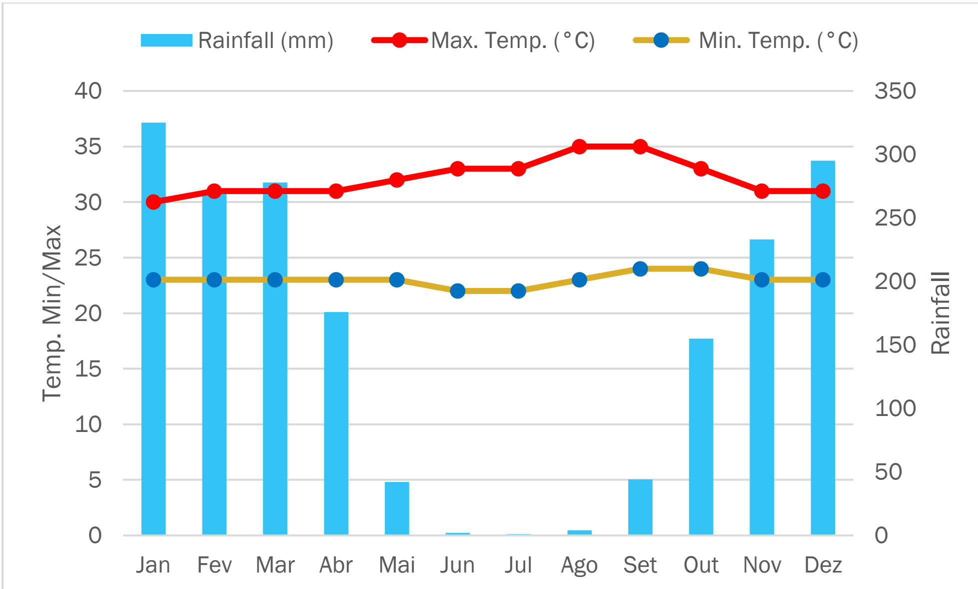
Figure 2. São José do Xingu climate graph.



The graph below presents the temperature and rainfall pattern in São Félix do Araguaia[13].

[11] EMBRAPA. Clima. https://www.cnpf.embrapa.br/pesquisa/efb/clima.htm
[12] Available at < https://www.climatempo.com.br/climatologia/4775/saojosedoxingu-mt >
[13] Available at https://www.climatempo.com.br/climatologia/1554/saofelixdoaraguaia-mt

Figure 3. São Félix do Araguaia climate graph.



The project area and reference region are located within the Amazonica watershed and Tocantins-Araguaia watershed.

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

The Mato Grosso State has modest altitudes, with large, flattened surfaces, carved in sedimentary rocks and covers three distinct regions: in the north-central portion of the state, the sedimentary plateaus and crystalline plateaus (with altitudes between 400 and 800m), that make up the central Brazilian plateau. The sandstone-basalt plateau, located in the south, is a simple portion of the southern plateau. The part of the Pantanal Mato-Grossense, lowered from the central-western portion[14].

The predominant soil types within the project area and reference region are dystrophic red latosol and dystrophic red-yellow argisoil.

<u>Vegetation cover</u>

Mato Grosso is the Brazilian state with three biomes: Amazon Rainforest, Cerrado and Pantanal. This makes the state unique, with great diversity and conservation importance. Of 141 municipalities, 86 are covered by the Amazon Rainforest. The Xingu-Araguaia Grouped REDD+ Project's boundaries are 100% covered by Amazon Rainforest and are composed by 1 phytophysiognomy, the Dense Lowland Tropical Rainforest

[14] GOVERNO DE MATO GROSSO. Geografia. http://www.mt.gov.br/geografia

Three vegetation types were found to be present in the project area: Dense Submontane Tropical Rainforest and Evergreen seasonal forest. The vegetation type present in the reference region is Evergreen seasonal forest.

Socio-economic conditions

São José do Xingu

São José do Xingu is a 746,556.30 ha municipality located in the State of Mato Grosso, in Brazil[15]. Its accounted population in the last census in 2010 was of 5,240 citizens, its demographic density being of 0.70 inhab/km^2. Of all population, in 2020 only 707 people had formal or informal jobs, which is less than 12,6% of the municipality's population[16]. The average monthly wage of formal workers in 2020 was of 2,6 minimum wages[17], and the minimum wage R$ 1,045.00[18]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[19]), and an average monthly wage of formal workers equivalent to US$ 558.61.

Almost 93.7% of the municipality's population studied until a 6 to 14 years old- range[15]. São José do Xingu's IDHM in 2010 was of 0.657. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[20]. Per capita GDP of the municipality was R$ 56,334.34 (equivalent to US$ 10,998.29) in 2019[15].

São Félix do Araguaia

São Félix do Araguaia is a 166,824.73 ha municipality located in the State of Mato Grosso, in Brazil[21]. Its accounted population in the last census in 2010 was of 10,625 citizens, its demographic density being of 0.64 inhab/km[21]. Of all population, in 2020 only 1,461 people had formal or informal jobs, which is less than 12,3% of the municipality's population[21]. The average monthly wage of formal workers in 2020 was of 2,8 minimum wages[21], and the minimum wage R$ 1,045.00[22]. This means a minimum wage of US$ 214.58 (considering the average exchange rate between January and June of 2020, of US$ 4,87[23]), and an average monthly wage of formal workers equivalent to US$ 600.82.

[15] Available at https://www.ibge.gov.br/cidades-e-estados/mt/sao-jose-do-xingu.html
[16] Available at https://cidades.ibge.gov.br/brasil/mt/sao-jose-do-xingu/panorama
[17] Available at Available at http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/L14013.htm#:~:text=e%20dois%20centavos).-,Art.,Par%C3%A1grafo%20%C3%BAnico.
[18] Available at http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/L14013.htm#:~:text=e%20dois%20centavos).-,Art.,Par%C3%A1grafo%20%C3%BAnico.
[19] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes
[20] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html
[21] Available at https://cidades.ibge.gov.br/brasil/mt/sao-felix-do-araguaia/panorama
[22] Available at http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/L14013.htm#:~:text=e%20dois%20centavos).-,Art.,Par%C3%A1grafo%20%C3%BAnico.
[23] Available at https://www.bcb.gov.br/estabilidadefinanceira/historicocotacoes

Almost 95.6% of the municipality's population studied until a 6 to 14 years old- range[21]. São Félix do Aranguaia's IDHM in 2010 was of 0.6668. The IDHM - *Índice de Desenvolvimento Humano Municipal* (Municipal Human Development Index in free translation) is a measurement composed by indicators of three dimensions of human development: longevity, education, and income. The index ranges from 0 to 1. The closer to 1, the greater human development[24]. Per capita GDP of the municipality was R$ 61,169.77 (equivalent to US$ 12,560.53) in 2019[21].

<u>Biodiversity</u>

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[25].

Brazil has the greatest flora species richness globally, with 46,392 species described. Furthermore, it contains over 8,700 known species of vertebrates consisting of 720 mammals, 986 amphibians, 759 reptiles, 1,924 birds and 4,388 fish species. It is estimated that around 93 thousand invertebrate species are known[26].

The project region is covered by Amazonian Rainforest but is located in a transition area with the Cerrado Biome. This area has great environmental heterogeneity, allowing great diversity of fauna and flora.

In the Mato Grossense Amazon biome, there are mainly two types of forests: the Rainforest and the Seasonal Forest. They occupy about 50% of the State territory. The Amazon is the most complex in terms of biodiversity in the world. Due to the difficulty of light entry, due to the abundance and thickness of the crowns, ground vegetation and land animals are very scarce in the Amazon. Most of the endemic fauna is made up of animals that inhabit the treetops. Among the birds in the canopy are parrots, toucans and woodpeckers. Among the mammals are bats, rodents, monkeys and marsupials.

<u>A study carried out in the municipality of São Félix do Araguaia found important tree species, such as: </u>*Tetragastris altissima, Tapirira guianensis, Brosimum rubescens, Trattinickia rhoifolium, Tetragastris altissima, Tapirira guianensis, Brosimum rubescens, Trattinickia rhoifolium*[27].

In addition, the region also has endemic animals such as marmosets, manatees and gray dolphins[28].

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[24] Available at https://www.br.undp.org/content/brazil/pt/home/idh0/conceitos/o-que-e-o-idhm.html

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

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

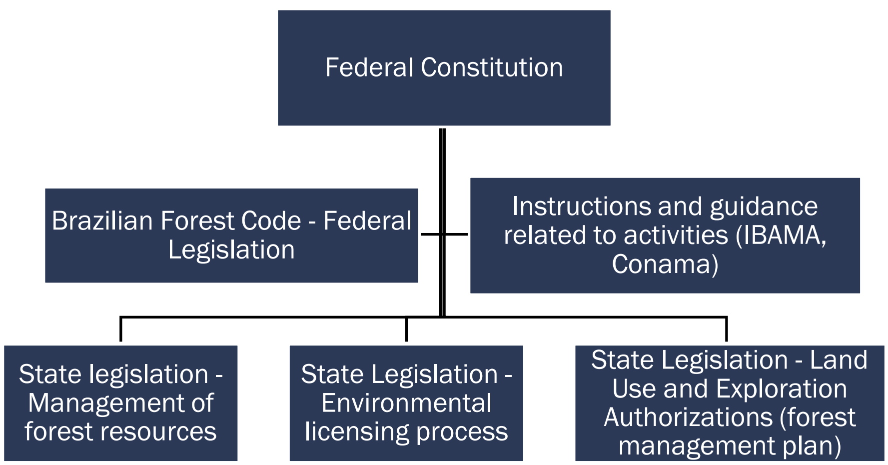
[27] https://repositorio.ufscar.br/bitstream/handle/ufscar/1626/2558.pdf?sequence=1&isAllowed=y

[28] https://oeco.org.br/dicionario-ambiental/28830-o-que-sao-ecotonos/

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[29]. 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[30]. 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 4. 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[31]), all rural estates located in forest zones shall have:

[29] Available at http://www.pge.sp.gov.br/centrodeestudos/bibliotecavirtual/Congresso/ztese17.htm
[30] Available at http://pnla.mma.gov.br/competencias-para-o-licenciamento-ambiental
[31] BRASIL. Law nº. 12.651, of 25 May 2012. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 25 May 2012.

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

II. Legal Reserve: an area located within a rural property or possession which is required to be segregated, as well as the permanent preservation area, for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[32], 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 Xingu-Araguaia Grouped REDD+ Project is 50%, as registered in the land title and following the forest code before the 2012 update. The 1934 version of the Brazilian Forestry Code demanded the conservation of only 25% of the vegetation coverage; 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 areas located in the Amazon biome[33].

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[34]. 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 proponents use their best efforts to prevent property invasion and to remain in compliance with Brazilian Forest Code.

The technical procedures for the preparation, presentation, execution and technical evaluation of sustainable forest management plans are regulated by IBAMA's Normative Instructions: 1, of

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[32] 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.

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

[34] 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.

24/04/2007[35], 5, of 11/12/2006[36] and 2, of 27/06/2007[37]; in addition to CONAMA's Resolution 406, of 02/02/2009[38]

- State legislation

In the state of Mato Grosso, the Secretariat for the Environment (Sema/MT) is the body responsible for environmental licensing. Legislation such as laws Nº233/2005[39], Nº 8,188/2006[40] and Nº698/2021[41], and normative instruction IN 02/2018[42] is applicable, as detailed in table below.

- Climate change legislation

Regarding other regulatory frameworks that exist in Brazil, on November 28th, 2019, occurred the approval of the Federal Decree 10,144/2019, which establishes the National Commission for Reducing Emissions of Greenhouse Gases from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks -REDD+[43].

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

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

[35] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=113233>
[36] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=112909>
[37] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&force=1&legislacao=113306>
[38] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=114762>
[39] Available at < http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/250a3b130089c1cc042572ed0051d0a1/4f42663cdf699582042570f2004f4aa2?OpenDocument>
[40] Available at < http://app1.sefaz.mt.gov.br/Sistema/legislacao/legislacaotribut.nsf/2b2e6c5ed54869788425671300480214/d137b809227f6f4f0425720c00476358?OpenDocument>
[41] Available at < http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/d52df8648ccf16c004258712006af1e0?OpenDocument>.
[42] Available at < https://www.legisweb.com.br/legislacao/?id=363548>
[43] The Decree is available in Portuguese at: < http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm>

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 Xingu-Araguaia Grouped REDD+ Project and such Decree.

Table below presents the compliance of the Project with mentioned 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.	The project area complies with current legislation, as evidenced by the regularity in the CAR, authorizations issued and the absence of legal pending issues on the environmental side.
State legislation		
Complementary law 233	Provides information for the Forest Policy of the State of Mato Grosso and other provisions.	The management plan and activities conducted within the project area were approved by the responsible environmental agency in Mato Grosso (SEMA)
Decree 1313	Regulates Forest Management in the State of Mato Grosso and makes other provisions.	The management plan and activities conducted within the project area were approved by the responsible environmental agency in Mato Grosso (SEMA), as well as the current UPA.
Complementary law 668[44]	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,	The property complies with state legislation and the environmental licensing required for carrying out forestry activities, in accordance with current exploration authorizations.

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

	2005, which provides for the Forest Policy of the State of Mato Grosso and other measures.	
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.	The property complies with state legislation and the environmental licensing required for carrying out forestry activities, in accordance with current exploration authorizations.
IN SEMA 1	Approves procedural rules for the issuance, use and control of Forestry Guides – GF, in internal and interstate operations.	The property complies with state legislation and the environmental licensing required for carrying out forestry activities, in accordance with current exploration authorizations. Forest guides are issued in accordance with applicable legislation, as evidenced by the management team.
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.	The property complies with state legislation and the environmental licensing required for carrying out forestry activities, in accordance with current exploration authorizations. Forest guides are issued in accordance with applicable legislation, as evidenced by the management team.
Standards and guidelines from national agencies		
Administrative Rule 1 IBAMA	It institutes, within the scope of this autarchy, the technical guidelines for the elaboration of sustainable forest management plans – SFMP mentioned in art. 19 of Law 4,771, of September 15, 1965.	The management plan and activities that might be eventually conducted within the project area, if an instance that carries out SFMP enters the project, must be approved by the responsible environmental agency in Mato Grosso (SEMA), as well as its UPA.
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.	The management plan and activities that might be eventually conducted within the project area, if an instance that carries out SFMP enters the project, must be approved by the responsible environmental agency in Mato Grosso (SEMA), as well as its UPA.
Normative instruction 2 MMA	Amends provisions of normative instruction no. 5, of December 11, 2006, and makes other provisions.	The management plan and activities that might be eventually conducted within the project area, if an instance

		that carries out SFMP enters the project, must be approved by the responsible environmental agency in Mato Grosso (SEMA), as well as its UPA.
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.	The management plan and activities that might be eventually conducted within the project area, if an instance that carries out SFMP enters the project, must be approved by the responsible environmental agency in Mato Grosso (SEMA), as well as the current UPA.
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, does not establish duties or obligations to the society.
Decree 11075[45]	Establishes the procedures for the elaboration of Sectoral Plans for Mitigation of Climate Changes, institutes the National System for the Reduction of Greenhouse Gas Emissions.	The decree defines the carbon credit as a financial asset, the institution of the National System for the Reduction of Greenhouse Gas Emissions and organizes the functioning of the Government about the carbon agenda. Its application is restricted to the federal entities of the Public Administration, and, because it is a decree, a normative type that only grants regulation to the matter of law,

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

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

As mentioned in Section 1.1 - Description of the Activity, the SOCIALCARBON standard will be a complementary standard to the VCS Standard. Thus, there will be no double counting and a project ID will not be generated in SOCIALCARBON.

1.16.2 Other Forms of Environmental Credit

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

As mentioned in Section 1.1 - Description of the Activity, the SOCIALCARBON standard will be a complementary standard to the VCS Standard. Thus, there will be no double counting and a project ID will not be generated in SOCIALCARBON.

Supply Chain (Scope 3) Emissions

The present REDD project's GHG emission reductions are not in a supply chain, ie., the 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 organization 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 Xingu-Araguaia 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)[46] 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[47]. 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[48] and by the IPEA reports[49]. In addition,

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

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 Xingu-Araguaia Grouped REDD+ Project main planned contributions to the Brazilian Priority Goals are listed below[50]. These contributions are monitored by the parameters defined by the REDD project, in addition to additional standards, such as CCB and SOCIALCARBON. For more information, please consult the applicable social benefit report:

- 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. This SDG is monitored by the SOCIALCARBON methodology in the Social resource (1. Women inclusion, 2. Expansion of community activities, 3. Associations and Cooperatives), Human (5. Public health, 6. Community education and training), Financial (7. Alternative income sources, 8. Carbon credit benefits) and Natural (11. Social and environmental investments) in the SOCIALCARBON Report. Thus, the project collaborates with targets such as:

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

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

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

- SDG 2: Zero hunger

The project itself enhances better management of non-timber forest products as, through the carbon credits sales, qualifies investments in the local community training and capacity building programs. Likewise, strengthen ecosystem conservation and preservation. This SDG is monitored in the Financial resource (7. Alternative income source) and Biodiversity (13. Non-timber forest products (NTFPs) in the SOCIALCARBON Report. Guideline targets are:

[50] Available at < https://odsbrasil.gov.br>

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

- SDG 3: Good health and well-being

Via carbon credits income, the project promotes the community's well-being and helps to sove local common issues. This SDG is monitored in the Social resource (2. Expansion of community activities) and Human (5. Public health) in the SOCIALCARBON Report. 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. This SDG is monitored in the Social resource (2. Expansion of community activities), Human (6. Community education and training), Financial (11. Social and environmental investments), and Carbon (17. Stakeholder consultation) in the SOCIALCARBON Report. 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. This SDG is monitored in the Social resource (1. Women inclusion, 2. Expansion of community activities, 3. Associations and Cooperatives), in the SOCIALCARBON Report. 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. This SDG is monitored in the Social resource (3. Associations and Cooperatives), Human (6. Community education and training), Financial (7. Alternative income sources), Natural (11. Social and environmental investments), Biodiversity (Non-timber forest products (NTFPs)) in the SOCIALCARBON Report. Guideline targets are:

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

- 8.6 “By 2020, substantially reduce the proportion of youth not in employment, education or training”;

- SDG 12: Ensure sustainable production and consumption patterns

The carbon project nurtures a better environmental management system since increases stakeholder awareness concerning the climate changes mitigations, and whichever environmental activity the landowners intend to apply. Alongside, the project is based on encouraging sustainable development and maintaining the standing forest through the sustainable use of its resources, and it aims to optimize access to non-timber forest products and the consumption of local inputs. One of the main objectives is to reduce illegal deforestation and profit from this activity, offering alternatives for income and extraction. This SDG is monitored in the following resources: Human Resource (6. Community education and training), Financial (7. Alternative income sources), Natural (11. Social and environmental investments), Biodiversity (13. Non-timber forest products (NTFPs), and Carbon (17. Stakeholder consultation). The Xingu-Araguaia Grouped REDD+ Project has the following target and guidelines:

- 12.2 “By 2030, achieve the sustainable management and efficient use of natural resources”

- 12.6 "Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
- 12.8 "By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature."

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

Another of the main objectives of the REDD project is to reduce greenhouse gas emissions through the conservation of standing forest. Thus, its activity is already an action to combat climate change and its effects. In addition, the project stimulates biodiversity monitoring initiatives in a measure to combat climate changes. This SDG is monitored in the Biodiversity (14. Biodiversity monitoring, 15. Impact on remaining flora) and Carbon (16. Buffer reduction, 18. Project performance) resources in the SOCIALCARBON Report. 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. This SDG is monitored in the Natural (11. Social and environmental investments) and Biodiversity (14. Biodiversity monitoring, 15. Impact on remaining flora, 15. Impact on remaining flora) resources in the SOCIALCARBON Report. 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";
- 15.2 "By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally";
- 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[51].

The following components of the Brazilian commitments under the Convention are reinforced by the development of the Xingu-Araguaia 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;

Enhancing sustainable native forest management systems, through georeferencing and tracking systems applicable to native forest management, with a view to curb illegal and unsustainable practices.

1.18 Additional Information Relevant to the Project

Leakage Management

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

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

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

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

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

Leakage Management Plan

[51] 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>

By means of Project monitoring activities, satellite imaging, and social and governmental cooperation for monitoring the project and its surroundings, the project proponent believes that the success of this business plan will generate an increased number of sustainably managed areas with REDD+. This Leakage Management plan will be based on the monitoring parameters, in addition to being verified in every SocialCarbon Report.

The main leakage management activities are outlined below:

- Surveillance activities designed to mitigate illegal logging and land occupation in the area will be achieved through the project activity. This process will be further consolidated through combined efforts with private and governmental entities, and NGOs.
- Inclusion of new instances: further areas with potential for REDD+ projects have already been identified around the project site, which will complement financial incentives obtained from credit sales and provide more social and environmental benefits to local communities.

Combatting illegal land occupation: the local community will be strategic in monitoring illegal land occupation and potential illegal logging. Those who are interested in being trained and carrying out local monitoring will be included in the project, an activity which may also become a new source of income for local communities.

Commercially Sensitive Information

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

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

Xingu-Araguaia Grouped REDD+ Project has conducted a social and environmental assessment within the Leakage Management Area. The performance of the socio-environmental diagnosis and in-site consultation with local stakeholders will happen during the project's validation. In addition, literature research was also performed to enhance information collected during the onsite visit that were vague or incomplete.

