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

The Rio Branco Grouped REDD Project has its properties located in the State of Acre, Brazil. Acre was one of the most isolated States in the country, however, the inauguration of the Abunã Bridge, built over the Madeira River, officially interconnected the State to the rest of Brazil's road network in May 2021[4]. Acre also registered high deforestation rates in 2021, with 889 km^2, behind only Pará (4,037 km^2), Amazonas (2,071 km^2), Mato Grosso (1,504 km^2) and Rondônia (1,290 km^2)[5].

The primary objective of this REDD Project is to avoid the unplanned deforestation (AUD) within the 3,290 ha project area, and 464.54 ha of avoided planned deforestation (APD), consisting of 100% Amazon rainforest. This project was designed as a grouped project, as to be able to increase its contribution to the standing forest with the addition of new project activity instances in the future.

Additionally, to the pressure of increasing livestock and other important activities in the region, the properties are located near a federal road and located in the state capital, besides receiving an energy transmission line that will pass inside the properties. Therefore, the area is a vulnerable target of invasions and illegal actions, such as fires and theft of wood. Thus, monitoring and vigilance actions are fundamental to guarantee the standing forest.

In addition to the project's ecological and carbon benefits, a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project region, specifically contributing to improving deforestation control, aiming at the propagation of

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[1] IBGE – Instituto Brasileiro de Geografia e Estatística. Brazil. 2019. Available at: <https://www.ibge.gov.br/cidades-e-estados>.
[2] FAO and UNEP. 2020. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. Available at: <https://doi.org/10.4060/ca8642en>.
[3] FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. Available at: < https://doi.org/10.4060/ca9825en>.
[4] ESTADÃO - Available at: <Ponte integrou Acre à malha rodoviária brasileira em 2021, mas Estado já tinha estrada federal (estadao.com.br)>
[5] Available at:< Acre é o quinto estado com maior índice de desmatamento em 2021, diz relatório - (contilnetnoticias.com.br)>

environmental awareness, generation of alternative sources of income and environmental education actions.

The AUD REDD project is expected to avoid a predicted 797.77 ha of deforestation, equating to 313,757 tCO_2e in emissions reductions over the 30-year project lifetime (07-January-2021 to 12-October-2050), with an annual average of 226.173 tCO_2e.

The APD REDD project is expected to avoid a predicted 464.54 ha of deforestation, equating to 144.492 tCO_2e in emissions reductions over the 30-year project lifetime (13-October-2020 to 12-October-2050).

1.2 Sectoral Scope and Project Type

Sectoral Scope: 14 – Agriculture, Forestry, Land Use

Project Category: Avoided Unplanned Deforestation (AUD Project Activity) and Avoided Planned Deforestation (APD Project Activity).

This is a grouped project.

1.3 Project Eligibility

According to the VCS Methodology Requirements[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[7], following the VCS Standard[8]:

Eligibility Conditions	Justification of Eligibility
Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document.	The project meets all applicable rules and requirements set out under the VCS Program, as detailed in this section and in Applicability of Methodology.
Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology	The applied methodology is VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1. and VM0007 - REDD+ Methodology Framework (REDD+MF) for Avoided Planned Deforestation, v1.6. Applicability conditions are detailed in section 3.2.

[6] Available at < https://verra.org/documents/vcs-methodology-requirements-v4-3/>
[7] Available at: https://verra.org/documents/vcs-program-guide-v4-3/>
[8] Available at < https://verra.org/documents/vcs-standard-v4-4/>

Eligibility Conditions	Justification of Eligibility
Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	The project activity involves the conservation of native Tropical Rainforest, including sustainable forest management plan or not. These activities are eligible under the Brazilian law according to conditions set out in sections 1.14 and 3.5.
Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document Program Definitions for definition of model), such model shall meet with the requirements set out in the VCS Program document VCS Methodology Requirements and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals).	Not applicable. Project applies the VM0015 Methodology and VM0007 methodologies.
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, and VM0007 methodologies, in addition to the VT0001 for Additionality assessment.
Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline	Not applicable. Project applies the VM0015 Methodology and VM0007 methodologies, in addition to the VT0001 for additionality assessment.

Eligibility Conditions	Justification of Eligibility
(i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project).	
Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence	The project applies approved VCS methodology and tools. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.
Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document Program Definitions for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	The project applies approved VCS methodology and tools. The project shall take precedence to the rules and requirements of the VCS Program over other approved GHG Program.
Where Verra issues new requirements relating to projects, registered projects do not need to adhere to the new requirements for the remainder of their project crediting periods (i.e., such projects remain eligible to issue VCUs through to the end of their project crediting period without revalidation against the new requirements). The new requirements	Project was designed under the VCS Standard, v4 and VM0015, v1.1 and VM0007 version 1.6. Any new requirements shall be adhered to at project crediting period renewal (i.e six years from Project Start Date).

Eligibility Conditions	Justification of Eligibility
shall be adhered to at project crediting period renewal.	
There are currently six AFOLU project categories eligible under the VCS Program, as defined in Appendix 1 Eligible AFOLU Project Categories below: afforestation, reforestation and revegetation (ARR), agricultural land management (ALM), improved forest management (IFM), reduced emissions from deforestation and degradation (REDD), avoided conversion of grasslands and shrublands (ACoGS), and wetland restoration and conservation (WRC).	This is an eligible AFOLU project category under the VCS Program: Reduced Emissions from Deforestation and Degradation (REDD).
Where projects are located within a jurisdiction covered by a jurisdictional REDD+ program, project proponents shall follow the requirements in this document and the requirements related to nested projects set out in the VCS Program document Jurisdictional and Nested REDD+ Requirements.	This project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

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

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

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

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

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

Eligibility Conditions	Justification of Eligibility
2) Avoiding Unplanned Deforestation and/or Degradation (AUDD): This category includes activities that reduce net GHG emissions by stopping deforestation and/or degradation of degraded to mature forests that would have occurred in any forest configuration.	

1.4 Project Design

This is a grouped project and has been designed to include multiple project activity instances.

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 Ro Branco REDD Project is a grouped project, all instances implemented after validation shall meet the requirements mentioned in the most recent version of the VCS Standard.

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

Table 1. Grouped Project eligibility criteria

VCS Standard Eligibility criteria for the inclusion of new project activity instances	Rio Branco REDD Project	Instance 1
Projects shall meet the applicability conditions set out in the methodology applied to the project.	The GHG emission reductions shall be calculated according to the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020.	Instance 1 complies with this requirement because it adopts the Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012 and Methodology VM0007 - Methodology for Avoided Planned Deforestation v1.6, published on 08-September-2020.

Projects shall use the technologies or measures specified in the project description.	All new instances shall use and apply the same technologies or measures specified in the Project description - forest conservation by avoiding unplanned deforestation, with or without forest management in project scenario.	The Instance 1 project activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the grouped Project. Also, this instance is in the same reference region described on the VCS PD. Instance 1 applies one of the technologies or measures specified on the present Project Description: forest conservation by avoiding unplanned deforestation, without forest management in project scenario.
Projects shall apply the technologies or measures in the same manner as specified in the project description.		
Projects are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.	The Project shall be in accordance with the same baseline scenario established in Section 3.4. of the VCS PD: "In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the reference region, project area and leakage belt. Therefore, the project falls into the AFOLU-REDD".	The Instance 1 Project Activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the grouped Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD.
Projects must have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same	All instances must be additional to be included in the Grouped Project. The project activity must be consistent with Grouped Project Description: forest conservation by avoiding unplanned deforestation. In this case, the project activity may or may not include Sustainable Forest Management Plan. In the additionality assessment, each instance shall determine the appropriate analysis method, whether to apply simple cost, investment comparison or benchmark analysis, according to STEP 2 of VCS VT001 v 3.0 tool. 1) Instances may or may not include Sustainable Forest Management Plan.	Since the PD was developed based on the characteristics, reference region and activity of the initial instance, Instance 1 complies with this additionality criterion. The additionality analysis for Instance 1 was made according to Option I of VCS VT0001 v3.0, as detailed in section 3.5.

investment, technological and/or other barriers as the initial instances.	2) In case the project activity does not involve Sustainable Forest Management Plan: - The instance should have financial, technical and scale consistent with the described in the VCS PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied. 3) In case the project activity includes a Sustainable Forest Management Plan: - A new additionality analysis shall be provided. In this case, the investment comparison analysis (Option II) or the benchmark analysis (Option III) of the Tool VCS VT001 v 3.0 shall be used. - In addition, a new AFOLU non-permanence risk analysis shall be performed.	
New Project Activity Instances shall occur within one of the designated geographic areas specified in the project description.	Projects must be located within the Reference Region described in Section 3.3 of the VCS PD. The areas to be included must evidence the ownership of the property in accordance with Brazilian legislation, even if overlapping public areas such as Protected Areas. - As per the VCS Standard, new *AFOLU Non-Permanence Risk* assessments shall be carried out for each geographic area specified in the project description (for requirements related to geographic areas of grouped projects, see the VCS Standard). Where risks are relevant to only a portion of each geographic area, the geographic area shall be further divided such that a single total risk rating can be determined for each geographic area. Where a project is divided into more than one geographic area for the purpose of risk analysis, the project's monitoring and verification reports shall list the total risk rating for each area and the corresponding net change in the project's carbon stocks in the same area, and the	The project activity within the area referring to instance 1 is located within the project's reference region as described in section 3.3 of the VCS PD.

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

reducing or removing GHG emissions).		
New Project Activity Instances must have a start date that is the same as or later than the grouped project start date.	The start date of the activity of each instance shall be the same as or after the start date of the grouped project, as established in Section 1.8 of the VCS PD.	Instance 1 project activity has the same start date of the grouped Project, as described in section 1.8 of the VCS PD.
Instances shall be eligible for crediting from the start date of the instance through the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period.	Instances shall be eligible for crediting from the start date of the instance activity until the end of the grouped project crediting period, i.e., the instance shall not generate credits after the end date of the Grouped Project. Where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period. New instances are eligible for crediting from the start of the next verification period.	Instance 1 project activity's crediting period has the same start and end dates of the grouped Project, as described in section 1.9 of the VCS PD.

1.5 Project Proponent

Organization name	Future Carbon Holding S.A. (Future Carbon Group)
Contact person	Marcelo Hector Sabbagh Haddad Bárbara Silva e Souza Carolina Chiarello de Andrade Carolina Pendl Abinajm Eliane Seiko Maffi Yamada Gabriel Fernandes de Toledo Piza Gabriella Hita Marangom Cesilio Guilherme Lucas Medeiros Prado Letícia Moraes Teixeira Lyara Carolina Montone Amaral Yara Fernandes da Silva

Title	Marcelo Hector Sabbagh Haddad – Head of Future Forest Bárbara Silva e Souza – Technical Analyst Carolina Chiarello de Andrade – Technical Analyst Carolina Pendl Abinajm – Technical Coordinator Eliane Seiko Maffi Yamada – Technical Coordinator Gabriel Fernandes de Toledo Piza – Technical Coordinator Gabriella Hita Marangom Cesilio – Technical Analyst Guilherme Lucas Medeiros Prado – Technical Coordinator Letícia Moraes Teixeira – Technical Analyst Lyara Carolina Montone Amaral – Technical Coordinator Yara Fernandes da Silva – Technical Coordinator
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Email	forest@futurecarbon.com.br

1.6 Other Entities Involved in the Project

Organization name	Fazenda Alegria
Role in the project	Instance 1
Contact person	José Aristides Junqueira Franco Júnior
Title	Owner Fazenda Alegria
Address	Rua Eugenio Beco Bezerra n 100 - Q 04, C 03, Condomínio Green Garden, CEP: 69901-519, Rio Branco – AC
Telephone	
Email	nenejunqueira@hotmail.com

Organization name	Fazenda Riozinho
Role in the project	Instance 1
Contact person	José Aristides Junqueira Franco Júnior
Title	Attorney of Fazenda Riozinho

Address	Rua Eugenio Beco Bezerra n 100 - Q 04, C 03, Condomínio Green Garden, CEP: 69901-519, Rio Branco – AC
Telephone	
Email	nenejunqueira@hotmail.com

1.7 Ownership

Instance 1 is located in the municipality of Rio Branco, State of Acre, and is composed by 2 properties that comprise the following areas:

- Fazenda Riozinho;
- Fazenda Alegria.

The properties composing Instance 1 are owned according to the following table. The legal documents proving the land title and ownership of the properties will be made available to the auditors during the validation process.

Table 2. List of properties and owners

Instance	Property name	Owner
1	Fazenda Alegria	José Aristides Junqueira Franco Júnior
2	Fazenda Riozinho	Marilda de Almeida Junqueira Franco

As per the Ownership requirements established in the VCS Standard, an enforceable and irrevocable agreement was set between aforementioned owners. – 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. Evidence of such agreement will also be made available to the audit team.

1.8 Project Start Date

According to the VCS Standard, “the project start date of an AFOLU project is the date on which activities that led to the generation of GHG emission reductions or removals are implemented (eg, preparing land for seeding, planting, changing agricultural or forestry practices, rewetting, restoring hydrological functions, or implementing management or protection plans)”.

AUD – Avoided Unplanned Deforestation

The owners signed a contract with a service provider to monitor the properties in order to avoid illegal deforestation, invasions, and fires that could later bring inspections and fines for the owners. Mainly because the project area is crossed by a road and because the properties are in the municipality of Rio Branco, which is the capital of the State of Acre, it has the greatest growth and expansion of urban areas and openings of access roads to other municipalities.

This contract includes satellite image monitoring and monthly information reporting to the owners and was signed between the owner and a forestry engineer on January 7, 2021. Environmental monitoring encompasses preservation actions, area maintenance strategies, isolation, and fire prevention measures.

Thus, for the AUD REDD Project, the Project Start Date was defined on 07-January-2021.

APD – Avoided Planned Deforestation

Based on the applicability of methodology VM0007 (section 4.3.3) which cites that REDD project for planned deforestation activity is applied where the conversion of forest land to a deforested condition must be legally permitted. Both properties, Fazenda Alegria and Fazenda Riozinho, have Authorizations for forest suppression and change of land use and thus, based on the date of issue of the authorization, the PSD was defined.

Therefore, to define the Project Start Date of the APD REDD Project, the date of issue of the authorizations for forest exploitation issued by the Environmental Institute of Acre-IMAC for Fazenda Riozinho was adopted. The PSD was defined on 13-October-2020 (**Erro! Fonte de referência não encontrada.**). This is the date on which the owner obtained authorization to clear the forest for use in pasture.

The legal documents supporting the project start date will be made available to the auditors during the validation process.

	Project Start Date
AUD	07 January 2021
APD	13 October 2020

1.9 Project Crediting Period

The project has a crediting period of 30 years, from 13-October-2020 to 12-October-2050, which may be renewed up to 100 years.

According to the VCS requirements, the baseline must be reassessed every 6 years for REDD AUDD projects because projections for deforestation are difficult to predict over the long term.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO2e) AUD	Estimated GHG emission reductions or removals (tCO2e) APD
2020	-	197,890
2021	11,842	-
2022	11,969	-
2023	12,096	-
2024	12,223	-
2025	12,350	-
2026	12,477	-
2027	11,420	-
2028	11,534	-
2029	11,649	-
2030	11,763	-
2031	11,610	-
2032	11,597	-
2033	10,518	-
2034	10,494	-
2035	10,470	-
2036	10,446	-
2037	10,449	-
2038	10,437	-
2039	9,467	-
2040	9,445	-
2041	9,423	-
2042	9,401	-
2043	9,404	-
2044	9,393	-
2045	8,520	-
2046	8,500	-
2047	8,481	-

2048	8,461	-
2049	8,463	-
2050	8,454	-
Total estimated ERs	312,757	197,890
Total number of crediting years	30	30
Average annual ERs	10,425	6,596

1.11 Description of the Project Activity

- The Rio Branco REDD Project is a grouped project that consists in the implementation of conservation measures for avoiding unplanned deforestation within the Project Area and for the APD project area, as there will be no tree suppression according to the authorizations issued for land change, will have its forest conservation. The area will not be converted to pasture and will maintain a stable habitat for plants and animals.

- The two projects being close will contribute to the activity of one favoring the preservation of the other and vice versa. The APD areas will serve as protection areas for the AUD area, where sustainable forest management takes place and ensures that no invasions occur and that environmental legislation is followed, as mentioned above.

- Instances 1 and 2 adopts forest conservation measures such as recruitment and management of surveillance teams to monitor suspicious and/or illegal activities and control of invasions within the project area. Other mitigation actions proposed by the Project in order to avoid unplanned deforestation will be carried out by strengthening surveillance in the area, mapping the local deforestation patterns, setting partnerships with educational and research institutions, and through providing benefits to surrounding communities, aiming to minimize invasions and illegal deforestation, offering alternative income, education and professional training.

- Therefore, besides forest conservation, the present project aims to 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.

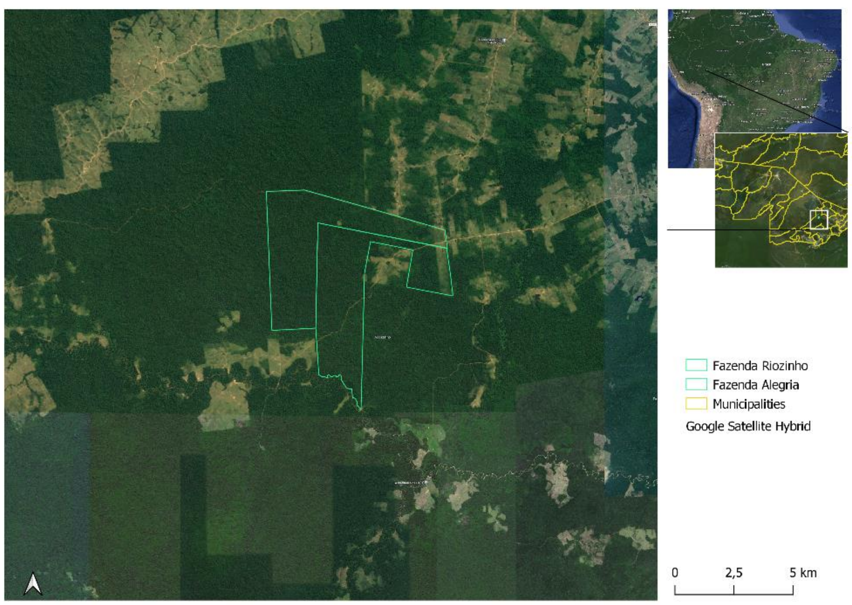
- The implementation of REDD + SOCIALCARBON mechanisms promotes sustainable development through forest conservation resulting in the permanence of carbon stocks, while reducing pressure for timber from other forest areas. In this way, biodiversity conservation and development of the local economy can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

- All the aforementioned measures are expected to result in net GHG emission reductions by preventing illegal deforestation agents to advance with their activities, as well as by retrieving their practices and, therefore, protecting and even restoring the carbon pools.
- It is important to highlight that this project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

1.12 Project Location

The Project Activity Instance Area is located in the municipality of Rio Branco, in the State of Acre (Figure 1), a region known as Northeastern Amazon within the Brazilian Arc of Deforestation (**Erro! Fonte de referência não encontrada.**). The project area is covered 100% by native vegetation, totaling approximately 3,754.54 ha.

Figure 1. Project Location

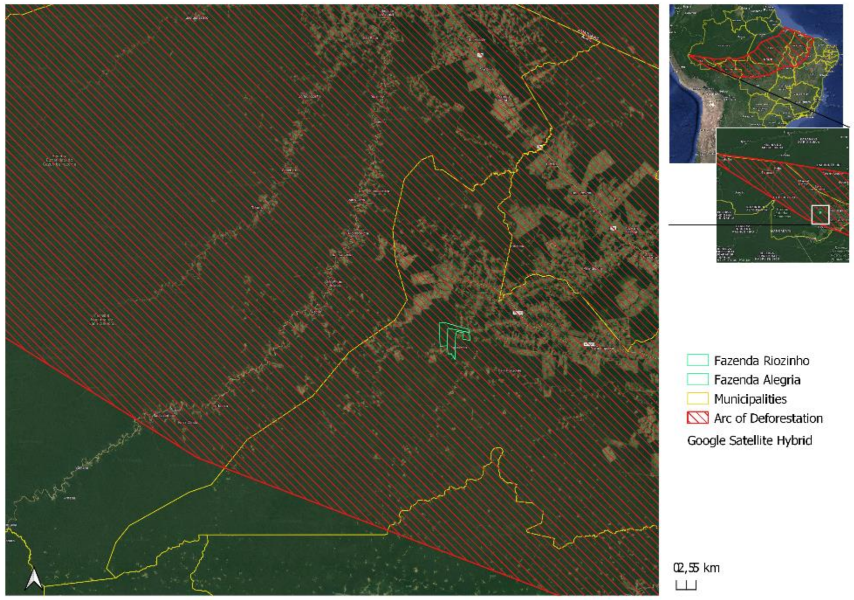


The closest access road is BR 364, called Rodovia Marechal Rondon, highway connecting the Brazilian states of São Paulo, Goiás, Mato Grosso, Rondônia, and Acre to Mâncio Lima, the last municipality in Brazil on the border with Peru.

The project is located in the municipality of Rio Branco, capital of the State of Acre and the second with the largest logging in the state in 2020[10].

[10] SIMEX – Sistema de Monitoramento da Exploração Madeireira. Acre Agosto 2019 a Julho de 2020. Available at: https://imazon.org.br/publicacoes/sistema-de-monitoramento-da-exploracao-madeireira-simex-mapeamento-da-exploracao-madeireira-no-acre-agosto-2019-a-julho-2020/

Figure 2. Arc of Deforestation



1.13 Conditions Prior to Project Initiation

The Rio Branco REDD Project makes an important contribution to the conservation of Northeast Amazonia's biodiversity as well as to climate regulation in Brazil and South America.

In addition to contributing to the long-term conservation of the region, this project also functions to establish a barrier against the advancement of the Brazilian Arc of Deforestation, creating a Northeast Amazon biodiversity corridor in a vulnerable region.

The present project activity has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal or destruction. On the other hand, the project aims to promote forest conservation combined with alternative income generation for local communities, associated with a greater surveillance against deforestation agents.

The general characteristics of the project area and reference region are described below.

Climate

The project region is classified as Megathermal (humid tropical), according to Köppen climate classification, with average temperatures in the coldest month above 18°C[11]. These are regions with high humidity and average rainfall, 2,022 mm/year[12] with reduced rainfall in the months between May and September[13]. These high precipitation values near the Andes Mountains are

[11] Pereira et. al. Agrometeorologia – Fundamentos e Aplicações Práticas, Guaíba/RS, Edipec, 2002.

[12] Sousa, J.W. Características Climáticas do município de Rio Branco, Acre, período de 1990-2019. Scientia Naturalis, v.2, n.2, p.723-740, 2020. Available at: https://periodicos.ufac.br/index.php/SciNat/article/view/4231/2412#:~:text=Segundo%20os%20crit%C3%A9rios%20adotados%20por,%3A%20B1%20rA'a'.

[13] Available at: https://www.climatempo.com.br/climatologia/2/riobranco-ac

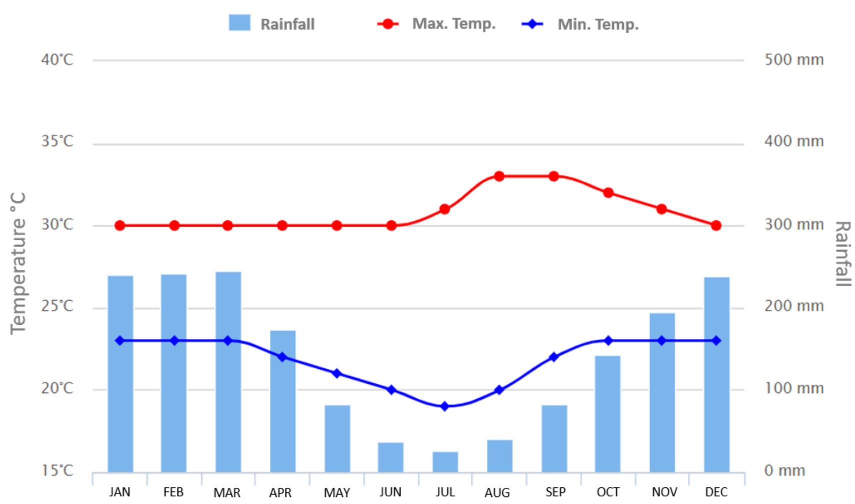
due to the orographic rise of moisture transported by the east trade winds of the Intertropical Convergence Zone (ITCZ)[14].

The project area is classified as Am category, according to the Köppen classification, with a short dry season, under the influence of monsoons. The Graph below presents the temperature and rainfall pattern in Rio Branco. The period between May and September is the driest, with rainfall up to 150mm. From November to March, rainfall exceeds 200 mm per month, with maximum temperatures of up to approximately 31ºC.

Regarding the pluviometric regime, the region has total annuals generally between 1,500 mm and 1,800 mm, but it is subject to important fluctuations during the time. The rains are not distributed equally during the year, being characterized by a sharp division in a period with heavy rains from January to July, and another with low rainfall from August to December.

The period between June and November is the driest, and with the highest temperatures. From January to March the rainfalls are up to 200 mm per month, and temperatures between 23 to 30ºC. The graph below presents data from Breves as it is the climate station closest to the project area.

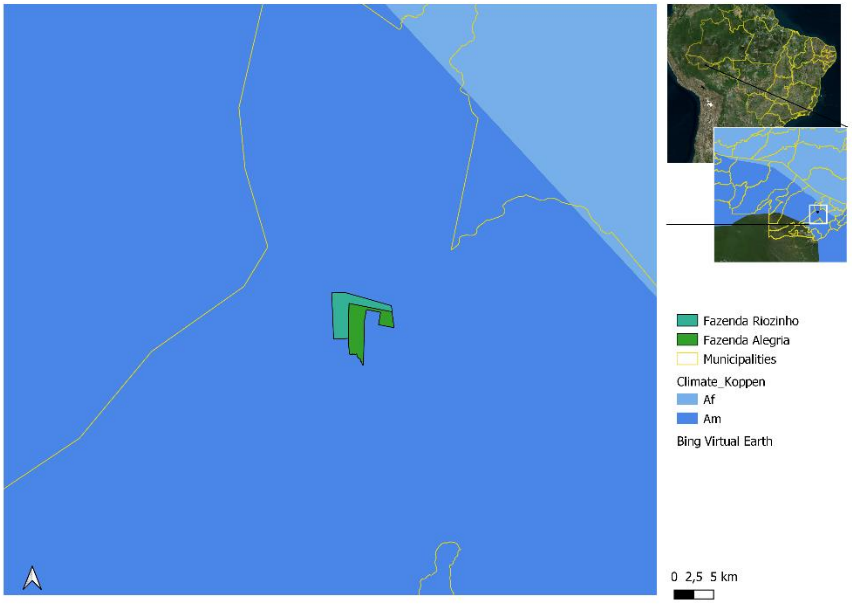
Figure 3. Climograph in the project region



According to the Köppen classification, the project area is included in the **Am** climate subtype. The **Am** class is characterized by a short dry season, under the influence of monsoons ().

[14] INPE/CPTEC. Available at: <http://climanalise.cptec.inpe.br/~rclimanl/boletim/cliesp10a/fish.html>

Figure 4. Climat Köppen Classification



Hydrography

The region has a hydrography rich in rivers, however, with regard to the use of regional hydrography, the most prominent rivers are the Rio Branco, which is close to the project area and permeates the reference region.

The project area is in the Amazon Basin, specifically in the Coari Lake and Purus River sub-bacin. The main river near the Project Area is the Rio Branco River (Figure 5). This River is a tributary of the Purus River and has a considerable volume of water that thickens the dense Purus basin. Its springs are in the state of Acre, but it cuts cities both in that state and in Amazonas.

Figure 5. Hydrography

Geology, Topography and Soils

In Acre, as in other parts of the Amazon, the altimetric variation is not expressive. The geomorphological unit in which the Project Area is inserted is the Rio Branco Depression, which has an altitude between 140 and 270m (Figure 6). It has a very dissected relief, with convex tops and a high drainage density, with medium slopes in the central-northern part, decreasing towards the south.

The predominant soil type within the Project Area is Argisols (Figure 7). Argisols are highly weathered soils with distinct horizon differentiation. They are a very diverse class that all share an increase in clay content with depth.

Figure 6. Distribution of geomorphological units in the State of Acre[15]

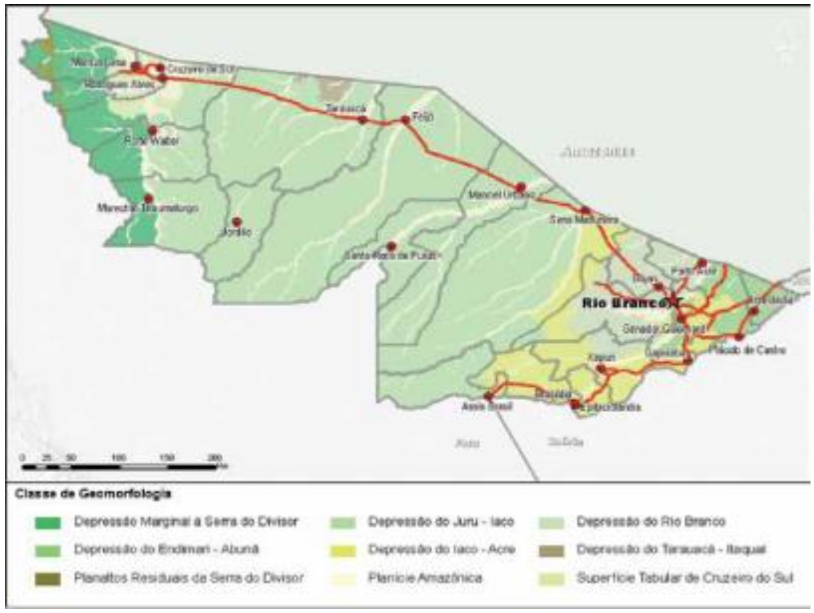


Figure 7. Project area and soil types

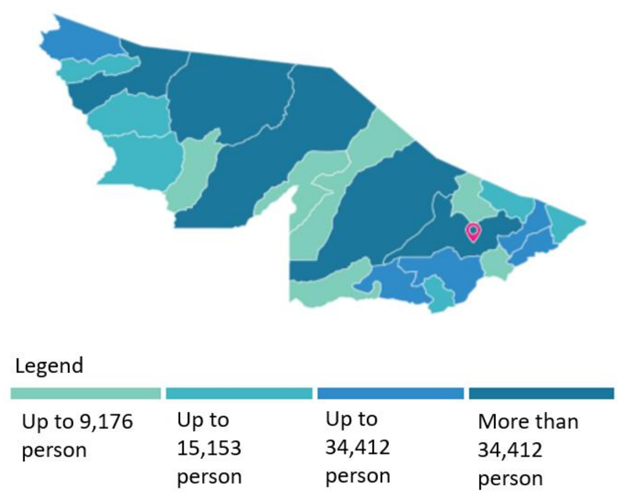
[15] ACRE, 2010. Zoneamento Ecológico-Econômico do Acre Fase II, 2006. Available at: https://agencia.ac.gov.br/zoneamento-ecologico-economico-do-acre-e-destaque-entre-os-estados-da-amazonia-legal/

Socio-Economic Conditions

The municipality of Rio Branco has more than 8,835 km^2 of territorial extension. The population count, in the last census of 2010, was around 336,038 (Figure 8) people and a population density of 38,03 inhab/km^2. The population estimate for 2021 is 419,452 people[16]. In 2020, only 24% of the total population was considered economically active. Formal workers received, on average, 3,3 minimum wages, which placed the municipality at the lowest levels in the state (1st out of 22 municipalities) and in the country (75th out of 5570).

Schooling rate from 6 to 14 years old in 2010 was 95,1% and The Municipal Human Development Index (HDIM) of the municipality of Rio Branco, in 2010 was 0.727. 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

Figure 8. Last census population



Biodiversity

The western Amazon is considered by some researchers a high priority region for biodiversity conservation. According to the Acre ZEE, the group of birds was the one that presented the greatest diversity within State, followed by fish, mammals, amphibians and reptiles[17]. According

[16] Available at: https://cidades.ibge.gov.br/brasil/ac/rio-branco/panorama

[17] ACRE, 2010. Zoneamento Ecológico-Econômico do Acre Fase II, 2006. Available at: https://agencia.ac.gov.br/zoneamento-ecologico-economico-do-acre-e-destaque-entre-os-estados-da-amazonia-legal/

to The World Conservation classification Union (IUCN), Acre has three species of mammals in the category “Endangered” and 14 in the category “Vulnerable”, with nearly all of these species are mammals, with the exception of two species of reptiles - the tracajá (Podocnemis unifilis) and the tortoise (Geochelone denticulata), highly targeted by hunters.

Figure 9. Tracajá (left) and tortoise (right)

Podocnemis unifilis

Geochelone denticulata

Two species that occur in Acre appear as “Endangered” by the IUCN. They are on the List of Brazilian Fauna Species Endangered: the giant otter (Pteronura brasiliensis) and the giant armadillo (Priodontes maximus). both are species targeted by hunters and with reproductive rates relatively low.

Figure 10. Giant otter (left) and giant armadillo (right).

Pteronura brasiliensis

Priodontes maximus

As some of the other conditions existing prior to the project initiation are the same as the baseline scenario and, as per the VCS guidelines, therefore, there is no need to repeat the description of the scenarios, the remaining conditions prior to the project initiation can be found at Section 3.4 (Baseline Scenario).

Vegetation Cover

According to the Brazilian Forests at a Glance 201918, the Brazilian Forest Service considers as forests the lands that correspond to the vegetation typologies according to the Classification System of the Brazilian Institute of Geography and Statistics (IBGE), updated by the SIVAM project19 (See Section **Erro! Fonte de referência não encontrada.**).

In Acre, two phytoecological regions predominate: the Dense Tropical Forest and the Open Tropical Forest. The Open Tropical Rainforest area variation of the Dense Tropical Rainforest, being a more open forest formation. The present REDD Project's boundaries are composed by Open Tropical Rainforest.

The Open Tropical Rainforest, which surrounds the southern part of the Amazon Basin, occurs in numerous disjoint clusters and is characterized by three facies dominated by typical genera, suggestively located in less humid areas. In the project area there is Lowland Open Rainforest with bamboo (Abb) and in the reference region there is also Lowland Open Rainforest with palm trees (Aap) and In figure below**Erro! Fonte de referência não encontrada.** it is possible to observe that the project area is not inserted in a peatland area and the rivers that cut the areas do not form wetlands areas.

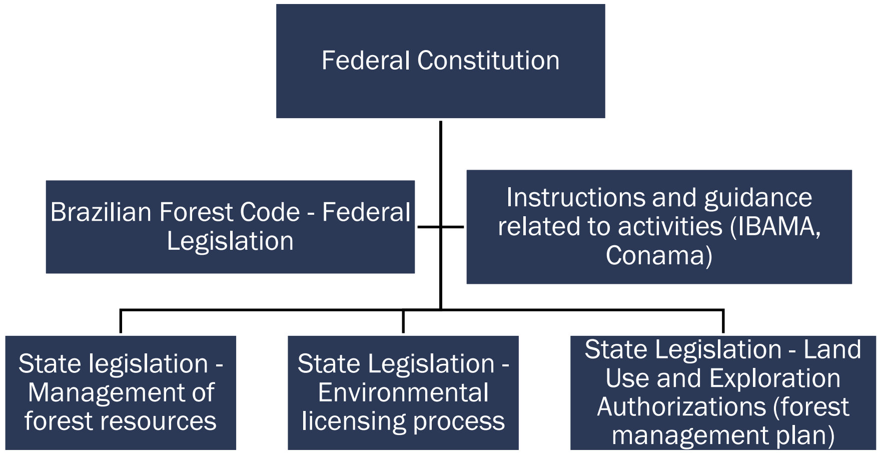
The project area is covered by native Amazonian vegetation, as per internationally accepted definition of forest. The Region has several types of vegetation groups, which vary depending on the types of soils and water drainage.

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[20]. 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[21]. 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.

18 Available at: <https://www.florestal.gov.br/documentos/publicacoes/4262-brazilian-forests-at-a-glance-2019/file>
19 As of 1996, through a contract signed between the Implementation Commission of the Airspace Control System - Ciscea, and its Amazon's Surveillance System Project - Sivam, and IBGE, updated the information that make up the Legal Amazon, attending, at the same time, the Systematization of Information on Natural Resources project. Information available at: <https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf>; SIVAM Project: <https://www.camara.leg.br/noticias/55929-o-que-e-o-sivam/>.
20 Available at http://www.pge.sp.gov.br/centrodeestudos/bibliotecavirtual/Congresso/ztese17.htm
21 Available at http://pnla.mma.gov.br/competencias-para-o-licenciamento-ambiental

Figure 11. Structure of the Brazilian legislation



Thus, in the state of Acre, the Secretary of the Environment (SEMA/AC) 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[22]), all rural estates located in forest zones shall have:

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

II. Legal Reserve: an area located within a rural property or possession which is required to be segregated, as well as the permanent preservation area, for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[23], 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 Rio Branco 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

[22] BRASIL. Law nº. 12.651, of 25 May 2012. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 25 May 2012.

[23] 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.

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[24].

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[25]. 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. Some of the farms hold sustainable logging activities. These activities are carried out according to Sustainable Forest Management Plans previously approved by the Acre State Government. These management plans were conceived in accordance with Brazilian Forest Code and local regulation.

As the project activity involves planned logging (Sustainable Forest Management) it is important to describe compliance with applicable law.

Sustainable Forest Management is defined in Article 3, VII, of Law 12.651/2012 (National Forest Code), as the administration of natural vegetation to obtain economic, social and environmental benefits, respecting the support mechanisms of the ecosystem object of management and considering, cumulatively or alternatively, the use of multiple wood species or not, of multiple products and by-products of the flora, as well as the use of other goods and services. Decree 5,975[26] also specifies the technical and scientific foundations of the PMFS.

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 24/04/2007[27], 5, of 11/12/2006[28] and 2, of 27/06/2007[29]; in addition to CONAMA's Resolution 406, of 02/02/2009[30]

- State legislation

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

[25] 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.

[26] Available at http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm

[27] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=113233>

[28] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=112909>

[29] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&force=1&legislacao=113306>

[30] Available at < https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=114762>

In the state of Acre, the Instituto de Meio Ambiente do Acre (IMAC/AC) is the body responsible for environmental licensing, authorizations and permissions for sustainable forest management and alternative land use. Legislation such as laws Nº1,426/2001[31], Decree 9,670/2018[32] and 7,734/2014[33], and IMAC N°27/2021[34] is applicable, as detailed in table below.

All the documents in their entirety are available for consultation by the audit team.

- 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+[35].

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.

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 Rio Branco 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;	The project areas, AUD and APD, complies with current legislation, as evidenced by the authorizations

[31] Available at < https://www.legisweb.com.br/legislacao/?id=116287>
[32] Available at < https://www.legisweb.com.br/legislacao/?id=367705>
[33] Available at < https://www.legisweb.com.br/legislacao/?id=271236>.
[34] Available at < https://www.legisweb.com.br/legislacao/?id=412693>
[35] The Decree is available in Portuguese at: < http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm>

	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.	issued and the absence of legal pending issues on the environmental side. The AUD project is being carried out in the areas of legal reserves of the properties, representing 80% according to legislation. And for the areas that would be destined for land use change, in this case livestock, the suppression authorizations prove that these areas are regular and applicable for the APD project.
Decree 5975	Provides information for the exploitation of forests and successor formations, comprising the regime of sustainable forest management and the regime of suppression of forests and successor formations for alternative land use.	The management plan conducted within the project area was approved by the responsible environmental agency in Acre (IMAC).
State legislation		
Law 1,426	Provides for the preservation and conservation of the State's forests, institutes the State System of Protected Natural Areas, creates the State Forestry Council and the State Forest Fund and other provisions	The management plan and activities conducted within the project area were approved by the responsible environmental agency in Acre (IMAC)
Decree 9670	Provides for forest restoration in the State of Acre.	The management plan and activities conducted within the project area were approved by the responsible environmental agency in Acre (IMAC), as well as the current APU. According to legislation, properties can only request a new authorization for sustainable forest management, after inspection by IMAC and proof of management in the previous APU.
Decree 7734	Regulates the Rural Environmental Registry - CAR, in the State of Acre 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.
IMAC 27	Defines the technical and administrative procedures referring to the environmental	The property complies with state legislation and the environmental

	licensing of activities potentially causing environmental impact, in the State of Acre, in which there is an alternative use of the soil for agricultural activities, agricultural planting and the raising of cattle and buffaloes for commercial purposes.	licensing required for carrying out forestry activities, in accordance with current exploration authorizations.
Law 1117[36]	Provides for the environmental policy of the State of Acre, and other measures, involving environmental zoning, environmental education and community participation, environmental protection, wild fauna protection, among others.	The property complies with the state legislation required for carrying out forestry activities, in accordance with the appropriate measures to protect the environment and wild fauna.
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	Instances 1 and 2 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Administrative Rule 5 IBAMA	Provides for technical procedures for the preparation, presentation, execution and technical evaluation of sustainable forest management plans - SFMP in primitive forests and their forms of succession in the legal Amazon, and other measures	Instances 1 and 2 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Normative instruction 2 MMA	Amends provisions of normative instruction no. 5, of December 11, 2006, and makes other provisions	Instances 1 and 2 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Resolution 406 CONAMA	Establishes technical parameters to be adopted in the preparation, presentation, technical evaluation and execution of a sustainable forest management plan - SFMP for timber purposes, for native forests and their forms of succession in the Amazon biome	Instances 1 and 2 does not perform sustainable forest management within its forest area; therefore, this Administrative Rule does not apply.
Legislation on climate change and carbon market		
Decree 10144	Establishes the National Commission for the Reduction of Greenhouse Gas Emissions	The development of this Project is not in conflict with such Decree. In terms

[36] Available at < https://www.legisweb.com.br/legislacao/?id=116194>

	from Deforestation and Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Increase of Forest Carbon Stocks - REDD+.	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[37]	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, does not establish duties or obligations to the society.

The project is in the State of Acre, which has a set of public policies that support forest conservation. In 2010, the State created a state system Sistema Estadual de Incentivos a Serviços Ambientais - SISA (State System of Incentives to Environmental Services) to promote the maintenance and expansion of environmental services. The SISA-Carbon Program, established in Articles 22 and 23 of Law no. 2,308 / 2010, sets out only the objectives of this program, which is to promote the GHG emission reductions, according to the voluntary goal of the State of Acre. The SISA-Carbon Program described in articles 22 and 23 of Law no. 2,308 / 2010 does not provide any determination, rule, limitation or specification about the execution of REDD projects in the territory of the State of Acre, by private initiative or by the State of Acre itself.

Thus, the articles of the Law on the SISA-Carbon Program were not regulated by the State of Acre in order to have a legal record on their accounting, registration of projects and distribution of emission reduction percentages. There is no regulation of articles 24, 25 and 26 of Law No.

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

2,308 / 2010, so that the applicability of these articles is not fully enforced. In other words, the SISA-Carbon Program has no legal applicability on these issues until they become fully regulated.

In addition, the SISA-Carbon Program, established by law, does not, under any circumstances, prohibit REDD projects from being carried out by private initiative, nor does it have, under any circumstances, the obligation of private REDD projects to adhere to the SISA-Carbon Program.

The Government of the State of Acre instituted on 23-December-2021 the ISA Clima Program, whose main objective is to implement initiatives that promote the mitigation and adaptation to climate change.

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 is not requesting registration in any other GHG Programs nor has the project been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

1.16.2 Other Forms of Environmental Credit

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

Supply Chain (Scope 3) Emissions

The present REDD project's GHG emission reductions are not in a supply chain, i.e., there is no network of organizations (e.g., manufacturers, wholesalers, distributors, and retailers) involved in the production, delivery, and sale of a product or service to the consumer. Therefore, there are no organizations upstream and downstream of the goods and services whose GHGs are impacted by the present REDD project activity.

1.17 Sustainable Development Contributions

The primary objective of the Rio Branco Grouped REDD Project is to avoid the unplanned deforestation (AUD) and the planned deforestation (APD) 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)[38] 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[39]. 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[40] and by the IPEA reports[41]. In addition, in 2018 there was the SDG Award, an initiative of the Federal Government whose objective is to encourage, value and give visibility to practices that contribute to achieving the goals of the 2030 Agenda throughout the national territory. The first edition of the Award had 1045 entries to compete in four categories: government; for-profit organizations; non-profit organizations; and teaching, research and extension institutions.

- SDG 4: Quality education

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

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

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

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

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

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

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

- SDG 5: Gender equality

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

- 5.2“Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation”;
- 5.4 “Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate”.

- SDG 8: Decent work and economic growth

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

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

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

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

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

- 13.2 “Integrate climate change measures into national policies, strategies and planning”;
- 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

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

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

- 15.1 “By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements";
- 15.5 “Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species”;
- 15.9 “By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts”;
- 15.a “Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems”;

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

Reducing deforestation and promoting sustainable development in the Amazon is also a key component to Brazil’s Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, Ministério do Meio Ambiente), the implementation of REDD activities are an important component to meet the Country’s contribution under the United Nations Framework Convention on Climate Change while preserving natural forest resources[42].

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

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

- Strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels;
- Strengthening policies and measures with a view to achieve, in the Brazilian Amazon, zero illegal deforestation by 2030 and compensate for greenhouse gas emissions from legal suppression of vegetation by 2030.

1.18 Additional Information Relevant to the Project

Leakage Management

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

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

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

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.

Brazilian law such as Decree No. 6,040 ensures the rights of traditional people and communities of attaining sustainable development, and by this, activities such as collection of forest products are permitted as long as they do not cause any damage to the area in question[43]. Hereupon, the project proponents neither can (by law) or want to prohibit the local communities from collecting NTFP in the project area.

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

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

Commercially Sensitive Information

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

Further Information

No further information to disclose.

2 SAFEGUARDS

2.1 No Net Harm

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

Table 3. Project Risks

Identify Risk	Potential impact of risk on climate, community and/or biodiversity benefits	Actions needed and designed to mitigate the risk
Uncertainties relating to standing native vegetation cover in the future	GHG emissions, loss of habitat, ecological interactions and animal and plant species.	Monitoring and supervision to avoid deforestation of forest within the project area.
Catastrophic natural and/or human-induced events (e.g. landslides, fire)	Potential risk to community life and permanence, loss of habitat, ecological interactions, animal and plant species.	
Illegal activities within the project area	Deforestation, social conflicts, development of parallel and illegal economies, increase in criminality.	Job creation, development of socioeconomic actions involving the community, promotion of formal and environmental education.
Increase suppression of native vegetation within the project area	Deforestation, land use change, GHG emissions.	REDD+ Project: the additional income generated by carbon credits aims to mitigate the absence of

		another economic activity that would be carried out in the forest area.
Conflict management with communities in the project area, due to banning of negative impacting/illegal activities	Conflicts with the community can prevent/hinder the implementation of new socioeconomic activities aimed at the local society.	Encouragement and investment in social, economic and environmental aspects in the project region; Increasing independence of the communities in the project area.

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

2.2 Local Stakeholder Consultation

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

Local entities having some influence and activities developed in the Reference Region were chosen through a process to identify them and their possible impact on the Project Activity. Stakeholders chosen for local consultation also include communities and neighbors that might be impacted as well as set potential partnerships in the future.

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

- Communities living within the Reference Region
- ITERACRE
- Municipality of Rio Branco
- Secretaria de Estado do Meio Ambiente e das Políticas Indígenas (SEMAPI-AC)
- Secretaria Municipal de Meio Ambiente
- Secretaria de Educação
- Instituto Nacional de Colonização e Reforma Agrária (INCRA)
- Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais (IBAMA).
- Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio);
- Serviço Florestal Brasileiro
- UFAC
- Figueira Settlement

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

- Public entities: The carbon project is believed to be in the public sector's interest as it can help the state and municipalities achieve their goals of mitigating greenhouse gas emissions and illegal deforestation. In addition, partnerships with the public sector are very important for the development of activities throughout the project.
- Unions: The participation of unions is important to spread knowledge of the carbon market and include the vision of local employees and workers in the development of the project.
- Universities: It is believed that the participation of education and research institutions throughout the project is important to develop partnerships and help in the search for sustainable technological innovations, as well as the development of monitoring of fauna and flora, employees and communities training, carbon stock research, etc.
- NGOs: NGOs are entities focused on the population's objectives, whether social, environmental or economic, without ties to public governmental entities. Thus, they bring a different point of view to the activities, and communication with these entities brings transparency to the project. In addition, they are key agents for the development of partnerships to strengthen the project activity and enhance socio-environmental co-benefits.
- Communities: The employees on the Instance 1 properties were included as stakeholders as it is considered that they are directly affected by the Project, since their work influence the Project development and activities. Therefore, their participation in the planning of activities, in addition to comments and suggestions, is essential.
- Settlements: Some communities near the Instance 1 are located in settlements. Thus, in addition to communicating with the resident families, it is also important to communicate with associations, cooperatives and public health programs that deal directly with the people of the region and can bring insight on the needs of these communities, generating opportunities for improvement with the income from the carbon project.

As required by the VCS Standard, “the management teams involved in the project have expertise and prior experience implementing land management and carbon projects with community engagement at the project scale”. Information on the Project Management Team is further detailed as part of the Non-Permanence Risk analysis.

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

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

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

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

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

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

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

The process for receiving, hearing, responding to and attempting to resolve grievances will be performed within a reasonable time period. This Grievance Redress Procedure has three stages:

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

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

3) Any grievances that are not resolved through mediation shall be referred either to a) arbitration, to the extent allowed by the laws of the relevant jurisdiction or b) competent courts in the relevant jurisdiction, without prejudice to a party's ability to submit the grievance to a competent supranational adjudicatory body, if any (the time to accomplish this stage depends on local jurisdiction delays).

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

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

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

Contact information of the Future Forest[44] team will be made available at the end of the meeting. Communication can be carried out via letter, email, or telephone. The presentation will be recorded, and a PDF version might be made available through e-mail should it be requested by any stakeholder. The participants will be informed that the period for requesting information and comments about the REDD Project will be open for 30 days starting from the presentation date.

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

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

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[45]. 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[46]. 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[47].

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

[45] 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/>.

[46] 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>.

[47] 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>.

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

2.4 Public Comments

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

2.5 AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

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

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

   Stakeholders were identified through research, visits to the project region, as well as local knowledge from the Instance 1 landowners and management team. As detailed in Section 2.2, stakeholders were identified considering the communities, government agencies, educational and research entities, taking into consideration relevant Amazon biome institutions, in addition to NGOs within the Reference Region. Sustainable development and rural development agencies were also contacted. The list is available at section Local Stakeholders Consultation, above.

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

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

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

   On July 13, 2006, the Commission for the Sustainable Development of Traditional Communities was instituted in Brazil by decree[48] and updated in 2016[49], with the objective of implementing a national policy especially directed at such communities.

[48] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/dnn/dnn10884.htm> Last visit 20/07/2022
[49] Available at <http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Decreto/D8750.htm#art20> Last visit 20/07/2022

The Decree No. 6,040 of February 7, 2007[50], 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[51].

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 form Brazilian society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[52].

The REDD methodology guarantees and is guidelines for the execution of a forest conservation project that ensures not only the avoidance of unplanned deforestation, but also the integration and benefits of the traditional communities surrounding the project area.

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

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

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

   For government agencies, private companies and NGOs, communication was carried out remotely, through writing and speaking, with the presentation of the Project, its impacts and

[50] Available at <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm> Last visited on 05/01/2021.
[51] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visit 05/01/2021
[52] Available at <https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf> Last visited on 05/01/2021.

monitoring methodologies, accounting for credits and actions in the region. In a different way, for communicating the Project to local communities within the Reference Region, a presentation was performed considering their particularities, as well as a socioeconomic diagnosis aiming the development of an action plan to be put into practice along the project lifetime.

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

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

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

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

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

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

   - PA Oriente: 9°56'28.26"S; 68°40'50.36" W
   - PA Figueira: 9°54'35.38"S; 68°30'2.42" W;
   - PA Itamaraty: 9°53'16.73"S; 68°31'3.86" W.

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

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

Risks to Local Stakeholders

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

Table 4. Risks to Local Stakeholders

Aspect	Impact	Effect		Comments / Observation
		Beneficial	Adverse	
Land use	Reduced access to land		X	The baseline scenario activity of the project area will be maintained, i.e, no activity will be

	and traditional areas due to the project activity			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[53]
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 landowners maintain a friendly relationship with the neighbors, and one of the objectives of the carbon project is to expand social and environmental benefits to local communities. The Project Activity understands the permanence and land use of the families in the surrounding areas. Monitored by the Carbon Resource: • Stakeholder Consultation Monitored by the Natural Resource: • Project efficiency in agents that fight deforestation/degradation
Food Security	Withdrawal of land used for food production or		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

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

	income generation			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.

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. Every consultation shall communicate:

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

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

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

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

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

This project uses the approved VCS Methodology VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1, published on 03-December-2012[54].

Furthermore, the following tools were used:
For AUD:

- 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[55];
- AFOLU Non-Permanence Risk Tool v4, published on 19-September-2019[56].

For APD:

[54] Available athttps://verra.org/methodology/vm0015-methodology-for-avoided-unplanned-deforestation-v1-1/
[55]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/
[56] Available at https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf

- VM0007 REDD + Methodology Framework (REDD+ MF) Version "Methodology for Avoided Unplanned Deforestation", Version 1.6, 08 September 2020[57].
- VMD0001 – Estimation of carbon stocks in the above and below ground biomass in the live tree and non-tree pools (CP-AB). Version 1.1, 11 October 2013.
- VMD0002 Estimation of carbon stocks in the dead wood pool (CP-D). Version 1.0, 03 December 2010.
- VMD0005 Estimation of carbon stocks in the long-term wood products pool (CP-W). Version 1.1, 20 November 2012.
- VMD0006 Estimation of baseline carbon stock changes and greenhouse gas emissions from planned deforestation/forest degradation and planned wetland degradation (BL-PL). Version 1.3, 08 September 2020.
- VMD0009 Estimation of emissions from activity shifting for avoiding planned deforestation/forest degradation and avoiding planned wetland degradation (LK-ASP). Version 1.3, 08 September 2020.
- VMD0015 Methods for monitoring of GHG Emissions and removals (M-MON). Version 2.1, 20 November 2012.
- VMD0016 Methods for Stratification of the Project Area (X-STR). Version 1.2, 08 September 2020.
- VT0001 Tool for the demonstration and assessment of additionality in VCS agriculture, forestry, and other land use (AFOLU) project activities (T-ADD). Version 3.0 1 February 2012.
- AFOLU Non-Permanence Risk Tool, v4.0, 19 September 2019.
- CDM – Executive Board "Tool for testing significance of GHG emissions in A/R CDM project activities (Version 01)" EB 31[58];

+future001*

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	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

[57] Available at: <https://verra.org/methodology/vm0007-redd-methodology-framework-redd-mf-v1-6/>

[58] Available at: <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-04-v1.pdf>.

is unplanned deforestation according to the most recent VCS AFOLU requirements.	deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard. The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvest, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure expansion, such as waterways and roads. Therefore, in the baseline scenario, the Project Area would continue to be illegally deforested by the deforestation agents described above. With that said, the present criteria are fulfilled.
b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the methodology (table 1 and figure 2).	Within the categories of Table 1 and Figure 2 of the applied Methodology, the present Project Activity falls within category A, “Avoided Deforestation without Logging”. The reason is that the project area contains 100% native vegetation and has never been deforested in the past. In addition, it is important to note that degradation is not included neither in the baseline nor in the project scenario.
c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agroforestry systems meeting the definition of “forest”.	The forest classes composing the Project Area are named as per the Technical Manual for Brazilian Vegetation[59]. The area is considered forest as per the definition of adopted by FAO[60]: 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.