In addition to the acknowledgment of the socioenvironmental conditions of the communities, the SOCIALCARBON certifications also may be applied to quantify the main potential environmental and socio-economic risks. The applicable SOCIALCARBON indicators for this grouped project are

"Indicators for projects in areas of high environmental impact"[52], and will be applied as guidance for monitoring of social, economic and environmental impacts of the project.

Table below provides details on the identified potential risks:

Table 3. Main social, economic and environmental impacts of the Xingu-Araguaia Grouped REDD+ Project

Activity	Aspect	Impact	Effect		Comments/ Observation
			Beneficial	Adverse	
REDD carbon project	Empowerment	Increase independence of communities in the Project Area	X		Monitored by: • Social Resource: Women's inclusion • Human Resource: Community education and formation programs • Financial Resource: Alternative income sources; Employment creation • Biodiversity Resource: Non-timber forest products (NTFPs)
REDD carbon project	Conservation of Amazon Rainforest	Avoided deforestation	X		Monitored by: • Carbon Resource: Project Performance; Buffer reduction
REDD carbon project	Surveillance	Increased deforestation outside the Project Area		X	Monitored by: • Human Resource: Workers' safety • Natural Resource: Monitoring methods; Project efficiency in agents that fight deforestation/degradation • Biodiversity Resource: Biodiversity

[52] Available at https://static1.squarespace.com/static/6161c89d030b89374bec0b70/t/635310b31e2508189acd9327/1666388148200/Indicators+for+projects+in+areas+of+high+environmental+impact_October+2022_v1.pdf

					monitoring; Biodiversity Conservation • Carbon Resource: Project Performance
REDD carbon project	Conservation of Amazon Rainforest	Greenhouse Gas Emissions Reductions	X		Monitored by: • Carbon Resource: Project Performance • Natural Resource: Project efficiency in agents that fight deforestation/degradation
REDD carbon project	Conservation of Amazon Rainforest	Monitoring and supervision to avoid deforestation of forest within the Project Area	X		Monitored by: • Biodiversity Resource: Biodiversity monitoring • Natural Resource: Monitoring methods
REDD carbon project	Conservation of Amazon Rainforest	Conservation of the standing forest	X		Monitored by: • Carbon Resource: Project Performance • Natural Resource: Project efficiency in agents that fight deforestation/degradation
REDD carbon project	Conservation of Amazon Rainforest	Conflict management with communities in the Project Area, due to banning of timber product extraction		X	Monitored by: • Carbon Resource: Stakeholder consultation
REDD carbon project	Expansion of knowledge and investment in the area	Encouragement and investment in research on social, economic and	X		Monitored by: • Human Resource: Research incentive; Community education and formation programs

		environmental aspects in the project region			• Financial Resource: Alternative income sources; Carbon credit benefits

The identified impacts will be monitored through the indicators described on the last column of the Table above.

In addition to the risks described above, Future Carbon has identified other risks that could affect the Project Activity. These risks are described on the Table below:

Table 4. Significant risks to the Project

Activity	Aspect	Risk	Indicators that will monitor the identified potential risks
REDD carbon project	Uncertainties related to the standing forest in the future	Non-permanence of the carbon stocks: period on which carbon will remain stocked in biomass, without being emitted into the atmosphere. Due to the uncertainties related to what will happen to the forest in the future, there is a risk of non-permanence of forest carbon	Monitored by: • Carbon Resource: Buffer reduction
REDD carbon project	Land demarcation process	Risk of encroachment by deforestation agents	Monitored by: • Natural Resource: Monitoring methods; Project efficiency in agents that fight deforestation/degradation

2.2 Local Stakeholder Consultation

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

Institutions with direct or direct relationships with the project will be mapped and contacted. Local entities having some influence and activities developed in the Reference Region will be chosen through a process to identify them and their possible impact on the Project Activity. Stakeholders who will be selected for local consultation also include communities and neighbors that might be impacted and set potential partnerships in the future.

To stakeholders in urban areas, mostly government agencies, an explanatory e-mail, and letter will be sent, briefly presenting the project and inviting them to the remote consultation.

The local community will be consulted individually and on-site by a consultant, presenting the project in simple and accessible language appropriate to the everyday discourse used by this community. During the consultation, these parties will collect comments, suggestions, and criticisms.

This presentation will detail a summary of the proposed activities of the project implementation and monitoring. The auditor from VVB, who will conduct the validation of this project, was also invited to this meeting.

The presential consultation with stakeholders (local community) will take place where the presence of housing is located. The meeting will have a simplified presentation about the project, with photos and videos, exposing the risks and benefits resulting from the project activities for the population..

These consultations will also 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 resolve eventual conflicts with stakeholders.

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

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

In addition, a permanent communication channel with local stakeholders will be created to receive any comments or suggestions regarding the current REDD project. All comments will be accepted, and outcomes will be documented and stored in digital format. The SOCIALCARBON methodology will also analyze the frequency and methods used for addressing the outcomes of each local stakeholder consultation, which will be analyzed at each verification event.

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[53]. 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[54]. 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[55].

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

2.4 Public Comments

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

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 will be identified through research, visits to the project region, and local knowledge from the Instance 1 and Instance 2 landowner and management team. As detailed in Section 2.2, stakeholders will be identified considering the communities,

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[53] 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/

[54] 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 .

[55] 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 .

government agencies, and educational and research entities, considering relevant Mato Grosso State and Amazon biome institutions and NGOs within the Reference Region. Sustainable development and rural development agencies will also be contacted. The list is available in the section Local Stakeholders Consultation above.

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

   There are no communities living within the Project Area. Instance 1 and Instance 2 landowner recognize the presence of the communities near the Project Area and take efforts to maintain a healthy relationship with them. These communities have no rights over the Project Area nor conflicts over land tenure or use rights with the owners.

   On July 13, 2006, the Commission for the Sustainable Development of Traditional Communities was instituted in Brazil by decree[56] and updated in 2016[57], with the objective of implementing a national policy especially directed at such communities.

   The Decree No. 6,040 of February 7, 2007[58], 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[59].

   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

[56] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/dnn/dnn10884.htm> Last visit 20/07/2022
[57] Available at <http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Decreto/D8750.htm#art20> Last visit 20/07/2022
[58] Available at <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm> Last visited on 05/01/2021.
[59] 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)[60].

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

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

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

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

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

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

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

   Any future significant changes will be informed in this Section.

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

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

Risks to Local Stakeholders

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

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 5. 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[61]
Resources	Withdrawal of natural, economic and cultural resources (water, food, alternative income, cultural events, etc.) from families		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
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 and Instance 2 landowner 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. Xingu-Araguaia Grouped REDD+ Project understands the

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

				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 properties or relocate people off their lands without consent. At present there are not any ongoing or unresolved conflicts over property ownership, usage or resources rights, the Project shall not undertake activities that could exacerbate the conflict or influence the outcome of unresolved disputes.

The Project intends to offer benefits and training for the local community, including health related benefits, in addition to providing education for children and women, as stablished and monitored by the SOCIALCARBON methodology.

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

Communication and Consultation

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

- The project implementation, including the project results and the importance of forest conservation activities.
- The risks, costs and benefits the project brings to local stakeholders.
- The benefit sharing mechanism.
- Procedures related to resolving eventual conflicts with stakeholders.
- The process of VCS Program validation and verification and the validation/verification body's site visit.

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

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

Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All 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[62].

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[63];
- AFOLU Non-Permanence Risk Tool v4, published on 19-September-2019[64].

3.2 Applicability of Methodology

VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1	
Applicability Conditions	**Justification of Applicability**
a) Baseline activities may include planned or unplanned logging for timber, fuelwood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.	None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4. The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvest, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure expansion, such as waterways and roads. 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	Within the categories of Table 1 and Figure 2

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

combination of the eligible categories defined in the description of the scope of the methodology (table 1 and figure 2).	of the Methodology, the present Project Activity falls within category A, "Avoided Deforestation without Logging". The reason is that the project area contains 100% native vegetation and has never been deforested in the past. In addition, it is important to note that degradation is not included neither in the baseline nor in the project scenario.
c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agroforestry systems meeting the definition of "forest".	These forest classes composing the Project Area are named as per the Technical Manual for Brazilian Vegetation[65]. The area is considered forest as per the definition of adopted by FAO[66]: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. No deforested, degraded or areas otherwise modified by humans were included in the Project Area at the Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The Project Area consisted of 100% tropical rainforest in 2007 – over 10 years prior to the project start date – all of which according to the Brazilian definition of forest[67]. This was ascertained using satellite images, as described in the section Baseline Scenario of the present VCS PD.
e) The project area can include forested 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	As described at Section 1.13 of the present VCS PD, the only soil type within the Project Area is the dystrophic Red-Yellow Argosols. Therefore, no peat or peat swamp forests were found within the Project Area, satisfying this applicability criterion.

[65] Avaliable at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf
[66] Available at <
https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses>
[67] 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>.

50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	

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

3.3 Project Boundary

- Reference Region

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

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

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

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

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

1. For projects below 100,000 ha, the Reference Region should be 20-40 times the size of the Project Area.
2. The conditions determining the likelihood of deforestation within the Project Area being similar or expected to become similar to those found within the Reference Region, depending on: the landscape configuration and ecological conditions (elevation, slope, vegetation, and rainfall), socio-economic and cultural conditions, and agents and drivers of deforestation (agent groups, infrastructure or other drivers). The latter condition was the most important for adjusting the RR for it to represent the land-use dynamics more accurately. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the principal means of human and product transportation in the region. As such, from the areas directly surrounding the project, the RR was expanded to meet the nearest main waterways and roads.

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

- **Agents and drivers of deforestation:** Timber logging (both legal and illegal) and cattle ranching are important economic activities within the Reference Region. As detailed in Section 1.13 and to be presented in Section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats 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[68], National Protected Areas[69]. It is important to note that neither Indigenous Lands[70] nor Protected Areas were found nearby the Project Area.

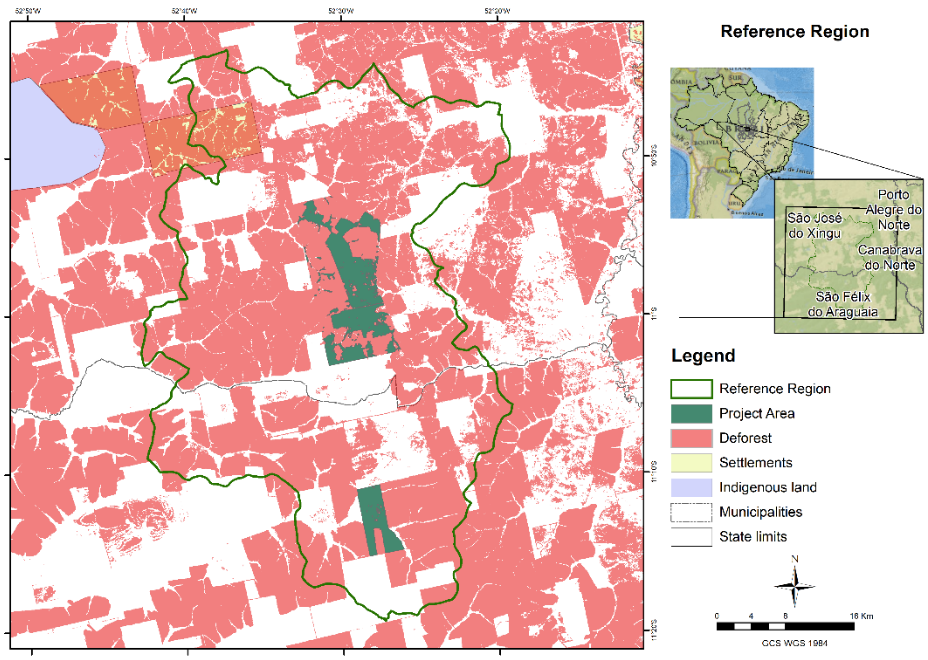
- **Landscape configuration and ecological conditions:** To define the Reference Region, the watersheds located around the Project Area were used as units. For each of these watersheds, the average values of elevation, slope and precipitation were determined, as well as the percentages of the different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

From the definition of this area, which has 187,954.95 hectares (20.1 times the Project Area) and is distributed over the following municipalities: São José do Xingu and São Félix do Araguaia. 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.

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

[70] Available at <https://www.gov.br/funai/pt-br/atuacao/terras-indigenas/geoprocessamento-e-mapas>

Figure 5. Reference Region Location



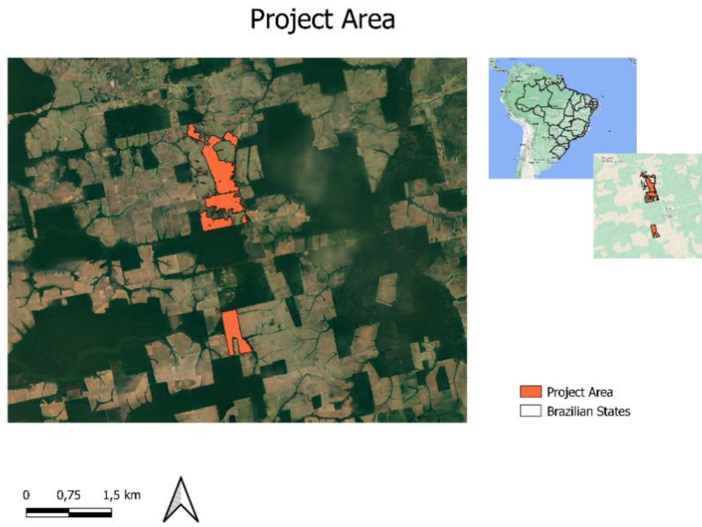
- Project Area

The Project Area comprises Instance 1 and Instance 2.

Instance 1 is composed by 1 property, which have a total area of 15,604 ha (Marcélia Farm) and Instance 2 is composed by 1 property, wich have a total area of 2,420 ha (Luciano Farm). According to the VM0015 methodology, the Project Area “shall include only land qualifying as ‘forest’ for a minimum of 10 years prior to the project start date”: the date when activities are initiated to protect against the risk of future deforestation. Thus, some adjustments and discounts are made to comply with the Methodology.

To define the Project Area, areas deforested up to the Project Start Date, vegetation areas classified as pioneer formation (including peats and wetlands) and areas containing water bodies were excluded from the properties’ area. As a result, the Project Area was defined as 9,010.17 ha. Further characteristics of the Project Area until the Project Start Date are described in Section 1.13.

Figure 6. Project Area of Xingu-Araguaia Grouped REDD+ Project



- Leakage Belt

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

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

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

For monetary costs, the freight table of Ordinance No. 034/2017 (SEFAZ, 2017) for minimum prices for the provision of transportation services. Ordinance details the value of freight for transporting live cargo, in which the scenario of a D. Deck 45/48 trailer transporting a load of 14,000 kg was considered.

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

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

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

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

Where:

PPx$_l$: 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

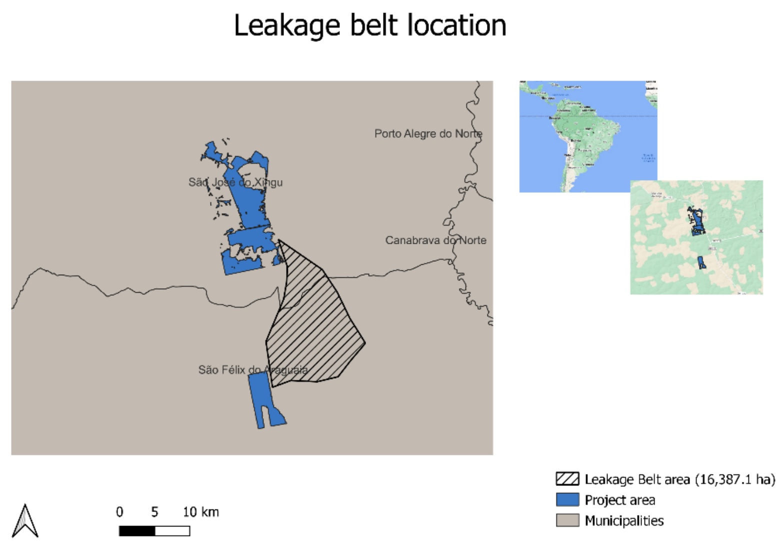
V: 1, 2, 3...V, surface type on which transportation occurs; dimensionless

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 10 km, would be where deforestation is most likely to occur due to the Project Activity. In more distant areas, the increase in deforestation, as it is already in course, is probably associated to their proximity to rivers and roads.

Finally, by overlapping the Project Area buffer with the areas with the highest profitability potential, an area of 16,387.1 ha was defined as the Leakage Belt. The Figure below illustrates its location. In summary, the Leakage Belt was composed by areas within a 3km radius from the Project Area boundaries, which present higher economic viability for cattle ranching.

Figure 7. Leakage belt Location

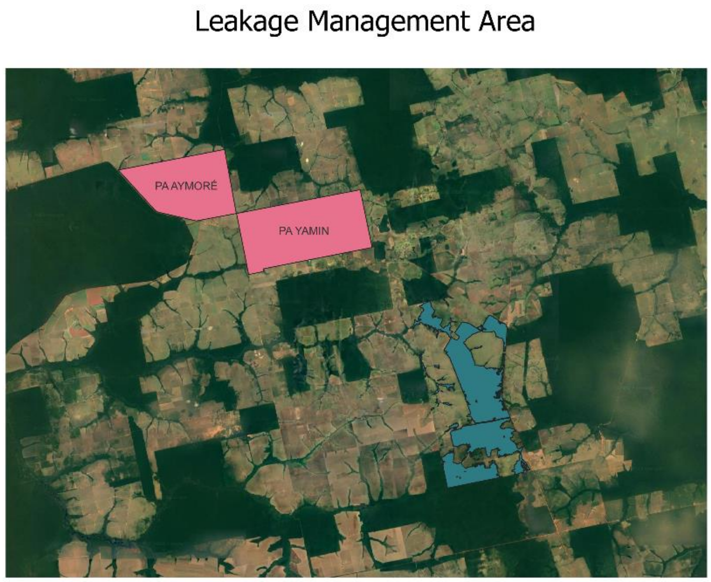


- Leakage Management Area

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 and Instance 2, their location represented in the Figure below:

Figure 8. Leakage Management Area of the Xingu-Araguaia Grouped REDD+ Project



- Forest

  The Brazilian Forest Service's definition of forests is lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE)[71], updated by the SIVAM project[72]. 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

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

[72] 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/>

national definition[73]. Thus, this assessment guarantees that the Project Area meets a definition of forest that has international recognition.

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

Temporal Boundaries

- Starting date and end date of the historical reference period

  The adopted historical reference period was from 2007 to 2019.

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

  The project has a crediting period of 30 years, from 15-October-2020 to 14-October-2050, which may be renewed up to 100 years.

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

  The first baseline period is from 15-October-2020 to 14-October-2026.

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:

Figure 9. 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

[73] 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>

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

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

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

Figure 10. Sources of GHG included or excluded within the boundary of the proposed AUD Project Activity

Source		Gas	Included / Excluded	Justification / Explanation of choice
Baseline scenario	Biomass burning	CO_2	Excluded	Excluded as recommended by the applied methodology. Counted as carbon stock change.
		CH_4	Included	Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.
		N_2O	Included	Included as non-CO2 emissions from biomass burning in the baseline scenario, according to the methodology.
		Other	Excluded	No other GHG gases were considered in this project activity.
		CO_2	Excluded	Not a significant source

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

3.4 Baseline Scenario

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

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

ANALYSIS OF AGENTS, DRIVERS, AND UNDERLYING CAUSES OF DEFORESTATION

As specified in the Methodology, it is necessary to understand "who" the deforesting agent is and what drives land-use decisions ("drivers" and "underlying causes"). This analysis is important for two main reasons: (i) Estimating the quantity and location of future deforestation; and (ii) Designing effective measures to address deforestation, including leakage prevention measures[74].

- Database organization and pre-processing

  The forest dynamics data, deforestation vectors and other base information from the region under analysis, which were used to build the Project Baseline, were organized in a spatialized database, in the File Geodatabase format of ArcGIS 10.8. The data come from different sources and have different cartographic scales (Table below). The files are stored in vector and matrix (raster) format. In order to standardize the spatial references, all data were reprojected to the WGS 1984 UTM Zone 22S projection.

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

Table 6. 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

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

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

- Identification of agents of deforestation

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

a) **Cattle ranching**

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

The representativeness of livestock in Mato Grosso is large both in terms of culture and economy. The colonization process in the region took place during the depletion of mines in central Brazil, and livestock was the main agent of formation and restructuring of the Mato Grosso's territory, especially in the south, where today is the state of Mato Grosso do Sul. In addition, after the Paraguay War, the region began to be restructured, receiving new residents who sought to rebuild areas affected by the war and to occupy pastures for raising cattle. The activity also helped to reduce the distance that separated the State from the large population centers, as the expansion of large cattle ranches and the occupation of fertile areas for agriculture created new population centers[75]. Thus, the economic base of the state gradually transmuted from mining to agro-pastoral activity.

The northern region of the state gained greater relevance in the livestock sector in the 70s, when the Brazilian military government decided to occupy the Amazon, and cattle once again accompanied the colonizers, resulting in an explosive expansion of pastures and herds. While the Brazilian herd increased by 60% between 1987 and 2013, the herd in the Amazon states (Mato Grosso, Pará, Acre, Rondônia, Roraima, Amazonas, Tocantins, Amapá, and Maranhão) practically tripled (280%), because livestock became the cheapest means of occupying the cleared land[76].

In summary, Brazilian beef cattle farming developed through the expansion of the agricultural frontier (which occurs through deforestation in regions lacking infrastructure)

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

and through the use of lands depleted by agriculture. The activity has contributed decisively, since colonial times, to the occupation of Brazilian territory.