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

	No deforested, degraded or areas otherwise modified by humans were included in the Project Area at the Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The Project Area consisted of 100% tropical rainforest over 10 years prior to the project start date – all of which according to the Brazilian definition of forest[61]. 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 50 cm. If the project area includes forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	As described at Section 1.13 of the present VCS PD, the main soil type within the Project Area is the Dystrophic Red-Yellow Argisol. Therefore, no peat or peat swamp forests were found within the Project Area and Reference Region, satisfying this applicability criterion.

VT001	
a) AFOLU activities the same or similar to the proposed project activity on the land within the proposed project boundary performed with or without being registered as the VCS AFOLU project shall not lead to violation of any applicable law even if the law is not enforced;	The activities in the proposed project boundary does not lead to violation of any applicable law even if the law is not enforced 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 Instances 1

[61] 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>.

	and 2 do 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

Spatial Boundaries

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

Table 5. Project Area, Reference Region, Leakage Belt and Leakage Management Area

Boundary	Area (ha)
Project Area total	3,533.54
AUD	
Reference Region	131,600
Project Area	3,069
Leakage Belt	1,224.00
Leakage Management Area	147.00
APD	
Project Area	464.54

- Project Area

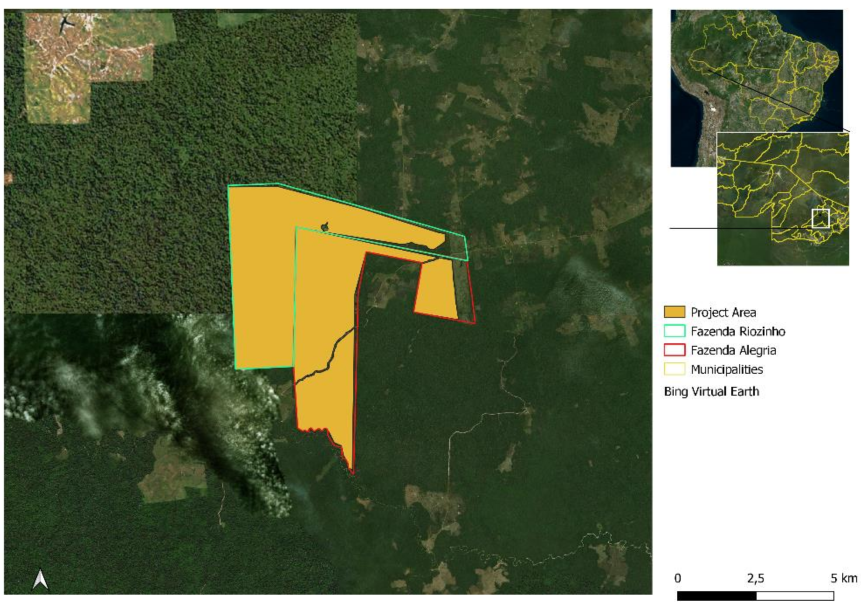
As described in section 1.7, the Project is composed by 2 properties, which have a total area of 3,533.54 ha. Methodology requirements for both AUD and APD is described below:

AUD – Avoided Unplanned Deforestation

According to VM00015, Project Area must comprise an area covered only by forest for at least 10 years before 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 to the methodology.

To define the project area, vegetation areas classified as grassland (including flooded fields and swamp areas), water body areas and a 40-meter-wide electrical transmission line area that cuts through part of the property were subtracted from the properties' area. As a result, the project area was defined as 3,069 ha. Further characteristics of the Project Area until Project Start Date are described in section 1.13.

Figure 12. AUD Project Area



APD – Avoided Planned Deforestation

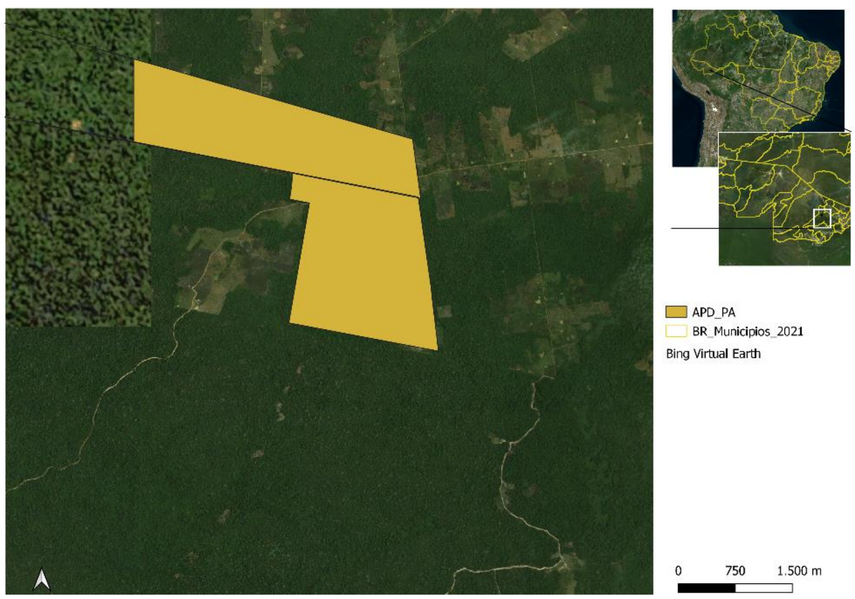
According to the Approved VCS Methodology VM0007, the REDD Boundaries must be clearly delineated and defined and include only land qualifying as forest for a minimum of 10 years prior to the project start date."[62].

[62] VM0007, version 1.6. Available at: <https://verra.org/methodology/vm0007-redd-methodology-framework-redd-mf-v1-6/>

To define the APD project area, deforested areas until the project start date, 10-October-2020, vegetation areas classified as grassland formation (including flooded fields and swamp areas) and water body areas were subtracted from the properties area, keeping only areas where planned deforestation should happen. These water body areas are Permanent Preservation Areas, also called APP (in Portuguese), according to the Brazilian Forest Code, Law nº 12.651/12, is a protected area.

The APD project area is 464.54 ha.

Figure 13. APD Project Area



- <u>Reference Region</u>

  AUD – Avoided Unplanned Deforestation

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

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

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

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

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

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

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

- **Agents and drivers of deforestation:** Timber logging (both legal and illegal) and cattle ranching are important economic activities within the Reference Region. As detailed in Section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats throughout the southern Amazon region. Thus, the analysis of the Reference Region definition includes these factors.
- **Socio-economic and cultural conditions:** The Methodology implies that "the legal status of the land (private, forest concession, conservation concession, etc.) in the baseline case within the project area must exist elsewhere in the reference region. If the legal status of the project area is a unique case, demonstrate that legal status is not biasing the baseline of the project area". This is complied with the areas surrounding the properties that are not public or part of any protected area, such as the Project Area. These conditions also comply with Land Use and Land Tenure items once the conditions of the Project Area are found elsewhere in the Reference Region. The Project Area is governed by the same policies, legislation and regulations that apply elsewhere in the Reference Region. These policies are detailed in Section 1.14. Data presented of the private areas is

available at Brazil's Environmental Rural Registration[63], National Protected Areas[64]. It is important to note that there are no Protected Areas included within the Reference Region. No Indigenous Land was included in the Reference Region.

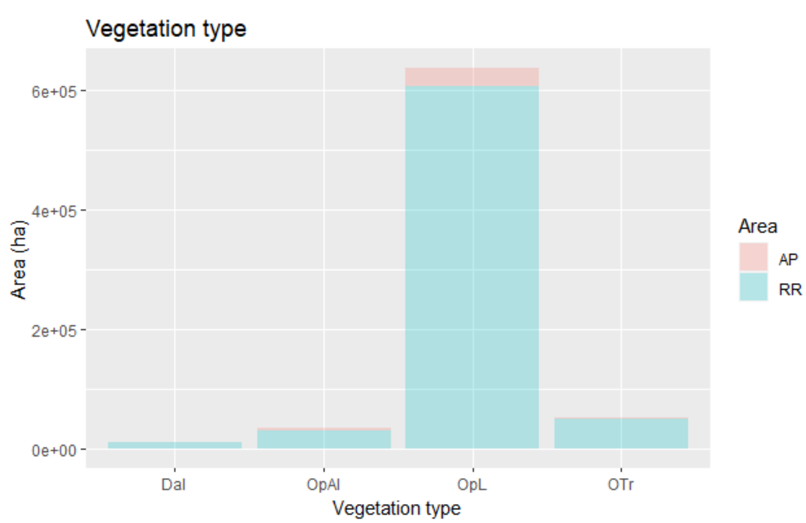
- **Landscape configuration and ecological conditions:** To define the Reference Region, the watersheds located around the Project Area were used as units. For each of these watersheds, the average values of elevation, slope and precipitation were determined, as well as the percentages of the different types of vegetation. Based on these values, it was possible to visualize areas that presented similar values to the Project Area's parameters. The area units were then used to achieve an extent of approximately 20-40 times the size of the Project Area as the Reference Region.

From the definition of this area, the criteria related to the type of vegetation, elevation, slope and precipitation were tested to verify the similarity in relation to the Project Area and the rest of the Reference Region. For all four variables, the values met the criteria, which indicates an adequacy of the Reference Region. The results are presented below:

Vegetation cover

The main Project Area's vegetation type, Open Lowland Tropical Rainforest (Ab), occupies more around 95% of the Reference Region, according to the graph below.

Figure 14. Distribution of phytophysiognomies, in area (ha), in the Reference Region and in the Project Area



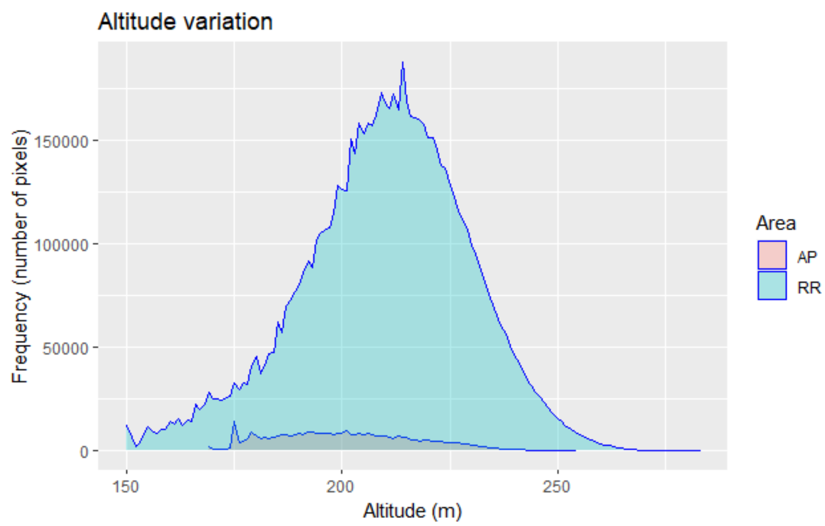
63 Available at <https://www.car.gov.br/publico/municipios/downloads>

64 Available at <https://metadados.snirh.gov.br/geonetwork/srv/api/records/9407d38f-84d2-48ea-97dd-ee152c493043>

Altitude

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

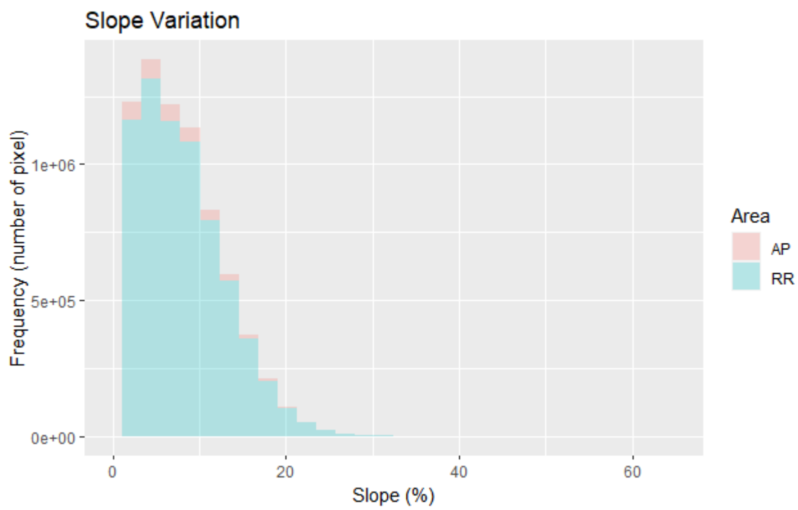
Figure 15. Altitude distribution (m), in number of pixels, in the Reference Region (RR) and in the Project Area



Slope

The average slope in the project area is 6.81% while in the rest of the reference region it is 7.26%. Therefore, the mean value of 90% of the project area is within the range of ± 10% of the mean in the reference region, which is between 6.54 and 7.99%.

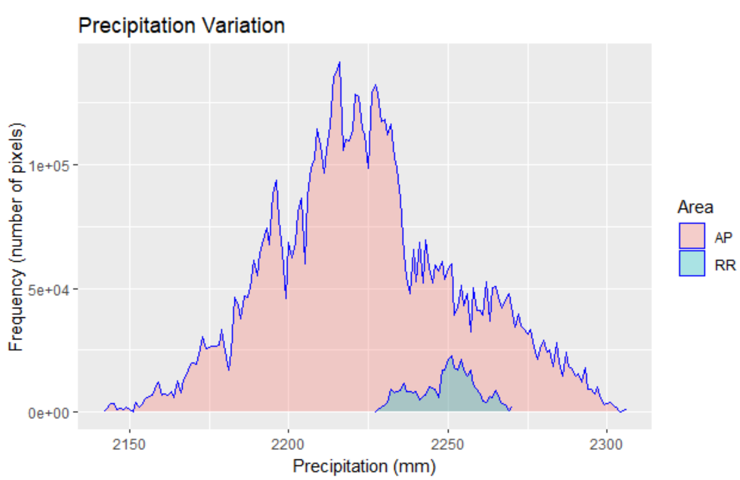
Figure 16. Slope distribution (degrees), in number of pixels, in the Reference Region and Project Area



Rainfall

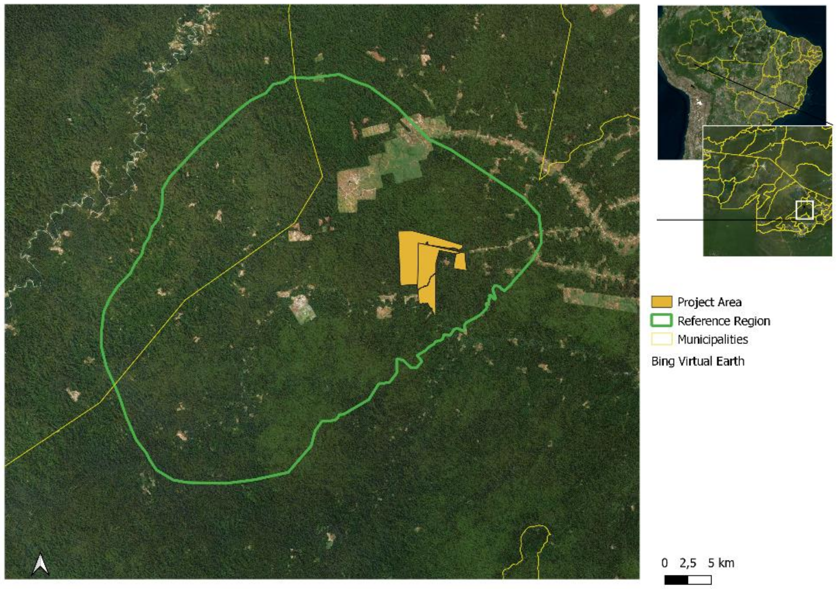
The annual rainfall in the project area is, on average, 2,249.37 mm, while in the rest of the reference region it is 2,224.61 mm. Thus, it is verified that the amount of rainfall in the project area remains within the variation of ± 10% of 100% of the average of the rest of the reference region, which varies between 2,002.15 and 2,447.07mm.

Figure 17. Distribution of annual precipitation (mm), in number of pixels, in the Reference Region (RR) and Project Area (PA)



Based on the criteria related to the type of vegetation, elevation, slope and precipitation above, the reference region was defined, which has 131.600 ha (40 times the Project Area). The map showing the RR and PA is presented below:

Figure *18*. Location of the Reference Region



- Leakage Belt

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

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

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

  For monetary costs, it was considered the freight table of “Portaria 314 de 21/05/2013”, which establishes the values for charging ICMS in providing intercity and interstate road transport services in the Acre market65. The single attachment of the ordinance mentioned above details the value of the dry cargo transport freight.

Thus, these values were corrected by the Broad National Consumer Price Index (in portuguese, Índice Nacional de Preços ao Consumidor Amplo - IPCA) on the project start date. The transport of 25 heads of 17 arrobas (12,750 kg) was considered, For sales values, Portaria 333 de 11/11/2021 was considered, which sets the minimum values of the ICMS tax base levied on operations and services with related goods.

Combining these two data, the economically viable areas for livestock production would be where the sum of revenues minus total costs are positive. The breeding cost per animal was estimated at approximately R$689.69, considering an extensive system of traditional breeding in the state of Acre for the year 201066. After correction by the Broad National Consumer Price Index (IPCA) on the project start date, this amount corresponds to R$1,145.80. The average price of arroba varied between R$252.38 and R$293.00 during the year 2021[67]. In the analysis, the minimum value of R$270.00 was used. For an average of 17 arrobas per animal, the income would be R$ 3,444.20.

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:

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

S$x: Selling price of product Px; $/t

PCxi: Average in situ production costs for one ton of product Px in stratum i; $/t

TDv: Transport distance on land, river or road of type v; km

TCv: Average transport cost per kilometer for one ton of product Px on land, river or road of type v; $/t/km

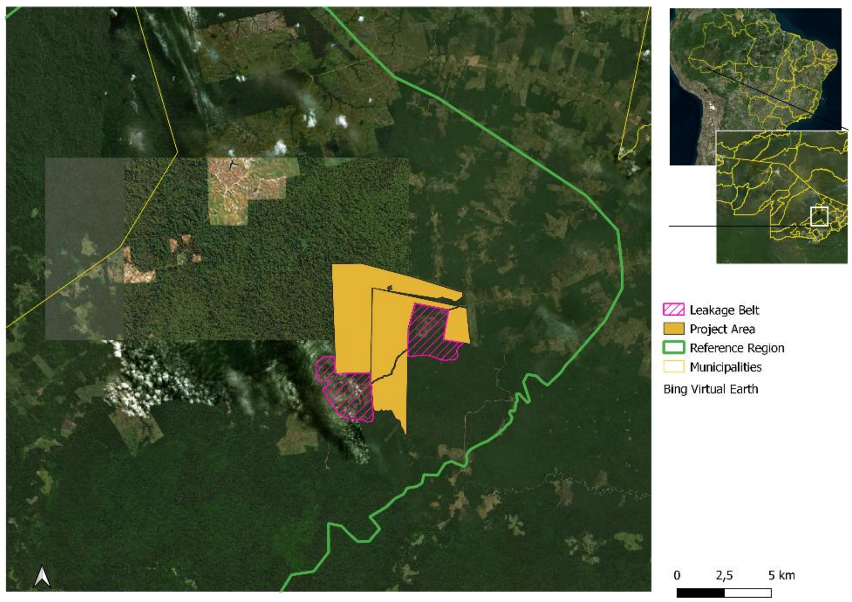
V: 1, 2, 3 …V, type of surface to on which transport occurs; dimensionless

[65] ACRE. Portaria nº 314, de 21 de maio de 2013. Estabelece os valores para cobrança do ICMS na prestação de serviço de transporte rodoviário intermunicipal e interestadual de cargas no mercado acreano. Rio Branco, AC. Available at: <http://sefaz.acre.gov.br/2021/?page_id=9510>. Acesso em 2 de julho de 2022.
[66] DE SÁ, C. P.; DE ANDRADE, C. M. S.; VALENTIM, J. F. Análise econômica para a pecuária de corte em pastagens melhoradas no Acre. Embrapa Acre-Circular Técnica (INFOTECA-E), 2010.
[67] CONAB. Companhia Nacional de Abastecimento. Preços agrícolas, da sociobio e da pesca. Available at: https://sisdep.conab.gov.br/precosiagroweb/.

With these considerations, the remaining areas with higher profitability values would be more attractive for the activity. Thus, the area with the highest potential value (R$ 7,499.24/t) was highlighted. Furthermore, was considered that areas adjacent to the project area viable according to the opportunity cost analysis within a radius of 5km would be where deforestation could occur directly due to the project's actions. In more distant areas, the increase in deforestation, as has already happened, is probably associated with the proximity to rivers and roads.

Finally, by overlapping the project area buffer with the areas with the greatest potential for profitability, we defined a Leakage Belt area of 1,224 ha. The figure below illustrates its location.

Figure 19. Location of the Leakage Belt

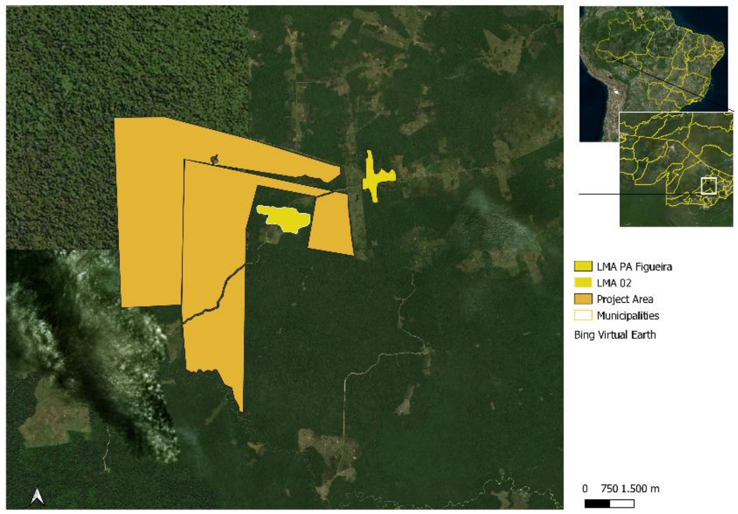


- Leakage Management Area

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

The Leakage Management Area was defined considering the nearest communities to Instance 1, with a total area of 147 ha, and their locations are represented in the Figures below:

Figure 20. Leakage Management Areas



APD – Avoided Planned Deforestation

Proxy Areas

For APD projects, it is necessary to define the Proxy Areas. These Proxy Areas may or may not be managed by the same deforestation agent as the project area baseline. At least 6 proxy areas must be included. Criteria for selecting Proxy Areas include:

1. Land conversion practices should be the same as those used by the baseline agent.
2. Post-deforestation land use should be the same in proxy areas as expected in the project area that have the same business.
3. Proxy areas shall have the same type of management and land use rights as the proposed project area.
4. If there are an insufficient number of sites in the immediate area of the project, the sites must be identified elsewhere in the same country as the project.
5. Deforestation agents in proxy areas must have deforested their land under the same criteria as the project lands (legally permitted and suitable for conversion).
6. Deforestation in the proxy area must have occurred in the 10 years prior to the baseline period.
7. The forest types surrounding the proxy area or in the proxy area prior to deforestation shall be in the same proportion as in the project area.
8. Analysis of proxy areas can be done through original data collection (field measurements and/or remote sensing analysis).

The annual deforestation rate in the proxy areas was calculated according to Equation 1. The results and parameters used for this calculation are described in the table below.

$$D\%_{planned,i\,t} = \frac{\left(\sum_{pn=1}^{n^*}\left(\frac{D\%_{pn}}{Yrs_{pn}}\right)\right)}{n}$$

Where:

$D\%_{planned,i\,t}$: Projected annual proportion of land that will be deforested in stratum *i* during year *t*; %

$D\%_{pn}$: Percentage of deforestation in *pn* portion of a proxy area as a result of planned deforestation; %

Yrs_{pn}: Number of years deforestation occurred in the *pn* plot in the proxy area;

n: Total number of plots examined.

Table 6. Deforestation rates and parameters used for this calculation on the proxy areas

Proxy Area	Total Parcel	Deforested Area	Yrspn	%Dpn	D%/Yrspn
	Area (ha)	2010-2020 (ha)			
ID1	9,933.11	1,617.09	10	16.28%	1.63%
ID2	8,012.42	1,022.24	10	12.76%	1.28%
ID3	661.50	11.92	8	1.80%	0.23%
ID4	1,787.75	12.28	9	0.69%	0.08%
ID5	2,110.35	3.96	7	0.19%	0.03%
ID6	1,007.91	173.76	10	17.24%	1.72%
ID7	15,342.56	1,109.78	10	7.23%	0.72%
Average (n=10)	0.81%				

Seven proxy areas were then defined.

<u>Leakage Area</u>

By estimating the total area of deforestation in all lands managed by the baseline deforestation agent, it is possible to observe the existing displacements of the activities of the same deforestation agent, but in other areas under its management.

The predicted deforestation within the project boundary is then subtracted from the total deforestation on all land managed by the baseline agent/class. This subtraction gives the expected deforestation if no leakage occurs. If deforestation is subtracted from the total area of deforestation monitored by the base deforestation agent, the result is the area of leaked deforestation.

It was possible to prove that the identified deforestation agent does not have forest areas subject to suppression beyond the project area. Thus, there will be no displacement of deforestation due to the project's management actions, and leakage will not be considered, as indicated in the methodology VMD0006-BL-PL v1.3.

- 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)[68], updated by the SIVAM project[69]. Brazil endorses the definition of forest adopted by FAO: "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 %, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use".

In order to define the Project Area, as previously described in this Section, only areas that comply with the definition of forest were considered. From this, the Project Area was submitted to an analysis using MapBiomas mapping and classification. MapBiomas applies a hierarchical system with a combination of LULC classes in accordance with national definition[70]. 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

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

[69] 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/>

[70] 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>

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

AUD – Avoided Unplanned Deforestation

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

The adopted historical reference period is January 2011 to December 2020.

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

The project has a crediting period of 30 years, from 07-January-2021 until 12-October-2050, following the APD crediting period.

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

The first baseline period is from 07-January-2021 to 06-January-2027.

APD – Avoided Planned Deforestation

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

The adopted historical reference period is January 2010 to December 2019.

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

APD Project Start Date is 13-October-2020. The project has a crediting period of 30 years, from 13-October-2020 until 12-October-2050.

Carbon Pools

AUD – Avoided Unplanned Deforestation

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

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

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Carbon stock change in this pool is always significant
	Non-Tree: Included	Included in carbon stocks estimates
Below-ground	Included	Stock change in this pool is significant

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

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

According to the most common species harvested by illegal agents in the project region[71], relating the species with the highest commercial value and their presence in the region, it can be concluded that the potential volume of wood harvested by illegal loggers during the baseline would be of 17 m^3/ha.

In addition, logging in the baseline case occurred through planned and unplanned activities. In both cases, harvesting targeted the most commercially valuable species[72], without the use of proper machinery and planning, i.e., the same species were harvested using low efficiency methods without any criteria regarding the number of remaining trees per species. In addition, in both scenarios, after harvesting the most valuable species, the area was abandoned for illegal deforestation.

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

[71] Term of apprehension of illegal wood from SEMA-PA. The document gathers information on wood species seized without documentation during the surveillance operation in the project area and its surroundings, originated from reports of illegal deforestation. From this, it is possible to evaluate the most sought-after species, usually for having greater commercial value.

[72] The comparison of the SEMA-PA apprehension term, literature and the post-exploratory report of the management plan executed before the project start date allowed to conclude that around 90% of the harvested volume carried out by baseline planned activities are composed by the same species illegally logged in the baseline.

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

This analysis was conducted for baseline logging activities (both planned and unplanned), and it was found that the sum of decreases in carbon pools and increases in emissions represents less than 5% of the total decrease in carbon pools and increase in emissions and less than 5% of net anthropogenic removals by sinks (i.e., 1.03%).

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

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

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

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

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

		N_2O	Excluded	Excluded for simplification. This is conservative.
		Other	Excluded	No other GHG gases were considered in this project activity.
Project scenario	Biomass burning	CO_2	Excluded	No biomass burning increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		CH_4	Included	Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology.
		N_2O	Included	Included as non-CO2 emissions from biomass burning in the project scenario, according to the methodology.
		Other	Excluded	No other GHG gases were considered in this project activity.
	Livestock emissions	CO_2	Excluded	Not a significant source
		CH_4	Excluded	No livestock agriculture increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		N_2O	Excluded	No livestock agriculture increase is predicted to occur in the project scenario compared to the baseline case. Therefore considered insignificant.
		Other	Excluded	No other GHG gases were considered in this project activity.