Thus, as commented in previous sections, cattle ranching is of great importance in the formation of the Mato Grosso territory, as a result of profitability and convenience, and pasture is the most common land use in deforested areas.

Given the historical context, it is relevant to emphasize the economic importance of livestock in Brazil, as a whole, and especially in the state of Mato Grosso. Although Brazil ended 2020 registering a GDP of BRL 7.4 trillion, 4.1% lower than 2019's GDP, on the other hand, livestock GDP totalled R$747.05 billion, 20.8% higher than the R$618.5 billion registered in 2019[77].

- Identification of agents of deforestation

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

b) **Cattle ranching**

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

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The northern region of the state gained greater relevance in the livestock sector in the 70s, when the Brazilian military government decided to occupy the Amazon, and cattle once again accompanied the colonizers, resulting in an explosive expansion of pastures and herds. While the Brazilian herd increased by 60% between 1987 and 2013, the herd

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

[78] Available in <https://periodicos.ufms.br/index.php/AlbRHis/article/download/5100/3781/>

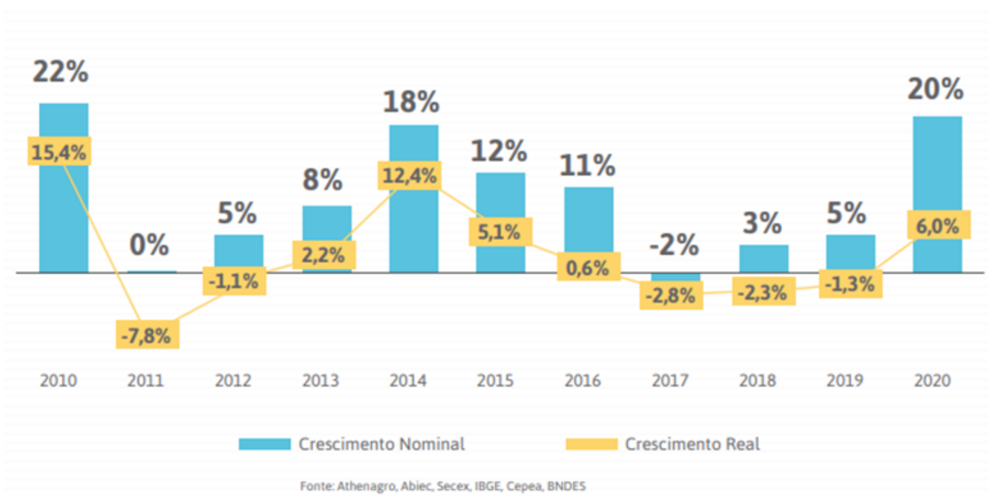
in the Amazon states (Mato Grosso, Pará, Acre, Rondônia, Roraima, Amazonas, Tocantins, Amapá, and Maranhão) practically tripled (280%), because livestock became the cheapest means of occupying the cleared land[79].

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

Thus, as commented in previous sections, cattle ranching is of great importance in the formation of the Mato Grosso territory, as a result of profitability and convenience, and pasture is the most common land use in deforested areas.

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

Figure 11. Livestock GDP and its average growth rate in nominal and real values (2010-2020)

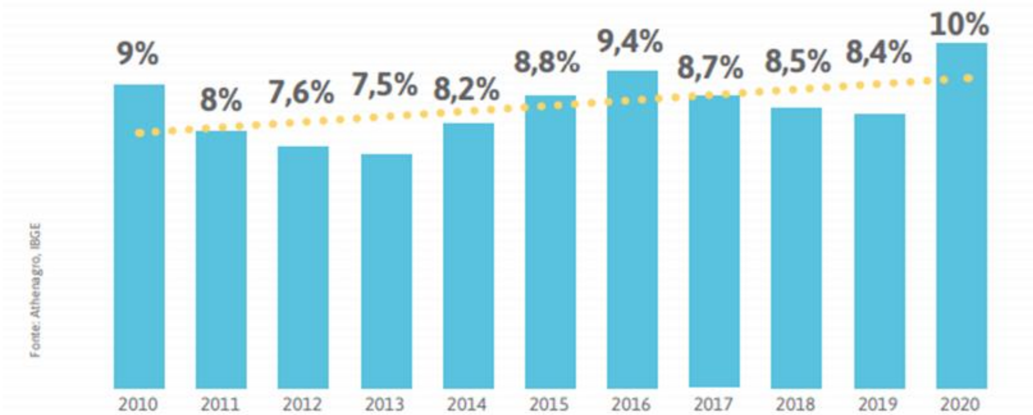


It is worth noting that in 2020, livestock GDP represented 10% of Brazil's total GDP, as may be observed in the Figure below:

[79] Available at <https://csr.ufmg.br/pecuaria/portfolio-item/historico-3/>

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

Figure 12. Evolution of the participation of the beef cattle GDP on the total GDP of Brazil[81]



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

c) Timber Harvesting

Timber logging (both legal and illegal) is an important economic activity within the reference region. Timber is one of the largest contributors to the value of annual production when compared to all extractivism products in the Amazon region. The logging area in Mato Grosso between August 2019 and July 2020 was 234,290 hectares. This area represents more than half of the total areas explored for timber purposes in the Amazon during this period[85].

Usually, deforestation in the region involves spatially overlapping activities: firstly, extraction of commercially valuable tree species for sale to timber companies. The final step is the slash-and-burn deforestation of the area above for cattle ranching or agriculture production.

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

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

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

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

[85] https://www.icv.org.br/website/wp-content/uploads/2021/10/tf-15-mapeamento-ilegalidade-exploracao-madeireira-mt-2020-icv-1.pdf

After harvesting the most valuable commercial species, the deforestation continues both in areas already explored and unexplored, and thus providing conditions for further expansion of logging, cattle ranching and agriculture production.

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

1) Population growth

This deforestation driver is associated with the dynamics of the local cattle market, as well as with the increase of potential deforestation agents working in the region. Several studies for the Amazon biome[86],[87],[88] mention that deforestation rates may increase because of population growth and the need for more land for food, fuelwood, timber, or other forest products. The number of people and their socio-economic conditions both have a significant impact on deforestation. As agriculturally based population density increases near forested areas, the strongest relationship between population growth and deforestation occurs, as local people and young migrant families arrive at the forest frontier and clear the land to provide more area for subsistence farming. Therefore, besides addressing the population numbers, policies that impact the socio-economic conditions of the people are needed if deforestation is to be delayed or forests are to remain standing.

From the 2010 census and the 2020 estimate provided by IBGE[89], it is possible to note that the population has grown in both municipalities, São Félix do Araguaia and São José do Xingu, at a very similar rate and trend:

City	Population - 2010 census	Population - 2021 estimate
São José do Xingu	91,340	132,138
São Félix do Araguaia	10,625	11,934

1) Prices of timber logs and livestock per arroba:

As previously described on itens a) Cattle ranching and b) Timber logging, the prices of timber logs and arroba (livestock) are the main reason why the cattle herd

[86] ANGELSEN; KAIMOWITZ. Rethinking the Causes of Deforestation: Lessons from Economic Models. The World Bank Research Observer, vol. 14, no. 1 (February 1999), pp. 73–98. Available at < https://www.researchgate.net/publication/11117669_Rethinking_the_Causes_of_Deforestation_Lessons_from_Economic_Models>

[87] ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997 Available at < https://doi.org/10.1300/J091v07n01_03>

[88] MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003 Available at < https://www.prb.org/resources/population-growth-and-deforestation-a-critical-and-complex-relationship/>

[89] Available at <https://cidades.ibge.gov.br/brasil/mt/nova-marilandia/panorama> and <https://cidades.ibge.gov.br/brasil/mt/santo-afonso/panorama>

increased in the period, reaching over 519 thousand animals in 2019 in the municipalities composing the Reference Region.

Firewood and timber prices have much higher value than other products exploited in the region, as they are the only extraction activities carried out.

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[90]. Thus, this disparity promotes the purchase of newly forested areas, deforestation, and an increase in the creation of new pasturelands.

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

Thus, partly due to the expansion of globalization, deforestation rates in the Amazon Rainforest appear to be linked to the growth of the international market, especially of beef[91].

b) **Driver variables explaining the location of deforestation:**

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

1) Distance from deforested areas

The presence of “non-forest” is a driver variable predicting quantity and location of future deforestation. Forested areas are influenced by their proximity to areas that have already been deforested. The distance from previously deforested areas is one of the major causes of forest degradation in the Amazon biome and their spatio-temporal dynamics are highly influenced by annual deforestation patterns. In addition, forest fragmentation results from deforestation and disturbance, with subsequent edge effects extending deep into remaining forest areas[92],[93]. This driver was also analysed for the deforestation projection model, as mentioned throughout the present VCS PD.

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[90] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. Economia Verde: Desafios e Oportunidades, Campinas, v. 8, p.143-155, jun. 2011. Available at: < https://silo.tips/download/o-desmatamento-da-floresta-amazonica-causas-e-soluoes>

[91] Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. Conservation Biology 19(3):680-688. Available at < https://www.jstor.org/stable/3591054>

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

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

2) Roads, highways, access roads and navigable rivers

Access roads are means of communication, which influence the spatial distribution of the land-use. They have an influence on fragmentation, population densities, agriculture and pastureland. The possible creation of new access roads, added to the already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation[94],[95],[96]. It is broadly recognized that deforestation is accelerated in regions that have denser road networks[97].

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

3) Presence of protected areas, indigenous lands and settlements

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

- *Yamin* Settlement
- *Aymoré* Settlement

The analysis of the contribution of settlements to deforestation in the Amazon was carried out from the 2016 reference[98], due to the lack of in-depth literature updated until 2021.

Agrarian reform settlements have emerged as one of the main focuses of deforestation in the Amazon between 2007 and 2014. The analysis indicates that deforestation seems to be closely linked to some of the main categories of existing settlement projects in the Amazon, as these classifications group together modalities

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

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

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

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

[98] Available at < https://ipam.org.br/wp-content/uploads/2016/02/Desmatamento-nos-Assentamentos-da-Amaz%C3%B4nia.pdf>

with specific objectives, established to promote, either agricultural-based, or forest-based and extractive land uses[99].

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

This pattern indicates that the processes that affect the dynamics of forest clearing outside the settlements have repercussions within them, and that the strategies to encourage the reduction of deforestation in these settlements cannot be treated as isolated cases, distant from the local context of the territory in which they are inserted. It should be considered, however, that punitive strategies must be treated cautiously and in a surgical and educational manner within them, considering the impact that these sanctions may have on the food security of the real beneficiaries of agrarian reform. Thus, the importance of this carbon project and the socio-environmental actions to be applied as a way of mitigating deforestation is highlighted. The strategy is to detach the need for illegal deforestation as alternative income is generated in these communities, creating other economically productive strategies.

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

- Identification of underlying causes of deforestation

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

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

Due to being in a region of large cattle ranchers, miners and settlements, the reference region has a considerable social conflict issue, primarily land conflict. Land is occasionally illegally occupied by squatters and illegal loggers[100],[101],[102]. Thus, the main underlying causes of deforestation within the reference region are associated with land conflicts (tenure issues), and the lack of public policies promoting sustainable alternatives to combat deforestation and degradation activities.

The continued lack of resolution of land tenure issues contributes to reducing legal production options and continues to promote the expansion of deforestation associated with cattle farming and land speculation.

According to studies conducted in the region by Idesam, there is a pressing need for restructuring at a local level, which is lacking investment in infrastructure, equipment, and human resources to attend to strong land-tenure demand. The low presence of Governance and lack of land-tenure documentation, with thousands of rural producers owning non-documented properties, promotes a scenario of forest destruction for exploration of natural resources and creation of pastureland, driving the tendency for the frontier to grow[103].

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

From 2016 onwards, the impeachment on Brazil's president Dilma Rousseff wide opened the dismantling policy of the environmental agenda created by the new government (Michel Temer, May 12, 2016 to December 31, 2018) to gain the support of the ruralist bench, constituted by a coalition of parliamentarians of the Brazilian National Congress

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

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

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

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

with common interests, such as the advance of the livestock and agribusiness barrier in Brazil – and, consequently, the deforestation and the environmental policies that prevent it from occur. The Brazilian National Congress has approximately 500 parliamentarians, which means that obtaining support from the ruralist caucus (which has around 350 parliamentarians) guarantees a strategic advantage for the approval of provisional measures and decrees.

The 2017's federal government is marked by a series of acts against the environmental area, and such as Cutting budget and freezing investments in Brazilian science. The main ministries linked to Higher Education Institutions (Ministry of Education and Ministry of Science and Technology) suffered billionaire budget cuts, endangering scientific research and environmental monitoring bodies, as the largest network of biodiversity research in Brazil, the PPBio. Besides the budget cut, the Ministry of Science and Technology suffered another attack when it was merged with the Ministry of Communications, devaluing science by uniting two ministries with opposing goals and threatening the future of the country's scientific research. After the measure, which froze investments in education for the next 20 years, the National Council for Scientific and Technological Development (CNPq), the responsible body for financing most undergraduate and graduate research projects in the country, had a budget in 2017 lower than the equivalent of 2004. The scrapping of Brazilian scientific research bodies directly affects the monitoring and production of knowledge about the dynamics of deforestation and the influence of agribusiness in it.

In the Bolsonaro's pre-election period in 2018, the country was already discussing the threat of political bargaining to climate mitigation and the forest conservation in general. In exchange of political support, the government offered landholders to increase deforestation, and the signature of provisionary acts and decrees lowering environmental licensing requirements, suspending the ratification of indigenous lands, reducing the size of protected areas and facilitating land grabbers to obtain the deeds of illegally deforested areas[104].

In the beginning of 2019, the fusion of Environment and Agriculture Ministries was a clear attempt to obtain more rights for the expansion of agriculture and livestock. The decision was canceled a few days later, after pressure from environmentalists and others in the sector; however, major changes occurred in the ministerial office, limiting the reach and autonomy of the Environmental Ministry, with the absence of resources to combat deforestation[105].

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[104] Available in < https://epoca.oglobo.globo.com/ciencia-e-meio-ambiente/blog-do-planeta/noticia/2017/09/o-desmanche-ambiental-do-governo-temer.html>

[105] Available in <https://www.socioambiental.org/pt-br/blog/blog-do-isa/a-anatomia-do-desmonte-das-politicas-socioambientais>

In addition, the transference of policies and instruments of water resources, including the National Water Agency (ANA) to the Ministry of Regional Development[106] and the Brazilian Forest Service and the Rural Environmental Registry (main instrument for controlling the regularization of large and small properties in forest regions) to the Ministry of Agriculture, Livestock and Supply[107] demonstrated the dismantling of the Environment Ministry. Furthermore, the officialization of indigenous lands, in addition to other land tenure issues, such as the agrarian reform and land regularization in the legal Amazon and traditional territories have also been transferred to the Ministry of Agriculture, Livestock and Supply[108].

Therefore, the deforestation in the Amazon Rainforest was widely reported in 2019, as it was the third largest in history, with an increase of 29.5% in comparison to 2018. In total, 9,762 km^2 were deforested during that year[109]. In August, during the peak of fire warnings in the forest, fact that caused climate effects in São Paulo, 2,790 km away from the Amazon[110], the government tried to deviate attention from the fires, claiming they were fake news[111]. The number of fires in Brazilian forests increased 70% in 2019, the highest rate in 7 years. According to National Spatial Research Institute (INPE), the most affected biome was the Amazon, with 51.9%[112].

Also, during August, Germany and Norway announced the suspension of transfers to Amazon Programs after affirming that the Brazilian Government was not playing its part in fighting deforestation. The contribution to protecting the rainforest amounted to more than 133 million Brazilian reais, destined to the Amazon Fund[113].

Even though fire alerts increased in the period between 2019 and 2020, the Brazilian Government reduced the budget for forest fire prevention and control personnel. A

[106] Available in <https://oeco.org.br/reportagens/ana-muda-de-pasta-e-atribuicao-mas-incertezas-continuam/>

[107] Available in <https://oglobo.globo.com/brasil/bolsonaro-transfere-concessao-de-florestas-publicas-para-ministerio-da-agricultura-24427684>

[108] Available in <https://politica.estadao.com.br/noticias/geral,ministerio-da-agricultura-sera-responsavel-por-reforma-agraria-terras-indigenas-e-quilombos,70002663895>

[109] Available in <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294>

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

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

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

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

reduction of 58% reached the brigade teams, with budget ranging from 23.78 million reais in 2019 to 9.99 million in 2020[114].

In June 2020, investment funds that manage approximately 4 trillion US dollars in assets asked Brazilian government to suspend the deforestation in the Amazon Rainforest. In an open letter, they warned of the systematic, reputational, operation and regulatory risks of clients and projects in Brazil, in addition to the survival of the forest[115].

Government agencies such as INPE and IBAMA, responsible for deforestation monitoring have suffered funding cutoffs, dismissals and had their functions and increasing deforestation data publicly questioned and denied by the government[116].

The quantity of national parks protected areas and indigenous lands in the country was already questioned by Bolsonaro, that intended to extinguish those by decree[117], an unconstitutional action, after announcing the intention to review the protected areas' law (SNUC) and the existing units[118]. In addition, the Minister of the Environment speaks publicly, in a video released during investigations, of his intention to take advantage of the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and justice processes[119].

There are also several threats to the national environmental license process, which has existed since 1981, including from the Minister of the Economy, who wants to loosen the process to favor mining companies, even with the several recent cases of environmental crimes of breaches of poorly executed and maintained mining dams from companies in the country[120].

Specialists affirm that, with the current pace of dismantling of the inspection structure and environmental legislation demonstrated since the first 6 months of the current government, the forest destruction can reach an irreversible limit in 4 to 8 years. Recent

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

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

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

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

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

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

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

scientific research shows that if an area of 40% of the original forest gets deforested, the rest cannot sustain the functioning of the tropical rainforest, and in this scenario, part of the forest may not be able to sustain itself. The Amazon has so far lost approximately 20% of its original coverage[121]

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

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

Another important underlying agent of deforestation is the poverty and wealth inequality, also influenced by the political situation. According to statistics on the municipality of São Félix do Araguaia/MT[122], an average monthly salary of 2.8 minimum wages was reported in 2020, and the proportion of employed people compared to the total population was only 12.3%. Approximately 41.8% of the population in São Félix do Araguaia had a monthly per capita income of up to 0.5 minimum wage in 2010.

In São José do Xingu an average monthly salary of 2.6 minimum wages was reported in 2020, and the proportion of employed people compared to the total population was only 12.6%. Approximately 36.8% of the population in São José do Xingu had a monthly per capita income of up to 0.5 minimum wage in 2010[123].

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.

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

[122] Available at < https://cidades.ibge.gov.br/brasil/mt/sao-felix-do-araguaia/panorama

[123] Available at < https://cidades.ibge.gov.br/brasil/mt/sao-jose-do-xingu/panorama>

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

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

ANALYSIS OF CHAIN OF EVENTS LEADING TO DEFORESTATION

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

Most of the deforestation occurring in the Amazon region is related to the implementation of infrastructure projects, population increase and agricultural and cattle ranching activities, mainly in the region known as the "Brazilian arc of deforestation", where the present Project is located. The historical deforestation that occurred over the past decade within the Reference Region followed this same pattern. Additionally, several other subjacent causes related to political, economic and social issues lead to an increased pressure over the region, mainly in the last few years.

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

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

The recent history of polemics and anti-environmentalism actions of the Brazilian government, in addition to not tackling the direct causes, minimizing monitoring and restrictions in critical environmental areas, and no investments in sustainable management and farming methods end up influencing and even motivating deforestation, illegal occupation and non-compliance with environmental laws. The lack of strong environmental policies causes Brazilian laws to have gaps that are taken in advantage of by landowners, intensified by weakened controlling mechanisms that have been dismantled by the Government, making the conservation of the extensive Brazilian biomes even more difficult.

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

CONCLUSION

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

3.5 Additionality

The VCS Tool for the Demonstration and Assessment of Additionality in VCS Agricultural, Forestry and Other Land Use (AFOLU) Project Activities - VT0001 version 3.0[124] must be applied for all project activities instances.

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

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

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

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

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

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

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

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

a) AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced;
b) The applied baseline methodology provides a stepwise approach to justify determination of the most plausible baseline scenario, in accordance to VCS AFOLU Requirements.

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

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

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

Instance 1 (Marcélia Farm) and Instance 2 (Luciano Farm)

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

As there is no activity being held on Instance 1 and Instance 2 , 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 promoted by the SOCIALCARBON Standard, among others. These investments are usually not made by the Brazilian Government, nor are part of sustainable forest management plans, as they are financially unattractive and not necessary to legally perform the timber harvest.

Therefore, the economic feasibility of this scenario would be reduced without additional revenues from the sale of VCUs.

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

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

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

Scenario III – Cattle raising in the Amazon biome is legal as long the owner follows the 80% Legal Reserve and Permanent Preservation Areas restriction described in the Brazilian legislation. The landowner must also provide a deforestation authorization for clearing the area for pasture. This authorization is provided by the State's government, and in Amazonas is regulated by Law 3785, from 24th, 2012.

Sub-step 1c. Selection of the baseline scenario

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

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

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

Instance 1 and Instance 2 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.

The NPV comparison between the cattle ranching scenario and the project scenario (VCS AFOLU with financial benefits from VCUs) shows that the cattle ranching scenario is 186% more profitable than the project scenario.

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

STEP 4. Common practice analysis

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 Mato Grosso State 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[125]. As previously detailed, Mato Grosso is the main producer of cattle and agriculture in the country, and this sector represents most of the State and Brazil's GDP.

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

- **Private Reserve of Natural Heritage (RPPN)[126]:** it is a category of conservation unit created voluntarily by the landowner. When the area is categorized as RPPN, the owner is committed to nature conservation, without land expropriation. The benefits of the private reserve are preference in the analysis of applications to acquire rural credit, tax benefits and the possibility of cooperation with private and public entities in the protection and management of the land, but no revenue is generated as it is on REDD+ projects due to the sale of verified carbon units. In Mato Grosso State, there are 15 registered RPPNs and none of them are located in Santo Afonso or Nova Marilândia.

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

- **Payment for Environmental Services (PES)[127]:** 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 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.

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

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

Not applicable as no methodology deviations were performed.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

<u>Analysis of historical land-use and land-cover change</u>

- <u>Collection of appropriate data sources</u>

<u>GIS MAPPING, REMOTE SENSING TECHNIQUES</u>

To carry out the assessment of land use and land cover (LU/LC) for the baseline period (2007-2017), remote sensing satellite analysis was carried out, which is described below.

The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. The historical reference period for the present project during the assessment of the baseline period comprised analysis of images from 2007 - 2017. In accordance with the methodology, the analysis shall be made using the data obtained from monitoring LU/LC changes in the reference region during the historical reference period.

To map the dynamics of land use in the reference region, images from 2007 to 2016 produced by MapBiomas (collection 5.0) were used, made available in raster format on the program's website (http: //mapbioma .org/) and supervised classifications using Google Earth Engine for the period of September 2017. This classifier is the same one used in MapBiomas, allowing a closer approximation of the methodology.

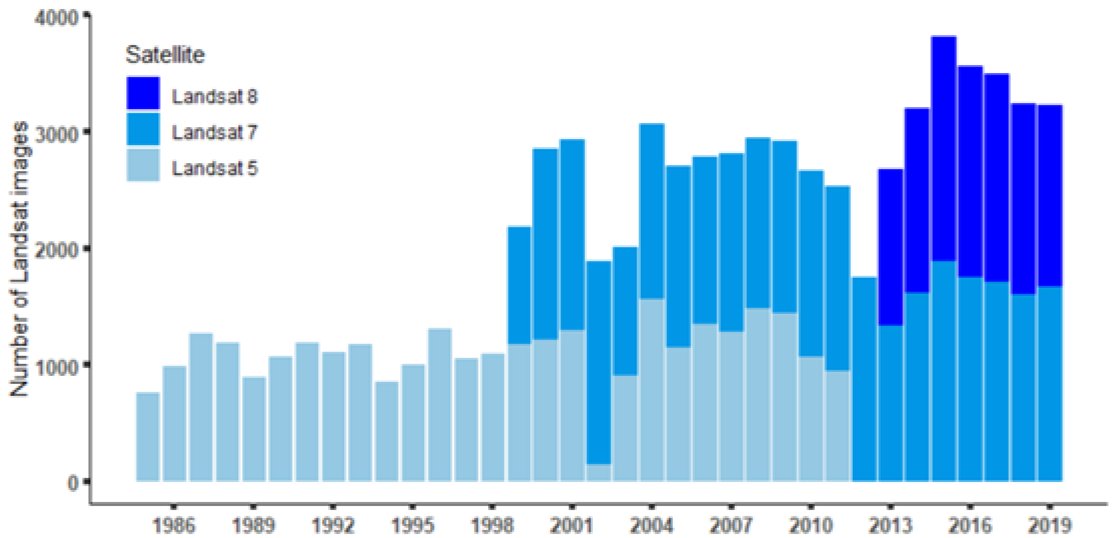
MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[128] promoted by the Climate Observatory. The MapBiomas creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

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

For the supervised classification of September 2017, 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 5% cloud cover limit were collected within the Reference Region and an average of these images was generated. Training samples were generated for each land use class (forest, water and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. Then the spatial filter with the Majority Filter tool from ArcGIS was applied using an 8-pixel neighborhood. This filter is used in MapBiomas in order to avoid unwanted modifications on the edges of pixel groups (blobs).

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

Figure 13. Number of Landsat images for mapping the Amazon. Source: MapBiomas



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

Following the VM00015 Methodology requirements, the LU/LC maps have been conducted using satellite images. There are 2 surveys available in Brazil for deforestation and forest mapping: INPE (PRODES) and Mapbiomas. However, none of them separates by forest classes.

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

Thus, definition of classes of land-use and land-cover was performed through MapBiomas' classification, which identifies forest, non-forest vegetation, anthropic uses (categorized as deforestation) and hydrography (lakes and rivers). For this map, the accuracy assessment has been conducted, which meets the methodology requirements.

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

Six vegetation types were found, and, according to this analysis, the Dense Lowland Tropical Rainforest is the main forest type present within the project area, with around 99% of the total forest cover. Thus, after verifying that most of the project boundaries were composed of only one phytophysiognomy (table 15), the mapping and modeling of the project proceeded without stratification.

In addition, the mean carbon stock within the project area calculated through weighed average with other forest classes showed a similarity of around 99.96% to the Dense Lowland Tropical Rainforest carbon stocks. Thus, due to the high representativeness of this forest type within the project area, and the very high similarity in terms of carbon stocks in relation to the mean, the forest class was not stratified, i.e., the "Forest" class includes just one stratum due to the low difference in average carbon stocks within the project area.

Table 7. Vegetation types found in the project boundaries

Forest class	Presence in the RR (%)	Presence in the PA (%)	Presence in the LB (%)
Dense Lowland Tropical Rainforest	93%	99%	89%
Dense Alluvial Tropical Rainforest	3%	1%	5%
Dense Tropical Rainforest	1%	0.32%	-
Dense Submontane Tropical Rainforest	2%	-	-

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

Satellite images were used to generate the land-use and land-cover map in 2020 shown in the figure below.

Figure 14. Land use and land cover map comparing 2007 and 2020

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

The main forest type present in RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[130]:

- **Dense Lowland Tropical Rainforest** – This type of vegetation is characterized by woody plants, in addition to woody lianas and epiphytes in abundance, which differentiate it from other classes of formations. However, its main ecological characteristic resides in the ombrophilous environments that mark the “floristic forest region”. Thus, the thermal characteristic of the Dense Ombrophylous Forest is linked to tropical climatic factors of high temperatures (averages of 25ºC) and high precipitation, well distributed throughout the year (from 0 to 60 dry days), which determines a bioecological situation with virtually no biologically dry period. The lowland rainforest is a formation that generally occupies the coastal plains. It occurs in the Amazon, extending throughout the Brazilian Northeast region to the vicinity of the São João River, in the State of Rio de Janeiro. Towards the south, this formation occurs in the Quaternary terrains located generally just above sea level, in the plains formed by silting due to erosion in the coastal mountains, and in the maritime inlets.

Figure 15. Dense Tropical Rainforest profile

[129] Available at https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/DQ-Degradacao-Florestal-Amazonia.pdf

[130] Available at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf

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

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

  It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map comparing 2007 with 2020. It is important to note that while the latter shows only deforestation from 2007–2020, the Tables below display deforestation across the whole crediting period.

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

Table 9. Land use change matrix in the reference region between 2010 and 2020

		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	8,760.95	0.00
	Non Forest in the PA	0.00	0.00

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	16,387.1	0.00
	Non Forest in the LK	0.00	0.00

PROJECT SCENARIO

	PA	Initial LU/LC class	
	IDcl	Forest	Non Forest in the PA
Final Class	Forest	8,760.95	0.00
	Non Forest in the PA	4,577.61	4,183.34

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	16,387.1	0.00
	Non Forest in the LK	8,736.93	7,650.17

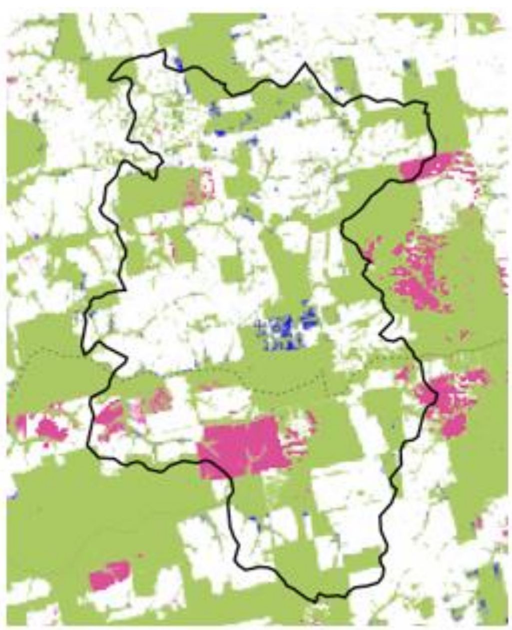
The Table below also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

Table 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

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

Figure 16. Deforestation dynamics, between the years 2007 and 2020, in the reference region and project area.



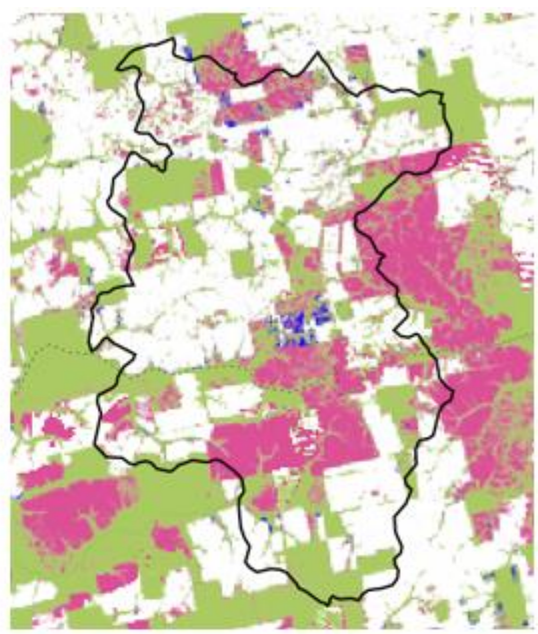


Table 11. Annual deforestation in the Reference Region between 2007-2017 (September-2007 to September-2017)

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2008	6,100.00	6,100.00
2009	6,770.00	670.00
2010	9,010.00	2,240.00
2011	9,311.00	301.00
2012	10,228.00	917.00
2013	11,508.00	1,280.00
2014	12,658.00	1,150.00
2015	13,603.00	945.00
2016	22,453.00	8,850.00
2017	27,383.00	4,930.00

Table 12. Annual deforestation in the Leakage Belt between 2007-2017 (September-2007 to September-2017)

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2008	252.00	252.00
2009	278.00	26.00
2010	708.00	430.00
2011	741.00	33.00
2012	966.00	225.00
2013	1,446.00	480.00
2014	2,080.00	634.00
2015	2,173.00	93.00

2016	5,293.00	3,120.00
2017	6,127.00	834.00

- Map accuracy assessment

The results of MapBiomas undergo an accuracy assessment, which for the entire Amazon Biome is on average 95%. However, to meet the particularities of the region, an independent evaluation was carried out for the reference region from the years 2007 to 2016.

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

For the supervised classification in September 2017, 300 random points were drawn over the RR, 100 in each of the classes (forest, hydrography and deforestation). It is noteworthy that for this year only deforestation classification information was considered.

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

Table 13. Summary of confusion matrices from the evaluation of MapBiomas from 2007 to 2017

Producer accuracy					User accuracy			
Year	Forest	Hydrography	Pioneer vegetation	Deforestation	Forest	Hydrography	Pioneer vegetation	Deforestation
2007	97.96%	97.96%	94.00%	92.31%	96.00%	96.00%	94.00%	96.00%
2008	97.78%	100.00%	94.23%	88.68%	88.00%	100.00%	98.00%	94.00%
2009	95.74%	98.04%	88.89%	89.58%	90.00%	100.00%	96.00%	86.00%
2010	97.62%	96.15%	90.38%	87.04%	82.00%	100.00%	94.00%	94.00%
2011	97.83%	98.04%	95.74%	85.71%	90.00%	100.00%	90.00%	96.00%
2012	91.67%	92.31%	85.45%	88.89%	88.00%	96.00%	94.00%	80.00%
2013	95.24%	96.15%	88.68%	81.13%	80.00%	100.00%	94.00%	86.00%
2014	93.88%	96.00%	96.08%	92.00%	92.00%	96.00%	98.00%	92.00%
2015	88.00%	92.45%	95.65%	86.27%	88.00%	98.00%	88.00%	88.00%

2016	97.62%	98.00%	85.71%	80.77%	82.00%	98.00%	96.00%	84.00%
2017	98.77%	95.15%		86.21%	80.00%	98.00%		100.00%

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

  As shown in sections above, and as per VM0015, the Historical Average (item a) was chosen as Baseline Approach, since the deforestation rates measured in different historical sub-periods in the reference region reveal a clear trend and this trend is a constant deforestation rate.

  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.

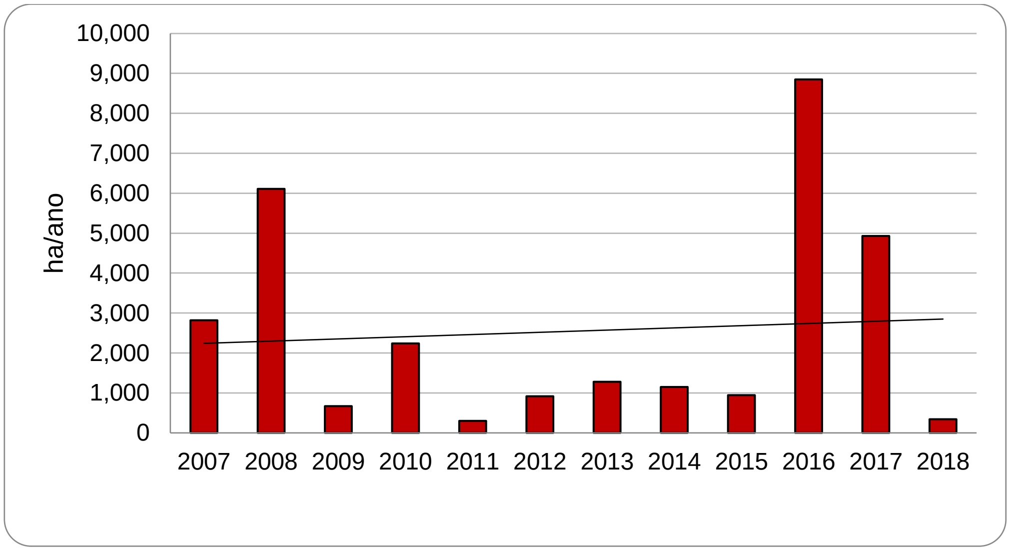
- Quantitative projection of future deforestation

  For the deforestation baseline, the average deforestation rate in the last 15 years was applied since the linear simple regression model was not representative (p-value 0.2540).

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

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

For the deforestation Figure 17. Variation in the deforestation rate in the reference region between the years 2007 and 2017. Source: Global Forest Watch



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 linear model, tables below show the results of the projection in reference region, leakage belt and Project area.

Table 14. 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
2020	187.954,95	3.571,14	3.571,14
2021	184.383,81	3.571,14	7.142,29
2021	180.812,66	3.571,14	10.713,43
2022	177.241,52	3.571,14	14.284,58
2023	173.670,37	3.571,14	17.855,72
2024	170.099,23	3.571,14	21.426,86
2025	166.528,09	3.571,14	24.998,01
2026	163.314,06	3.214,03	28.212,04
2027	160.100,03	3.214,03	31.426,07
2028	156.886,00	3.214,03	34.640,10
2029	153.671,97	3.214,03	37.854,13
2030	150.457,94	3.214,03	41.068,16
2031	147.243,91	3.214,03	44.282,19
2032	144.351,28	2.892,63	47.174,81
2033	141.458,65	2.892,63	50.067,44
2034	138.566,03	2.892,63	52.960,07
2035	135.673,40	2.892,63	55.852,69
2036	132.780,77	2.892,63	58.745,32
2037	129.888,15	2.892,63	61.637,95
2038	127.284,78	2.603,36	64.241,31
2039	124.681,42	2.603,36	66.844,67
2040	122.078,06	2.603,36	69.448,04
2041	119.474,69	2.603,36	72.051,40
2042	116.871,33	2.603,36	74.654,77
2043	114.267,96	2.603,36	77.258,13
2044	111.924,94	2.343,03	79.601,16
2045	109.581,91	2.343,03	81.944,19
2046	107.238,88	2.343,03	84.287,21
2047	104.895,85	2.343,03	86.630,24
2048	102.552,83	2.343,03	88.973,27
2049	100.209,80	2.343,03	91.316,30

Table 15. 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
2020	8.790,69	170,26	170,26
2021	8.620,43	170,26	340,52
2022	8.450,18	170,26	510,77
2023	8.279,92	170,26	681,03
2024	8.109,66	170,26	851,29
2025	7.939,40	170,26	1.021,55
2026	7.786,17	153,23	1.174,78
2027	7.632,94	153,23	1.328,01
2028	7.479,70	153,23	1.481,25
2029	7.326,47	153,23	1.634,48
2030	7.173,24	153,23	1.787,71
2031	7.020,01	153,23	1.940,94
2032	6.882,10	137,91	2.078,85
2033	6.744,19	137,91	2.216,76
2034	6.606,28	137,91	2.354,67
2035	6.468,37	137,91	2.492,58
2036	6.330,46	137,91	2.630,49
2037	6.192,55	137,91	2.768,40
2038	6.068,44	124,12	2.892,51
2039	5.944,32	124,12	3.016,63
2040	5.820,20	124,12	3.140,75
2041	5.696,08	124,12	3.264,87
2042	5.571,96	124,12	3.388,99
2043	5.447,85	124,12	3.513,10
2044	5.336,14	111,71	3.624,81
2045	5.224,43	111,71	3.736,52
2046	5.112,73	111,71	3.848,22
2047	5.001,02	111,71	3.959,93
2048	4.889,31	111,71	4.071,64
2049	4.777,61	111,71	4.183,34

Table 16. 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
2020	16.387,10	311,35	311,35
2021	16.075,75	311,35	622,71
2021	15.764,39	311,35	934,06
2022	15.453,04	311,35	1.245,42
2023	15.141,68	311,35	1.556,77
2024	14.830,33	311,35	1.868,13
2025	14.550,11	280,22	2.148,35
2026	14.269,89	280,22	2.428,57
2027	13.989,67	280,22	2.708,79
2028	13.709,45	280,22	2.989,01
2029	13.429,23	280,22	3.269,23
2030	13.149,01	280,22	3.549,45
2031	12.896,81	252,20	3.801,64
2032	12.644,61	252,20	4.053,84
2033	12.392,42	252,20	4.306,04
2034	12.140,22	252,20	4.558,24
2035	11.888,02	252,20	4.810,43
2036	11.635,82	252,20	5.062,63
2037	11.408,85	226,98	5.289,61
2038	11.181,87	226,98	5.516,59
2039	10.954,89	226,98	5.743,56
2040	10.727,91	226,98	5.970,54
2041	10.500,94	226,98	6.197,52
2042	10.273,96	226,98	6.424,50
2043	10.069,68	204,28	6.628,78
2044	9.865,40	204,28	6.833,06
2045	9.661,12	204,28	7.037,34
2046	9.456,84	204,28	7.241,62
2047	9.252,56	204,28	7.445,90
2048	9.048,28	204,28	7.650,18
2049	8.844,00	204,28	7.854,46

Projection of the location of future deforestation

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

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

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

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

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

Assigning weightings to change agents

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

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

Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created using Dinamica EGO Software[131], which modeling techniques are used for calibrating, running and validating space-time models.

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

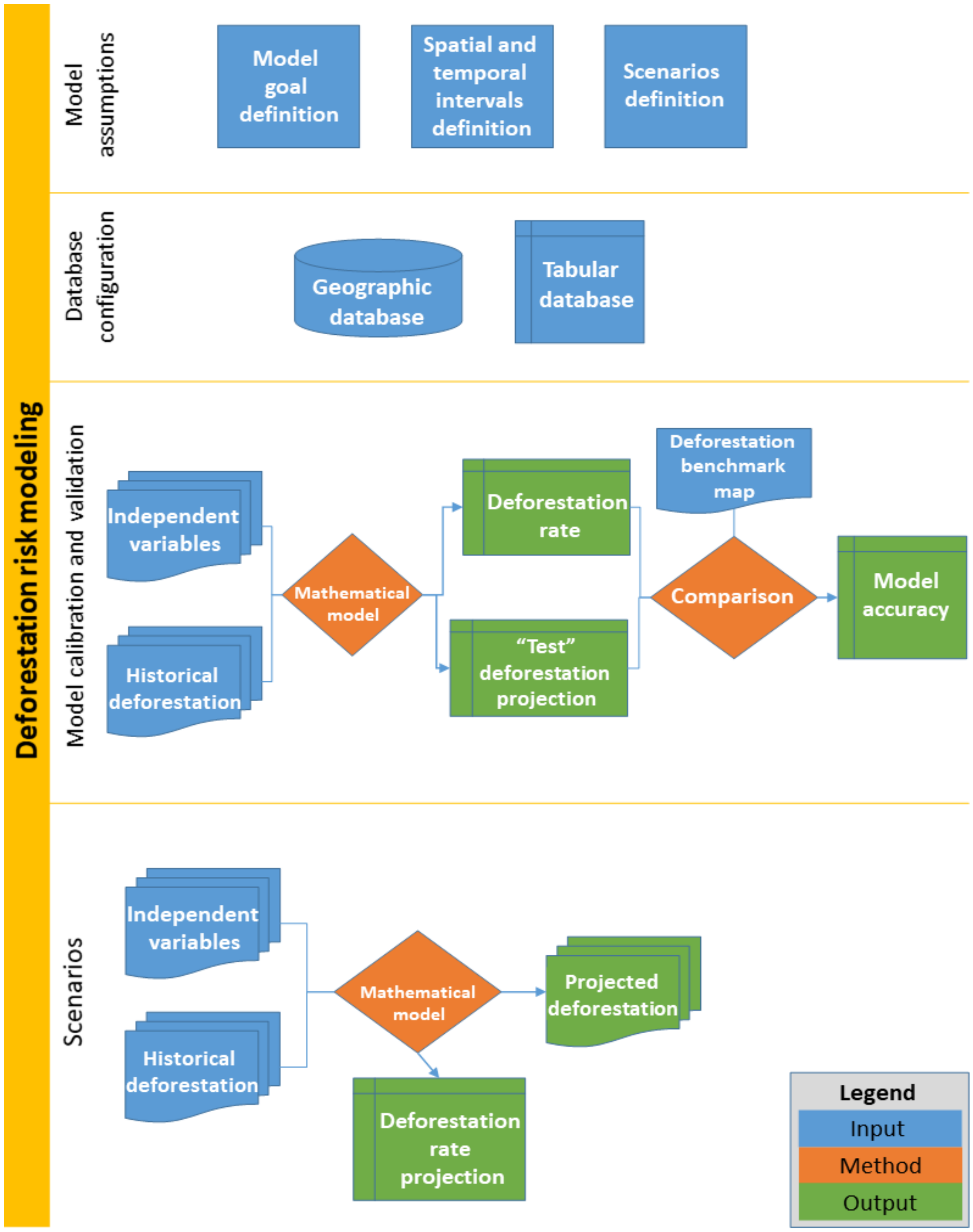
In addition, Dinamica EGO holds multiple transitions that can be calibrated employing the Weights of Evidence. This method calculates the influence of spatial determinants on the changes, producing as a result an integrated transition potential map, also known as the transition probability map.