APD – Avoided Planned Deforestation

The table below describes the relevant carbon stock considered in the scope of the project, according to VM0007.

Table 9. Carbon pools included or excluded within the boundary of the proposed APD project activity

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Inclusion is mandatory as per VM0007 v1.6, table 04. Carbon stock in this pool may increase or decrease in the baseline scenario and may increase due to the implementation of the project activity

	Non-Tree: Excluded	Included in carbon stocks estimates. Inclusion is optional in the case stocks are not greater in the baseline than in the project scenario
Below-ground	Included	Stock change in this pool is significant
	Non-Tree: Included	Included in carbon stocks estimates. Inclusion is optional in the case stocks are not greater in the baseline than in the project scenario.
Dead wood	Excluded	Excluded for simplification.
Harvested wood products	Included	Inclusion of the harvested wood pool as part of the project boundary is mandatory when the process of the deforestation involves timber harvesting for commercial markets, as per VM0007 v1.6, table 04.
Litter	Excluded	Excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the APD project activity. This exclusion is conservative.
Soil organic carbon	Excluded	Inclusion is optional, as per VM0007 v1.6, table 04.

In addition, 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 and APD project activities, as well as the respective justification/explanation, are described in the Table below.

Table 10. Sources and GHG included or excluded within the boundary of the proposed APD Project Activity.

Source		Gas	Included?	Justification / Explanation of choice
Baseline scenario	Burning of woody biomass	CO_2	Included	Excluded as recommended by the applied methodology. Counted as carbon stock change.
		CH_4	Included	For some regions fire is used as a tool to convert the forest into pasture and other crops. In the process of legal forest clearing, commercial timber is harvested, and the remaining woody material is felled and burned on site. Non-CO2 gases are expected to be emitted due to the burning of woody biomass in the baseline scenario.
		N_2O	Included	
	Combustion of fossil fules	CO_2	Excluded	It is conservative to exclude according to VM0007 v1.6, table 7
		CH_4	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
		N_2O	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
	Use of fertilizers	CO_2	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7. Fertilizer use is not common for stater pastures.

		CH_4	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7. Fertilizer use is not common for stater pastures.
		N_2O	Excluded	It is conservative to exclude according to VM0007 v1.6, table 7.
Project scenario	Burning of woody biomass	CO_2	Included	Carbon stock decreases due to burning are accounted as a carbon stock change.
		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.
	Combustion of fossil fules	CO_2	Excluded	Excluded from baseline
		CH_4	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
		N_2O	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
	Use of fertilizers	CO_2	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
		CH_4	Excluded	Potential emissions are negligible according to VM0007 v1.6, table 7
		N_2O	Excluded	Excluded from baseline

3.4 Baseline Scenario

AUD – Avoided Unplanned Deforestation

In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the Reference Region, Project Area and Leakage Belt, as described below. Therefore, the project falls into the AFOLU-REDD category, specifically: Avoided Unplanned Deforestation (AUD). The revenue from the present REDD project is essential to maintain this area as standing forest, as described under the Additionality of the Project (Section 3.5), and also to carry out the present Project's Leakage Management Activities.

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

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

- Collection of appropriate data sources

GIS MAPPING, REMOTE SENSING TECHNIQUES

The assessment of land use and land cover (LU/LC) for the baseline period shall be made using the data obtained from monitoring LU/LC changes in the Reference Region during the historical reference period. The historical reference period for the present Project comprised image analysis from 2010 to 2020.

In order to map land use dynamics within the Reference Region, remote sensing satellite analysis was carried out with MapBiomas[73] (collection 6.0) from 2010 to 2020, using images that are available in raster format on the program's website. Supervised classifications from Google Earth Engine were also used. This classifier is the same used in MapBiomas, allowing a closer adequacy to the Methodology.

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

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[74] promoted by the Climate Observatory. Its creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology uses, for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]), with a cloud cover less than or equal to 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomas series and direct collection by visual interpretation of Landsat images to classify as a single map per class. This classification then goes through the stages of the spatial filter, applying neighbourhood rules and temporal filters, in particular land cover change and other impossible or prohibited kinds of use, in order to reduce spatial and temporal inconsistencies.

For the supervised classification, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomas methodology. In order to obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 15% cloud cover limit were collected within the Reference Region, and an average of these images was generated. Training samples were generated for each land use class (forest, water and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. The spatial filter was then applied with the Majority Filter tool from ArcGIS, using 8-pixel neighborhood.

[73] Available at <http://mapbiomas.org/>
[74] Available at <SEEG - http://seeg.eco.br/en/>

This filter is used in MapBiomas in order to avoid unwanted modifications on the edges of pixel groups (blobs).

Table 11. Satellite images used on the historical LU/LC change analysis

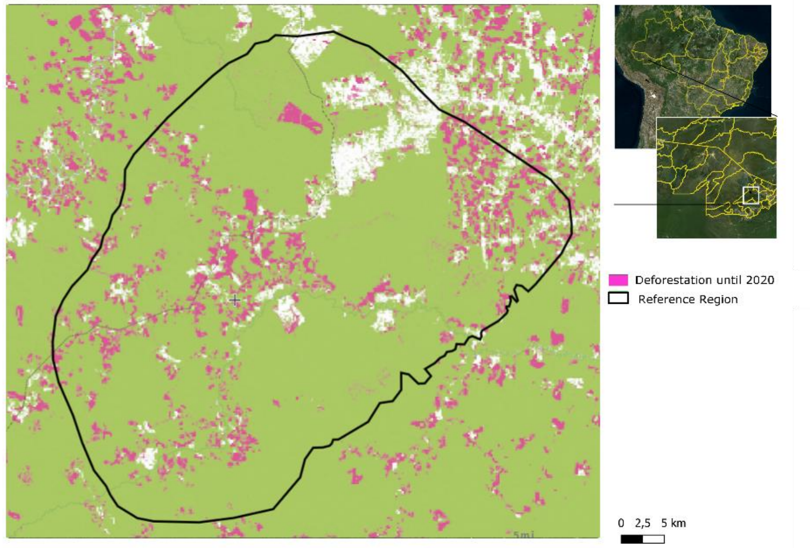
Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)	DD/MM/YY	Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	2	67
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	3	67
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	2	66

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

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

Stratification was not carried out in either class, and therefore the categories “forest” and “non-forest” have homogenous carbon stocks. Satellite images were used to generate the land-use and land-cover map in 2021, shown on the Figure below:

Figure 21. Land use and land cover dynamics between 2010 and 2020 within the Reference Region



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

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

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

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

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 95% of the total forest cover. Thus, after verifying that most of the project boundaries were composed of only one phytophysiognomy, the mapping and modeling of the project proceeded without stratification.

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

Table 12. 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[75] between 2009-2016 shows that there is no trend in degradation, although it affects an area larger than deforestation. It was concluded that degradation can serve as a warning that the region will soon be the target of deforestation practices. As the degradation has low local recurrence over the years, i.e., on average the same area is classified as degraded only once during the analyzed period, it is very unusual that the same area will suffer another degradation, since the valuable woods have already been harvested. Thus, it is very likely that carbon stocks after degradation might increase. Therefore, it is conservatively assumed that the trend in carbon stocks in the baseline case is constant.

The main forest type present in RR, PA and LB is described below, according to the Technical Manual of the Brazilian Vegetation[76]:

- Open Alluvial Tropical Rainforest – Forest formation established along watercourses, occupying periodically or permanently flooded plains and terraces, which in the Amazon

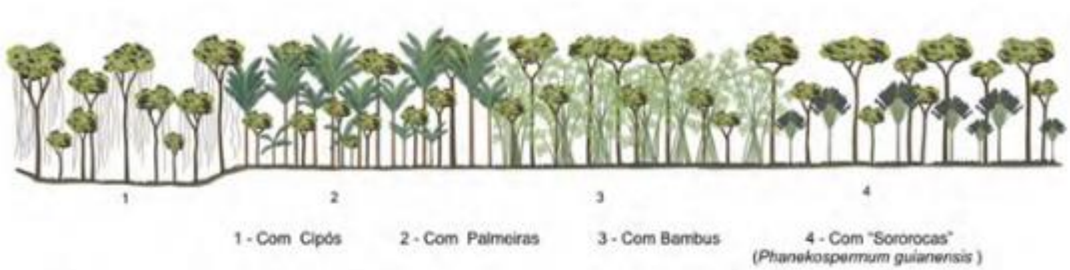
[75] Available at https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/DQ-Degradacao-Florestal-Amazonia.pdf
[76] Available at https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf

constitute floodplain forests or igapó forests, respectively. It has a predominant floristic composition and ecological characteristics, similar to those of the Ombrophilous Dense Alluvial Forest, except that in its physiognomy it stands out for presenting a large number of large palm trees that, not infrequently, form gregarious groups. Sometimes it is also distinguished by the dominance of woody and herbaceous lianas, covering a rarefied stratum of trees.

- Open Lowland Tropical Rainforest – This forest formation is located between 4° North latitude and 16° South latitude, at altitudes ranging from 5 to 100 m, and has a predominance of palm trees. In the states of Piauí and Maranhão, it can be considered as a "babassu forest".
- Open Tropical Rainforest – It is considered a transition type of dense ombrophilous forest, characterized by climatic gradients with more than 60 dry days. It has four floristic factions: with vine, in the areas of circular depressions of the Precambrian basement; with palm trees, in sandstone terrain that occurs throughout the Amazon and even outside it; with bamboo, it occurs from the western part of the Amazon to the southern plateau of the State of Paraná (generally occupying areas where noble species were exploited); with sororoca (*Phenakosperma guyanensis*) in the south of the Amazon basin, in the middle Xingu River, occurring in depressions that are temporarily flooded and in small areas where soils of the Red-yellow Latosol type predominate[77].

  The alluvial, submontane and upper montane terminology is related to the elevation and location of the forest type, according to the proximity of rivers and mountains.

Figure 22.Open Tropical Rainforest profile



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

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

[77] Available at <https://www.cnpf.embrapa.br/pesquisa/efb/aspec.htm>

It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map.

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

Table 13. Land use change matrix in the reference region

		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	2,271.23	0.00
	Non Forest in the PA	797.77	0.00

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	275.89	0.00
	Non Forest in the LK	359.11	318.00

PROJECT SCENARIO

	PA	Initial LU/LC class	
	IDcl	Forest	Non Forest in the PA
Final Class	Forest	3,027.46	0.00
	Non Forest in the PA	14.59	0.00

	LB	Initial LU/LC class	
	IDcl	Forest	Non Forest in the LK
Final Class	Forest	156.22	0.00
	Non Forest in the LK	478.78	318.00

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

Table 14. List of land use and land cover change categories

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

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

According to the GIS analysis, between 2010 and 2020, there was a deforestation of 12,900 ha within the Reference Region, with an average oscillation of approximately 1,290 ha/year. The location where the deforestation occurred may be observed in the Figure below:

Figure 23. Deforestation dynamics between 2010 and 2020 in the Reference Region

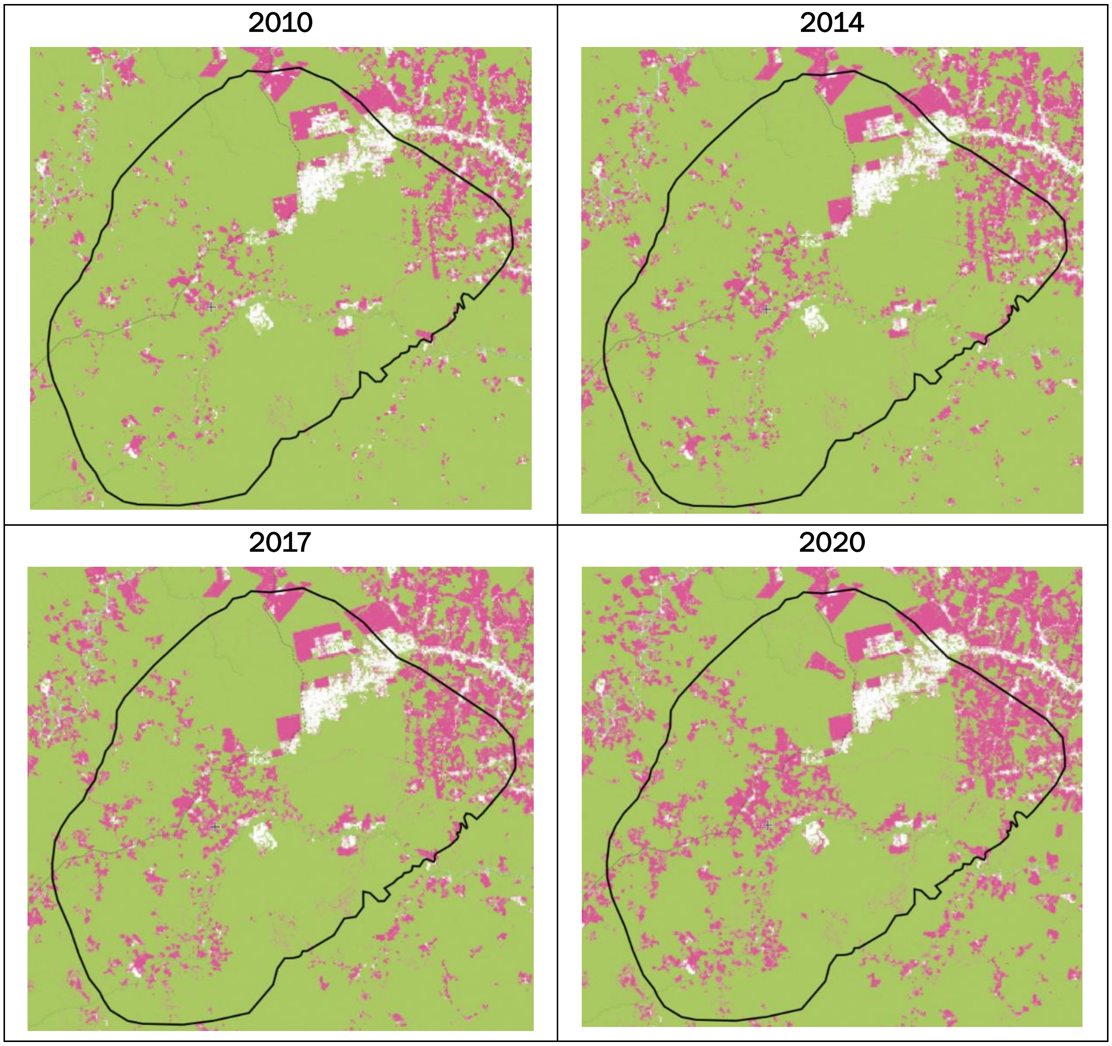


Figure 24. Variation in the deforestation rate within the reference region between 2010 and 2020

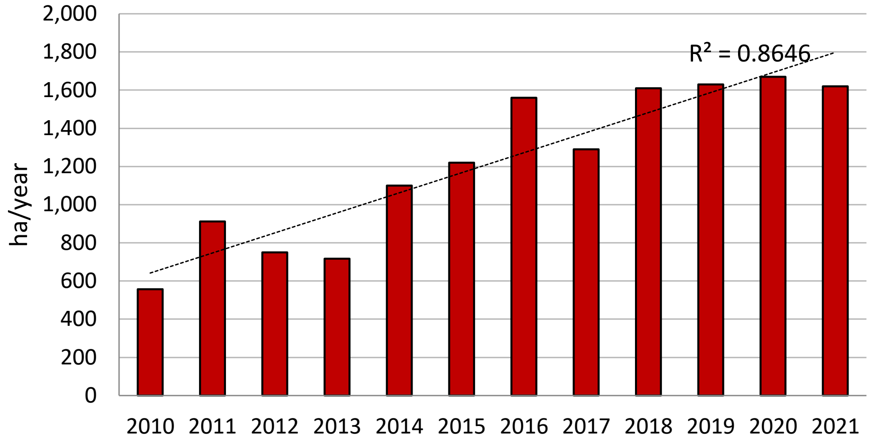


Table 15. Annual deforestation in the Reference Region between 2010 and 2020

Year	Forest	Annual deforestation (ha)	Cumulative deforestation (ha)
2010	120,000.00	557	39,500.00
2011	119,088.00	912	40,412.00
2012	118,338.00	750	41,162.00
2013	117,621.00	717	41,879.00
2014	116,521.00	1,100	42,979.00
2015	115,301.00	1,220	44,199.00
2016	113,741.00	1,560	45,759.00
2017	112,451.00	1,290	47,049.00
2018	110,841.00	1,610	48,659.00
2019	109,211.00	1,630	50,289.00
2020	107,541.00	1,670	51,959.00

- 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 2010 to 2020.

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

For the supervised classification, 300 random points were drawn over the RR, 100 in each of the classes (forest, hydrography and deforestation). The table below shows the accuracy analysis carried out for each year and each land use class.

Table 16. Summary of confusion matrices from the evaluation of MapBiomas from 2010 to 2020

	Producer accuracy				User accuracy			
Year	Forest	Hydrography	Pioneer vegetation	Deforestation	Forest	Hydrography	Pioneer vegetation	Deforestation
2010	98,77%	96,34%	97,30%	95,18%	100,00%	98,75%	90,00%	98,75%
2011	98,77%	91,67%	95,52%	89,77%	100,00%	96,25%	80,00%	98,75%
2012	98,77%	87,65%	87,67%	92,94%	100,00%	88,75%	80,00%	98,75%
2013	100,00%	92,86%	79,27%	88,64%	100,00%	81,25%	81,25%	97,50%
2014	100,00%	89,19%	80,25%	90,59%	100,00%	82,50%	81,25%	96,25%
2015	100,00%	92,00%	85,00%	92,94%	100,00%	86,25%	85,00%	98,75%
2016	100,00%	85,19%	85,33%	94,05%	100,00%	86,25%	80,00%	98,75%
2017	100,00%	92,11%	82,05%	88,37%	100,00%	87,50%	80,00%	95,00%
2018	100,00%	94,20%	79,52%	88,64%	100,00%	81,25%	82,50%	97,50%
2019	98,77%	87,80%	87,84%	92,77%	100,00%	90,00%	81,25%	96,25%
2020	100,00%	90,54%	82,05%	89,77%	100,00%	83,75%	80,00%	98,75%

<u>Analysis of agents, drivers, and underlying causes of deforestation</u>

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[78].

- **Identification of agents of deforestation**

[78] 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>.

In the past few years, the project region has been the subject of news and studies, mainly due to the advancement of the arc of deforestation in the Amazon biome. This pressure is expected to continue, given the globalization of markets in the amazon region and international development policies planned for the region[79].
The following information is provided for the identified agent of deforestation:

a) Timber harvesting

As aforementioned in section 1 above, timber logging (both legal and illegal) is an important economic activity within the reference region. Economic data sources show that timber is the largest contributor to the value of annual production when compared to all extractivism products in the project area and reference region municipalities.

Timber harvesting can be regarded as the initial approach in a series of activities by deforestation agents, it is the precursor of cattle ranching implementation. Official registration of formally documented logging for sale to sawmills has been volatile over the last 10 years, according to official IBGE data. From that year afterwards, the supply of legal wood only continued to increase. Based on official data from the last 6 years, it is projected that the production tends to increase during the project lifetime, reaching 138,613 m^3 in 2050, which also points to a significant increase in timber demand for the following years of project.

However, beyond the high production level shown in official data, the production of timber continues to be conducted illegally: studies, estimate that 36% of Brazil's timber production is legal[80]. Illegal wood harvesting is known to take place within the reference region and project area, being transported to the sawmills by riverboat. Usually, timber logging is the first deforestation agent that reaches previously inaccessible forest lands, using existing roads or creating illegal ones, followed by land speculators or farmers in search of cheap land.

It can be concluded that timber, whether firewood or roundwood, represents a product of much more attractive value compared to other types, being even more advantageous when combined with animal production afterwards, where there is no need for forest management.

b) Cattle ranching

[79] Nepstad, D. C.; C. M. Stickler e O. T. Almeida. 2006. Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation. Conservation Biology 20(6):1595-1603
[80] Serviço Florestal Brasileiro (SFB), Instituto de Pesquisa Ambiental da Amazônia (2011), "Florestas Nativas de Produção Brasileiras".

According to Razera (2005)[81], the lack of economic alternatives has created the conditions for livestock farming to establish itself as the main economic activity causing settlement of deforested areas in Amazonia.

Cattle farming in the Amazon region is primarily due to low land prices combined with adequate rainfall levels[82]. The Amazon region attends to national and regional demand. Analysis of supply and demand show that livestock farming could expand even more to attend to the majority of global demand. This scenario is extremely worrying in relation to Amazon deforestation levels.

Livestock farmers do not pay for the public lands which they acquire legally or illegally, and furthermore they harvest timber without paying the government and, in this way, they accumulate capital freely to reinvest into their operations. Thus, land speculation and cattle farming contribute to the advancement of deforestation in more isolated regions[83]. In this way, the predominance of the free market (with no legal restrictions) will lead to the expansion of cattle farming, especially of the type based upon indiscriminate deforestation.

Description of the main features of the main agent of deforestation: Cattle ranching (pasture) is usually financed by means of initial capital obtained in wood logging. Deforestation is considered to occur through clear-cutting of forests for logging followed by pasture installation. This deforestation pattern may be caused by private landowners themselves and also by professional land-grabbers, by means of invasions in unguarded areas. The final use of virtually all occupied lands would be cattle ranching (pasture). Thus, it can be affirmed that the deforestation agent group is composed by large and small-scale cattle ranchers supported by land-grabbers and loggers in the initial stage of deforestation. This group is composed by private owners and itinerant land-grabbers. It can also be affirmed that this group of deforestation agents is culturally and economically adapted to this “business cycle” of deforestation, whose results are clearly demonstrated in the Reference Region during the reference period.

Assessment of the most likely development of the population size of the deforestation agent group in the Reference Region, Project Area and Leakage Belt: As the main deforestation agent in the region, cattle ranching (pasture) is expected to increase in the project region.

[81] RAZERA, A. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005.

[82] BRANDÃO, F. Tendências para o consumo de carne bovina no Brasil. 2013. 102 f. Thesis (Doctor grade) - Curso de Agronegócio, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013

[83] RAZERA, A. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005

Figure 25. Evolution of the cattle herd in the state of Acre[84]

Municípios	2011	2012	2013	2014	2015
Acre	**2.549.497**	**2.634.467**	**2.697.489**	**2.799.673**	**2.916.207**
Acrelândia	173.174	173.341	176.318	181.757	191.969
Assis Brasil	35.454	38.796	39.318	41.791	43.684
Brasiléia	186.067	197.588	202.584	209.888	222.677
Bujari	210.211	204.816	206.059	216.695	217.238
Capixaba	118.040	138.677	147.187	153.850	155.881
Cruzeiro do Sul	33.985	32.974	35.266	33.417	35.890
Epitaciolândia	78.894	82.683	83.657	82.515	88.726
Feijó	73.355	80.990	81.324	83.632	87.198
Jordão	6.303	6.100	6.293	5.421	5.678
Mâncio Lima	13.733	14.108	13.271	12.964	12.517
Manoel Urbano	24.391	25.532	29.657	31.633	33.710
Marechal Thaumaturgo	16.900	17.100	14.828	9.997	10.297
Plácido de Castro	140.928	163.722	168.993	174.038	183.986
Porto Acre	143.659	169.042	171.149	176.466	184.477
Porto Walter	6.720	8.050	9.711	8.020	7.461
Rio Branco	466.240	487.534	498.418	513.259	542.781
Rodrigues Alves	9.503	9.804	8.641	8.439	9.234
Santa Rosa do Purus	4.698	6.500	5.163	6.138	5.628
Sena Madureira	249.490	223.329	224.450	267.220	280.223
Senador Guiomard	214.368	213.369	222.955	223.769	225.359
Tarauacá	134.134	134.121	133.165	132.773	136.161
Xapuri	209.250	206.291	219.082	225.991	235.432

Pastureland (either planted, natural or degraded) represents the main land use after forest (natural and protected areas) in the main municipalities of the reference region, which also shows that this is the main economic activity in the region[85,86].

In addition, the price per unit (specifically, the "*arroba*") of beef increased considerably in mid-2010. This fact seems to stimulate rural producers to deforest new areas and expand their herds, attracting migration to forest borders distant from the municipality's main city.

- Identification of drivers of deforestation

Furthermore, according to the methodology, after analyzing the main deforestation agents acting within the reference region during the historical reference period, it is necessary to identify the main drivers affecting the amount of deforestation in the reference region.

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

[84] Available at: http://acre.gov.br/wp-content/uploads/2019/02/acre-em-numeros-2017.pdf
[85] Brazilian Institute for Geography and Statistics (IBGE): <http://www.ibge.gov.br/home/>.
[86] Available at: <https://cidades.ibge.gov.br/brasil/pa/>.

municipalities and the meat market of the region[87]. Key driver variables are detailed in the section below.

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

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

1) **Population growth:**

Several studies for the Amazon biome[88,89,90] 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 in and 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 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 be sustained.

From the 2010 census and the 2021 estimate provided by IBGE[91], it is possible to note that the population has grown in the three municipalities of the reference region at a very similar rate and trend.

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

As previously described above, the prices of timber logs and *arroba* (livestock) are the main reason why the cattle herd increased in the period. According to CEPEA (2021)[92], the price of cattle increased 245% over the 2010 (R$ 88.51 per arroba) to 2021 (R$ 305.46 per arroba) period. This economic phenomenon can be observed throughout the country. Young (1998) as cited in Rivero et al. (2009)[93], evaluating the mechanisms that cause deforestation in the Legal Amazon, found a positive relation between the expansion of agricultural areas and the variation of prices of agricultural products. For

87 FAPESPA. Boletim Agropecuário do Estado do Pará (2017). Available At: http://www.fapespa.pa.gov.br/upload/Arquivo/anexo/1383.pdf?id=1533567716.
88 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.
89 ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997
90 MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003
91 Available at <https://cidades.ibge.gov.br/brasil>
92 Available at: <https://www.cepea.esalq.usp.br/br/consultas-ao-banco-de-dados-do-site.aspx>
93 Available at: <https://www.scielo.br/j/neco/a/jZHjd9B8ZghY7tG9G7qchTk/?format=pdf&lang=pt>

Margulis (2001) as cited in Rivero et al. (2009), the higher the agricultural prices, the higher is the migration to rural lands, which results in deforestation.

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

China's demand for beef is still a reflection of swine flu, which has decimated between 40% and 60% of the country's pig stock (about one third of the world's pork production). In addition to this conjuncture factor, China also contributed to the growth of imports, since it was the only major economy in the world to record economic growth in 2020, even amid the coronavirus pandemic, and a more long-term factor, which is the gradual increase in income of the Chinese population, which results in higher consumption of more expensive proteins, such as beef. Analysts estimate that the price of beef should remain under pressure for the next few years, due to the livestock cycle: the low supply of ox is not something that can be solved immediately, because cattle is a multi-year production, as it begins to produce today to deliver animals in two, three, or four years[94]. In 2020, Brazil broke its beef export record, with more than 2 million tons sold (8% more than in 2019). For 2021, the projection indicates an increase of 5% over the value of 2020[95], indicating a strong trend of increased in exports for the coming years. Beef exports have continued increased, growing by almost 7% in 2020 and close to 8% in 2021, increasing by more than 15% in the biennium 2020/2021[96]. Chinese importers have increased the purchases of Brazilian beef by more than 150% in 2020[97]. The dynamics of cattle prices are regulated by micro and macroeconomic scenario throughout the country and abroad, and there are no applicable measures that can be implemented to address this driver.