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

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

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

Figure 18. 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 17. List of variables, maps and factor maps

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

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

Based on the weights of the evidence, the transition probability of each forest pixel to become other types of anthropic use is calculated. This probability is calculated based on the sum of all the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps[132].

[132] 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>.

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

Table 18. Variation of the weights of evidence according to deforestation distance ranges

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

Table 19. Variation of the weights of evidence according to the distance from roads

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

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

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

Table 21.Variation of the weights of evidence according to slope

Slope		Weight of evidence
0	2	-0.137
2	34	0.017

Table 22. Variation of the weights of evidence according to altitude

Altitude		Weight of evidence	Altitude		Weight of evidence
0	2	0.88	40	41	-0.25
2	3	-1.76	41	43	-0.43
3	4	-1.22	43	44	-0.65
4	6	-0.95	44	45	-0.93
6	8	-0.46	45	47	-1.19
8	10	0.01	47	50	-1.50
10	11	0.20	50	54	-1.51
11	12	0.48	54	59	-1.25
12	13	0.91	59	60	-0.93

13	15	0.64	60	66	-0.81
15	16	0.95	66	68	-0.51
16	19	0.58	68	74	-0.42
19	26	0.69	74	79	-0.24
26	27	1.06	79	80	0.56
27	28	0.75	80	82	0.35
28	30	0.47	82	90	0.49
30	33	0.45	90	96	0.72
33	35	0.16	96	97	1.07
35	37	-0.05	97	103	1.47
37	38	-0.22	103	140	1.98
38	40	-0.04			

Table 23. Variation of the weights of evidence according to Protected Areas categories

Protected areas	Weight of evidence
Outside protected areas	-0.06
Protected Areas within the Sustainable Use Category	0.68

It is important to highlight that the weight distribution reflects the trend analysed during the historical period. In this case, there is a greater chance of deforestation within the protected area compared to areas outside it because of the type of conservation unit analyzed - Extractive Reserve, which allows the sustainable use of the land. The weight is calculated according to the areas where there was deforestation in the historical analysis, therefore, this weight allows us to conclude that there was more deforestation within the conservation units than outside, hence the higher weight.

Table 24. Variation of the weights of evidence according to the presence of settlements

Settlements	Weight of evidence
Outside settlements	-0.34
Within settlements	0.97

Table 25. Variation of the weights of evidence according to distance from urban areas

Distance from urban areas		Weight of evidence
0	11000	1.00
11000	13000	1.50
13000	13500	2.08
13500	17500	1.44
17500	18000	0.89
18000	18500	0.46

Distance from urban areas		Weight of evidence
48500	49500	-0.17
49500	50000	-0.42
50000	53000	-0.44
53000	54500	-0.65
54500	55000	-1.04
55000	55500	-0.74

18500	19000	0.69	55500	56500	-1.00
19000	19500	0.05	56500	57000	-1.35
19500	21000	0.18	57000	57500	-0.90
21000	21500	0.68	57500	60500	-0.82
21500	22000	1.03	60500	61000	-0.53
22000	22500	0.77	61000	63500	-0.46
22500	23000	0.55	63500	64000	-0.68
23000	23500	0.22	64000	65000	-0.94
23500	24000	0.37	65000	68000	-0.86
24000	26000	0.15	68000	68500	-0.39
26000	28500	-0.03	68500	71500	-0.22
28500	29000	-0.31	71500	75000	-0.11
29000	29500	-0.68	75000	78500	-0.21
29500	30000	-0.90	78500	79000	-0.01
30000	31500	-0.74	79000	81500	0.23
31500	32000	-0.08	81500	82000	0.72
32000	32500	0.11	82000	85000	0.48
32500	33000	0.33	85000	85500	-0.23
33000	33500	0.14	85500	86500	-0.02
33500	36500	0.32	86500	87500	0.27
36500	41000	0.22	87500	88000	0.70
41000	45000	0.19	88000	92500	0.83
45000	48500	0.03	92500	101500	0.73

According to the analysis in Dinamica Ego for land use change modelling, all pixels should present multiple characteristics that can make it more or less prone to land use changes, which means that one pixel can be part of a settlement and, at the same time, of a protect area of sustainable use. Firstly, Dinamica calculates the weight of evidence for each variable alone, quantifying whether one class is more prone of deforestation than the other. Then, Dinamica sums up the weights of evidence for all the selected variables. Therefore, if one pixel is inside a setlement and also inside a protected area of sustainable use, it may receive a higher weight of evidence because it is in a setlement and receive a lower weight of evidence because it will be influenced by the fact that it is also a protected area. Therefore, one variable will balance with the other, and maybe one variable will neutralize the effect of the other, avoiding double counting.

Selection of most accurate deforestation risk map

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

For that, simulations of the deforestation projection were made, taking three dates as reference: 2007, 2014 and 2021. The period of 2007-2014 was used to generate the correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the models. After that a projection from 2014 to 2021 was made, developing a reference region scenario for this date. Therefore, the deforestation map for the period of 2014 to 2021 and two 2021 scenarios, real and projected, were developed. These scenarios were compared regarding the degree of similarity considering the exponential decay. The higher the similarity, the better the prediction of the model. The average similarity values of the models ranged between 0.163 and 0.217, as presented in table below.

Table 26. Best deforestation projection models from 2014 to December 2019. Each line corresponds to a model and was evaluated by the degree of Similarity.

Model	Similarity 1	Similarity 2	Average	Settlement	Distance from roads	Distance from rivers	Distance from urban areas	Slope	Altitude
m00	0.176	0.243	0.210	1	1	1	1	1	1
m01	0.156	0.250	0.203	0	1	1	1	1	1
m02	0.179	0.250	0.214	1	0	1	1	1	1
m03	0.163	0.235	0.199	1	1	0	1	1	1
m04	0.120	0.206	0.163	1	1	1	0	1	1
m05	0.180	0.252	0.216	1	1	1	1	0	1
m06	0.167	0.251	0.209	1	1	1	1	1	0
m07	0.171	0.224	0.197	0	0	0	1	0	0
m08	0.149	0.237	0.193	0	0	1	1	0	0
m09	0.177	0.256	0.217	1	0	1	1	0	0
m10	0.180	0.251	0.215	1	0	1	1	0	1

m11	0.177	0.253	0.215	1	1	1	1	0	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 m06). Therefore, the most important variables were those in which their absence caused a greater drop in the degree of similarity between the real and projected deforestation maps.

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

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

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 0.72[133].

<u>Definition of the Land-Use and Land-Cover Change Component of the Baseline</u>

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

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

[133] 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.

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

Area deforested per florest 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		
2020	187.954,95	3.571,14	3.571,14
2021	184.383,81	3.571,14	7.142,29
2021	180.812,66	3.571,14	10.713,43
2022	177.241,52	3.571,14	14.284,58
2023	173.670,37	3.571,14	17.855,72
2024	170.099,23	3.571,14	21.426,86
2025	166.528,09	3.571,14	24.998,01
2026	163.314,06	3.214,03	28.212,04
2027	160.100,03	3.214,03	31.426,07
2028	156.886,00	3.214,03	34.640,10
2029	153.671,97	3.214,03	37.854,13
2030	150.457,94	3.214,03	41.068,16
2031	147.243,91	3.214,03	44.282,19
2032	144.351,28	2.892,63	47.174,81
2033	141.458,65	2.892,63	50.067,44
2034	138.566,03	2.892,63	52.960,07
2035	135.673,40	2.892,63	55.852,69
2036	132.780,77	2.892,63	58.745,32
2037	129.888,15	2.892,63	61.637,95
2038	127.284,78	2.603,36	64.241,31
2039	124.681,42	2.603,36	66.844,67
2040	122.078,06	2.603,36	69.448,04

2041	119.474,69	2.603,36	72.051,40
2042	116.871,33	2.603,36	74.654,77
2043	114.267,96	2.603,36	77.258,13
2044	111.924,94	2.343,03	79.601,16
2045	109.581,91	2.343,03	81.944,19
2046	107.238,88	2.343,03	84.287,21
2047	104.895,85	2.343,03	86.630,24
2048	102.552,83	2.343,03	88.973,27
2049	100.209,80	2.343,03	91.316,30

Table 28. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)

Area deforested per florest 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		
2020	8.790,69	170,26	170,26
2021	8.620,43	170,26	340,52
2022	8.450,18	170,26	510,77
2023	8.279,92	170,26	681,03
2024	8.109,66	170,26	851,29
2025	7.939,40	170,26	1.021,55
2026	7.786,17	153,23	1.174,78
2027	7.632,94	153,23	1.328,01
2028	7.479,70	153,23	1.481,25
2029	7.326,47	153,23	1.634,48
2030	7.173,24	153,23	1.787,71
2031	7.020,01	153,23	1.940,94
2032	6.882,10	137,91	2.078,85
2033	6.744,19	137,91	2.216,76
2034	6.606,28	137,91	2.354,67
2035	6.468,37	137,91	2.492,58
2036	6.330,46	137,91	2.630,49
2037	6.192,55	137,91	2.768,40
2038	6.068,44	124,12	2.892,51
2039	5.944,32	124,12	3.016,63
2040	5.820,20	124,12	3.140,75
2041	5.696,08	124,12	3.264,87
2042	5.571,96	124,12	3.388,99
2043	5.447,85	124,12	3.513,10
2044	5.336,14	111,71	3.624,81
2045	5.224,43	111,71	3.736,52
2046	5.112,73	111,71	3.848,22
2047	5.001,02	111,71	3.959,93
2048	4.889,31	111,71	4.071,64
2049	4.777,61	111,71	4.183,34

Table 29. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

Area deforested per florest 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		
2020	16.387,10	311,35	311,35
2021	16.075,75	311,35	622,71
2021	15.764,39	311,35	934,06
2022	15.453,04	311,35	1.245,42
2023	15.141,68	311,35	1.556,77
2024	14.830,33	311,35	1.868,13
2025	14.550,11	280,22	2.148,35
2026	14.269,89	280,22	2.428,57
2027	13.989,67	280,22	2.708,79
2028	13.709,45	280,22	2.989,01
2029	13.429,23	280,22	3.269,23
2030	13.149,01	280,22	3.549,45
2031	12.896,81	252,20	3.801,64
2032	12.644,61	252,20	4.053,84
2033	12.392,42	252,20	4.306,04
2034	12.140,22	252,20	4.558,24
2035	11.888,02	252,20	4.810,43
2036	11.635,82	252,20	5.062,63
2037	11.408,85	226,98	5.289,61
2038	11.181,87	226,98	5.516,59
2039	10.954,89	226,98	5.743,56
2040	10.727,91	226,98	5.970,54
2041	10.500,94	226,98	6.197,52
2042	10.273,96	226,98	6.424,50
2043	10.069,68	204,28	6.628,78
2044	9.865,40	204,28	6.833,06
2045	9.661,12	204,28	7.037,34
2046	9.456,84	204,28	7.241,62
2047	9.252,56	204,28	7.445,90
2048	9.048,28	204,28	7.650,18
2049	8.844,00	204,28	7.854,46

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.

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 30. 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
2020	187.954,95	3.571,14	3.571,14
2021	184.383,81	3.571,14	7.142,29
2021	180.812,66	3.571,14	10.713,43
2022	177.241,52	3.571,14	14.284,58
2023	173.670,37	3.571,14	17.855,72
2024	170.099,23	3.571,14	21.426,86
2025	166.528,09	3.571,14	24.998,01
2026	163.314,06	3.214,03	28.212,04
2027	160.100,03	3.214,03	31.426,07
2028	156.886,00	3.214,03	34.640,10
2029	153.671,97	3.214,03	37.854,13
2030	150.457,94	3.214,03	41.068,16
2031	147.243,91	3.214,03	44.282,19
2032	144.351,28	2.892,63	47.174,81
2033	141.458,65	2.892,63	50.067,44
2034	138.566,03	2.892,63	52.960,07
2035	135.673,40	2.892,63	55.852,69
2036	132.780,77	2.892,63	58.745,32
2037	129.888,15	2.892,63	61.637,95
2038	127.284,78	2.603,36	64.241,31

2039	124.681,42	2.603,36	66.844,67
2040	122.078,06	2.603,36	69.448,04
2041	119.474,69	2.603,36	72.051,40
2042	116.871,33	2.603,36	74.654,77
2043	114.267,96	2.603,36	77.258,13
2044	111.924,94	2.343,03	79.601,16
2045	109.581,91	2.343,03	81.944,19
2046	107.238,88	2.343,03	84.287,21
2047	104.895,85	2.343,03	86.630,24
2048	102.552,83	2.343,03	88.973,27
2049	100.209,80	2.343,03	91.316,30

Table 31. 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
2020	8.790,69	170,26	170,26
2021	8.620,43	170,26	340,52
2022	8.450,18	170,26	510,77
2023	8.279,92	170,26	681,03
2024	8.109,66	170,26	851,29
2025	7.939,40	170,26	1.021,55
2026	7.786,17	153,23	1.174,78
2027	7.632,94	153,23	1.328,01
2028	7.479,70	153,23	1.481,25
2029	7.326,47	153,23	1.634,48
2030	7.173,24	153,23	1.787,71
2031	7.020,01	153,23	1.940,94
2032	6.882,10	137,91	2.078,85
2033	6.744,19	137,91	2.216,76
2034	6.606,28	137,91	2.354,67
2035	6.468,37	137,91	2.492,58
2036	6.330,46	137,91	2.630,49
2037	6.192,55	137,91	2.768,40
2038	6.068,44	124,12	2.892,51
2039	5.944,32	124,12	3.016,63
2040	5.820,20	124,12	3.140,75

2041	5.696,08	124,12	3.264,87
2042	5.571,96	124,12	3.388,99
2043	5.447,85	124,12	3.513,10
2044	5.336,14	111,71	3.624,81
2045	5.224,43	111,71	3.736,52
2046	5.112,73	111,71	3.848,22
2047	5.001,02	111,71	3.959,93
2048	4.889,31	111,71	4.071,64
2049	4.777,61	111,71	4.183,34

Table 32. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

Leakage Belt			
Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	*$ABSLLK_t$*	*ABSLLK*
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2020	16.387,10	311,35	311,35
2021	16.075,75	311,35	622,71
2021	15.764,39	311,35	934,06
2022	15.453,04	311,35	1.245,42
2023	15.141,68	311,35	1.556,77
2024	14.830,33	311,35	1.868,13
2025	14.550,11	280,22	2.148,35
2026	14.269,89	280,22	2.428,57
2027	13.989,67	280,22	2.708,79
2028	13.709,45	280,22	2.989,01
2029	13.429,23	280,22	3.269,23
2030	13.149,01	280,22	3.549,45
2031	12.896,81	252,20	3.801,64
2032	12.644,61	252,20	4.053,84
2033	12.392,42	252,20	4.306,04
2034	12.140,22	252,20	4.558,24
2035	11.888,02	252,20	4.810,43
2036	11.635,82	252,20	5.062,63
2037	11.408,85	226,98	5.289,61
2038	11.181,87	226,98	5.516,59

2039	10.954,89	226,98	5.743,56
2040	10.727,91	226,98	5.970,54
2041	10.500,94	226,98	6.197,52
2042	10.273,96	226,98	6.424,50
2043	10.069,68	204,28	6.628,78
2044	9.865,40	204,28	6.833,06
2045	9.661,12	204,28	7.037,34
2046	9.456,84	204,28	7.241,62
2047	9.252,56	204,28	7.445,90
2048	9.048,28	204,28	7.650,18
2049	8.844,00	204,28	7.854,46

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,

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

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

Where,

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

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

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

Where,

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

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

Where,

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

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

Where,

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

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

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

- The data is less than 10 years old;

- The data are derived from multiple measurement plots;
- All species above a minimum diameter are included in the inventories;
- The minimum diameter for trees included is 30 cm or less at breast height (DBH);
- Data is sampled from good coverage of the classes over which they will be extrapolated.

Project carbon stocks were calculated on the basis of biomass values from the study from FAO,2020[134] and Higuchi, 2015[135]. Both studies fulfil the criteria mentioned above.

The classification of the Brazilian vegetation is still constantly updated and studied, being evaluated and subdivided according to biological, geological or biodiversity characteristics.

Pires & Prance (1985)[136] classified the forest formation of the Amazon biome into two major groups, Forest on terra firme (dense forest) and Várzeas and igapós forests, and their respective subdivisions. The authors classify that terra firme forests dominate the largest percentage of area in the Amazon. Most of it consist of low-lying undulating terrain, rarely above 200 m, and most below 100 m.

The IBGE “Technical Manual for Brazilian Vegetation” (1992)[137] divides forestry formation into two types: Ombrophilous and Seasonal, being Ombrophilous, open and dense, predominant in the Brazilian Amazon.

Thus, it can be concluded that the general definition of Dense Ombrophylous rainforest is similar to the definition of terra firme forests, as described by Higuchi.

Therefore, the Higuchi’s study of volume and biomass dynamics of the Amazonian forest was adopted to define the carbon stock of two categories of dense tropical rainforest (submontane and tropical) located in PA, RR and LK. It is important to highlight that the two types of vegetation are characterized as Dense Ombrophylous Forest.

This choice was motivated by the focus of the study, which covered upland forests and the same phytophysiognomy, despite focusing on the State of Amazonas, the study

134 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.

135 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. Available at: <https://acervodigital.ufpr.br/bitstream/handle/1884/41822/R%20-%20T%20-%20FRANCISCO%20GASPARETTO%20HIGUCHI.pdf?sequence=1&isAllowed=y>

136 Pires & Prance (J.M.Pires, & Prance, G.T.. (1985). The vegetation types of the Brazilian Amazon. Available at <https://www.researchgate.net/publication/259688522_The_vegetation_types_of_the_Brazilian_Amazon>.

137 Manual Técnico da Vegetação Brasileira – IBGE, 1992. Available at <https://biblioteca.ibge.gov.br/visualizacao/monografias/GEBIS%20-%20RJ/ManuaisdeGeociencias/Manual%20Tecnico%20da%20Vegetacao%20Brasileira%20n.1.pdf>.

covered a large number of sample plots and low uncertainty, with a confidence interval of 95%.

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.

For the other phytophysiognomies, identified in the project area, reference region and leakage belt, Open Submontane Tropical Rainforest, Open Tropical Rainforest, Seasonal Parkland Savannah, Open Alluvial Tropical Rainforest, Seasonal Forested Savannah, Dense Alluvial Tropical Rainforest, Contact between Savannah and Rainforest, the FAO report was used.

The methodology of both studies is summarized below:

HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015.

The research was conducted in 11 locations distributed in 12 different municipalities in the State of Amazonas. All plots were allocated in areas of mature upland forests. None of the sampled areas has shown any clear sign of human disturbance in the past 50 years.

Regarding the sampling method, permanent plots were used, in addition to the standard EMBRAPA method.

EMBRAPA Method: 18 square plots of 1 ha (100 m x 100 m) each were installed and measured, randomly distributed over an area of 4 km² (2,000 m x 2,000 m). Each plot of 1 ha was subdivided into 100 units of 100 m², dimensioned in 10 m x 10 m. In each plot, the DBHs of all trees with a diameter greater than or equal to 10 cm were identified and measured. Dead trees and palm trees were not sampled in this location. Trees with DBH between 5 and 10 cm were sampled in ten subsamples randomly distributed in the 1 ha plot.

Permanent plots method: rectangular units with 2,500 m² were installed (¼ ha), dimensioned in 20 m x 125 m, according to the work of Higuchi et al. (1982), Higuchi, 1986-87 and Oliveira et al. (2014). Each sample unit had two sub-plots of 100 m² (10 mx 10 m) at the ends, one at the beginning of the left side and another at the end of the right side of the central path, for the measurement of natural regeneration (RN) (trees with DBH greater than or equal to 5 cm and less than 10 cm). The access path of each plot was arranged in the center of it, dividing it into two sides of 10 m each.

The sampling process adopted was mixed, where the sampling point of the first parcel was randomly drawn and the following parcels were systematically allocated from the first sampling unit.

The estimates of biomass were calculated using the equations adjusted by Silva (2007), in Manaus. The transformation to dry biomass considered the values of water and carbon in the wood determined by Silva (2007). A correction factor (fc) was applied for the use of these equations in different locations according to the dominant height of the sampled site. The equations used were:

Figure 19. Biomass Table 33. Biomass values used for the "forest" classes within the reference region and correction equations used in Higuchi (2015)

$$BStot = 2{,}7179 \times DAP^{1{,}8774} \times 0{,}584 \times fc \text{, onde } R^2 = 0{,}94 \text{ e } Syx\% = 3{,}91.$$

$$AGB = 2{,}2737 \times DAP^{1{,}9156} \times 0{,}584 \times fc \text{, onde } R^2 = 0{,}85 \text{ e } Syx\% = 4{,}20.$$

$$BGB = 0{,}0469 \times DAP^{2{,}4754} \times 0{,}533 \times fc \text{, onde } R^2 = 0{,}95 \text{ e } Syx\% = 5{,}12.$$

$$fc = \frac{Hdom_i}{Hdom_{ZF2}}$$

Considering a minimum DBH of 5 cm and the arithmetic mean of the estimated averages for each site, the aboveground dry biomass (AGB) of terra firme forests in the state of Amazonas is 327.4 t.ha-1 (± 24.2). This value was used for phytophysiognomies of Dense Ombrophilous Forest (Dense Tropical Rainforest).

According to the applied methodology, as the uncertainty of the total average carbon stock is less than 10% of the average value, the average carbon stock value can be used.

FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020 – Brazil Report, Rome, 2020.

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 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 OWL categories.

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 40 were used.

Table 34. Biomass to CO2 conversion factors[138]

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

Table 35. Biomass values used for the "forest" classes within the reference region.

REFERENCE REGION									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{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)
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

Table 36. Biomass values used for the "forest" classes within the project area.

REFERENCE REGION									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass	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)

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

	(Mg ha-1)								
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

Table 37. Biomass values used for the "forest" classes within the leakage belt.

REFERENCE REGION									
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)
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

Average carbon stocks of post-deforestation classes

Fearnside (1996)139 is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO2e/ha. It is important to note that no sampling was applied to calculate this data.

Table 38. 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	

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

Following a literature review, the use of Fearnside (1996) value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory140, the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used.

<u>Uncertainty assessment</u>

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

Higuchi (2015), for the Dense tropical and submontane rainforest, was conducted at a 95% confidence interval and present an uncertainty level less than 10% of the average carbon stock value.

<u>Carbon stock change factors</u>

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

a) Above-ground biomass:

- Initial forest classes (icl): immediate release of 100% of the carbon stock is assumed to happen during year t = t* (year in which deforestation occurs).
- Post-deforestation classes (fcl): linear increase from 0 tCO_2e/ha in year t = t* to 100% of the long-term average carbon stock in year t = t*+9 is assumed to happen in the 10-years period following deforestation (i.e. 1/10th of the final carbon stock is accumulated each year).

b) Below-ground biomass:

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

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

- Post-deforestation classes (fcl): linear increase from 0 tCO_2e/ha in year t = t* to 100% of the long-term average carbon stock in year t = t*+9 is assumed to happen in the 10 years period following deforestation (i.e. 1/10th 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 39. 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*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
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 40. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41

4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
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 41. 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*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
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 42. 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*	-600.23
2	t*+1	0
2	t*+2	0
4	t*+3	0
5	t*+4	0
6	t*+5	0
7	t*+6	0
8	t*+7	0
9	t*+8	0
10	t*+9	0
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 43. 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
2020	2,143,520	2,143,520	2,143,520
2021	2,143,520	2,143,520	4,287,039
2022	2,143,520	2,143,520	6,430,559
2023	2,143,520	2,143,520	8,574,079
2024	2,143,520	2,143,520	10,717,598
2025	2,143,520	2,143,520	12,861,118
2026	1,929,168	1,929,168	14,790,286
2027	1,929,168	1,929,168	16,719,454
2028	1,929,168	1,929,168	18,648,621
2029	1,929,168	1,929,168	20,577,789
2030	1,929,168	1,929,168	22,506,957
2031	1,929,168	1,929,168	24,436,125
2032	1,736,251	1,736,251	26,172,375
2033	1,736,251	1,736,251	27,908,626
2034	1,736,251	1,736,251	29,644,877

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
2020	51,444	51,444	51,444
2021	102,889	102,889	154,333
2022	154,333	154,333	308,667
2023	205,778	205,778	514,445
2024	257,222	257,222	771,667
2025	308,667	308,667	1,080,334
2026	354,967	354,967	1,435,301
2027	401,267	401,267	1,836,568
2028	447,567	447,567	2,284,135
2029	493,867	493,867	2,778,002
2030	488,722	488,722	3,266,724
2031	483,578	483,578	3,750,302
2032	473,804	473,804	4,224,106
2033	464,029	464,029	4,688,135
2034	454,255	454,255	5,142,389

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_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0
2021	18,623	18,623	961,527
2022	37,246	37,246	2,865,959
2023	55,869	55,869	5,694,673
2024	74,491	74,491	9,429,045
2025	93,114	93,114	14,050,454
2026	111,737	111,737	19,540,276
2027	128,498	128,498	25,881,750
2028	145,258	145,258	33,058,116
2029	162,019	162,019	41,052,613
2030	178,779	178,779	49,848,482
2031	176,917	176,917	58,467,433
2032	175,055	175,055	66,911,330
2033	171,516	171,516	75,183,710
2034	167,978	167,978	83,288,111

Project year	Total net carbon stock change in the reference region	
	$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
	annual	cumulative
	tCO_2e	tCO_2e
2020	1,306,166	1,306,166
2021	4,353,235	5,659,401
2022	6,072,598	11,731,999
2023	6,496,488	18,228,487
2024	6,911,353	25,139,840
2025	7,316,134	32,455,974
2026	7,710,187	40,166,161
2027	8,092,806	48,258,967
2028	8,463,228	56,722,195
2029	8,820,892	65,543,087
2030	9,134,570	74,677,657
2031	9,374,967	84,052,624
2032	9,588,735	93,641,359
2033	9,794,556	103,435,915
2034	9,980,591	113,416,506

2035	1,736,251	1,736,251	31,381,128	2035	444,480	444,480	5,586,870	2035	164,440	164,440	91,228,073	10,146,913	123,563,419
2036	1,736,251	1,736,251	33,117,379	2036	439,850	439,850	6,026,720	2036	160,901	160,901	99,007,134	10,293,542	133,856,961
2037	1,736,251	1,736,251	34,853,630	2037	435,220	435,220	6,461,940	2037	159,225	159,225	106,626,969	10,420,563	144,277,524
2038	1,562,626	1,562,626	36,416,256	2038	426,423	426,423	6,888,363	2038	157,549	157,549	114,089,255	10,527,909	154,805,432
2039	1,562,626	1,562,626	37,978,882	2039	417,626	417,626	7,305,990	2039	154,365	154,365	121,397,176	10,615,889	165,421,321
2040	1,562,626	1,562,626	39,541,508	2040	408,829	408,829	7,714,819	2040	151,180	151,180	128,553,916	10,684,824	176,106,145
2041	1,562,626	1,562,626	41,104,134	2041	400,032	400,032	8,114,851	2041	147,996	147,996	135,562,661	10,734,878	186,841,023
2042	1,562,626	1,562,626	42,666,760	2042	395,865	395,865	8,510,716	2042	144,811	144,811	142,426,595	10,766,439	197,607,462
2043	1,562,626	1,562,626	44,229,385	2043	391,698	391,698	8,902,415	2043	143,303	143,303	149,147,225	10,779,951	208,387,413
2044	1,406,363	1,406,363	45,635,749	2044	383,781	383,781	9,286,195	2044	141,794	141,794	155,726,061	10,775,764	219,163,177
2045	1,406,363	1,406,363	47,042,112	2045	375,864	375,864	9,662,059	2045	138,928	138,928	162,165,969	10,754,494	229,917,672
2046	1,406,363	1,406,363	48,448,475	2046	367,946	367,946	10,030,005	2046	136,062	136,062	168,469,815	10,716,607	240,634,279
2047	1,406,363	1,406,363	49,854,839	2047	360,029	360,029	10,390,034	2047	133,196	133,196	174,640,464	10,662,624	251,296,903
2048	1,406,363	1,406,363	51,261,202	2048	356,279	356,279	10,746,313	2048	130,330	130,330	180,680,783	10,593,238	261,890,140
2049	1,406,363	1,406,363	52,667,565	2049	352,528	352,528	11,098,841	2049	128,973	128,973	186,592,129	10,509,034	272,399,175

Table 44. Baseline carbon stock change in the Project Area

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the project area		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area		Total net carbon stock change in the project area	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$	ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$	ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$	$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	Year	tCO_2e	tCO_2e	tCO_2e	Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	102,195	102,195	102,195	2020	2,453	2,453	2,453	2020	0	0	0	104,647	104,647

2021	102,195	102,195	204,389
2022	102,195	102,195	306,584
2023	102,195	102,195	408,778
2024	102,195	102,195	510,973
2025	102,195	102,195	613,167
2026	91,975	91,975	705,142
2027	91,975	91,975	797,118
2028	91,975	91,975	889,093
2029	91,975	91,975	981,068
2030	91,975	91,975	1,073,043
2031	91,975	91,975	1,165,018
2032	82,778	82,778	1,247,796
2033	82,778	82,778	1,330,573
2034	82,778	82,778	1,413,351
2035	82,778	82,778	1,496,128
2036	82,778	82,778	1,578,906
2037	82,778	82,778	1,661,683
2038	74,500	74,500	1,736,183
2039	74,500	74,500	1,810,683
2040	74,500	74,500	1,885,183
2041	74,500	74,500	1,959,683
2042	74,500	74,500	2,034,183
2043	74,500	74,500	2,108,682
2044	67,050	67,050	2,175,732
2045	67,050	67,050	2,242,782
2046	67,050	67,050	2,309,832
2047	67,050	67,050	2,376,882
2048	67,050	67,050	2,443,932
2049	67,050	67,050	2,510,982
2050	67,050	67,050	2,578,031

2021	4,905	4,905	7,358
2022	7,358	7,358	14,716
2023	9,811	9,811	24,527
2024	12,263	12,263	36,790
2025	14,716	14,716	51,506
2026	16,923	16,923	68,429
2027	19,131	19,131	87,560
2028	21,338	21,338	108,899
2029	23,546	23,546	132,444
2030	23,300	23,300	155,745
2031	23,055	23,055	178,800
2032	22,589	22,589	201,389
2033	22,123	22,123	223,512
2034	21,657	21,657	245,169
2035	21,191	21,191	266,360
2036	20,970	20,970	287,330
2037	20,750	20,750	308,080
2038	20,330	20,330	328,410
2039	19,911	19,911	348,321
2040	19,491	19,491	367,812
2041	19,072	19,072	386,884
2042	18,873	18,873	405,757
2043	18,675	18,675	424,432
2044	18,297	18,297	442,729
2045	17,920	17,920	460,649
2046	17,542	17,542	478,191
2047	17,165	17,165	495,356
2048	16,986	16,986	512,342
2049	16,807	16,807	529,149
2050	16,628	16,628	545,777

2021	888	888	888
2022	1,776	1,776	2,664
2023	2,664	2,664	5,327
2024	3,551	3,551	8,879
2025	4,439	4,439	13,318
2026	5,327	5,327	18,645
2027	6,126	6,126	24,771
2028	6,925	6,925	31,697
2029	7,724	7,724	39,421
2030	8,523	8,523	47,945
2031	8,435	8,435	56,379
2032	8,346	8,346	64,725
2033	8,177	8,177	72,903
2034	8,009	8,009	80,911
2035	7,840	7,840	88,751
2036	7,671	7,671	96,422
2037	7,591	7,591	104,013
2038	7,511	7,511	111,525
2039	7,360	7,360	118,884
2040	7,208	7,208	126,092
2041	7,056	7,056	133,148
2042	6,904	6,904	140,052
2043	6,832	6,832	146,884
2044	6,760	6,760	153,644
2045	6,624	6,624	160,268
2046	6,487	6,487	166,754
2047	6,350	6,350	173,105
2048	6,214	6,214	179,318
2049	6,149	6,149	185,467
2050	6,084	6,084	191,551

106,212	210,859
107,777	318,636
109,342	427,978
110,906	538,884
112,471	651,355
103,571	754,927
104,980	859,906
106,388	966,294
107,796	1,074,091
106,752	1,180,843
106,595	1,287,438
97,021	1,384,459
96,723	1,481,182
96,426	1,577,608
96,129	1,673,737
96,077	1,769,814
95,936	1,865,750
87,319	1,953,069
87,051	2,040,120
86,784	2,126,903
86,516	2,213,419
86,469	2,299,888
86,342	2,386,231
78,587	2,464,817
78,346	2,543,163
78,105	2,621,269
77,864	2,699,133
77,822	2,776,955
77,708	2,854,663
77,594	2,932,257

Table 45. Baseline carbon stock change in the Leakage Belt

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt		Total net carbon stock change in the leakage belt	
ID_{cl}	1	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$	ID_{cl}	1	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$	ID_{iz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$	$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	186,886	186,886	186,886	2020	4,485	4,485	4,485	2020	0	0	0	191,371	191,371
2021	186,886	186,886	373,771	2021	8,971	8,971	13,456	2021	1,624	1,624	1,624	194,232	385,603
2022	186,886	186,886	560,657	2022	13,456	13,456	26,912	2022	3,247	3,247	4,871	197,094	582,697
2023	186,886	186,886	747,542	2023	17,941	17,941	44,853	2023	4,871	4,871	9,742	199,956	782,653
2024	186,886	186,886	934,428	2024	22,426	22,426	67,279	2024	6,495	6,495	16,237	202,817	985,470
2025	186,886	186,886	1,121,314	2025	26,912	26,912	94,190	2025	8,118	8,118	24,355	205,679	1,191,149
2026	168,197	168,197	1,289,511	2026	30,948	30,948	125,139	2026	9,742	9,742	34,097	189,403	1,380,552
2027	168,197	168,197	1,457,708	2027	34,985	34,985	160,124	2027	11,203	11,203	45,300	191,979	1,572,531
2028	168,197	168,197	1,625,905	2028	39,022	39,022	199,145	2028	12,665	12,665	57,965	194,554	1,767,085
2029	168,197	168,197	1,794,102	2029	43,058	43,058	242,204	2029	14,126	14,126	72,090	197,130	1,964,215
2030	168,197	168,197	1,962,299	2030	42,610	42,610	284,814	2030	15,587	15,587	87,678	195,220	2,159,435
2031	168,197	168,197	2,130,496	2031	42,161	42,161	326,975	2031	15,425	15,425	103,102	194,934	2,354,368
2032	151,377	151,377	2,281,873	2032	41,309	41,309	368,284	2032	15,262	15,262	118,365	177,424	2,531,793
2033	151,377	151,377	2,433,250	2033	40,457	40,457	408,741	2033	14,954	14,954	133,319	176,880	2,708,673
2034	151,377	151,377	2,584,628	2034	39,605	39,605	448,346	2034	14,645	14,645	147,964	176,337	2,885,010
2035	151,377	151,377	2,736,005	2035	38,753	38,753	487,099	2035	14,337	14,337	162,301	175,793	3,060,803

2036	151,377	151,377	2,887,382	2036	38,349	38,349	525,448	2036	14,028	14,028	176,329	175,698	3,236,501
2037	151,377	151,377	3,038,760	2037	37,945	37,945	563,393	2037	13,882	13,882	190,212	175,440	3,411,941
2038	136,240	136,240	3,174,999	2038	37,178	37,178	600,571	2038	13,736	13,736	203,948	159,682	3,571,623
2039	136,240	136,240	3,311,239	2039	36,411	36,411	636,982	2039	13,459	13,459	217,406	159,192	3,730,815
2040	136,240	136,240	3,447,478	2040	35,644	35,644	672,627	2040	13,181	13,181	230,587	158,703	3,889,518
2041	136,240	136,240	3,583,718	2041	34,877	34,877	707,504	2041	12,903	12,903	243,490	158,214	4,047,732
2042	136,240	136,240	3,719,958	2042	34,514	34,514	742,018	2042	12,626	12,626	256,116	158,128	4,205,860
2043	136,240	136,240	3,856,197	2043	34,151	34,151	776,169	2043	12,494	12,494	268,610	157,896	4,363,756
2044	122,616	122,616	3,978,813	2044	33,460	33,460	809,629	2044	12,363	12,363	280,972	143,714	4,507,470
2045	122,616	122,616	4,101,429	2045	32,770	32,770	842,399	2045	12,113	12,113	293,085	143,273	4,650,743
2046	122,616	122,616	4,224,044	2046	32,080	32,080	874,479	2046	11,863	11,863	304,948	142,833	4,793,576
2047	122,616	122,616	4,346,660	2047	31,390	31,390	905,869	2047	11,613	11,613	316,561	142,392	4,935,968
2048	122,616	122,616	4,469,275	2048	31,063	31,063	936,931	2048	11,363	11,363	327,924	142,315	5,078,283
2049	122,616	122,616	4,591,891	2049	30,736	30,736	967,667	2049	11,245	11,245	339,168	142,107	5,220,390
2050	122,616	122,616	4,714,507	2050	30,409	30,409	998,076	2050	11,126	11,126	350,295	141,898	5,362,288

<u>Baseline non-CO2 emissions from forest fires</u>

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

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

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

Where,

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

$EBBN_2O_{icl,t}$ N_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)[141]

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

Where,

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

ER_{CH4} Emission ratio for CH_4 (IPCC default value = 0.012)

[141] According to the VCS Standard 4.0, 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) [142]

$$EBBCO2_{icl,t} = Fburnt_{icl} * \sum_{p=1}^{P} (C_{picl,t} * Pburnt_{p,icl} * CE_{p,icl})$$

Where,

$EBBCO2_{icl,t}$ 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 Project Area is fully inserted in, as well as most of the Reference Region. Hot spots were considered during the period from 2014 to 2019 (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.

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%.

[142] According to the VCS Standard v4.0, 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).

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.

Thus, the total actual non-CO_2 emissions from forest fire at year t in the project area at the baseline scenario ($EBBBSLPA_t$) are 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 46. Parameters used to calculate non-CO2 emissions from forest fires

Initial Forest Class		Parameters								
		$Fburnt_{icl}$	Cab	$Pburnt_{ab,icl}$	$CE_{ab,icl}$	ECO2-ab	EBBCO2-tot	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
IDcl	Name	%	tCO2e/ha	%	%	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
1	Forest	89%	579.74	78%	50%	202.23	202.23	1.81	22.06	23.87

Table 47. 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
First baseline period	2020	170.26	24.71	4,207.67	4,207.67
	2021	170.26	24.71	4,207.67	8,415.34
	2022	170.26	24.71	4,207.67	12,623.01
	2023	170.26	24.71	4,207.67	16,830.68
	2024	170.26	24.71	4,207.67	21,038.35
	2025	170.26	24.71	4,207.67	25,246.03
	2026	153.23	24.71	3,786.90	29,032.93
	2027	153.23	24.71	3,786.90	32,819.83
	2028	153.23	24.71	3,786.90	36,606.74
	2029	153.23	24.71	3,786.90	40,393.64
Second baseline period	2030	153.23	24.71	3,786.90	44,180.54
	2031	153.23	24.71	3,786.90	47,967.45
	2032	137.91	24.71	3,408.21	51,375.66
	2033	137.91	24.71	3,408.21	54,783.88
	2034	137.91	24.71	3,408.21	58,192.09
	2035	137.91	24.71	3,408.21	61,600.30
	2036	137.91	24.71	3,408.21	65,008.52
	2037	137.91	24.71	3,408.21	68,416.73
	2038	124.12	24.71	3,067.39	71,484.12
	2039	124.12	24.71	3,067.39	74,551.51
Third baseline period	2040	124.12	24.71	3,067.39	77,618.91
	2041	124.12	24.71	3,067.39	80,686.30
	2042	124.12	24.71	3,067.39	83,753.69
	2043	124.12	24.71	3,067.39	86,821.08
	2044	111.71	24.71	2,760.65	89,581.73
	2045	111.71	24.71	2,760.65	92,342.39
	2046	111.71	24.71	2,760.65	95,103.04
	2047	111.71	24.71	2,760.65	97,863.69
	2048	111.71	24.71	2,760.65	100,624.35
	2049	111.71	24.71	2,760.65	103,385.00
	2050	111.71	24.71	2,760.65	106,145.65