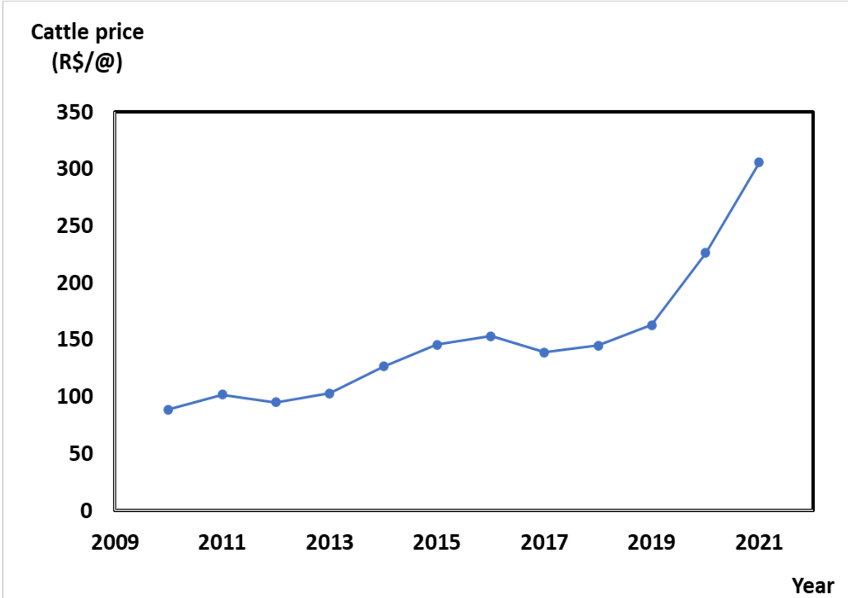
[94] Available at: <https://www.bbc.com/portuguese/brasil-55664305>

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

[96] Available at: <https://www.avisite.com.br/index.php?page=noticias&id=21284>

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

Figure 26. Cattle prices in Brazil (CEPEA, 2021)



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[98,99].

2) **Roads, highways, access roads and navigable rivers**

Access roads are means of communication, which influence the spatial distribution of land-uses. Access roads have an influence on fragmentation, population densities, agriculture and pastureland. The possible creation of new access roads, added to the

98 BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757

99 IMAZON. Carbon emissions from deforestation and forest fragmentation in the Brazilian Amazon. 2011. Available at: <http://imazon.org.br/publicacoes/carbon-emissions-from-deforestation-and-forest-fragmentation-in-the-brazilian-amazon/?lang=en>. Last visit on: August 6th, 2021.

already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation[100,101,102].

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[103].

3) Extreme poverty

Poverty and government abandonment, which does not develop welfare public policies aimed at the sustainable development of the region, encourages illegal activities associated with the lack of economic options and the need to generate income. Logging in the region is marked by a strong connection between communities and companies. This connection was mainly based on the need to generate income for these families, who sell wood logs from their land at extremely low prices, clandestinely, without any planning of use or notion of the value of the forest[104].

Even though the reference region and project area are in the main municipality of Acre, the human development rate evolved little between 2011 and 2014. Income and education were the most impactful factors (figure below).

Figure 27. HDI evolution, State of Acre

Índices	2011	2012	2013	2014
IDHM	0,688	0,696	0,694	0,719
IDHM_Renda	0,667	0,674	0,660	0,679
IDHM_Longevidade	0,785	0,792	0,798	0,804
IDHM_Educação	0,612	0,621	0,624	0,673

Fonte: PNUD, Fundação João Pinheiro e Ipea

Proximity to forest edges

[100] BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. Biological Conservation. Volume 141, Issue 7, July 2008, Pages 1745–1757.
[101] GENELETTI, D. Biodiversity Impact Assessment of roads: an approach based on ecosystem rarity. Environmental Impact Assessment Review, v.23, n.3, p.343-365, 2003
[102] Fearnside, P.M. e P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the Potential Impact of Linking the Arc of Deforestation to Central Amazonia. Environmental Management 38:705-716
[103] Grupo Executivo do Estado do Pará para o Plano Marajó (GEPLAM) (2007), "Plano De Desenvolvimento Territorial Sustentável Do Arquipélago Do Marajó".
[104] D'Arace, L. M. B. et al. Wood production in log and firewood in northern Brazil and the state of Pará. Brazilian Journal. of Development, Curitiba, v. 5, n. 9, p. 16885-16896, september 2019.

Studies on historical location of deforestation in the Reference Region provide evidence that this has also been a driver for deforestation over the historical reference period. Similarly, to the proximity to roads and navigable rivers, the effect of this driver on deforestation decisions is related to easier logistics when clearing areas and easier and quicker revenue from logging. The proximity to forest edges has been used in similar ways by other REDD projects, including the "Fortaleza Ituxi REDD Project", "The Suruí Forest Carbon Project", the "RMDLT Portel-Pará REDD Project", the "Florestal Santa Maria REDD Project", and others. Furthermore, this deforestation driver has been used to explain the dynamics of deforestation in similar analyses (LAURANCE et al. 2009[105]; ROSA et al. 2013[106]). According to ROSA et al. (2013), deforestation is contagious, such that local deforestation rates increase over time if adjacent locations are deforested.

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

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

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

- **Identification of underlying causes of deforestation**

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

  Due to being located in a region of large cattle ranchers and settlements, the reference region has a considerable social conflict issue, primarily land conflict. Land is

105 Available at: <https://doi.org/10.1016/j.tree.2009.06.009>
106 Available at: <https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0077231&type=printable>

occasionally illegally occupied by squatters and illegal loggers[107],[108],[109]. 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.

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

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

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

[107] Available at <https://g1.globo.com/natureza/noticia/2019/09/04/invasoes-grilagem-e-queimadas-ameacam-areas-protegidas-na-amazonia.ghtml>
[108] Available at <https://acervo.socioambiental.org/sites/default/files/documents/prov0227_0.pdf>
[109] Available at https://www.bbc.com/portuguese/brasil-56211156

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[110].

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

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

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

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

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

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

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

As a consequence, the deforestation in the Amazon Rainforest was widely reported in 2019, as it was the third largest in history, with an increase of 29.5% in comparison to 2018. In total, 9,762 km^2 were deforested during that year[115]. In August, during the peak of fire warnings in the forest, fact that caused climate effects in São Paulo, 2,790 km away from the Amazon[116], the government tried to deviate attention from the fires, claiming they were fake news[117]. The number of fires in Brazilian forests increased 70% in 2019, the highest rate in 7 years. According to National Spatial Research Institute (INPE), the most affected biome was the Amazon, with 51.9%[118].

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

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

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

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

The quantity of national parks protected areas and indigenous lands in the country was already questioned by Bolsonaro, that intended to extinguish those by decree[123], an unconstitutional action, after announcing the intention to review the protected areas' law

115 Available in <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294>
116 Available in <https://www.economist.com/the-americas/2019/08/22/forest-fires-in-the-amazon-blacken-the-sun-in-sao-paulo>
117 Available in <https://www.theguardian.com/environment/2019/sep/09/amazon-fires-brazil-rainforest>
118 Available in <https://noticias.uol.com.br/meio-ambiente/ultimas-noticias/redacao/2019/08/19/numero-de-queimadas-cresce-70-e-e-o-maior-desde-2013-amazonia-lidera.htm>
119 Available in <https://brasil.elpais.com/brasil/2019/08/15/politica/1565898219_277747.html>
120 Available in <https://g1.globo.com/natureza/noticia/2020/09/12/em-um-ano-governo-bolsonaro-corta-verba-para-brigadistas-em-58.ghtml>
121 Available in <https://noticias.uol.com.br/ultimas-noticias/rfi/2020/06/23/fundos-de-investimentos-estrangeiros-cobram-de-bolsonaro-fim-do-desmatamento-da-amazonia.htm?cmpid=copiaecola>
122 Available in <https://g1.globo.com/natureza/noticia/2019/08/02/cronologia-reacao-do-governo-ao-uso-de-dados-sobre-desmatamento-leva-a-exoneracao-de-diretor-do-inpe.ghtml>
123 Available at <http://www.ihu.unisinos.br/78-noticias/589958-em-live-bolsonaro-reclama-que-nao-consegue-extinguir-parques-por-decreto>

(SNUC) and the existing units[124]. In addition, the Minister of the Environment speaks publicly, in a video released during investigations, of his intention to take advantage of the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and justice processes[125].

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

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

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

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

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

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124 Available at <https://oeco.org.br/noticias/ricardo-salles-quer-rever-todas-as-unidades-de-conservacao-federais-do-pais-e-mudar-snuc/#:~:text=A%20lei%20do%20SNUC%20determina,extinguir%20uma%20unidade%20de%20conserva%C3%A7%C3%A3o>
125 Available at <https://g1.globo.com/politica/noticia/2020/05/22/ministro-do-meio-ambiente-defende-passar-a-boiada-e-mudar-regramento-e-simplificar-normas.ghtml>
126 Available at <https://brasil.elpais.com/brasil/2019/01/27/opinion/1548547908_087976.html>
127 Available at <https://www.bbc.com/portuguese/brasil-48805675>

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

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

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

- Analysis of chain of events leading to deforestation

The analysis of chain events leading to deforestation within the reference region was based on the facts presented above, analyzing the relations between main deforestation agents, drivers and underlying causes that caused and most likely will lead to deforestation.

Based on the historical evidence collected, the relations between main agent groups, key drivers and underlying causes of deforestation explain the sequence of events that typically has lead and most likely will lead to deforestation within the reference region.

The project region is located in the main Brazilian biome, a region of high vulnerability, deforestation risk and rate. Furthermore, it is a region of intense and traditional livestock activity, followed by a growing market. The historical deforestation that has been occurring over the past 15 years within the reference region has followed this same pattern.

It is possible to relate the deforestation curve to the increase in livestock and wood production in the region, all of which are growing. Those two land-use changes (timber harvesting and cattle ranching) are the main deforestation agents in the region. The profit from both products is also considerably higher than the production of other common forest products in the region, such as Brazil nuts and *açaí*. Furthermore, deforestation will probably increase due to setbacks in environmental legislation and deforestation control occurred in 2016 onwards, namely reduction in control programs to reduce deforestation in the Amazon, reduction of protected areas and the amnesty to deforesters.

The socioeconomic conditions of the population of the region, the fact that it is predominantly dominated by large properties landowners (with political and historical contributions that made the region an important livestock center), and the demographic growth implies the need for new infrastructure projects and the arrival of new habitants coming from other regions of the country, attracted by the favorable conditions of production in low-cost forested areas. This increases the pressure on the forests in the project area.

The historic of polemics and anti-environmentalism of the last Brazilian governments, 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. There is no strong environmental policy, and even with good advances, Brazilian laws have gaps that allows to be taken advantage of by landowners, or the inspection mechanisms suffer dismantling by the interest parties, making the conservation of the extensive Brazilian biomes even more difficult.

- <u>Conclusion</u>

The conduction of this analysis and available evidence allows to analyze that the most likely future deforestation trend within the reference region and project area is conclusive.

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 good knowledge about the project area and the reference region.

The increasing deforestation rate, added to the region's cattle ranching advancement, population increase and 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.

APD – Avoided Planned Deforestation

- **Agent of Planned Deforestation**

The owner was identified as the agent of planned deforestation in the baseline considering the current Rio Branco Grouped REDD Project, which is considered as the "simplest scenario" per VMD0006.

- **Area of Deforestation**

According to methodology, the area of deforestation ($A_{planned,i}$) is defined as an immediate site-specific threat of deforestation, which can be demonstrated by the following points:

Legal permissibility for deforestation: The application of a sustainable forest management plan is regulated in Brazil by the laws Nº 12,651/2012[128], decree Nº 5,975[129], in addition to Acre's legislation, with law N°1,117/1994[130]. In Art. 12, N°12,651/2012 every rural property must maintain an area with native vegetation coverage. Every rural property must maintain an area of native vegetation such as the Legal Reserve (RL), in addition to the Permanent Preservation Area (APP), observing the minimum required according to the biome. For properties located in the Legal Amazon, the percentage is 80%. Thus, deforestation in the Legal Amazon of a maximum of 20% of the property's area is legally permitted. Authorizations for alternative land use present a series of conditions that must be complied with in accordance with the State's environmental legislation. Among the conditions of the license, highlight the prohibition of forest exploitation of trees in Permanent Preservation Area - APP. It is expressly prohibited even if the trees are not so described in the forest inventory. The forest inventory is a mandatory document for applying for the license. IMAC performs inspections without prior notice, to verify compliance with the authorization conditions. An activity carried out to verify that the removal of vegetation is complying with all requirements and laws regarding forest preservation and exploitation.

Suitability of project area for conversion to alternative non-forest land use: To determine the suitability of the project area, a series of analyzes and geoprocessing are performed for the baseline activity. Based on the primary data from the CAR, obtained from the Rural Environmental Registry System (SICAR), the declarations and delimitations of areas protected by law (area of permanent preservation and legal reserve) as well as the limits of the property are verified. Subsequently, it overlaps deforestation data to exclude deforested areas. Data are obtained from MAPBIOMAS[131] for the baseline period. Areas deforested prior to 10 years before the project start date are disregarded to meet the applicability conditions of the methodology. After this step, the information is crossed with topographic data to exclude areas with an inclination greater than 25°, which must also have forest preservation areas according to Brazilian legislation. This topographic criterion is related to the ecology of the forest whose function is to prevent landslides. Afterwards, the use is evaluated according to the soil and climate of the region. Finally, the analysis of access to relevant markets is carried out based on the logistics network used in the existing production chains, such as the BR 364 that connects the project area to the state capital, Rio Branco and the Branco and Purus rivers that will flow into others important rivers in the region, which pass through important municipalities in the states of Acre and Amazonas. This analysis of the existing modalities makes it possible to evaluate the flow of wood, cattle, among other products from the existing chains.

[128] Available at <https://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12651.htm>
[129] Available at <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm> 1
[130] Available at: <http://pnla.mma.gov.br/images/2018/08/Procedimentos-de-Licencamento-Ambiental-ACRE-AC.pdf>
[131] Available at: <https://mapbiomas.org/>

Government approval for deforestation to occur: according to VMD0006 v1.3, the intention to deforestation within the project area is demonstrated by recent approval from relevant government department for conversion of forest to an alternative land use or documentation that a request for approval has be filed with the relevant government department for permission to deforest and convert to alternative land use. The properties that make up the project area have documents that present the eligibility of authorization for vegetation suppression to change land use. Generally, in Brazil, deforestation permits are requested for areas smaller than 1,000 ha. This is due to a few reasons: 1) the validity period of the suppression authorization is short; in some states it is valid for only 1 year; 2) high cost of the suppression operation. These two reasons lead landowners to opt for deforestation in smaller plots and 3) implementation of agricultural projects larger than 1,000 ha requires the preparation of an Environmental Impact Study (Estudo de Impacto Ambiental – EIA, in Portuguese) and the issuance of an Environmental Impact Report (Relatório de Impacto Ambiental – RIMA, in Portuguese)[132], which must be submitted for approval by the competent state environmental agency, which entails high costs and a long period of analysis by the agency.

Intent to deforest: the intention to deforest is demonstrated by the existence of a land use management plan valid for the project area, called the Forest Exploration Project (Projeto de Exploração Florestal – PEF, in Portuguese). Deforestation authorization must be requested from the responsible government in each state. Brazilian environmental law establishes requirements for forest clearing, leaving specific regulation to the states. In the State of Acre, the competent body is IMAC – Instituto de Meio Ambiente do Acre, which issues both the authorization for the use of forest raw materials (Autorização para Utilização de Matéria Prima Florestal-AUMPF, in Portuguese), and the Authorization for Forest Exploration (Autorização para Exploração Florestal-AUTEX, in Portuguese) for alternative land use.

- **Rate of Deforestation**

Deforestation rates are defined in accordance with forest exploitation plans. These plans show the area to be deforested in a spatially explicit way and contain an associated execution schedule. The deforestation rate is yet to be defined.

[132] CONAMA: item XVII, art. .2 of CONAMA Resolution No. 01, of January 23, 1986, amended by CONAMA Resolution No. 11, of March 18, 1986

Table 17. Annual deforestation D% planned

Annual deforestation D% planned, i.t					
Plots	Area (ha) planned	n	*Yrspn*	*%Dpn*	*D%/Yrspn*
Fazenda Riozinho	261.10	1	1	100%	100%
Fazenda Alegria	203.44	1	1	100%	100%
				$D\%_{planned,i.t}$	100.00%

- **Likelihood of Deforestation L-Di**

According to VMD0006, v1.3, the likelihood of deforestation (*L-D*$_i$) is set to be 100%, because the project area is not under government control and is not zoned for deforestation.

- **Risk of Abandonment**

The risk of abandonment is considered based on proxy areas that have the same class of deforestation agent in an interval of 10 years. Properties close to the project area were analyzed based on the same classes and agents of deforestation, climate, soil and topography. Proxy are areas with similar spatial characteristics to the project area as well as similarities in terms of activities and land use conditions. These areas were selected according to the criteria of VMD0006 based on analysis of geographic data and knowledge by project proponent of existing properties in the proximity of the project area.

Thus, how the history of land use conversion will be analyzed. If any of the proxy areas have been abandoned to forest regrowth, then thee planned deforestation activities is not eligible and this module must not be used.

Table 18. Elevation classes similarity between Project Area and proxy areas.

Elevation (m)	Project Area	Proxy Areas	ID1	ID2	ID3	ID4	ID5	ID6	ID7
0 - 500	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 19. Forest type similarity between Project Area and proxy areas

Phytophysiognomy	Open Lowland tropical rainforest
PA (ha)	4,955.07
PA (%)	92.40%
Proxy Areas (ha)	46,573.42
Proxy Areas (%)	95.36%
Proxy Area id1 (ha)	9,757.67
Proxy Area id1 (%)	98.23%
Proxy Area id2 (ha)	6,661.50
Proxy Area id2 (%)	98.23%
Proxy Area id3 (ha)	424.66
Proxy Area id3 (%)	64.20%
Proxy Area id4 (ha)	1,650.70
Proxy Area id4 (%)	92.33%
Proxy Area id5 (ha)	1,863.05
Proxy Area id5 (%)	88.28%
Proxy Area id6 (ha)	888.74
Proxy Area id6 (%)	88.18%
Proxy Area id7 (ha)	15,342.56
Proxy Area id7 (%)	100.00%

Table 20. Slope classes similarity between Project Area and proxy areas

Slope	"gentle" (slope <15%)	"steep" (slope ≥15%)
PA pixel	55,011.00	4,533.00
PA (%)	92.39%	7.61%
Proxy Areas pixel	475,391.00	67,253.00
Proxy Areas (%)	87.61%	12.39%
Proxy Area id1 pixel	99,690.00	10,664.00
Proxy Area id1 (%)	90.34%	9.66%
Proxy Area id2 pixel	76,579.00	12,447.00
Proxy Area id2 (%)	86.02%	13.98%
Proxy Area id3 pixel	6,800.00	547.00
Proxy Area id3 (%)	92.55%	7.45%
Proxy Area id4 pixel	17,018.00	2,852.00
Proxy Area id4 (%)	85.65%	14.35%
Proxy Area id5 pixel	19,384.00	4,053.00
Proxy Area id5 (%)	82.71%	17.29%
Proxy Area id6 pixel	10,352.00	842.00
Proxy Area id6 (%)	92.48%	7.52%
Proxy Area id7 pixel	146,625.00	23,843.00
Proxy Area id7 (%)	86.01%	13.99%

Table 21. Soil type similarity between Project Area and proxy areas

Soil type	GXve	PVAa	PVAal	TCo	TXo
PA (ha)	233.10	0.00	0.00	3,781.48	1,348.24
PA (%)	4.35%	0.00%	0.00%	70.51%	25.14%
Proxy Areas (ha)	0.00	0.00	0.00	23,570.44	25,269.71
Proxy Areas (%)	0.00%	0.00%	0.00%	48.26%	51.74%
Proxy Area id1 (ha)	0.00	0.00	0.00	9,933.11	0.00
Proxy Area id1 (%)	0.00%	0.00%	0.00%	100.00%	0.00%
Proxy Area id2 (ha)	0.00	0.00	0.00	1,086.63	6,925.79
Proxy Area id2 (%)	0.00%	0.00%	0.00%	13.56%	86.44%
Proxy Area id3 (ha)	0.00	0.00	0.00	0.00	661.50
Proxy Area id3 (%)	0.00%	0.00%	0.00%	0.00%	100.00%
Proxy Area id4 (ha)	0.00	0.00	0.00	1,787.75	0.00
Proxy Area id4 (%)	0.00%	0.00%	0.00%	100.00%	0.00%
Proxy Area id5 (ha)	0.00	0.00	0.00	2,110.35	0.00
Proxy Area id5 (%)	0.00%	0.00%	0.00%	100.00%	0.00%
Proxy Area id6 (ha)	0.00	0.00	0.00	0.00	1,007.91
Proxy Area id6 (%)	0.00%	0.00%	0.00%	0.00%	100.00%
Proxy Area id7 (ha)	0.00	0.00	0.00	942.72	14,399.84
Proxy Area id7 (%)	0.00%	0.00%	0.00%	6.14%	93.86%

Where:

GXve = haplic gelisols Ta Eutrophic

PVAa = aluminum Red-Yellow argisols

PVAal = Red-yellow argisols Ta Aluminium

TCo = Orthic Chromic luvisols

TXo = Orthic haplic luvisols

The figures above demonstrate that there is similarity between the analyzed classes of the project area and the proxy areas. The following figures show the evolution of the properties regarding the change in land use based on the history of deforestation in the analyzed period. It is possible to conclude that the deforested areas are not abandoned in the region and that there was an increase and consolidation of these areas. The time series depicts the increase in pasture area opening. All maps compare land use and transitions in the years 2010 and 2020, showing that these properties were not abandoned.

- **Annual Area of Deforestation**

The annual Area of Deforestation in the baseline case is determined according to the VMD0006 v1.3, equation 5, which considers:

- $AA_{planned,i,t}$ – Annual area of baseline planned deforestation for stratum *i* at time *t*; ha
- D(%) – projected annual proportion of land that will be deforested in stratum *I* during year *t*.
- $A_{planned,i,t}$ – total area of planned deforestation over baseline period for stratum *I*;
- $L\text{-}D_i$ – likelihood of deforestation for stratum *i.*

The annual projection of the proportion land that will be deforested in each stratum I during year t (D%) is determined according to the forest suppression authorizations issued by the competent environmental agency of the State of Acre, IMAC.

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[133] must be applied for all project activities instances.

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

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

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

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

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

- The instance shall have financial, technical and scale consistent with the described in this PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied.

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

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

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:

Instances 1 and 2 (Fazenda Riozinho and Fazenda Alegria)

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

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

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

The application of the Project Activity could be carried out on the land within the project boundary, nevertheless performed without being registered as the VCS REDD project. This scenario would include avoiding deforestation through security and monitoring installation. Additionally, complementary activities to improve the monitoring of deforestation caused by the agents (identified in Section 3.4, above) would have to be carried out, such as: increased surveillance, monitoring and control by satellite images, REDD technical studies, social and environmental activities promoted, among others. These investments are usually not made by the Brazilian Government, as they are not mandatory. Therefore, the economic feasibility of this scenario would be reduced without additional revenues from the sale of VCUs.

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

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

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

Sub-step 1c. Selection of the baseline scenario

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

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

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

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

Sub-step 2b. Simple Cost Analysis

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

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

Table 22. Estimated annual costs for the REDD Project[134]

Estimated Annual Costs of Conservation (R$/year)	
Surveillance and security of the area	R$ 18,000.00

[134] Costs were estimated based on the quotes provided by the respective service providers, according to the available cashflow.

Fuel and machinery maintenance	R$ 6,500.00
Proposed socio-environmental activities	R$ 29,166.00[135]
TOTAL	**R$ 53,666.00**

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 State of Acre 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[136].

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

- **Private Reserve of Natural Heritage (RPPN)[137]:** 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 6 registered RPPNs and none of them are located in the municipalities of the reference region[138].

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

- **Payment for Environmental Services (PES)[139]:** PES is a transaction of voluntary nature, through which a buyer of environmental services grants the provider of these services

[135] The cost with socio-environmental activities was calculated based on other REDD projects, which have implemented similar measures.
[136] Available at <https://www.gov.br/icmbio/pt-br/servicos/crie-sua-reserva/perguntas-e-respostas-sobre-rppn>.
[137] Available at <https://www.icmbio.gov.br/portal/images/stories/comunicacao/downloads/perguntaserespostasrppn.pdf>
[138] Available at: <https://dados.mma.gov.br/>
[139] Available at <http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/L14119.htm>

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.

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.

APD – Avoided Planned Deforestation

The following sections present the results of each step to demonstrate additionality in VCS AFOLU projects according to VT0001 v3.0.

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

The following describes the realistic and credible land use scenarios that would have occurred within the proposed project boundary in the absence of the AFOLU project activity under VCS.

I. **The continuation of the current (pre-project) land use scenario:** in this scenario, no REDD project is undertaken. The authorized deforestation, through licenses and authorizations for forest exploitation in up to 20% of the property is executed, and the entire project area is suppressed.

Scenario I is realistic and credible, as it represents an activity that the project agent has already performed on other properties.

II. **Implementation of a sustainable forest management plan, combined with the implementation of additional activities:** In this scenario, the Project activity would be carried out on the land within the project boundary, nevertheless performed without being registered as the VCS REDD project. Thus, the maintenance of the property's forest cover, without exploitation of the 20% permitted by law;

Scenario II is difficult to occur, as it implies leaving the property without generating financial resources and with maintenance costs, fees and taxes and risk of encroachment and illegal deforestation. This scenario is more unlikely, but it is in accordance with environmental legislation.

Scenario I is considered the most plausible baseline scenario because the land is expected to be converted to non-forest land in the baseline case and the conversion is legally authorized and documented. Deforestation with an increase in livestock is intrinsically linked and follows a pattern in the Amazon region. What can be confirmed by the increase in head of cattle in the municipality.

In this scenario, the landowner would change its activity from forest management to cattle ranching. This is a plausible scenario since cattle is one of Brazil's main economic activities, as previously described in section above.

The State of Acre is not the most expressive in the number of herds in the northern region of Brazil, but it is pressured by neighboring states, mainly Rondônia and the south of Amazonas. The northern region had more than 24% of the country's herd[140].

This growth in the number of herds over the years in the region can be observed by the type of land use on agricultural properties.

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

Scenario I and II: The application of an authorized deforestation is regulated in Brazil by the laws Nº 12,651[141], decree Nº 5,975[142], as detailed in AUD analysis.

Scenario III - Cattle raising in the Amazon Forest is legal as long as 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

140 Available at https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9107-producao-da-pecuaria-municipal.html?=&t=resultados
141 Available at: <https://www.planalto.gov.br/ccivil_03/_Ato2011-2014/2012/Lei/L12651.htm>
142 Available at: <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm>

for pasture. This authorization is provided by the State's government[143], in the responsible environmental agency. The legal reserve area can be exploited and compensation in another area, if there is no duplication of the compensated area. Thus, the AUD project area may have pasture and livestock if the owner requests authorization from the competent body, indicating another area for forest compensation[144].

Sub-step 1c. Selection of the baseline scenario

Based on the scenarios presented, it is possible to conclude that the baseline scenario is Scenario I.

Cattle ranching is the most profitable alternative land use, and thus, the clearing of the land and execution of the authorization is the most plausible baseline scenario.

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

This stage follows the same as for the AUD stage, that is, the proposed project activity is less attractive than the commercialization of wood after suppression and implementation of agricultural activity.

Same for steps 2b, 2c and 2d described in AUD.

STEP 3. Common practice analysis

As previously presented, forest conservation is extremely rare, due to the financial attractiveness of other activities, especially when dealing with an area that is allowed to be legally deforested.

The maintenance of 80% of legal reserve in the Legal Amazon is extremely contested by the agricultural sector, and the pressure to change the forest code is high. There is movement to reduce mandatory conservation to 50% in states such as Mato Grosso[145], Roraima and Amapá[146], which indicates the trend and pressure between the environment and agriculture sector. Thus, it can be concluded that the conservation of areas authorized for plant suppression is not a common practice in the municipality.

Therefore, the proposed VCS AFOLU project is not the baseline scenario and is not common practice in the region. Hence, it is additional.