4.2 Project Emissions

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

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

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

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

Where,

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

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

Where,

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

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

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

Table 48. 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
2020	0.00	0.00	0.00	0.00	34.95	34.95	34.95	34.95
2021	0.00	0.00	0.00	0.00	850.71	885.66	850.71	885.66
2022	0.00	0.00	0.00	0.00	1,111.73	1,997.40	1,111.73	1,997.40
2023	0.00	0.00	0.00	0.00	1,039.51	3,036.90	1,039.51	3,036.90
2024	0.00	0.00	0.00	0.00	952.30	3,989.20	952.30	3,989.20
2025	0.00	0.00	0.00	0.00	1,005.51	4,994.71	1,005.51	4,994.71
2026	0.00	0.00	0.00	0.00	772.34	5,767.05	772.34	5,767.05
2027	0.00	0.00	0.00	0.00	748.73	6,515.79	748.73	6,515.79
2028	0.00	0.00	0.00	0.00	908.94	7,424.73	908.94	7,424.73
2029	0.00	0.00	0.00	0.00	842.19	8,266.92	842.19	8,266.92
2030	0.00	0.00	0.00	0.00	917.17	9,184.09	917.17	9,184.09
2031	0.00	0.00	0.00	0.00	1,054.71	10,238.79	1,054.71	10,238.79
2032	0.00	0.00	0.00	0.00	1,011.77	11,250.57	1,011.77	11,250.57
2033	0.00	0.00	0.00	0.00	876.31	12,126.88	876.31	12,126.88
2034	0.00	0.00	0.00	0.00	1,126.27	13,253.15	1,126.27	13,253.15
2035	0.00	0.00	0.00	0.00	801.72	14,054.87	801.72	14,054.87
2036	0.00	0.00	0.00	0.00	764.26	14,819.13	764.26	14,819.13
2037	0.00	0.00	0.00	0.00	1,000.88	15,820.02	1,000.88	15,820.02
2038	0.00	0.00	0.00	0.00	733.09	16,553.10	733.09	16,553.10
2039	0.00	0.00	0.00	0.00	901.36	17,454.46	901.36	17,454.46
2040	0.00	0.00	0.00	0.00	773.27	18,227.73	773.27	18,227.73
2041	0.00	0.00	0.00	0.00	541.60	18,769.32	541.60	18,769.32
2042	0.00	0.00	0.00	0.00	691.19	19,460.51	691.19	19,460.51
2043	0.00	0.00	0.00	0.00	652.27	20,112.78	652.27	20,112.78
2044	0.00	0.00	0.00	0.00	621.45	20,734.23	621.45	20,734.23
2045	0.00	0.00	0.00	0.00	450.24	21,184.48	450.24	21,184.48

2046	0.00	0.00	0.00	0.00	459.66	21,644.14	459.66	21,644.14
2047	0.00	0.00	0.00	0.00	407.68	22,051.81	407.68	22,051.81
2048	0.00	0.00	0.00	0.00	408.97	22,460.79	408.97	22,460.79
2049	0.00	0.00	0.00	0.00	499.95	22,960.73	499.95	22,960.73
2050	0.00	0.00	0.00	0.00	370.09	23,330.82	370.09	23,330.82

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 49. Total ex ante estimated actual emissions of non-CO_2 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	
	$EBBPSPA_t$	EBBPSPA
	annual	cumulative
	tCO_2e	tCO_2e
2020	230.21	230.21
2021	230.21	460.41
2022	230.21	690.62
2023	230.21	920.83
2024	230.21	1,151.03
2025	230.21	1,381.24
2026	207.19	1,588.43
2027	207.19	1,795.61
2028	207.19	2,002.80

2029	207.19	2,209.98
2030	207.19	2,417.17
2031	207.19	2,624.36
2032	186.47	2,810.82
2033	186.47	2,997.29
2034	186.47	3,183.76
2035	186.47	3,370.23
2036	186.47	3,556.69
2037	186.47	3,743.16
2038	167.82	3,910.98
2039	167.82	4,078.80
2040	167.82	4,246.62
2041	167.82	4,414.44
2042	167.82	4,582.27
2043	167.82	4,750.09
2044	151.04	4,901.13
2045	151.04	5,052.16
2046	151.04	5,203.20
2047	151.04	5,354.24
2048	151.04	5,505.28
2049	151.04	5,656.32
2050	151.04	5,807.36

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

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

Table 50. 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
2020	0.00	0.00	0.00	0.00	5,725.38	5,725.38	5,725.38	5,725.38	230.21	230.21
2021	0.00	0.00	0.00	0.00	5,810.99	11,536.37	5,810.99	11,536.37	230.21	460.41
2022	0.00	0.00	0.00	0.00	5,896.60	17,432.97	5,896.60	17,432.97	230.21	690.62
2023	0.00	0.00	0.00	0.00	5,982.21	23,415.18	5,982.21	23,415.18	230.21	920.83
2024	0.00	0.00	0.00	0.00	6,067.83	29,483.01	6,067.83	29,483.01	230.21	1,151.03
2025	0.00	0.00	0.00	0.00	6,153.44	35,636.44	6,153.44	35,636.44	230.21	1,381.24
2026	0.00	0.00	0.00	0.00	5,666.51	41,302.96	5,666.51	41,302.96	207.19	1,588.43
2027	0.00	0.00	0.00	0.00	5,743.56	47,046.52	5,743.56	47,046.52	207.19	1,795.61
2028	0.00	0.00	0.00	0.00	5,820.62	52,867.14	5,820.62	52,867.14	207.19	2,002.80

2029	0.00	0.00	0.00	0.00	5,897.67	58,764.80	5,897.67	58,764.80	207.19	2,209.98
2030	0.00	0.00	0.00	0.00	5,840.53	64,605.33	5,840.53	64,605.33	207.19	2,417.17
2031	0.00	0.00	0.00	0.00	5,831.97	70,437.30	5,831.97	70,437.30	207.19	2,624.36
2032	0.00	0.00	0.00	0.00	5,308.12	75,745.42	5,308.12	75,745.42	186.47	2,810.82
2033	0.00	0.00	0.00	0.00	5,291.86	81,037.28	5,291.86	81,037.28	186.47	2,997.29
2034	0.00	0.00	0.00	0.00	5,275.59	86,312.87	5,275.59	86,312.87	186.47	3,183.76
2035	0.00	0.00	0.00	0.00	5,259.32	91,572.19	5,259.32	91,572.19	186.47	3,370.23
2036	0.00	0.00	0.00	0.00	5,256.48	96,828.67	5,256.48	96,828.67	186.47	3,556.69
2037	0.00	0.00	0.00	0.00	5,248.77	102,077.44	5,248.77	102,077.44	186.47	3,743.16
2038	0.00	0.00	0.00	0.00	4,777.31	106,854.75	4,777.31	106,854.75	167.82	3,910.98
2039	0.00	0.00	0.00	0.00	4,762.67	111,617.42	4,762.67	111,617.42	167.82	4,078.80
2040	0.00	0.00	0.00	0.00	4,748.03	116,365.45	4,748.03	116,365.45	167.82	4,246.62
2041	0.00	0.00	0.00	0.00	4,733.39	121,098.84	4,733.39	121,098.84	167.82	4,414.44
2042	0.00	0.00	0.00	0.00	4,730.83	125,829.67	4,730.83	125,829.67	167.82	4,582.27
2043	0.00	0.00	0.00	0.00	4,723.89	130,553.57	4,723.89	130,553.57	167.82	4,750.09
2044	0.00	0.00	0.00	0.00	4,299.58	134,853.15	4,299.58	134,853.15	151.04	4,901.13
2045	0.00	0.00	0.00	0.00	4,286.40	139,139.55	4,286.40	139,139.55	151.04	5,052.16
2046	0.00	0.00	0.00	0.00	4,273.23	143,412.78	4,273.23	143,412.78	151.04	5,203.20
2047	0.00	0.00	0.00	0.00	4,260.05	147,672.83	4,260.05	147,672.83	151.04	5,354.24
2048	0.00	0.00	0.00	0.00	4,257.75	151,930.58	4,257.75	151,930.58	151.04	5,505.28
2049	0.00	0.00	0.00	0.00	4,251.50	156,182.08	4,251.50	156,182.08	151.04	5,656.32
2050	0.00	0.00	0.00	0.00	4,245.26	160,427.34	4,245.26	160,427.34	151.04	5,807.36

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,

ΔCLPMLKt	Carbon stock decrease due to leakage prevention measures at year t; tCO_2e
ΔCBSLLKt	Annual carbon stock changes in leakage management areas in the baseline case at year t; tCO_2e
ΔCPSLKt	Annual carbon stock change in leakage management areas in the project case; tCO_2e

If the net sum of carbon stock changes within a monitoring period is more than zero, leakage prevention measures are not causing any carbon stock decrease. The net increase shall conservatively be ignored in the calculation of net GHG emission reductions of the project activity. Nevertheless, if the net sum is negative, it must be accounted if significant.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

$EgLK_t$	Emissions from grazing animals in leakage management areas at year t; tCO_2e/year
ECH_4ferm_t	CH_4 emissions from enteric fermentation in leakage management areas at year t; tCO_2e/year
ECH_4man_t	CH_4 emissions from manure management in leakage management areas year t; tCO_2e/year
EN_2Oman_t	N_2O emissions from manure management in leakage management areas at year t; tCO_2e/year
t	1, 2, 3, … T years of the project crediting period; dimensionless

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

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

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

Table 51. 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
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00
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

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

Table 52. Ex ante estimated total emissions above the baseline from leakage prevention activities

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total *ex ante* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2017	0.00	0.00	0.00	0.00	0.00	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00
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

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

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

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

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

Where,

ΔCADLKt	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e
DLF	Displacement leakage factor; %

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

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

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

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

$EADLKt_t$	Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_2e

$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
DLF	Displacement leakage factor; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

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

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

Table 53. 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
2020	15,697.08	15,697.08	631.15	631.15
2021	15,931.80	31,628.89	631.15	1,262.30
2022	16,166.53	47,795.41	631.15	1,893.45
2023	16,401.25	64,196.66	631.15	2,524.60
2024	16,635.97	80,832.63	631.15	3,155.75
2025	16,870.69	97,703.32	631.15	3,786.90
2026	15,535.70	113,239.02	568.04	4,354.94
2027	15,746.95	128,985.96	568.04	4,922.97
2028	15,958.20	144,944.16	568.04	5,491.01
2029	16,169.45	161,113.61	568.04	6,059.05
2030	16,012.79	177,126.40	568.04	6,627.08
2031	15,989.32	193,115.73	568.04	7,195.12
2032	14,553.11	207,668.84	511.23	7,706.35
2033	14,508.52	222,177.35	511.23	8,217.58
2034	14,463.92	236,641.27	511.23	8,728.81
2035	14,419.32	251,060.60	511.23	9,240.05
2036	14,411.52	265,472.11	511.23	9,751.28
2037	14,390.39	279,862.50	511.23	10,262.51
2038	13,097.80	292,960.30	460.11	10,722.62
2039	13,057.66	306,017.97	460.11	11,182.73
2040	13,017.53	319,035.49	460.11	11,642.84
2041	12,977.39	332,012.88	460.11	12,102.94
2042	12,970.36	344,983.25	460.11	12,563.05
2043	12,951.35	357,934.60	460.11	13,023.16
2044	11,788.02	369,722.62	414.10	13,437.26
2045	11,751.90	381,474.52	414.10	13,851.36

2046	11,715.77	393,190.29	414.10	14,265.46
2047	11,679.65	404,869.94	414.10	14,679.55
2048	11,673.33	416,543.27	414.10	15,093.65
2049	11,656.22	428,199.49	414.10	15,507.75
2050	11,639.10	439,838.59	414.10	15,921.85

***Ex ante* estimation of total leakage**

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

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

Where,

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

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

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

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

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

$$ELK_t = EgLK_t + EADLK_t$$

Where,

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

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

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

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

Table 54. 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	$\Delta CADLK_t$	ΔCADLK	$\Delta CLPMLK_t$	ΔCLPMLK	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
2020	0.00	0.00	631.15	631.15	15,697.08	15,697.08	0.00	0.00	15,697.08	15,697.08	631.15	631.15
2021	0.00	0.00	631.15	1,262.30	15,931.80	31,628.89	0.00	0.00	15,931.80	31,628.89	631.15	1,262.30
2022	0.00	0.00	631.15	1,893.45	16,166.53	47,795.41	0.00	0.00	16,166.53	47,795.41	631.15	1,893.45
2023	0.00	0.00	631.15	2,524.60	16,401.25	64,196.66	0.00	0.00	16,401.25	64,196.66	631.15	2,524.60
2024	0.00	0.00	631.15	3,155.75	16,635.97	80,832.63	0.00	0.00	16,635.97	80,832.63	631.15	3,155.75
2025	0.00	0.00	631.15	3,786.90	16,870.69	97,703.32	0.00	0.00	16,870.69	97,703.32	631.15	3,786.90
2026	0.00	0.00	568.04	4,354.94	15,535.70	113,239.02	0.00	0.00	15,535.70	113,239.02	568.04	4,354.94
2027	0.00	0.00	568.04	4,922.97	15,746.95	128,985.96	0.00	0.00	15,746.95	128,985.96	568.04	4,922.97
2028	0.00	0.00	568.04	5,491.01	15,958.20	144,944.16	0.00	0.00	15,958.20	144,944.16	568.04	5,491.01
2029	0.00	0.00	568.04	6,059.05	16,169.45	161,113.61	0.00	0.00	16,169.45	161,113.61	568.04	6,059.05
2030	0.00	0.00	568.04	6,627.08	16,012.79	177,126.40	0.00	0.00	16,012.79	177,126.40	568.04	6,627.08
2031	0.00	0.00	568.04	7,195.12	15,989.32	193,115.73	0.00	0.00	15,989.32	193,115.73	568.04	7,195.12
2032	0.00	0.00	511.23	7,706.35	14,553.11	207,668.84	0.00	0.00	14,553.11	207,668.84	511.23	7,706.35
2033	0.00	0.00	511.23	8,217.58	14,508.52	222,177.35	0.00	0.00	14,508.52	222,177.35	511.23	8,217.58
2034	0.00	0.00	511.23	8,728.81	14,463.92	236,641.27	0.00	0.00	14,463.92	236,641.27	511.23	8,728.81
2035	0.00	0.00	511.23	9,240.05	14,419.32	251,060.60	0.00	0.00	14,419.32	251,060.60	511.23	9,240.05
2036	0.00	0.00	511.23	9,751.28	14,411.52	265,472.11	0.00	0.00	14,411.52	265,472.11	511.23	9,751.28
2037	0.00	0.00	511.23	10,262.51	14,390.39	279,862.50	0.00	0.00	14,390.39	279,862.50	511.23	10,262.51
2038	0.00	0.00	460.11	10,722.62	13,097.80	292,960.30	0.00	0.00	13,097.80	292,960.30	460.11	10,722.62
2039	0.00	0.00	460.11	11,182.73	13,057.66	306,017.97	0.00	0.00	13,057.66	306,017.97	460.11	11,182.73
2040	0.00	0.00	460.11	11,642.84	13,017.53	319,035.49	0.00	0.00	13,017.53	319,035.49	460.11	11,642.84
2041	0.00	0.00	460.11	12,102.94	12,977.39	332,012.88	0.00	0.00	12,977.39	332,012.88	460.11	12,102.94
2042	0.00	0.00	460.11	12,563.05	12,970.36	344,983.25	0.00	0.00	12,970.36	344,983.25	460.11	12,563.05
2043	0.00	0.00	460.11	13,023.16	12,951.35	357,934.60	0.00	0.00	12,951.35	357,934.60	460.11	13,023.16
2044	0.00	0.00	414.10	13,437.26	11,788.02	369,722.62	0.00	0.00	11,788.02	369,722.62	414.10	13,437.26
2045	0.00	0.00	414.10	13,851.36	11,751.90	381,474.52	0.00	0.00	11,751.90	381,474.52	414.10	13,851.36
2046	0.00	0.00	414.10	14,265.46	11,715.77	393,190.29	0.00	0.00	11,715.77	393,190.29	414.10	14,265.46
2047	0.00	0.00	414.10	14,679.55	11,679.65	404,869.94	0.00	0.00	11,679.65	404,869.94	414.10	14,679.55
2048	0.00	0.00	414.10	15,093.65	11,673.33	416,543.27	0.00	0.00	11,673.33	416,543.27	414.10	15,093.65
2049	0.00	0.00	414.10	15,507.75	11,656.22	428,199.49	0.00	0.00	11,656.22	428,199.49	414.10	15,507.75
2050	0.00	0.00	414.10	15,921.85	11,639.10	439,838.59	0.00	0.00	11,639.10	439,838.59	414.10	15,921.85

4.4 Net GHG Emission Reductions and Removals

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

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

Where:

ΔREDDt	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e
ΔCBSLPAt	Sum of baseline carbon stock changes in the project area at year t; tCO2e
EBBBSLPAt	Sum of baseline emissions from biomass burning in the project area at year t; tCO2e
ΔCPSPAt	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e Note: If ΔCPSPAt represents a net increase in carbon stocks, a negative sign before the absolute value of ΔCPSPAt shall be used. If ΔCPSPAt represents a net decrease, the positive sign shall be used.
EBBPSPAt	Sum of (ex ante estimated) actual emissions from biomass burning in the project area at year t; tCO2e
ΔCLKt	Sum of ex ante estimated leakage net carbon stock changes at year t; tCO2e Note: If the cumulative sum of ΔCLKt within a fixed baseline period is > 0, ΔCLKt shall be set to zero.
ELKt	Sum of ex ante estimated leakage emissions at year t; tCO2e
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless.

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

$$VCUt = \Delta REDDt - VBCt$$

$$VBCt = (\Delta CBSLPAt - \Delta CPSPAt) * RFt$$

Where:

VCUt	Number of Verified Carbon Units that can be traded at time t; t CO2e
ΔREDDt	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e
VBCt	Number of Buffer Credits deposited in the VCS Buffer at time t; t CO2e

ΔCBSLPAt	Sum of baseline carbon stock changes in the project area at year t; tCO2e
ΔCPSPAt	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e ha-1
Ft	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless.

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value of RFt for the first project instance activity was 10%.

The net GHG emission reductions and removals by the project activity of Xingu-Araguaia Grouped REDD+ Project are summarized in the table below.

Table 55. Summary of net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	*Ex ante* buffer credits (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2020	108,855	5,956	16,328	14,838	71,732
2021	110,420	6,041	16,563	15,060	72,755
2022	111,985	6,127	16,798	15,282	73,777
2023	113,549	6,212	17,032	15,504	74,800
2024	115,114	6,298	17,267	15,726	75,823
2025	116,679	6,384	17,502	15,948	76,845
2026	107,358	5,874	16,104	14,686	70,695
2027	108,767	5,951	16,315	14,885	71,615
2028	110,175	6,028	16,526	15,085	72,535
2029	111,583	6,105	16,737	15,285	73,456
2030	110,539	6,048	16,581	15,137	72,773
2031	110,382	6,039	16,557	15,115	72,671
2032	100,429	5,495	15,064	13,757	66,113
2033	100,132	5,478	15,020	13,715	65,918
2034	99,834	5,462	14,975	13,673	65,724
2035	99,537	5,446	14,931	13,630	65,530
2036	99,485	5,443	14,923	13,623	65,496
2037	99,344	5,435	14,902	13,603	65,404
2038	90,386	4,945	13,558	12,381	59,501
2039	90,118	4,930	13,518	12,343	59,326
2040	89,851	4,916	13,478	12,305	59,152
2041	89,583	4,901	13,437	12,267	58,977
2042	89,536	4,899	13,430	12,261	58,946

2043	89,410	4,892	13,411	12,243	58,863
2044	81,347	4,451	12,202	11,143	53,551
2045	81,107	4,437	12,166	11,109	53,394
2046	80,866	4,424	12,130	11,075	53,236
2047	80,625	4,411	12,094	11,041	53,079
2048	80,583	4,409	12,087	11,035	53,051
2049	80,469	4,403	12,070	11,018	52,977
2050	56,138	3,071	8,422	7,687	36,958
Total	**3,014,186**	**164,910**	**452,129**	**412,459**	**1,984,673**

The specific summary of GHG reductions and removals in the Xingu-Araguaia Grouped REDD project is included in the table below, which includes estimates of GHG emissions reduction (REDDt), calculations of buffer and leakage, and the calculation of tradable Verified Carbon Units (VCUt).

Table 56. Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and verified carbon units (VCUt)

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex ante project carbon stock changes		Ex ante project GHG emissions from biomass burning		Ex ante leakage carbon stock changes		Ex ante leakage GHG emissions		Ex ante net anthropogenic GHG emission reductions		Ex ante VCUs tradable		Ex ante buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	104,647	104,647	4,208	4,208	5,725	5,725	230	230	15,697	15,697	631	631	86,571	86,571	71,732	71,732	14,838	14,838
2021	106,212	210,859	4,208	8,415	5,811	11,536	230	460	15,932	31,629	631	1,262	87,816	174,387	72,755	144,487	15,060	29,898
2022	107,777	318,636	4,208	12,623	5,897	17,433	230	691	16,167	47,795	631	1,893	89,060	263,447	73,777	218,264	15,282	45,180
2023	109,342	427,978	4,208	16,831	5,982	23,415	230	921	16,401	64,197	631	2,525	90,304	353,751	74,800	293,064	15,504	60,684
2024	110,906	538,884	4,208	21,038	6,068	29,483	230	1,151	16,636	80,833	631	3,156	91,549	445,300	75,823	368,887	15,726	76,410
2025	112,471	651,355	4,208	25,246	6,153	35,636	230	1,381	16,871	97,703	631	3,787	92,793	538,094	76,845	445,732	15,948	92,358
2026	103,571	754,927	3,787	29,033	5,667	41,303	207	1,588	15,536	113,239	568	4,355	85,381	623,474	70,695	516,427	14,686	107,044
2027	104,980	859,906	3,787	32,820	5,744	47,047	207	1,796	15,747	128,986	568	4,923	86,501	709,975	71,615	588,042	14,885	121,929
2028	106,388	966,294	3,787	36,607	5,821	52,867	207	2,003	15,958	144,944	568	5,491	87,621	797,596	72,535	660,577	15,085	137,014
2029	107,796	1,074,091	3,787	40,394	5,898	58,765	207	2,210	16,169	161,114	568	6,059	88,741	886,337	73,456	734,033	15,285	152,299
2030	106,752	1,180,843	3,787	44,181	5,841	64,605	207	2,417	16,013	177,126	568	6,627	87,910	974,247	72,773	806,806	15,137	167,436
2031	106,595	1,287,438	3,787	47,967	5,832	70,437	207	2,624	15,989	193,116	568	7,195	87,786	1,062,033	72,671	879,477	15,115	182,550
2032	97,021	1,384,459	3,408	51,376	5,308	75,745	186	2,811	14,553	207,669	511	7,706	79,870	1,141,903	66,113	945,590	13,757	196,307
2033	96,723	1,481,182	3,408	54,784	5,292	81,037	186	2,997	14,509	222,177	511	8,218	79,634	1,221,537	65,918	1,011,508	13,715	210,022
2034	96,426	1,577,608	3,408	58,192	5,276	86,313	186	3,184	14,464	236,641	511	8,729	79,397	1,300,934	65,724	1,077,232	13,673	223,694
2035	96,129	1,673,737	3,408	61,600	5,259	91,572	186	3,370	14,419	251,061	511	9,240	79,161	1,380,095	65,530	1,142,762	13,630	237,325
2036	96,077	1,769,814	3,408	65,009	5,256	96,829	186	3,557	14,412	265,472	511	9,751	79,119	1,459,214	65,496	1,208,258	13,623	250,948
2037	95,936	1,865,750	3,408	68,417	5,249	102,077	186	3,743	14,390	279,863	511	10,263	79,007	1,538,221	65,404	1,273,662	13,603	264,551
2038	87,319	1,953,069	3,067	71,484	4,777	106,855	168	3,911	13,098	292,960	460	10,723	71,883	1,610,104	59,501	1,333,163	12,381	276,932
2039	87,051	2,040,120	3,067	74,552	4,763	111,617	168	4,079	13,058	306,018	460	11,183	71,670	1,681,774	59,326	1,392,489	12,343	289,275
2040	86,784	2,126,903	3,067	77,619	4,748	116,365	168	4,247	13,018	319,035	460	11,643	71,457	1,753,232	59,152	1,451,641	12,305	301,581
2041	86,516	2,213,419	3,067	80,686	4,733	121,099	168	4,414	12,977	332,013	460	12,103	71,245	1,824,476	58,977	1,510,618	12,267	313,848
2042	86,469	2,299,888	3,067	83,754	4,731	125,830	168	4,582	12,970	344,983	460	12,563	71,207	1,895,684	58,946	1,569,564	12,261	326,109
2043	86,342	2,386,231	3,067	86,821	4,724	130,554	168	4,750	12,951	357,935	460	13,023	71,107	1,966,790	58,863	1,628,427	12,243	338,352
2044	78,587	2,464,817	2,761	89,582	4,300	134,853	151	4,901	11,788	369,723	414	13,437	64,695	2,031,485	53,551	1,681,978	11,143	349,495
2045	78,346	2,543,163	2,761	92,342	4,286	139,140	151	5,052	11,752	381,475	414	13,851	64,503	2,095,988	53,394	1,735,372	11,109	360,604
2046	78,105	2,621,269	2,761	95,103	4,273	143,413	151	5,203	11,716	393,190	414	14,265	64,312	2,160,300	53,236	1,788,608	11,075	371,678
2047	77,864	2,699,133	2,761	97,864	4,260	147,673	151	5,354	11,680	404,870	414	14,680	64,120	2,224,420	53,079	1,841,687	11,041	382,719
2048	77,822	2,776,955	2,761	100,624	4,258	151,931	151	5,505	11,673	416,543	414	15,094	64,087	2,288,507	53,051	1,894,738	11,035	393,754
2049	77,708	2,854,663	2,761	103,385	4,252	156,182	151	5,656	11,656	428,199	414	15,508	63,996	2,352,503	52,977	1,947,715	11,018	404,772
2050	54,210	2,908,873	1,929	105,314	2,966	159,148	106	5,762	8,131	436,331	290	15,798	44,645	2,397,148	36,958	1,984,673	7,687	412,459

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	CF
Data unit	tC/tdm
Description	Default value of carbon fraction in biomass
Source of data	Values from the literature, e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	The default IPCC value was used.
Purpose of Data	This parameter is used to calculate the baseline, project and leakage emissions from deforestation occurred in the baseline and project scenarios. Provides an estimate of the carbon content of the vegetation biomass within the project reference region.
Comments	If new and more accurate carbon fraction data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	$Ctot_{fcl}$
Data unit	tCO_2e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in tCO_2e/ha
Source of data	Long-term average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region were taken from the following study: FEARNSIDE, Philip M. Amazonian

	deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management**, Manaus, v. 80, p.21-34, 1996.
Value applied	46.93
Justification of choice of data or description of measurement methods and procedures applied	Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. Following a literature review, the use of Fearnside value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory from 2019, the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO2e. Therefore, the most conservative value between these two data was used.
Purpose of Data	This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	DLF was adopted as an average of displaced leakage in the Monitoring Reports of VM0015 projects developed in Brazil. An assessment of 15 verified projects located in Brazil was conducted, comparing leakage due to displaced deforestation on baseline and project scenarios.
Value applied	0.71%
Justification of choice of data or description of measurement methods and procedures applied	The DLF was estimated as 0.71%, based on other REDD project activities and taking into account the project situation.

Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$\Delta CBSLLK_t$
Data unit	tCO_2e
Description	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data	- Planned interventions proposed by the project proponent. - Remote sensing and GIS.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.
Purpose of Data	This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented.
Comments	*Ex post* monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$EBBBSLPA_t$

Data unit	tCO_2e
Description	Sum of (or total) baseline non-CO2 emissions from forest fire at year t in the project area
Source of data	Remote sensing data and GIS, supervisor reports.
Value applied	3,424.05 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Justification of choice of data or description of measurement methods and procedures applied	Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. Non-CO_2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. In order to estimate non-CO_2 emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t).
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an ex-ante estimation.
Comments	Ex post monitoring of forest fires and non-CO_2 emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$Fburnt_{icl}$
Data unit	%
Description	Proportion of forest area burned during the historical reference period in the forest class.
Source of data	Measured or estimated from literature. *Fburnt data source:* VThird National Communication from Brazil to the United Nations Framework Convention on Climate Change - Volume 3, Table A2.4, page 305 <http://www.ccst.inpe.br/publicacao/terceira-comunicacao-nacional-do-brasil-a-convencao-quadro-das-nacoes-unidas-sobre-mudanca-do-clima-portugues/>
Value applied	46.40
Justification of choice of data or description of measurement methods and procedures applied	Value of "Biomass combustion factors by phytophysiognomies group in the Amazon biome" for Seasonal semideciduous forest available at the Third National Communication from Brazil to the United Nations Framework Convention on Climate Change.
Purpose of data	This parameter is the average percentage of the area within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	$Pburnt_{p,icl}$
Data unit	%
Description	Average proportion of mass burnt in the carbon pool in the forest class
Source of data	Measured or estimated from literature. *Pburnt data source:* Anderson LO, Aragão LE, Gloor M, et al. **Disentangling the contribution of multiple land covers to fire-mediated carbon emissions in Amazonia during the 2010 drought.** Global Biogeochem Cycles. 2015; 29 (10):1739-1753. Doi:

	10.1002/2014GB005008. Available at <https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014GB005008>.
Value applied	78
Justification of choice of data or description of measurement methods and procedures applied	Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m³/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%. However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation. The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%. It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.
Purpose of data	This parameter is the average of biomass that has commercial value, and could be removed prior to clear cutting and burning, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	Estimate from project proponent based on verified reports of similar VM0015 REDD projects in Brazil up to date. Available in VERRA database.
Value applied	92.07%

Justification of choice of data or description of 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. FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020 – Brazil Report, Rome, 2020.
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	(nested table below)
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.

Value applied:

		Above-ground biomass ab_{icl} (Mg/ha)		
ID_{icl}	Vegetation	Reference Region	Project Area	Leakage Belt
1	Dense Tropical Rainforest	327.40	327.40	327.40

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)		
	ID_{icl}	Vegetation	Reference Region	Project Area	Leakage Belt
	1	Dense Tropical Rainforest	78.58	78.58	78.58
Monitoring equipment	No monitoring equipment is used to determine this parameter.				
QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements				
Purpose of data	This parameter is used to calculate baseline, project and leakage emissions in the baseline and project scenarios.				
Calculation method	Calculation according to the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.				
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.				

Data / Parameter	ACPAt
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.
Source of data	- Remote sensing data and GIS, - Forest management team and other field data.
Description of measurement methods and procedures to be applied	In addition to field data from the management team, he following sources will also be monitored: - INMET[143] - INPE[144]
Frequency of monitoring/recording	At each time a catastrophic event occurs.

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

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	The table below shows the annual average deforestation projected in the leakage belt during the crediting period for each vegetation type. Vegetation type | $ABSLLK_t$ (ha)

<table>
<tr><td></td><td><table><tr><td>Forest</td><td>253.37</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>Remote sensing and GIS</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>Best practices in remote sensing.</td></tr>
<tr><td>Purpose of data</td><td>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.</td></tr>
<tr><td>Calculation method</td><td>Analysis of satellite images and maps.</td></tr>
<tr><td>Comments</td><td>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.</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>ABSLPAt</td></tr>
<tr><td>Data unit</td><td>Ha</td></tr>
<tr><td>Description</td><td>Annual area of deforestation in the project area at year t</td></tr>
<tr><td>Source of data</td><td>Remote sensing and GIS</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Annually</td></tr>
<tr><td>Value applied</td><td>The table below shows the annual average projected deforestation in the project area for each vegetation type during the crediting period.<table><tr><th>Vegetation type</th><th>$ABSLPA_t$ (ha)</th></tr><tr><td>Forest</td><td>138.55</td></tr></table></td></tr>
<tr><td>Monitoring equipment</td><td>Remote sensing and GIS</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>Best practices in remote sensing.</td></tr>
<tr><td>Purpose of data</td><td>This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides</td></tr>
</table>

	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	The table below shows the annual average projected deforestation within the reference region for each vegetation type during the crediting period. <table><tr><th>Vegetation type</th><th>$ABSLRR_t$ (ha)</th></tr><tr><td>Forest</td><td>2,924.84</td></tr></table>
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	14,188.34 (Annual average projected decrease in carbon stocks due to displaced deforestation in the leakage belt during the crediting period)
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	ΔCPAdPAt
Data unit	tCO2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Source of data	Documents, remote sensing and GIS.

Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0.00 (Annual average decrease in carbon stocks due to all planned activities within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS SFMP reports, including the post-harvesting annual report.
QA/QC procedures to be applied	- Best practices in remote sensing. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing and GIS
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually

Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.
Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Source of data	- Remote sensing and GIS - Field reports.
Description of measurement methods and procedures to be applied	Forest cover change due to unplanned deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	5,175.08 (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	513.61
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	186.00 (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

<table>
<tr><td>Value applied</td><td>

Initial Forest Class		$EBBtot_{icl}$ tCO_2e/ha
IDcl	Name	
1	Forest	24.71

</td></tr>
<tr><td>Monitoring equipment</td><td>Remote sensing and GIS</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>Best practices in remote sensing and GIS.</td></tr>
<tr><td>Purpose of data</td><td>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</td></tr>
<tr><td>Calculation method</td><td>This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology.</td></tr>
<tr><td>Comments</td><td>GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.</td></tr>
</table>

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	0.00 (annual average for the crediting period)
Monitoring equipment	Remote sensing and GIS Field assessment data
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	The community living within the leakage management area practices grazing activities. Therefore, this shall be monitored during the crediting period. GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report; - Remote sensing data and GIS; - SFMP data; - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	15
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event.

Purpose of data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors described in the VCS Non-Permanence Risk Report will be assessed.
Comments	N/A

5.3 Monitoring Plan

This monitoring plan has been developed according to the VCS Methodology VM0015 version 1.1.

Organizational structure

According to the contract stipulated between Future Carbon and the landowner, the landowner is responsible for the costing and implementation and/or maintenance of the project's forest management and activities to reduce deforestation and degradation, surveillance, fire prevention, illegal extraction of wood, prevention of invasions, among others, implementation and maintenance of social and environmental activities to reduce leakage, decrease the risks of non-permanence of carbon and improve the results of SOCIALCARBON, or other Standard for the assessment of social and environmental co-benefits.

In addition, it is responsible for keeping all documentation required by the project in order, as well as project maintenance expenses; Execute, monitor and maintain in full operation the structure that authorizes and serves as the basis for the development of the Project, ensuring the reduction of deforestation and degradation, the implementation and maintenance of social and environmental activities (or designating and hiring third parties responsible for the activities).

The owner is responsible for establishing prospects in each Social Carbon report, as well as complying with at least 50% of the proposed actions, under penalty of losing the Social Carbon standard.

Future Carbon is responsible for the development of the project documents, assessment of the mapping files for application of the methodology, and internal auditing.

- **Revision of the baseline**

The current baseline is valid for 6 years. The baseline will be reassessed every 6 years, and it will be validated at the same time as the subsequent verification.

Technical description of the monitoring task

The baseline scenario will be monitored through the assessment of agents and drivers variables and satellite images to project expected deforestation. Information on agents, drivers and underlying causes of deforestation in the reference region will be collected at the end of each fixed baseline period, as these are essential for improving future deforestation projections and the design of the project activity. In addition, in the same frequency, the projected annual areas of baseline deforestation for the reference region will be revisited and eventually adjusted for the subsequent fixed baseline period.

The location of the projected baseline deforestation will be reassessed using the adjusted projections for annual areas of baseline deforestation and spatial data. All areas credited for avoided deforestation in past fixed baseline periods will be excluded from the revisited baseline projections as these areas cannot be credited again.

Baseline monitoring task will be done in accordance with the applied methodology, VM0015, version 1.1 or the most recent.

Data to be collected

Data will be collected to comply with the parameters used in the VM0015 v1.1, listed in Appendix 5, or the most recent.

Overview of data collection procedures

Data will be collected according to measurement methods and procedures described in section 5.1 and 5.2 above. All *ex ante* and *ex post* parameters will be reassessed at the moment of revision of the baseline.

Quality control and quality assurance procedures

QA/QC will be done according to best practices in remote sensing and as stated by VM0015 methodology.

Data archiving

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by the instance owner. Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the first monitoring period, as well as further monitoring reports in case it participates in the development of subsequent monitoring periods in the future.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VVBs at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

Organization and responsibilities of the parties involved in all the above

Future Carbon is responsible for the development of the Project Design Document and the first Monitoring Report. Therefore, it is responsible for the organization and calculation of items related to the methodology.

The instance owner is responsible for the development of the project activity, monitoring of the required parameters in section 5.2 above, and for the development of subsequent monitoring reports. In addition, it is also responsible for forest surveillance and generation of socioenvironmental activities to local communities.

Future Carbon and/or a related partner is responsible for all GIS related information.

- **Monitoring of actual carbon stock changes and GHG emissions within the project area**
    - **Monitoring of project implementation**

The instance owner is responsible for the implementation of the project activity. The monitoring of the sustainable management plan is carried out by the municipal and state secretariats.

Information from the sustainable forest management plan and post-exploratory reports will be used to update parameters related to planned deforestation and will be verified during the validation and verification of the carbon project.

Updating Forest Carbon Stocks Estimates

If new and more accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction, provided that these data are in accordance to the requirements established by the applied methodology VM0015. New data on carbon stocks will only be used if they are validated by an accredited VVB.

Methods for generating, recording, aggregating, collating and reporting data on monitored parameters

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by Future Carbon.

Future Carbon will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the subsequent baseline reports and monitoring periods.

Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

All maps and records generated during project implementation will be stored and made available to VCS verifiers at verification for inspection. In addition, any data collected from ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) will be recorded and archived.

Monitored data will be kept for two years after the end of the crediting period or the last issuance of carbon credits for this project activity, whichever occurs later. For this purpose, the authority for the registration, monitoring, measurement and reporting will be Future Carbon Ltda. Monitored parameters are described in Section 5.2 and will be monitored with the frequency described further below.

Quality Assurance/Quality Control

To ensure consistency and quality of results, spatial analysts carrying out the image processing, interpretation, and change detection procedures will strictly adhere to the steps detailed in the Methodology.

All of this reliable data, which will be collected and documented, will be used as a technical support tool for decision-making in order to improve project outcomes, and to adapt the project according to the current needs and realities. Project activities implemented within the project area must be consistent with the management plan of the PD.

The implementation of the project activity will be monitored by continuous monitoring activities using remote sensing techniques. Additionally, field studies will also be used. The land-use monitoring will be carried out with remote sensing methods, using images generated by Mapbiomas, INPE (PRODES)[145] and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

The management structure will also rely on the local community to help monitor the area. All the monitored parameters will be checked with the frequency detailed in the Section 5.2 above, as requested in the VCS Methodology VM0015, version 1.1.

With the carbon credits income, in order to complement the monitoring of the project area and its surroundings, the project proponent intends to improve the remote sensing methods and data used, which meet the accuracy assessment requirements laid out in the methodology.

The present REDD project will also implement the sustainability report following the SOCIALCARBON methodology, which was developed by *Instituto Ecológica* and focus on implementing environmental and social activities within the project area. This methodology follows the SOCIALCARBON Guidelines available at: http://www.socialcarbon.org/documents/.

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

In addition, the SOCIALCARBON Reports will be available on the VCS Registry once the project is registered.

Procedures for handling internal auditing and non-conformities

The procedures for handling internal auditing and non-conformities are going to be established by both project developer and project proponent. All the necessary taskforce and procedures will be in place to meet the highest levels of control.

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 Xingu-Araguaia Grouped REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of Future Carbon.

If non-conformities exist during the internal or external auditing processes, the data should be reviewed, and the non-conformities addressed.

- **Monitoring of land-use and land-cover change within the project area**

Forest cover change due to unplanned deforestation is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.

The project boundary, as set out in the PD, will serve as the initial "forest cover benchmark map" against which changes in forest cover will be assessed over the interval of the monitoring period.

The entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event.

The increase or decrease in carbon stocks due to planned activities in the project area will also be monitored through documents and periodic assessment of classified satellite imagery covering the project area. In case of planned deforestation, emissions are estimated by multiplying the area of forest loss by the average forest carbon stock per unit area.

The results of monitoring shall be reported by creating *ex post* tables of activity data per stratum; per initial forest class *icl*; and per post-deforestation zone *z*, for the reference region, project area and leakage belt.

In addition, a map showing Cumulative Areas Credited within the project area shall be updated and presented to VCS verifiers at each verification event. The cumulative area cannot generate additional VCUs in future periods.

Other applied methodologies for monitoring of deforestation are listed below:

Monitoring bases

The instance owner is responsible for the implementation of monitoring bases, if necessary, to guarantee the standing forest and carbon stock.

Satellite images and remote sensing monitoring

The land use and land use cover change will be analyzed through remote sensing methods, using data from INPE (PRODES – deforestation; Queimadas – fire monitoring; TerraClass – qualification of Amazon deforestation), satellite images (LANDSAT, Sentinel, CBRES).

All reliable data collected and documented will be used as a technical support tool for decision making in order to improve project outcomes, and to adapt the project according to the current needs and reality. These decisions will be made during periodic meetings to review the Action Plan – that will be developed as part of the SocialCarbon Methodology. On these occasions, the design of the Monitoring Plan will be analyzed according to its efficiency in generating reliable feedback and all the necessary information. If any changes in the Monitoring Plan or management actions are identified, a corrective action will be designed and implemented.

Security procedures

The instance owner is responsible for the security procedures and reporting illegal activity to responsible authorities.

These actions are planned to avoid unplanned deforestation and carbon stock changes in the area. Related parameters shall be monitored and reassessed at every verification and revalidation point.

SOCIALCARBON Report will also monitor the relationship between the company and the communities, and its evolution on mitigating unplanned deforestation caused by these agents.

- **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 company must notify Future Carbon so that it can include the related impacts in the carbon project reports, updating the related parameters, including the buffer report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, flooding, drought, fires or storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring, when significant. If the area (or a sub-set of it) affected by natural disturbances or man-made events generated VCUs in past verifications, the total net change in carbon stocks and GHG emissions in the area(s) that generated VCUs will be estimated, and an equivalent amount of VCUs will be cancelled from the VCS buffer. No VCUs can be issued for the project until all carbon stock losses and increases in GHG emissions have been offset.

- **Monitoring of Leakage**

Monitoring of the leakage belt and leakage management area will be carried out as in the project area and reference region.

The most recent VCS guidelines on this subject matter shall be applied. Furthermore, as the leakage belt was determined using Option 1 (Opportunity cost analysis), the boundary of the leakage belt will have to be reassessed at the end of each fixed baseline period using the same methodological approaches used in the previous period. The calculation procedure for estimating leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

- Carbon stock changes and GHG emissions associated with leakage prevention activities.

The carbon stock decrease or increase in GHG emissions due to leakage prevention measures, which will probably take place inside the leakage management area, will be monitored through documents and field assessment. In areas undergoing carbon stock enhancement, the project conservatively assumes stable stocks and no biomass monitoring is conducted.

- Carbon stock decrease and increases in GHG emissions due to activity displacement leakage

Deforestation in the leakage belt area above the baseline may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

- **Organizational structure, responsibilities and competencies**

Monitoring will be done by the project proponent and outsourced to a third party having sufficient capacities to perform the monitoring tasks. To ensure the operation of the monitoring activities, the operational and managerial structure will be established according to the table below.

For all aspects of project monitoring, the project proponent will ensure that data collection, processing, analysis, management and archiving are conducted in accordance with the monitoring plan. The authority for the registration, monitoring, measurement and reporting will be Future Carbon.

Table 57. 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

Use appendices for supporting information. Delete this appendix (title and instructions) where no appendix is required.