[143] Available at < https://www.legisweb.com.br/legislacao/?id=132746>

[144] On the other hand, the registration of another area equivalent to and in excess of the Legal Reserve, in a property owned by the same owner or acquired in a third-party property, consists of the acquisition of a different area for compensation purposes, provided that it has established native vegetation, in regeneration or recomposition, and located in the same biome as the area being regularized. Available at: https://buzaglodantas.adv.br/2021/08/11/compensacao-de-reserva-legal/

[145] Available at: < https://observatorioflorestal.org.br/nota-tecnica-pl337-22-proposta-de-retirada-do-mato-grosso-da-amazonia-legal-traz-prejuizos-ao-brasil-em-beneficio-de-poucos/>

[146] Available at: < https://www.bbc.com/portuguese/brasil-51510482>

3.6 Methodology Deviations

This project activity does not apply any methodology deviations.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

PROJECTION OF FUTURE DEFORESTATION

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

- Selection of Baseline Approach

According to the Section 3.4 – Baseline Scenario above, between 2010 and 2020, there was a deforestation of 51,959 ha within the Reference Region, with an average oscillation of approximately 1,183 ha/year and a increasing trend (R^2 = 0.87).

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

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

- Quantitative projection of future deforestation

For the deforestation baseline, the average deforestation rate during the 2010-2020 period (1,10%/year).

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

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

Table 23. Annual areas of baseline deforestation in the reference region

Project year t	Stratum i in the reference region (ha)	Total (ha)	
	ABSLRR	annual $ABSLRR_t$	cumulative ABSLRR
2021	1,236.85	1,236.85	1,236.85
2022	1,236.85	1,236.85	2,473.71
2023	1,236.85	1,236.85	3,710.56
2024	1,236.85	1,236.85	4,947.42
2025	1,236.85	1,236.85	6,184.27
2026	1,236.85	1,236.85	7,421.13
2027	1,113.17	1,113.17	8,534.30
2028	1,113.17	1,113.17	9,647.47
2029	1,113.17	1,113.17	10,760.64
2030	1,113.17	1,113.17	11,873.80
2031	1,113.17	1,113.17	12,986.97
2032	1,113.17	1,113.17	14,100.14
2033	1,001.85	1,001.85	15,102.00
2034	1,001.85	1,001.85	16,103.85
2035	1,001.85	1,001.85	17,105.70
2036	1,001.85	1,001.85	18,107.55
2037	1,001.85	1,001.85	19,109.40
2038	1,001.85	1,001.85	20,111.26
2039	901.67	901.67	21,012.92
2040	901.67	901.67	21,914.59
2041	901.67	901.67	22,816.26
2042	901.67	901.67	23,717.92
2043	901.67	901.67	24,619.59
2044	901.67	901.67	25,521.26
2045	811.50	811.50	26,332.76
2046	811.50	811.50	27,144.26
2047	811.50	811.50	27,955.76
2048	811.50	811.50	28,767.26
2049	811.50	811.50	29,578.76
2050	811.50	811.50	30,390.26

Table 24. Annual areas of baseline deforestation in the project area

Project year t	Stratum i in the project area (ha)	Total (ha)

	ABSLPA	annual $ABSLPA_t$	cumulative ABSLPA
2021	32.47	32.47	32.47
2022	32.47	32.47	64.94
2023	32.47	32.47	97.41
2024	32.47	32.47	129.87
2025	32.47	32.47	162.34
2026	32.47	32.47	194.81
2027	29.22	29.22	224.03
2028	29.22	29.22	253.26
2029	29.22	29.22	282.48
2030	29.22	29.22	311.70
2031	29.22	29.22	340.92
2032	29.22	29.22	370.14
2033	26.30	26.30	396.44
2034	26.30	26.30	422.74
2035	26.30	26.30	449.04
2036	26.30	26.30	475.34
2037	26.30	26.30	501.64
2038	26.30	26.30	527.94
2039	23.67	23.67	551.61
2040	23.67	23.67	575.28
2041	23.67	23.67	598.95
2042	23.67	23.67	622.62
2043	23.67	23.67	646.29
2044	23.67	23.67	669.96
2045	21.30	21.30	691.26
2046	21.30	21.30	712.56
2047	21.30	21.30	733.87
2048	21.30	21.30	755.17
2049	21.30	21.30	776.47
2050	21.30	21.30	797.77

Table 25. Annual areas of baseline deforestation in the leakage belt

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	ABSLLK	annual $ABSLLK_t$	cumulative ABSLLK
2021	14.62	14.62	14.62
2022	14.62	14.62	29.23
2023	14.62	14.62	43.85
2024	14.62	14.62	58.46
2025	14.62	14.62	73.08
2026	14.62	14.62	87.69
2027	13.15	13.15	100.85

2028	13.15	13.15	114.00
2029	13.15	13.15	127.16
2030	13.15	13.15	140.31
2031	13.15	13.15	153.46
2032	13.15	13.15	166.62
2033	11.84	11.84	178.46
2034	11.84	11.84	190.29
2035	11.84	11.84	202.13
2036	11.84	11.84	213.97
2037	11.84	11.84	225.81
2038	11.84	11.84	237.65
2039	10.65	10.65	248.30
2040	10.65	10.65	258.96
2041	10.65	10.65	269.61
2042	10.65	10.65	280.27
2043	10.65	10.65	290.92
2044	10.65	10.65	301.58
2045	9.59	9.59	311.17
2046	9.59	9.59	320.76
2047	9.59	9.59	330.35
2048	9.59	9.59	339.93
2049	9.59	9.59	349.52
2050	9.59	9.59	359.11

- <u>**Projection of the location of future deforestation**</u>

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

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

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

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

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

- <u>Assigning weightings to change agents</u>

The predictive variables considered to have the potential to influence the risk of deforestation in the region are the proximity to roads, proximity to cities, slope, altitude, proximity to settlements and proximity rivers.

Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created using Dinamica EGO Software[147], 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 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[148].

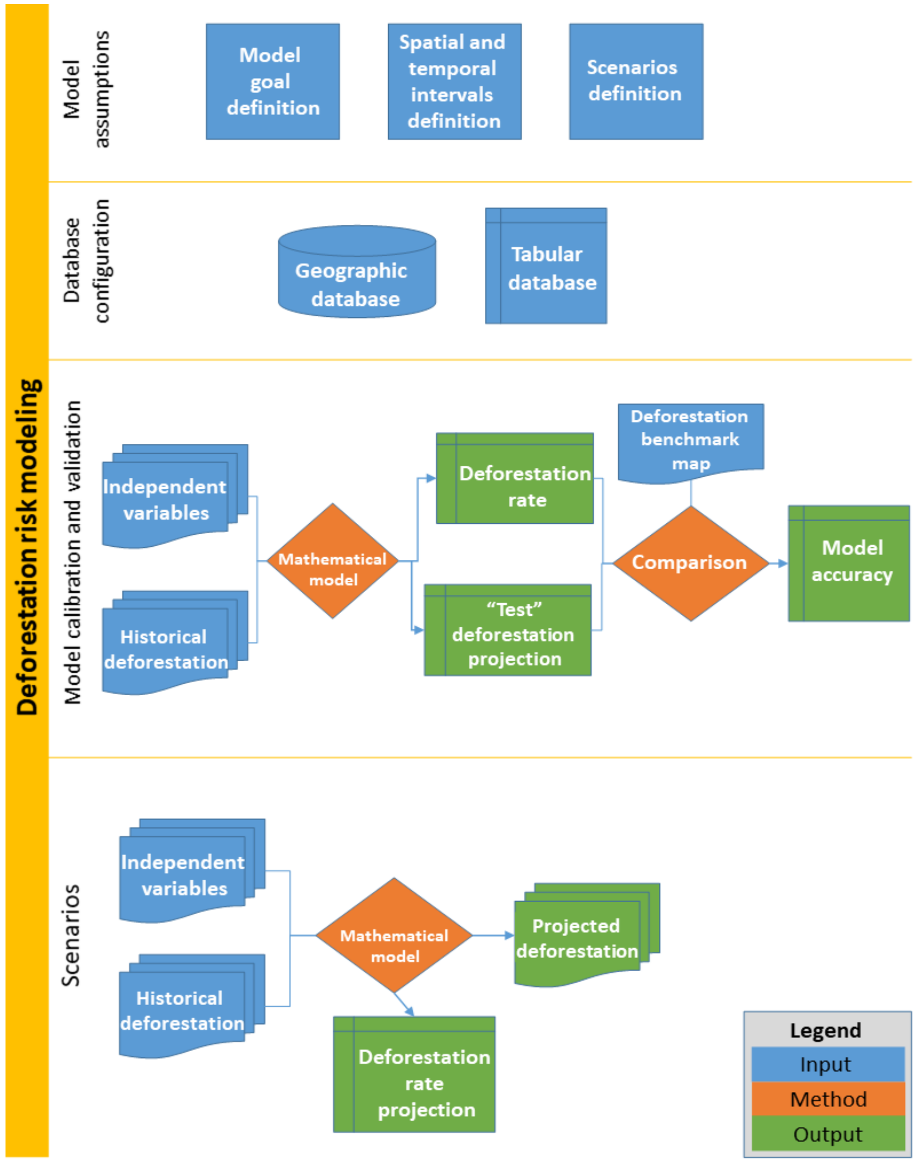
The result of the application of Dinamica EGO is a transition potential map that identifies areas that present favorable conditions for deforestation to occur in areas classified as forest. This map is the starting point for spatialization of future areas of deforestation, from which annual rates are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

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

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

Figure 28. 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 26. 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.tif**	IBGE/Imazon	Meters	Distances to paved and unpaved roads	0	34892.6	Lower values indicate greater proximity		MERGE_estradas	Euclidean Distance (ArcGIS 10.8)	Quantitative variable
2	**d_rios_mbiomas.tif**	MapBiomas	Meters	Distance to rivers mapped by MapBiomas	0	23685.1	Lower values indicate greater proximity		Rios_MapBiomas	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
3	**d_rios.tif**	ANA	Meters	Distance to rivers	0	6512.28	Lower values indicate greater proximity		Rios_ANA	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
4	**d_urbana.tif**	IBGE	Meters	Distance to urban centers	0	83463.9	Lower values indicate greater proximity		Cidades_IBGE	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
5	**dem.tif**	SRTM	Meters	Average altitude change	250	283	Lower values indicate lower altitude				Quantitative variable
6	**slope_perc.tif**	SRTM	Percentage	Average variation of land slope	0	65.2453	Lower values indicate less slope			Slope (ArcGIS 10.8)	Quantitative variable

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

Table 27. Variation of the weights of evidence according to deforestation distance ranges

Deforestation distance ranges		Weight of evidence
0	100	1.97
100	200	1.05
200	300	0.63
300	400	0.32
400	500	0.08
500	600	-0.10
600	800	-0.29
800	1000	-0.41
1000	1200	-0.49
1200	1400	-0.60
1400	1600	-0.69
1600	1900	-0.77
1900	2200	-0.92
2200	2500	-1.03
2500	2900	-1.02
2900	3400	-0.91
3400	3700	-0.69
3700	3900	-0.50
3900	4100	-0.27
4100	4700	-0.08
4700	5900	-0.26
5900	6600	-0.46
6600	6700	-2.80
6700	9100	-5.26

Table 28. Variation of the weights of evidence according to the distance from roads

Distance from roads		Weight of evidence
0	100	1.53
100	200	1.10
200	300	0.81
300	500	0.59
500	700	0.32
700	1000	0.14
1000	1300	0.00
1300	1600	-0.13
1600	1900	-0.18
1900	2200	-0.15
2200	2600	-0.28
2600	3000	-0.42
3000	3100	-0.68
3100	3600	-0.64
3600	4200	-0.60
4200	4800	-0.76
4800	5500	-0.59
5500	5600	-0.40
5600	6500	-0.37
6500	7800	-0.36
7800	7900	-0.59
7900	8100	-0.91
8100	8200	-1.32
8200	12300	-1.04
12300	12400	0.05
12400	12900	-0.14
12900	13000	-0.63
13000	13300	-0.91
13300	13600	-1.31
13600	14500	-1.75
14500	14600	0.00
14600	15100	0.00

Table 29. Variation of the weights of evidence according to the distance from rivers

Distance from rivers		Weight of evidence
0	100	0.25
100	300	0.47
300	600	0.58
600	900	0.36
900	1200	0.17
1200	1400	-0.01
1400	1700	-0.16
1700	2000	-0.24

2000	2300	-0.23
2300	2600	-0.23
2600	3000	-0.26
3000	3400	-0.29
3400	3800	-0.31
3800	4100	-0.13
4100	4600	0.00
4600	5200	0.09
5200	5800	-0.05
5800	5900	-0.26
5900	6400	-0.07
6400	6700	0.11
6700	7900	-0.06
7900	8000	-0.45
8000	8800	-0.23
8800	8900	0.11
8900	10300	-0.10
10300	10400	-5.29
10400	11400	-5.36

Table 30. Variation of the weights of evidence according to slope

Slope		Weight of evidence
0	2	-0.19
2	3	-0.18
3	4	-0.16
4	5	-0.13
5	6	-0.06
6	7	-0.01

7	8	0.07
8	10	0.17
10	13	0.36
13	22	0.57
22	98	0.67
12	13	-0.21
13	15	-0.22
15	18	-0.19
18	55	-0.35

Table 31. 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	85	0.56
27	28	0.75	86	92	0.35
28	30	0.47	93	100	0.49
30	33	0.45	101	115	0.72

33	35	0.16	116	135	1.07
35	37	-0.05	136	155	1.47
37	38	-0.22	156	175	1.98
38	40	-0.04	176	200	1.45

Table 32. Variation of the weights of evidence according to Protected Areas categories

Protected areas	Weight of evidence
Outside protected areas	0.65
Protected Areas within the Sustainable Use Category	-0.16

Table 33. Variation of the weights of evidence according to the presence of settlements

Settlements	Weight of evidence
Outside settlements	-0.28
Within settlements	1.53

Table 34. Variation of the weights of evidence according to distance from urban areas

Distance from urban areas		Weight of evidence	Distance from urban areas		Weight of evidence
0	11000	1.00	48500	49500	-0.17
11000	13000	1.50	49500	50000	-0.42
13000	13500	2.08	50000	53000	-0.44
13500	17500	1.44	53000	54500	-0.65
17500	18000	0.89	54500	55000	-1.04
18000	18500	0.46	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

- <u>Selection of most accurate deforestation risk map</u>

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

For that, simulations of the deforestation projection were made, taking three dates as reference: 2010, 2015 and 2020. The period of 2010-2015 was used to generate the correlations between the deforested areas and the predictor variables, calculating the adjustment parameters of the models. After that a projection from 2016 to 2020 was made, developing a reference region scenario for this date. Therefore, the deforestation map for the period of 2016 to 2020 and two 2020 scenarios, real and projected, were developed. These scenarios were compared regarding the degree of similarity considering the exponential decay. The higher the similarity, the better the prediction of the model. This index ranges from 0 (no overlapping) to 1 (completely overlapped), and the closer to 1, the more similar is the simulated scenario in relation to the real. Two values are calculated for the indices, the comparison of the simulated map in relation to the real deforestation map and, the opposite, the real map in relation to the simulated map. Thus, to define the most accurate map, the average of these two values was used.

The first tested model was the one with all the predictor variables of deforestation (m00); next, the models were tested by removing each factor separately and measuring the degree of correctness of the model (m01 to m08). Therefore, the most important variables were those in which their absence caused a greater drop in the degree of similarity between the real and projected deforestation maps.

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

The best model was m04, with an average similarity of 0.493. This model applies seven variables: distance from deforestation, distance from protected areas, distance from settlements, distance from roads, distance from urban areas, slope and altitude. Thus, it was selected to project the future deforestation.

In addition, the AUC (Area Under the Curve), which is the area under the ROC curve (Receiver Operating Characteristic) was calculated. This represents the accuracy of the probability maps, that is, it shows whether the actual deforestation is indicated with the deforestation probabilities by the models (deforestation risk map). Regarding the AUC values, the best model presented a value of 0.78[149].

- <u>Definition of 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.

[149] 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.

In accordance with analysis achieved through the procedure described above, the quantity of baseline LU/LC-change was projected throughout the crediting period, in the reference region, project area and leakage belt in each stratum. This is in accordance with step 5 of the methodology “Definition of the land-use and land-cover change component of the baseline”.

- Calculation of baseline activity data per forest class

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

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

Table 35. 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		
2021	1,236.85	1,236.85	1,236.85
2022	1,236.85	1,236.85	2,473.71
2023	1,236.85	1,236.85	3,710.56
2024	1,236.85	1,236.85	4,947.42
2025	1,236.85	1,236.85	6,184.27
2026	1,236.85	1,236.85	7,421.13
2027	1,113.17	1,113.17	8,534.30
2028	1,113.17	1,113.17	9,647.47
2029	1,113.17	1,113.17	10,760.64
2030	1,113.17	1,113.17	11,873.80
2031	1,113.17	1,113.17	12,986.97
2032	1,113.17	1,113.17	14,100.14
2033	1,001.85	1,001.85	15,102.00
2034	1,001.85	1,001.85	16,103.85
2035	1,001.85	1,001.85	17,105.70
2036	1,001.85	1,001.85	18,107.55
2037	1,001.85	1,001.85	19,109.40
2038	1,001.85	1,001.85	20,111.26
2039	901.67	901.67	21,012.92
2040	901.67	901.67	21,914.59
2041	901.67	901.67	22,816.26
2042	901.67	901.67	23,717.92
2043	901.67	901.67	24,619.59
2044	901.67	901.67	25,521.26
2045	811.50	811.50	26,332.76
2046	811.50	811.50	27,144.26
2047	811.50	811.50	27,955.76
2048	811.50	811.50	28,767.26
2049	811.50	811.50	29,578.76
2050	811.50	811.50	30,390.26

Table 36. 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		
2021	32.47	32.47	32.47
2022	32.47	32.47	64.94
2023	32.47	32.47	97.41
2024	32.47	32.47	129.87
2025	32.47	32.47	162.34
2026	32.47	32.47	194.81
2027	29.22	29.22	224.03
2028	29.22	29.22	253.26
2029	29.22	29.22	282.48
2030	29.22	29.22	311.70
2031	29.22	29.22	340.92
2032	29.22	29.22	370.14
2033	26.30	26.30	396.44
2034	26.30	26.30	422.74
2035	26.30	26.30	449.04
2036	26.30	26.30	475.34
2037	26.30	26.30	501.64
2038	26.30	26.30	527.94
2039	23.67	23.67	551.61
2040	23.67	23.67	575.28
2041	23.67	23.67	598.95
2042	23.67	23.67	622.62
2043	23.67	23.67	646.29
2044	23.67	23.67	669.96
2045	21.30	21.30	691.26
2046	21.30	21.30	712.56
2047	21.30	21.30	733.87
2048	21.30	21.30	755.17
2049	21.30	21.30	776.47
2050	21.30	21.30	797.77

Table 37. 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		
2021	14.62	14.62	14.62
2022	14.62	14.62	29.23
2023	14.62	14.62	43.85
2024	14.62	14.62	58.46
2025	14.62	14.62	73.08
2026	14.62	14.62	87.69
2027	13.15	13.15	100.85
2028	13.15	13.15	114.00
2029	13.15	13.15	127.16
2030	13.15	13.15	140.31
2031	13.15	13.15	153.46
2032	13.15	13.15	166.62
2033	11.84	11.84	178.46
2034	11.84	11.84	190.29
2035	11.84	11.84	202.13
2036	11.84	11.84	213.97
2037	11.84	11.84	225.81
2038	11.84	11.84	237.65
2039	10.65	10.65	248.30
2040	10.65	10.65	258.96
2041	10.65	10.65	269.61
2042	10.65	10.65	280.27
2043	10.65	10.65	290.92
2044	10.65	10.65	301.58
2045	9.59	9.59	311.17
2046	9.59	9.59	320.76
2047	9.59	9.59	330.35
2048	9.59	9.59	339.93
2049	9.59	9.59	349.52
2050	9.59	9.59	359.11

- <u>Calculation of baseline activity data per post deforestation forest class</u>

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 VM0015, the Historical LU/LC-change (Method 1) was used to calculate the LU/LC class that will replace the forest cover in the baseline scenario. The table below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region.

Table 38. Zone of the Reference Region encompassing potential post deforestation LU/LC class

Zone		Name		Total area of each zone	
		Non-forest			
		ID_{fcl}	1		
		Area	% of zone	Area	% of zone
IDz	Name	ha	%	ha	%
1	Reference region	30,390.26	19%	30,390.26	19%
Total area of each class *fcl*		30,390.26	19%	30,390.26	19%

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 39. 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	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	1,236.85	1,236.85	1,236.85
2022	1,236.85	1,236.85	2,473.71
2023	1,236.85	1,236.85	3,710.56
2024	1,236.85	1,236.85	4,947.42
2025	1,236.85	1,236.85	6,184.27
2026	1,236.85	1,236.85	7,421.13
2027	1,113.17	1,113.17	8,534.30
2028	1,113.17	1,113.17	9,647.47
2029	1,113.17	1,113.17	10,760.64
2030	1,113.17	1,113.17	11,873.80
2031	1,113.17	1,113.17	12,986.97
2032	1,113.17	1,113.17	14,100.14
2033	1,001.85	1,001.85	15,102.00
2034	1,001.85	1,001.85	16,103.85
2035	1,001.85	1,001.85	17,105.70
2036	1,001.85	1,001.85	18,107.55
2037	1,001.85	1,001.85	19,109.40
2038	1,001.85	1,001.85	20,111.26
2039	901.67	901.67	21,012.92
2040	901.67	901.67	21,914.59
2041	901.67	901.67	22,816.26
2042	901.67	901.67	23,717.92
2043	901.67	901.67	24,619.59
2044	901.67	901.67	25,521.26
2045	811.50	811.50	26,332.76
2046	811.50	811.50	27,144.26
2047	811.50	811.50	27,955.76
2048	811.50	811.50	28,767.26
2049	811.50	811.50	29,578.76
2050	811.50	811.50	30,390.26

Table 40. 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	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	32.47	32.47	32.47
2022	32.47	32.47	64.94
2023	32.47	32.47	97.41
2024	32.47	32.47	129.87
2025	32.47	32.47	162.34
2026	32.47	32.47	194.81
2027	29.22	29.22	224.03
2028	29.22	29.22	253.26
2029	29.22	29.22	282.48
2030	29.22	29.22	311.70
2031	29.22	29.22	340.92
2032	29.22	29.22	370.14
2033	26.30	26.30	396.44
2034	26.30	26.30	422.74
2035	26.30	26.30	449.04
2036	26.30	26.30	475.34
2037	26.30	26.30	501.64
2038	26.30	26.30	527.94
2039	23.67	23.67	551.61
2040	23.67	23.67	575.28
2041	23.67	23.67	598.95
2042	23.67	23.67	622.62
2043	23.67	23.67	646.29
2044	23.67	23.67	669.96
2045	21.30	21.30	691.26
2046	21.30	21.30	712.56
2047	21.30	21.30	733.87
2048	21.30	21.30	755.17
2049	21.30	21.30	776.47
2050	21.30	21.30	797.77

Table 41. Annual areas deforested in each zone within the Leakage Belt in the baseline case (baseline activity data per zone)

Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	$ABSLLK_t$	$ABSLLK$
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	14.62	14.62	14.62
2022	14.62	14.62	29.23
2023	14.62	14.62	43.85
2024	14.62	14.62	58.46
2025	14.62	14.62	73.08
2026	14.62	14.62	87.69
2027	13.15	13.15	100.85
2028	13.15	13.15	114.00
2029	13.15	13.15	127.16
2030	13.15	13.15	140.31
2031	13.15	13.15	153.46
2032	13.15	13.15	166.62
2033	11.84	11.84	178.46
2034	11.84	11.84	190.29
2035	11.84	11.84	202.13
2036	11.84	11.84	213.97
2037	11.84	11.84	225.81
2038	11.84	11.84	237.65
2039	10.65	10.65	248.30
2040	10.65	10.65	258.96
2041	10.65	10.65	269.61
2042	10.65	10.65	280.27
2043	10.65	10.65	290.92
2044	10.65	10.65	301.58
2045	9.59	9.59	311.17
2046	9.59	9.59	320.76
2047	9.59	9.59	330.35
2048	9.59	9.59	339.93
2049	9.59	9.59	349.52
2050	9.59	9.59	359.11

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 are less than 10 years old;
- The data are derived from multiple measurement plots;
- All species above a minimum diameter are included in the inventories;
- The minimum diameter for trees included is 30 cm or less at breast height (DBH);
- Data are sampled from good coverage of the classes over which they will be extrapolated.

As previously described, Dense Lowland Tropical Rainforest is the main forest type present within the project area, with around 95% of the total forest cover. Thus, due to the high representativeness of this forest type within the project area, the forest class was not stratified, i.e., the "Forest" class includes just one strata due to the low difference in average carbon stocks within the project area.

The estimation of the average carbon stocks for Dense Lowland Tropical Rainforest was based on Higuchi (2015)[150], which 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)[151] 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 lowland undulating terrain, rarely above 200 m, and most below 100 m.

The IBGE "Technical Manual for Brazilian Vegetation" (1992)[152] divides forestry formation into two types: Ombrophilous and Seasonal, being Ombrophilous, open and dense, predominant in the Brazilian Amazon.

As both classifications are based on characteristics of cover, soil, climate and location of the biome, the table below lists the respective definitions, comparing them:

Table 42. Comparison of forest classifications by Pires & Prance and IBGE

Pires & Prance (1985)		Technical Manual of the Brazilian vegetation (2012)
Forest on *Terra firme* (dense forest)	<u>Dense forest</u> Dense forest is the formation with the greatest biomass, with a clear litter and occurs where environmental conditions are optimal and there are no limiting factors such as scarcity or excess of water.	<u>Dense Ombrophylous rainforest (tropical rain forest)</u> The ombrothermal characteristic of the Dense Ombrophilous Forest is linked to tropical climatic factors of high temperatures and high rainfall, well distributed throughout the year, with practically no biologically dry period. It can be of uniform or emergent canopy.

[150] 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> Last visited on: August 2021.

[151] 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> Last visited on 21/March/2021.

[152] 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> Last visited on 21/March/2021.

		It is subdivided into five formations ordered according to topographic hierarchy, which reflect different physiognomies: **Alluvial, low land, submontane, montane and high montane formations.**
	Open forest without palms Since there is a greater penetration of light, because of its lower trees, there is a tendency for shrub and liana species to develop well, and the forest floor is much more densely covered by vegetation. In this forest, even though it is much lower, occasional scattered individuals of very large trees occur. The lower biomass can be caused by a lower water table, by the impermeability of the soil, by poor drainage or by conditions which do not permit good root penetration, or by the occurrence of relatively long dry seasons and a lower relative humidity. These forests are not notably seasonally deciduous, and they are also not affected by fire. Open forest with palms Similar to the preceding, with trees of about the same height in the same density and of a similar floristic composition. It occurs more frequently than the forest without palms. Liana forest: Generally has an abundance of lianas. Generally not continuous. Usually intermeshed with dense forests wthout lianas forming a complex mosaic. Dry forest: Formation of transition forest that is occasionally found in the southeastern part of Amazonia on the border between Amazonia and Central Brazil. In this region, the climate is much more	Open Ombrophylous forest This type of vegetation was considered for years as a type of transition between the Amazon rainforest and the extra-Amazonian areas. It presents four floristic factions that alter the ecological physiognomy of the dense rainforest, giving it a clear appearance, hence the name adopted, in addition to the climatic gradients with more than 60 dry days per year. It is divided into: Lowland – predominance of palm trees Submontane – predominance of palm trees, vines, sororoca and bamboo Montane – predominance of palms and vines, the latter much more common. Alluvial – on ancient terraces located along the river; riverside formation that always occupies alluvial lands located in the fluvia of coastal mountains or plateaus.

	seasonal and dryer with lower relative humidity, with the result that in the dry season, the trees lose some of their leaves. Dry forest occurs in small clusters that do not occupy large areas. Montane forests: Forest formations which are differentiated by their altitude and rocky soil types. It occurs only at the extremities of Amazonia.	
Inundated forests (*várzeas* and *igapós*) Várzeas and igapós are regional terms applied both to types of soil and vegetation, noting the excess of humidity or swampy conditions, i.e., any ground that is not terra firme. *Igapó* is located in black and clearwater areas, while *Várzea* to muddy water inundation. Várzeas are formed by sedimentar ground that during its formation were influenced by fluctuation in sea levels.		Classification of forests by location - alluvial. While Pires and Prance unified the marshy characteristic in a classification, the manual divides them according to the context of the other formations, with respective information on species, cover, etc. Thus, the term alluvial represents, as a whole, riverside formation or riparian forest that occurs along water courses, occupying the old terraces of quaternary plains. It can occur in dense, open and mixed rain forest within the classifications above.

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 (2015).

Therefore, the Higuchi's study of volume and biomass dynamics of the Amazonian rainforest was adopted to define the carbon stock of the category of dense tropical rainforest (lowland) located in PA, RR and LK. It is important to highlight that this vegetation type is 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 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.

The methodology of Higuchi (2015) is summarized below.

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:

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

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

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

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

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 at 95% CI). 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.

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

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

Table 43. Biomass to CO2 conversion factors[153]

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

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

Table 44. Biomass values used for the "forest" classes within the Project area.

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

Average carbon stocks of post-deforestation classes

Fearnside (1996)[154] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO_2e/ha. It is important to note that no sampling was applied to calculate this data.

153 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

154 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>

Table 45. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

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

Following a literature review, the use of Fearnside (1996) value for non-forest vegetation carbon stocks in equilibrium is conservative because it is based on several land-use types in the Amazon, including agriculture, pasturelands and secondary vegetation, reaching a final value of 46.93 tCO_2/ha. Meanwhile, based on the Brazilian Government data available in the 3rd National GHG Inventory[155], the weighted average for carbon stocks in other land uses (mainly agriculture and pasturelands) was 32.99 tCO_2e. 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.

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

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

Table 46. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt

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

Table 47. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties

	Initial forest class *icl*						
	Boundaries	Average carbon stock 90% CI					
		Name	Forest - Dense Lowland Tropical Rainforest				
		ID_{icl}	1				
		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
		C stock	C stock change	C stock	C stock change	C stock	C stock change
		tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
Initial forest class	Project Area	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55
Initial forest class	Leakage Belt	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55

<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*+10 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.
- Post-deforestation classes (fcl): linear increase from 0 tCO_2e/ha in year t = t* to 100% of the long-term average carbon stock in year t = t*+10 is assumed to happen in the 10 years period following deforestation (i.e. 1/10th 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 48. Carbon stock change factors for initial forest classes (icl) in the reference region (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	413.34	9.92
2	t*+1	0	9.92
3	t*+2	0	9.92
4	t*+3	0	9.92
5	t*+4	0	9.92
6	t*+5	0	9.92
7	t*+6	0	9.92
8	t*+7	0	9.92
9	t*+8	0	9.92
10	t*+9	0	9.92
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0

20	t*+19	0	0
21-T	t*+20…	0	0

Table 49. 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*	-413.34	-9.92
2	t*+1	0	-9.92
3	t*+2	0	-9.92
4	t*+3	0	-9.92
5	t*+4	0	-9.92
6	t*+5	0	-9.92
7	t*+6	0	-9.92
8	t*+7	0	-9.92
9	t*+8	0	-9.92
10	t*+9	0	-9.92
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20…	0	0

Table 50. Carbon stock change factors for initial forest classes (icl) in the Leakage Belt (Method 1)

Forest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-413.34	-9.92
2	t*+1	0	-9.92
3	t*+2	0	-9.92
4	t*+3	0	-9.92
5	t*+4	0	-9.92
6	t*+5	0	-9.92
7	t*+6	0	-9.92

8	t*+7	0	-9.92
9	t*+8	0	-9.92
10	t*+9	0	-9.92
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20…	0	0

Table 51. Carbon stock change factors for final classes fcl or zones z (Method 1)

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/ha)
1	t*	0.00
2	t*+1	5.21
3	t*+2	5.21
4	t*+3	5.21
5	t*+4	5.21
6	t*+5	5.21
7	t*+6	5.21
8	t*+7	5.21
9	t*+8	5.21
10	t*+9	5.21
11	t*+10	0
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0
16	t*+15	0
17	t*+16	0
18	t*+17	0
19	t*+18	0
20	t*+19	0
21-T	t*+20…	0

<u>Calculation of baseline carbon stock changes</u>

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 52. Baseline carbon stock change in the Reference Region

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the reference region		Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the reference region		Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region		Total net carbon stock change in the reference region	
ID_{cl}	1	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$	ID_{cl}	1	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$	ID_{lz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$	$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
Name	Forest	annual	cumulative	Name	Forest	annual	cumulative	Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_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
2021	511,246	511,246	511,246	2021	12,270	12,270	12,270	2021	0	0	0	523,516	523,516
2022	511,246	511,246	1,022,491	2022	24,540	24,540	36,810	2022	6,450	6,450	6,450	529,335	1,052,851
2023	511,246	511,246	1,533,737	2023	36,810	36,810	73,619	2023	12,900	12,900	19,350	535,155	1,588,006
2024	511,246	511,246	2,044,983	2024	49,080	49,080	122,699	2024	19,350	19,350	38,700	540,975	2,128,982
2025	511,246	511,246	2,556,228	2025	61,349	61,349	184,048	2025	25,800	25,800	64,500	546,795	2,675,777
2026	511,246	511,246	3,067,474	2026	73,619	73,619	257,668	2026	32,250	32,250	96,750	552,615	3,228,392
2027	460,121	460,121	3,527,595	2027	84,662	84,662	342,330	2027	38,700	38,700	135,449	506,084	3,734,476
2028	460,121	460,121	3,987,716	2028	95,705	95,705	438,035	2028	44,505	44,505	179,954	511,321	4,245,797
2029	460,121	460,121	4,447,837	2029	106,748	106,748	544,783	2029	50,310	50,310	230,264	516,559	4,762,356
2030	460,121	460,121	4,907,958	2030	117,791	117,791	662,574	2030	56,115	56,115	286,379	521,797	5,284,154
2031	460,121	460,121	5,368,079	2031	116,564	116,564	779,138	2031	61,920	61,920	348,298	514,765	5,798,919
2032	460,121	460,121	5,828,200	2032	115,337	115,337	894,475	2032	61,275	61,275	409,573	514,183	6,313,103
2033	414,109	414,109	6,242,309	2033	113,006	113,006	1,007,481	2033	60,630	60,630	470,203	466,485	6,779,588
2034	414,109	414,109	6,656,418	2034	110,674	110,674	1,118,156	2034	59,404	59,404	529,607	465,379	7,244,967
2035	414,109	414,109	7,070,527	2035	108,343	108,343	1,226,499	2035	58,179	58,179	587,786	464,273	7,709,240
2036	414,109	414,109	7,484,636	2036	106,012	106,012	1,332,511	2036	56,953	56,953	644,739	463,168	8,172,408
2037	414,109	414,109	7,898,745	2037	104,908	104,908	1,437,418	2037	55,728	55,728	700,467	463,289	8,635,697
2038	414,109	414,109	8,312,854	2038	103,803	103,803	1,541,222	2038	55,147	55,147	755,614	462,765	9,098,462
2039	372,698	372,698	8,685,552	2039	101,705	101,705	1,642,927	2039	54,567	54,567	810,180	419,836	9,518,298
2040	372,698	372,698	9,058,250	2040	99,607	99,607	1,742,534	2040	53,464	53,464	863,644	418,841	9,937,139
2041	372,698	372,698	9,430,948	2041	97,509	97,509	1,840,043	2041	52,361	52,361	916,005	417,846	10,354,986
2042	372,698	372,698	9,803,646	2042	95,411	95,411	1,935,453	2042	51,258	51,258	967,263	416,851	10,771,836
2043	372,698	372,698	10,176,344	2043	94,417	94,417	2,029,870	2043	50,155	50,155	1,017,418	416,960	11,188,796
2044	372,698	372,698	10,549,042	2044	93,423	93,423	2,123,293	2044	49,633	49,633	1,067,050	416,489	11,605,285
2045	335,428	335,428	10,884,471	2045	91,535	91,535	2,214,828	2045	49,110	49,110	1,116,161	377,853	11,983,138
2046	335,428	335,428	11,219,899	2046	89,646	89,646	2,304,474	2046	48,117	48,117	1,164,278	376,957	12,360,095
2047	335,428	335,428	11,555,327	2047	87,758	87,758	2,392,232	2047	47,125	47,125	1,211,403	376,061	12,736,156
2048	335,428	335,428	11,890,755	2048	85,870	85,870	2,478,102	2048	46,132	46,132	1,257,535	375,166	13,111,322
2049	335,428	335,428	12,226,184	2049	84,975	84,975	2,563,077	2049	45,139	45,139	1,302,674	375,264	13,486,586
2050	335,428	335,428	12,561,612	2050	84,081	84,081	2,647,157	2050	44,669	44,669	1,347,343	374,840	13,861,426

Table 53. Baseline carbon stock change in the Project Area

Carbon stock change in the above-ground biomass per initial forest class *icl*		Total carbon stock change in the above-ground biomass of initial forest class in the project area	
ID_{cl}	1	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Forest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e
2021	13,421	13,421	13,421
2022	13,421	13,421	26,841
2023	13,421	13,421	40,262
2024	13,421	13,421	53,683
2025	13,421	13,421	67,103
2026	13,421	13,421	80,524
2027	12,079	12,079	92,603
2028	12,079	12,079	104,681
2029	12,079	12,079	116,760
2030	12,079	12,079	128,839
2031	12,079	12,079	140,917
2032	12,079	12,079	152,996
2033	10,871	10,871	163,867
2034	10,871	10,871	174,737
2035	10,871	10,871	185,608
2036	10,871	10,871	196,479
2037	10,871	10,871	207,350
2038	10,871	10,871	218,220
2039	9,784	9,784	228,004
2040	9,784	9,784	237,788
2041	9,784	9,784	247,571
2042	9,784	9,784	257,355
2043	9,784	9,784	267,139
2044	9,784	9,784	276,923
2045	8,805	8,805	285,728
2046	8,805	8,805	294,533
2047	8,805	8,805	303,338
2048	8,805	8,805	312,144
2049	8,805	8,805	320,949
2050	8,805	8,805	329,754

Carbon stock change in the below-ground biomass per initial forest class *icl*		Total carbon stock change in the below-ground biomass of initial forest class in the project area	
ID_{cl}	1	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Forest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e
2021	322	322	322
2022	644	644	966
2023	966	966	1,933
2024	1,288	1,288	3,221
2025	1,610	1,610	4,831
2026	1,933	1,933	6,764
2027	2,222	2,222	8,986
2028	2,512	2,512	11,499
2029	2,802	2,802	14,301
2030	3,092	3,092	17,393
2031	3,060	3,060	20,453
2032	3,028	3,028	23,481
2033	2,967	2,967	26,447
2034	2,905	2,905	29,353
2035	2,844	2,844	32,197
2036	2,783	2,783	34,980
2037	2,754	2,754	37,734
2038	2,725	2,725	40,459
2039	2,670	2,670	43,128
2040	2,615	2,615	45,743
2041	2,560	2,560	48,303
2042	2,505	2,505	50,808
2043	2,479	2,479	53,286
2044	2,452	2,452	55,738
2045	2,403	2,403	58,141
2046	2,353	2,353	60,495
2047	2,304	2,304	62,798
2048	2,254	2,254	65,053
2049	2,231	2,231	67,283
2050	2,207	2,207	69,490

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_{lz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$	$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
Name	Non-forest	annual	cumulative	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0	0	0	13,743	13,743
2022	169	169	169	13,896	27,638
2023	339	339	508	14,048	41,687
2024	508	508	1,016	14,201	55,888
2025	677	677	1,693	14,354	70,242
2026	847	847	2,540	14,507	84,748
2027	1,016	1,016	3,556	13,285	98,034
2028	1,168	1,168	4,724	13,423	111,456
2029	1,321	1,321	6,045	13,560	125,016
2030	1,473	1,473	7,518	13,698	138,714
2031	1,625	1,625	9,143	13,513	152,227
2032	1,609	1,609	10,752	13,498	165,725
2033	1,592	1,592	12,343	12,246	177,971
2034	1,559	1,559	13,903	12,217	190,187
2035	1,527	1,527	15,430	12,188	202,375
2036	1,495	1,495	16,925	12,159	214,534
2037	1,463	1,463	18,388	12,162	226,695
2038	1,448	1,448	19,836	12,148	238,843
2039	1,432	1,432	21,268	11,021	249,864
2040	1,403	1,403	22,671	10,995	260,859
2041	1,375	1,375	24,046	10,969	271,828
2042	1,346	1,346	25,392	10,943	282,771
2043	1,317	1,317	26,708	10,946	293,717
2044	1,303	1,303	28,011	10,933	304,650
2045	1,289	1,289	29,300	9,919	314,569
2046	1,263	1,263	30,563	9,895	324,464
2047	1,237	1,237	31,800	9,872	334,336
2048	1,211	1,211	33,011	9,848	344,185
2049	1,185	1,185	34,196	9,851	354,036
2050	1,173	1,173	35,369	9,840	363,876

Table 54. 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
2021	6,041	6,041	6,041	2021	145	145	145	2021	0	0	0	6,186	6,186
2022	6,041	6,041	12,082	2022	290	290	435	2022	76	76	76	6,255	12,441
2023	6,041	6,041	18,124	2023	435	435	870	2023	152	152	229	6,324	18,765
2024	6,041	6,041	24,165	2024	580	580	1,450	2024	229	229	457	6,393	25,158
2025	6,041	6,041	30,206	2025	725	725	2,175	2025	305	305	762	6,461	31,619
2026	6,041	6,041	36,247	2026	870	870	3,045	2026	381	381	1,143	6,530	38,149
2027	5,437	5,437	41,685	2027	1,000	1,000	4,045	2027	457	457	1,601	5,980	44,129
2028	5,437	5,437	47,122	2028	1,131	1,131	5,176	2028	526	526	2,126	6,042	50,171
2029	5,437	5,437	52,559	2029	1,261	1,261	6,438	2029	594	594	2,721	6,104	56,275
2030	5,437	5,437	57,996	2030	1,392	1,392	7,829	2030	663	663	3,384	6,166	62,441
2031	5,437	5,437	63,433	2031	1,377	1,377	9,207	2031	732	732	4,116	6,083	68,524
2032	5,437	5,437	68,870	2032	1,363	1,363	10,570	2032	724	724	4,840	6,076	74,600
2033	4,893	4,893	73,764	2033	1,335	1,335	11,905	2033	716	716	5,556	5,512	80,112
2034	4,893	4,893	78,657	2034	1,308	1,308	13,213	2034	702	702	6,258	5,499	85,612
2035	4,893	4,893	83,550	2035	1,280	1,280	14,493	2035	687	687	6,946	5,486	91,098
2036	4,893	4,893	88,444	2036	1,253	1,253	15,746	2036	673	673	7,619	5,473	96,571
2037	4,893	4,893	93,337	2037	1,240	1,240	16,986	2037	659	659	8,277	5,475	102,045
2038	4,893	4,893	98,231	2038	1,227	1,227	18,212	2038	652	652	8,929	5,468	107,514
2039	4,404	4,404	102,635	2039	1,202	1,202	19,414	2039	645	645	9,574	4,961	112,475
2040	4,404	4,404	107,039	2040	1,177	1,177	20,591	2040	632	632	10,205	4,949	117,424
2041	4,404	4,404	111,443	2041	1,152	1,152	21,743	2041	619	619	10,824	4,938	122,362
2042	4,404	4,404	115,847	2042	1,127	1,127	22,871	2042	606	606	11,430	4,926	127,288
2043	4,404	4,404	120,251	2043	1,116	1,116	23,986	2043	593	593	12,023	4,927	132,215
2044	4,404	4,404	124,655	2044	1,104	1,104	25,090	2044	586	586	12,609	4,922	137,136
2045	3,964	3,964	128,619	2045	1,082	1,082	26,172	2045	580	580	13,189	4,465	141,601
2046	3,964	3,964	132,582	2046	1,059	1,059	27,231	2046	569	569	13,758	4,454	146,056
2047	3,964	3,964	136,546	2047	1,037	1,037	28,268	2047	557	557	14,315	4,444	150,499
2048	3,964	3,964	140,510	2048	1,015	1,015	29,283	2048	545	545	14,860	4,433	154,933
2049	3,964	3,964	144,473	2049	1,004	1,004	30,287	2049	533	533	15,393	4,434	159,367
2050	3,964	3,964	148,437	2050	994	994	31,281	2050	528	528	15,921	4,429	163,796

Baseline non-CO2 emissions from forest fires

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

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

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

Where,

$EBBtot_{icl,t}$	Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBN_2O_{icl,t}$	N_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)[156]

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

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)

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

GWP_{CH4}	Global Warming Potential for CH_4 (IPCC default value) [157]

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

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

The Pburnt estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m^3/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%.

However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by

[157] According to the VCS Standard, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fifth Assessment Report (GWP for CH_4 = 28).

fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation. The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.

It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.

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

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

Where,

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

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

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

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

Table 55. 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	Open Lowland Tropical Forest	73%	413.34	78%	50%	117.18	117.18	0.93	14.32	15.25

Table 56. Baseline non-CO2 emissions from forest fires in the project area

Project year *t*	Emissions of non-CO_2 gasses from baseline forest fires		Total baseline non-CO_2 emissions from forest fires in the project area	
	ID_{cl} = 1 Forest		annual	cumulative
	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	EBBBSLPA
	ha	tCO_2e/ha	tCO_2e	tCO_2e
2021	32.47	15.25	495.11	495.11
2022	32.47	15.25	495.11	990.21
2023	32.47	15.25	495.11	1,485.32
2024	32.47	15.25	495.11	1,980.42
2025	32.47	15.25	495.11	2,475.53
2026	32.47	15.25	495.11	2,970.63
2027	29.22	15.25	445.59	3,416.23
2028	29.22	15.25	445.59	3,861.82
2029	29.22	15.25	445.59	4,307.42
2030	29.22	15.25	445.59	4,753.01
2031	29.22	15.25	445.59	5,198.61
2032	29.22	15.25	445.59	5,644.20
2033	26.30	15.25	401.04	6,045.24
2034	26.30	15.25	401.04	6,446.27
2035	26.30	15.25	401.04	6,847.31
2036	26.30	15.25	401.04	7,248.34
2037	26.30	15.25	401.04	7,649.38
2038	26.30	15.25	401.04	8,050.41
2039	23.67	15.25	360.93	8,411.34
2040	23.67	15.25	360.93	8,772.28
2041	23.67	15.25	360.93	9,133.21
2042	23.67	15.25	360.93	9,494.14
2043	23.67	15.25	360.93	9,855.07
2044	23.67	15.25	360.93	10,216.00
2045	21.30	15.25	324.84	10,540.84
2046	21.30	15.25	324.84	10,865.68
2047	21.30	15.25	324.84	11,190.52
2048	21.30	15.25	324.84	11,515.36
2049	21.30	15.25	324.84	11,840.20
2050	21.30	15.25	324.84	12,165.04

APD – Avoided Planned Deforestation

Regarding the estimation of baseline emissions from planned deforestation, the VMD0006 v1.3 (BL-PL) was applied to determine the baseline net GHG emissions.

Deforestation in the Baseline Scenario

According to module VMD0006 v1.3, the annual area of deforestation in the baseline (AAplaned,i,t) is calculated as the equation below.

$$AA_{planned,i,t} = \left(A_{planned,i} * D\%_{planned,i,t}\right) * L - D_i$$

Where:

$AA_{planned,i,t}$,: Annual area of baseline planned deforestation for stratum *i* at time *t*; ha;

$D\%_{planned,i,t}$: Projected annual proportion of land that will be deforested in stratum *i* during year *t*. If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; %;

$A_{planned,i}$:, Total area of planned deforestation over the baseline period for stratum *i*; ha;

L-Di: Likelihood of deforestation for stratum *i*; %.

The below shows the total and annual area of planned deforestation over the baseline scenario in Project Area.

Table 57. Total and annual area of planned deforestation over the baseline scenario in PA - APD

Year	Open Lowland Tropical Rainforest	$AA_{planned,i,t}$
	ha	ha
2021	464.54	464.54
2022	0.00	0.00
2023	0.00	0.00
2024	0.00	0.00
2025	0.00	0.00
2026	0.00	0.00
2027	0.00	0.00
2028	0.00	0.00
2029	0.00	0.00
2030	0.00	0.00
2031	0.00	0.00
2032	0.00	0.00
2033	0.00	0.00

2034	0.00	0.00
2035	0.00	0.00
2036	0.00	0.00
2037	0.00	0.00
2038	0.00	0.00
2039	0.00	0.00
2040	0.00	0.00
2041	0.00	0.00
2042	0.00	0.00
2043	0.00	0.00
2044	0.00	0.00
2045	0.00	0.00
2046	0.00	0.00
2047	0.00	0.00
2048	0.00	0.00
2049	0.00	0.00
2050	0.00	0.00
Total	**464.54**	**464.54**

<u>Carbon Stock Change in the Baseline Scenario</u>

According to the module VMD0006 v1.3 the net carbon stock changes in the baseline is equal to the baseline pre-deforestation stock minus the long-term carbon stock after deforestation and minus the baseline stock that enters the wood products pool at the time of deforestation. They are calculated as follows.

Aboveground Tree Biomass

The baseline carbon stock change in aboveground tree biomass is calculated according to the equation below.

$$\Delta C_{AB_{tree},i} = C_{AB_{tree_{bsl}},i} - C_{AB_{tree_{post}},i}$$

Where:

$\Delta C_{ABtree,i}$: Baseline carbon stock change in aboveground tree biomass in stratum *i*; t CO_2-e ha^{-1};

$C_{ABtree,bsl,i}$: Forest carbon stock in aboveground tree biomass in stratum *i*; t CO_2-e ha^{-1};

$C_{ABtree,post,i}$: Post-deforestation carbon stock in aboveground tree biomass in stratum *i*; t CO_2-e ha^{-1};

i: 1, 2, 3, … *M strata.*

Table 58. Baseline carbon stock change in aboveground tree biomass (t CO2-e ha-1)

Stratum/forest class	$C_{AB\_tree,bsl,i}$	$C_{AB\_tree,post,i}$	$\Delta C_{AB\_tree,i}$
	tCO2e/ha	tCO2e/ha	tCO2e/ha
Open Lowland Tropical Rainforest	413.34	7.57	405.77

The stock of forest carbon in the aboveground tree biomass $C_{ABtree,I}$ was estimated from a literature review for the region and by the type of phytophysiognomy, while the estimate of post-deforestation carbon stock in aboveground tree biomass $C_{ABtree,post,i}$ is taken from peer reviewed literature (Ministério da Ciência, Tecnologia e Inovação, 2015)[158].

Belowground Tree Biomass

The baseline carbon stock change in belowground tree biomass is calculated according to the equation below.

$$\Delta C_{BB\_tree,i} = C_{BB_{tree_{bsl}},i} - C_{BB_{tree_{post}},i}$$

Where:

$\Delta C_{BBtree,i}$: Baseline carbon stock change in belowground tree biomass in stratum *i*; t CO_2-e ha^{-1};

$C_{BBtree,bsl,i}$: Forest carbon stock in belowground tree biomass in stratum *i*; t CO_2-e ha^{-1};

$C_{BBtree,post,i}$: Post-deforestation carbon stock in belowground tree biomass in stratum *i*; t CO_2-e ha^{-1};

i: 1, 2, 3, … *M strata.*

Table 59. Baseline carbon stock change in belowground tree biomass (t CO2-e ha-1)

Stratum/forest class	$C_{BB\_tree,bsl,i}$	$C_{BB\_tree,post,i}$	$\Delta C_{BB\_tree,i}$
	tCO2e/ha	tCO2e/ha	tCO2e/ha

[158] Available at: <http://redd.mma.gov.br/images/FREL/RR_LULUCF_Mudana-de-Uso-e-Floresta.pdf>

Open Lowland Tropical Rainforest	99,20	6	93,20

Values for forest carbon stock in belowground tree biomass $C_{BBtree,bsl,i}$ were obtained from the peer reviewed literature FAO, 2020[159] and the estimate of post-deforestation carbon stock in belowground tree biomass $C_{BBtree,post,i}$ is taken from peer reviewed literature (Ministério da Ciência, Tecnologia e Inovação, 2015).

The baseline carbon stock change in aboveground non-tree biomass is calculated according to the equation below.

$$\Delta C_{AB_{non-tree},i} = C_{AB_{non-tree_{bsl}},i} - C_{AB_{non-tree_{post}},i}$$

Where:

$\Delta C_{ABnon\text{-}tree,i}$: Baseline carbon stock change in aboveground non-tree biomass in stratum *i*; t CO_2-e ha^{-1};

$C_{ABnon\text{-}tree,bsl,i}$: Forest carbon stock in aboveground non-tree vegetation in stratum *i*; t CO_2-e ha^{-1};

$C_{ABnon\text{-}tree,post,i}$: Post-deforestation carbon stock in aboveground non-tree vegetation in stratum *i*; t CO_2-e ha^{-1};

i: 1, 2, 3, … *M strata.*

Table 60. Baseline carbon stock change in aboveground non-tree biomass (t CO2-e ha-1)

Stratum/forest class	$C_{AB\_non\text{-}tree,bsl,i}$	$C_{AB\_non\text{-}tree,post,i}$	$\Delta C_{AB\_non\text{-}tree,i}$
	tCO2e/ha	tCO2e/ha	tCO2e/ha
Open Lowland Tropical Rainforest	16,53	8,6	7,93

[159] Available at: <https://www.fao.org/3/ca9976en/ca9976en.pdf>.

Values for forest carbon stock in aboveground non-tree biomass $C_{ABnon\text{-}tree,bsl,I}$ were obtained from the peer reviewed literature[160] (Nogueira, 2008)[161], according Nogueira, non-tree in Acre, palm trees represent 4% of the forest biomass stock. While the estimate of post-deforestation carbon stock in aboveground tree biomass $C_{ABtree,post,i}$ is taken from peer reviewed literature (Ministério da Ciência, Tecnologia e Inovação, 2015).

Belowground Non-Tree Biomass

The baseline carbon stock change in belowground non-tree Biomass is calculated according to the equation below.

$$\Delta C_{BB_{non-tree},i} = C_{BB_{non}-tree,bsl,i} - C_{BB_{non}-tree,post,i}$$

Where:

$\Delta C_{BBnon\text{-}tree,i}$: Baseline carbon stock change in belowground non-tree biomass in stratum i; t CO_2-e ha^{-1};

$C_{BBnontree,bsl,i}$: Forest carbon stock in belowground non-tree biomass in stratum i; t CO_2-e ha^{-1};

$C_{BBnontree,post,i}$: Post-deforestation carbon stock in belowground non-tree biomass in stratum i; t CO_2-e ha^{-1};

i: 1, 2, 3, … *M strata.*

Table 61. Baseline carbon stock change in belowground non-tree biomass (t CO2-e ha-1)

Stratum/forest class	$C_{BB\_non\text{-}tree,bsl,i}$	$C_{BB\_non\text{-}tree,post,i}$	$\Delta C_{BB\_non\text{-}tree,i}$
	tCO2e/ha	tCO2e/ha	tCO2e/ha
Open Lowland Tropical Rainforest	9,92	8,6	1,32

Values for forest carbon stock in belowground non-tree biomass $C_{BB\_non\text{-}tree,bsl,i}$ were obtained from the peer reviewed literature FAO, 2020[162] and the estimate of post-deforestation carbon stock in

[160] Available at: <https://www.fao.org/3/ca9976en/ca9976en.pdf>.
[161] NOGUEIRA, Euler Melo et al. Estimates of forest biomass in the Brazilian Amazon: New allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management, v. 256, n. 11, p.1853-1867, 2008. Available at: <https://www.sciencedirect.com/science/article/abs/pii/S0378112708005689>
[162] Available at: <https://www.fao.org/3/ca9976en/ca9976en.pdf>.

belowground non-tree biomass $C_{BB\_non\text{-}tree,post,i}$ is taken from peer reviewed literature (Ministério da Ciência, Tecnologia e Inovação, 2015).

Deadwood and Litter

Both deadwood and litter were excluded for simplicity and to be conservative in the calculations.

Soil organic

According to the methodology VM0007 v1.6, table 4, the inclusion of soil organic carbon is optional. Thus, the present project excluded soil organic from the carbon pool estimation.

Harvested wood products

For estimating the change in carbon stock from baseline in wood products ($C_{WP,i}$) it is calculated from the equation below, according to VMD0005 v1.1.

$$C_{WP,i} = \sum_{ty=s,w,oir,p,o} C_{XB,ty,i} * (1 - WW_{ty})$$

Where:

$C_{WP,I}$: Carbon stock entering the wood products products pool from stratum *i*; t CO2-e ha-1

$C_{XB,ty,I}$ Mean stock of extracted biomass carbon by class of wood product ty from stratum i; t CO2-e ha-1

WW_{ty}: Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product ty; dimensionless

ty: Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)

i: *1, 2, 3, … M* strata

For Wood Waste, the cited literature reference from Winjum et al. 1998 as indicated in VMD0005 (CP-W) v1.1, which for developed countries multiplies the $C_{XB,ty}$ by 0.19.

The estimate of biomass carbon from the commercial volume extracted by the type of wood product $_{ty}$, $C_{XB,ty,}$ is obtained by the equation below:

$$C_{XB,ty,i} = \frac{1}{A_i} * \sum_{j=1}^{S} (V_{ex,ty,j,i} * D_j * CF_j * \frac{44}{12})$$

Where:

$C_{XB,ty,i}$ Mean stock of extracted biomass carbon by class of wood product ty from stratum i; t CO2-e ha^{-1} .

A_i Total area of stratum i; ha

$V_{ex,ty,j}$ Volume of timber extracted from within stratum i (does not include slash left onsite) by species j and wood product class ty; m^3

D_j Mean wood density of species j; t d.m.m^{-3}

CF_j Carbon fraction of biomass for tree species j; t C t^{-1} d.m.

j 1, 2, 3, … S tree species

ty Wood product class – defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o)

44/12 Ratio of molecular weight of CO_2 to carbon, t CO_2-e t C^{-1}

The carbon expected to be emitted over 100 years ($C_{WP100,i}$) at the time of deforestation and entering the wood product pool is calculated according to equation VMD0005, v1.1:

$$C_{WP100,i} = C_{WP,i} - C_{WP,i} * (1 - SLFp) * (1 - Ofp)$$

Where:

$C_{WP100,i}$ Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; t CO_2-e ha^{-1}.

$C_{WP,I}$ Carbon stock entering wood products pool at time of deforestation from stratum i; t CO2-e ha-1.

SLF_{ty} Fraction of wood products that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product ty; dimensionless.

OF_{ty} Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product ty; dimensionless.

ty Wood product class –defined here as sawnwood (s), wood-based panels (w), other industrial roundwood (oir), paper and paper board (p), and other (o).

i 1, 2, 3, … Mstrata.

Both the fraction of wood products that will be emitted to the atmosphere in 5 years and between 5 and 100 years were obtained from a literature review, Winjum et al, 1998.

SLF_{ty}	0.2
OF_{ty}	0.8

Table 62. Carbon stocks in wood products pool

Stratum/forest class	$C_{WP,i}$	$C_{WP100,i}$	ΔC_{XB}
	tCO2e/ha	tCO2e/ha	tCO2e/ha
Open Lowland Tropical Rainforest	3.99	3.19	6.66

Carbon Stock Change in All Pools in the Baseline Scenario

According to the module VMD0006 v1.3, the net carbon stock changes in all pools in the baseline ($\Delta C_{BSL,i,t}$) are calculated as the equation below.

$$\Delta C_{BSL,i,t} = AA_{planned,i,t} * (\Delta C_{AB_{tree},i} - \Delta C_{WP,i} + \Delta C_{AB_{non-tree},i} + \Delta C_{LI,i})$$
$$+ (\sum_{t-10}^{t} A_{planned,i,t}) * (\Delta C_{BB_{tree},i} + \Delta C_{BB_{non-tree},i} + \Delta C_{DW,i}) * \left(\frac{1}{10}\right)$$
$$+ (\sum_{t-20}^{t} AA_{unplanned,i,t}) * (C_{WP100,i} + \Delta C_{SOC,i}) * \left(\frac{1}{20}\right)$$

Where:

$\Delta C_{BSL,i,t}$: Sum of the baseline carbon stock change in all terrestrial pools in stratum i in year t, t CO_2-e;

$AA_{planned,i,t}$: Annual area of baseline planned deforestation for stratum *i* in year *t*; ha;

$C_{WP100,i}$: Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum i; t CO_2-e ha^{-1};

$\Delta C_{AB\_tree,i}$: Baseline carbon stock change in aboveground tree biomass in stratum *i*;*t* CO_2-e ha^{-1};

$\Delta C_{BB\_tree,i}$: Baseline carbon stock change in belowground tree biomass in stratum i *i*;*t* CO_2-e ha^{-1};

$\Delta C_{AB\_non\text{-}tree,i}$: Baseline carbon stock change in aboveground non-tree biomass in stratum *i*;*t* CO_2-e ha^{-1};

$\Delta C_{BB\_non\text{-}tree,i}$: Baseline carbon stock change in belowground non-tree biomass in stratum i *i*;*t* CO_2-e ha^{-1}.

$\Delta C_{WP,i}$: Baseline carbon stock change in wood products in stratum *i*;*t* CO_2-e ha^{-1};

$\Delta C_{DW,i}$: Baseline carbon stock change in dead wood in stratum *i*;*t* CO_2-e ha^{-1};

$\Delta C_{LI,i}$: Baseline carbon stock change in litter in stratum *i*;*t* CO_2-e ha^{-1};

$\Delta C_{SOC,i}$: Baseline carbon stock change in soil organic carbon in stratum *i*;*t* CO_2-e ha^{-1};

i: 1, 2, 3, … *M* strata;

t: 1, 2, 3, … *t** years elapsed since the projected start of the project activity.

Table 63. Net carbon stock changes in all pools in the baseline period

Idi	1
Name	Open Lowland Tropical Rainforest
Project year	tCO_2e
2021	198,354
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0
2043	0
2044	0
2045	0
2046	0
2047	0
2048	0
2049	0
2050	0

Year	$\Delta C_{BSL, i,t}$	$\Delta C_{BSL, i,t}$
	annual	cumulative
	tCO_2e	tCO_2e
2021	198,354	198,354
2022	0	198,354
2023	0	198,354
2024	0	198,354
2025	0	198,354
2026	0	198,354
2027	0	198,354
2028	0	198,354
2029	0	198,354
2030	0	198,354
2031	0	198,354
2032	0	198,354
2033	0	198,354
2034	0	198,354
2035	0	198,354
2036	0	198,354
2037	0	198,354
2038	0	198,354
2039	0	198,354
2040	0	198,354
2041	0	198,354
2042	0	198,354
2043	0	198,354
2044	0	198,354
2045	0	198,354
2046	0	198,354
2047	0	198,354
2048	0	198,354
2049	0	198,354
2050	0	198,354

Non-CO_2 Emissions in the Baseline Scenario

The GHG emissions in the baseline within the project boundary are estimated according to equation 15 of module VMD0006 v1.3.

$$GHG_{BSL,E,i,t} = E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Where:

$GHG_{BSL,E}$: Greenhouse gas emissions as a result deforestation activities within the project boundary in the stratum *i* in year *t*; t CO_2-e;

$E_{FC,i,t}$: Net CO2e emission from fossil fuel combustion in stratum *i* in year *t*; t CO_2-e;

$E_{BiomassBurn,i,t}$: Non-CO2 emissions due to biomass burning in stratum *i* in year *t*; t CO_2-e;

$N_2O_{direct-N,i,t}$: Direct N2O emission as a result of nitrogen application on the alternative land use within the project boundary in stratum *i* in year *t*; t CO_2-e;

i: 1, 2, 3, … *M* strata;

t: 1, 2, 3, … *t** years elapsed since the start of the REDD VCS project activity.

For the EFC,i,t net CO2e emission from fossil fuel combustion and $N_2O_{direct-N,i,t}$ nitrogen application in the baseline scenario are conservative excluded.

The non-CO_2 emissions due to biomass burning ($E_{BiomassBurn,i,t}$) are calculated according to VMD0013 v1.2:

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

Where:

Ebiomassburn,i,t Greenhouse gas emissions due to biomass burning in stratum *i* in year t of each GHG (CO2, CH4, N2O) (t CO2e);

Aburn,i,t Area burnt for stratum *i* in year t (ha);

Bi,t Average aboveground biomass stock before burning stratum *i,* year (t d.m. ha^{-1});

COMFi Combustion factor for stratum *i* (unitless);

Gg,I Emission factor for stratum *i* for gas g (kg t-1 d.m. burnt);

GWPg Global warming potential for gas g (t CO2/t gas g);

g 1, 2, 3 … G greenhouse gases including carbon dioxide[163], methane and nitrous oxide(unitless);

i 1, 2, 3 … M strata (unitless);

t 1, 2, 3, … t* time elapsed since the start of the project activity (years);

The average aboveground biomass stock before burning for each stratum is estimated as follows:

$B_{i,t} = (C_{AB\_tree,i,t} + C_{DW i,t} + C_{LI,i,t}) \times 12/44 \times (1/CF)$

Where:

Bi,t *Average aboveground biomass stock before burning for stratum i, year t (tonnes d.m. ha-1);*

CAB_tree,i,t *Carbon stock in aboveground biomass in trees in stratum i in year t (t CO2e ha-1);*

CDWi,t *Carbon stock in dead wood for stratum i in year t (t CO2e ha-1);*

CLI,i,t *Carbon stock in litter for stratum i in year t (t CO2e ha-1);*

12/44 *Inverse ratio of molecular weight of CO2 to carbon (t CO2e t C-1);*

CF *Carbon fraction of biomass (t C t-1 d.m.);*

i 1, 2, 3 ⋯ *M strata (unitless);*

t 1, 2, 3, ⋯ *t* time elapsed since the start of the project activity (years);*

Table 64. Area burnt for stratum *i* in year *t* (ha)

Aburn	Open Lowland Tropical Rainforest
Project year *t*	$Area_{burn,i,t}$
	ha
2021	464.54
2022	0.00
2023	0.00
2024	0.00
2025	0.00
2026	0.00
2027	0.00

[163] According to VMD0013-E-BPB v1.2 Carbon dioxide may be omitted where carbon dioxide emissions are calculated in an alternate module through stock change

2028	0.00
2029	0.00
2030	0.00
2031	0.00
2032	0.00
2033	0.00
2034	0.00
2035	0.00
2036	0.00
2037	0.00
2038	0.00
2039	0.00
2040	0.00
2041	0.00
2042	0.00
2043	0.00
2044	0.00
2045	0.00
2046	0.00
2047	0.00
2048	0.00
2049	0.00
2050	0.00

Table 65. Greenhouse gas emissions in the baseline within the project boundary

Project year *t*	Total GHG emissions					
	Open Lowland Tropical Rainforest			annual Open Lowland Tropical Rainforest	annual TOTAL	cumulative
	$E_{FC,i,t}$	$E_{BiomassBurn,i,t}$	$N_2O_{direct\text{-}N,i,t}$	$GHG_{BSL\text{-}E,t}$	$GHG_{BSL\text{-}E,t}$	$GHG_{BSL\text{-}E,t}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0	401,493	0	401,493	401,493	401,493
2022	0	0	0	0	0	401,493
2023	0	0	0	0	0	401,493
2024	0	0	0	0	0	401,493
2025	0	0	0	0	0	401,493
2026	0	0	0	0	0	401,493
2027	0	0	0	0	0	401,493
2028	0	0	0	0	0	401,493

2029	0	0	0	0	0	401,493
2030	0	0	0	0	0	401,493
2031	0	0	0	0	0	401,493
2032	0	0	0	0	0	401,493
2033	0	0	0	0	0	401,493
2034	0	0	0	0	0	401,493
2035	0	0	0	0	0	401,493
2036	0	0	0	0	0	401,493
2037	0	0	0	0	0	401,493
2038	0	0	0	0	0	401,493
2039	0	0	0	0	0	401,493
2040	0	0	0	0	0	401,493
2041	0	0	0	0	0	401,493
2042	0	0	0	0	0	401,493
2043	0	0	0	0	0	401,493
2044	0	0	0	0	0	401,493
2045	0	0	0	0	0	401,493
2046	0	0	0	0	0	401,493
2047	0	0	0	0	0	401,493
2048	0	0	0	0	0	401,493
2049	0	0	0	0	0	401,493
2050	0	0	0	0	0	401,493

Net GHG emissions in the Baseline Scenario

The baseline net GHG emissions for planned deforestation was determined as follow.

$$\Delta C_{BSL,planned} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(\Delta C_{BSL,i,t} + GHG_{BSL-E,i,t} \right)$$

Where:

$\Delta C_{BSL,planned}$ Net greenhouse gas emissions in the baseline from planned deforestation up to year t*; t CO2-e;

$\Delta C_{BSL,i,t}$ Net carbon stock changes in all pools in the baseline stratum *i* in year *t*; t CO_2-e;

$GHG_{BSL-E,i,t}$ Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum *i* in year *t*; t CO_2-e yr^{-1};

i: 1, 2, 3, … *M* strata;

t: 1, 2, 3, … *t** years elapsed since the projected start of the project activity;

Table 66. Estimated net GHG emission in the baseline (tCO2e)

Net greenhouse gas emissions in the baseline from planned deforestation up to year *t*			Total greenhouse gas emissions planned	
Idi	1		$\Delta C_{BSL, planned}$	$\Delta C_{BSL, planned}$
Name	Open Lowland Tropical Rainforest	Project year	annual	cumulative
Project year	tCO_2e		tCO_2e	tCO_2e
2021	599,847	2021	599,847	599,847
2022	0	2022	0	599,847
2023	0	2023	0	599,847
2024	0	2024	0	599,847
2025	0	2025	0	599,847
2026	0	2026	0	599,847
2027	0	2027	0	599,847
2028	0	2028	0	599,847
2029	0	2029	0	599,847
2030	0	2030	0	599,847
2031	0	2031	0	599,847
2032	0	2032	0	599,847
2033	0	2033	0	599,847
2034	0	2034	0	599,847
2035	0	2035	0	599,847
2036	0	2036	0	599,847
2037	0	2037	0	599,847
2038	0	2038	0	599,847
2039	0	2039	0	599,847
2040	0	2040	0	599,847
2041	0	2041	0	599,847
2042	0	2042	0	599,847
2043	0	2043	0	599,847
2044	0	2044	0	599,847
2045	0	2045	0	599,847
2046	0	2046	0	599,847
2047	0	2047	0	599,847
2048	0	2048	0	599,847
2049	0	2049	0	599,847
2050	0	2050	0	599,847

4.2 Project Emissions

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

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

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

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

Where,

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

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

Where,

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

$\Delta CPAiPA_t$ Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

Due to the importance of project activities, which is expected to generate improvements in the local economy and employment generation, the Effectiveness Index (EI) was conservatively assumed as 94.53%. This percentage was calculated based on the effectiveness of other VM0015 REDD projects located in Brazil in containing deforestation, comparing the project versus the baseline scenarios in verified monitoring reports.

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

Table 67. Ex ante estimated net carbon stock change in the project area under the project scenario

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	251.37	251.37	251.37	251.37
2022	0.00	0.00	0.00	0.00	254.16	505.53	254.16	505.53
2023	0.00	0.00	0.00	0.00	256.96	762.49	256.96	762.49
2024	0.00	0.00	0.00	0.00	259.75	1,022.24	259.75	1,022.24
2025	0.00	0.00	0.00	0.00	262.55	1,284.79	262.55	1,284.79
2026	0.00	0.00	0.00	0.00	265.34	1,550.13	265.34	1,550.13
2027	0.00	0.00	0.00	0.00	243.00	1,793.13	243.00	1,793.13
2028	0.00	0.00	0.00	0.00	245.51	2,038.64	245.51	2,038.64
2029	0.00	0.00	0.00	0.00	248.03	2,286.67	248.03	2,286.67
2030	0.00	0.00	0.00	0.00	250.54	2,537.22	250.54	2,537.22
2031	0.00	0.00	0.00	0.00	247.17	2,784.39	247.17	2,784.39
2032	0.00	0.00	0.00	0.00	246.89	3,031.27	246.89	3,031.27
2033	0.00	0.00	0.00	0.00	223.99	3,255.26	223.99	3,255.26
2034	0.00	0.00	0.00	0.00	223.45	3,478.71	223.45	3,478.71
2035	0.00	0.00	0.00	0.00	222.92	3,701.64	222.92	3,701.64
2036	0.00	0.00	0.00	0.00	222.39	3,924.03	222.39	3,924.03
2037	0.00	0.00	0.00	0.00	222.45	4,146.48	222.45	4,146.48
2038	0.00	0.00	0.00	0.00	222.20	4,368.68	222.20	4,368.68
2039	0.00	0.00	0.00	0.00	201.59	4,570.27	201.59	4,570.27
2040	0.00	0.00	0.00	0.00	201.11	4,771.38	201.11	4,771.38
2041	0.00	0.00	0.00	0.00	200.63	4,972.01	200.63	4,972.01
2042	0.00	0.00	0.00	0.00	200.15	5,172.16	200.15	5,172.16
2043	0.00	0.00	0.00	0.00	200.21	5,372.37	200.21	5,372.37
2044	0.00	0.00	0.00	0.00	199.98	5,572.35	199.98	5,572.35
2045	0.00	0.00	0.00	0.00	181.43	5,753.77	181.43	5,753.77

2046	0.00	0.00	0.00	0.00	181.00	5,934.77	181.00	5,934.77
2047	0.00	0.00	0.00	0.00	180.57	6,115.34	180.57	6,115.34
2048	0.00	0.00	0.00	0.00	180.14	6,295.48	180.14	6,295.48
2049	0.00	0.00	0.00	0.00	180.19	6,475.66	180.19	6,475.66
2050	0.00	0.00	0.00	0.00	179.98	6,655.64	179.98	6,655.64

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

Project year *t*	Total ex ante estimated actual non-CO_2 emissions from forest fires in the Project area	
	$EBBPSPA_t$	EBBPSPA
	annual	cumulative
	tCO_2e	tCO_2e
2021	9.06	9.06
2022	9.06	18.11
2023	9.06	27.17
2024	9.06	36.22
2025	9.06	45.28
2026	9.06	54.34
2027	8.15	62.49
2028	8.15	70.64
2029	8.15	78.79
2030	8.15	86.94
2031	8.15	95.09
2032	8.15	103.24
2033	7.34	110.57
2034	7.34	117.91
2035	7.34	125.24
2036	7.34	132.58
2037	7.34	139.91
2038	7.34	147.25
2039	6.60	153.85
2040	6.60	160.45
2041	6.60	167.06
2042	6.60	173.66
2043	6.60	180.26
2044	6.60	186.86
2045	5.94	192.80
2046	5.94	198.74
2047	5.94	204.69
2048	5.94	210.63
2049	5.94	216.57
2050	5.94	222.51

Total *ex ante* estimations for the project area

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

Table 69. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area

Project year *t*	Total *ex ante* carbon stock decrease due to planned activities		Total *ex ante* carbon stock increase due to planned activities		Total *ex ante* carbon stock decrease due to unavoided unplanned deforestation		Total *ex ante* carbon stock change		Total *ex ante* estimated actual non-CO_2 emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	251.37	251.37	251.37	251.37	9.06	9.06
2022	0.00	0.00	0.00	0.00	254.16	505.53	254.16	505.53	9.06	18.11
2023	0.00	0.00	0.00	0.00	256.96	762.49	256.96	762.49	9.06	27.17
2024	0.00	0.00	0.00	0.00	259.75	1,022.24	259.75	1,022.24	9.06	36.22
2025	0.00	0.00	0.00	0.00	262.55	1,284.79	262.55	1,284.79	9.06	45.28
2026	0.00	0.00	0.00	0.00	265.34	1,550.13	265.34	1,550.13	9.06	54.34
2027	0.00	0.00	0.00	0.00	243.00	1,793.13	243.00	1,793.13	8.15	62.49
2028	0.00	0.00	0.00	0.00	245.51	2,038.64	245.51	2,038.64	8.15	70.64
2029	0.00	0.00	0.00	0.00	248.03	2,286.67	248.03	2,286.67	8.15	78.79
2030	0.00	0.00	0.00	0.00	250.54	2,537.22	250.54	2,537.22	8.15	86.94
2031	0.00	0.00	0.00	0.00	247.17	2,784.39	247.17	2,784.39	8.15	95.09
2032	0.00	0.00	0.00	0.00	246.89	3,031.27	246.89	3,031.27	8.15	103.24
2033	0.00	0.00	0.00	0.00	223.99	3,255.26	223.99	3,255.26	7.34	110.57
2034	0.00	0.00	0.00	0.00	223.45	3,478.71	223.45	3,478.71	7.34	117.91
2035	0.00	0.00	0.00	0.00	222.92	3,701.64	222.92	3,701.64	7.34	125.24
2036	0.00	0.00	0.00	0.00	222.39	3,924.03	222.39	3,924.03	7.34	132.58
2037	0.00	0.00	0.00	0.00	222.45	4,146.48	222.45	4,146.48	7.34	139.91
2038	0.00	0.00	0.00	0.00	222.20	4,368.68	222.20	4,368.68	7.34	147.25
2039	0.00	0.00	0.00	0.00	201.59	4,570.27	201.59	4,570.27	6.60	153.85
2040	0.00	0.00	0.00	0.00	201.11	4,771.38	201.11	4,771.38	6.60	160.45
2041	0.00	0.00	0.00	0.00	200.63	4,972.01	200.63	4,972.01	6.60	167.06
2042	0.00	0.00	0.00	0.00	200.15	5,172.16	200.15	5,172.16	6.60	173.66
2043	0.00	0.00	0.00	0.00	200.21	5,372.37	200.21	5,372.37	6.60	180.26
2044	0.00	0.00	0.00	0.00	199.98	5,572.35	199.98	5,572.35	6.60	186.86
2045	0.00	0.00	0.00	0.00	181.43	5,753.77	181.43	5,753.77	5.94	192.80
2046	0.00	0.00	0.00	0.00	181.00	5,934.77	181.00	5,934.77	5.94	198.74
2047	0.00	0.00	0.00	0.00	180.57	6,115.34	180.57	6,115.34	5.94	204.69
2048	0.00	0.00	0.00	0.00	180.14	6,295.48	180.14	6,295.48	5.94	210.63
2049	0.00	0.00	0.00	0.00	180.19	6,475.66	180.19	6,475.66	5.94	216.57
2050	0.00	0.00	0.00	0.00	179.98	6,655.64	179.98	6,655.64	5.94	222.51

APD – Avoided Planned Deforestation

Project emissions were estimated according to module VMD0015, Version 2.2. In order to calculate the Net GHG emissions, emissions from Deforestation, Forest Degradation and Non-CO_2 Emissions were considered.

The emission per unit area in all pools is equal to the difference between the stocks before and after deforestation minus any wood products created from timber extraction in the process of deforestation. The following equation shows the net carbon stock changes.

$$\Delta C_{pools,Def,i,t} = C_{BSL,i} - C_{P,post,i} - C_{WP,i}$$

Where:

$\Delta C_{pools,Def,u,i,t}$:	Net carbon stock changes in all pools as a result of deforestation in the project case in land use *u* in stratum *i* in year *t*; t CO_2-e ha^{-1};
$C_{BSL,i}$:	Carbon stock in all pools in the baseline case in stratum *i*; t CO_2-e ha^{-1};
$C_{P,post,u,i}$:	Carbon stock in all pools in post-deforestation land use u in stratum *i*; t CO_2-e ha^{-1};
$C_{WP,i}$:	Carbon stock sequestered in wood products from harvests in stratum *i*; t CO_2-e ha^{-1};
u: 1, 2, 3, …	*U post-deforestation* land uses;
i: 1, 2, 3, …	*M* strata;
t: 1, 2, 3, …	*t** years elapsed since the start of the project activity.

Table 70. Net carbon stock changes in all pools in the Project case

Stratum (i)	$C_{BSL,i}$	$C_{P,post,u,i}$	$C_{WP,i}$	$\Delta C_{pools, Def,u,i.t}$
	t CO2-e	t CO2-e	t CO2-e	t CO2-e
Open Lowland Tropical Rainforest	512.55	31	3.99	485.76

<u>Deforestation</u>

The net carbon stock change as a result of deforestation is equal to the area deforested multiplied by the emission per unit area, as follow.

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^{U} \left(A_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right)$$

Where:

$\Delta C_{P,DefPA,i,t}$:	Net carbon stock change as a result of deforestation in the project case in the project area in stratum *i* in year *t*; t CO2-e;
$A_{DefPA,u,i,t}$:	Area of recorded deforestation in the project area stratum *i* converted to land use *u* in year *t*; ha;
$\Delta C_{pools,Def,u,i,t}$:	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* in year *t*; t CO_2-e ha^{-1};
u: 1, 2, 3, ,...	*U post-deforestation* land uses;
i: 1, 2, 3, ...	*M* strata;
t: 1, 2, 3, ...	*t** years elapsed since the start of the project activity.

Area of deforestation recorded in project area stratum i converted to land use u in year t, $A_{DefPA,u,i,t}$, was analyzed based on the historical rate of deforestation observed in the project area between 2010 and 2020 using satellite images for ex ante estimates.

There was no deforestation between 2010 and 2020, so the projection will also remain zero for the coming years.

Table 71. Net carbon stock change as a result of deforestation in the Project Area in the Project case in stratum *i* in year *t*;

ΔCP,DefPA,i,t			
Year	Open Lowland Tropical Rainforest	$\Delta C_{P,DefPA,i,t}$	$\Delta C_{P,DefPA,i,t}$
	t CO2-e	Total	Cumulative
2021	0.00	0.00	0.00
2022	0.00	0.00	0.00
2023	0.00	0.00	0.00
2024	0.00	0.00	0.00

2025	0.00	0.00	0.00
2026	0.00	0.00	0.00
2027	0.00	0.00	0.00
2028	0.00	0.00	0.00
2029	0.00	0.00	0.00
2030	0.00	0.00	0.00
2031	0.00	0.00	0.00
2032	0.00	0.00	0.00
2033	0.00	0.00	0.00
2034	0.00	0.00	0.00
2035	0.00	0.00	0.00
2036	0.00	0.00	0.00
2037	0.00	0.00	0.00
2038	0.00	0.00	0.00
2039	0.00	0.00	0.00
2040	0.00	0.00	0.00
2041	0.00	0.00	0.00
2042	0.00	0.00	0.00
2043	0.00	0.00	0.00
2044	0.00	0.00	0.00
2045	0.00	0.00	0.00
2046	0.00	0.00	0.00
2047	0.00	0.00	0.00
2048	0.00	0.00	0.00
2049	0.00	0.00	0.00
2050	0.00	0.00	0.00

Forest Degradation

According to the person in charge of the properties, the surrounding communities do not enter the properties to carry out any type of activity. And within the project area there are no communities living. So, $\Delta C_{P,DegW,i,t}$ it is equal to zero (0).

$$\Delta C_{P,DegW,i,t} = 0$$

For the project area, the net greenhouse gas emissions resulting from degradation is equal to the sum of stock changes due to degradation through extraction of trees for illegal timber or fuelwood and charcoal, and extraction of trees for selective logging from forest management areas possessing a FSC certificate, as expressed in the following equation.

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

Where:

$\Delta C_{P,Deg,i,t}$: Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* in year *t*; t CO_2-e;

$\Delta C_{P,DegW,i,t}$: Net carbon stock change as a result of degradation through extraction of trees for illegal timber or fuelwood and charcoal in the project area in the project case in stratum *i* in year *t*; t CO_2-e;

$\Delta C_{P,SelLog,i,t}$: Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum *i* in year *t*; t CO_2-e;

i: 1, 2, 3, … M strata;

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

Table 72. Net carbon stock change as a result of degradation in the Project Area in the Project case in stratum *i* in year *t*;

Year	Open Lowland Tropical Rainforest	$\Delta C_{P,Deg,i,t}$	$\Delta C_{P,Deg,i,t}$
	t CO2-e	Total	Cumulative
2021	0.00	0.00	0.00
2022	0.00	0.00	0.00
2023	0.00	0.00	0.00
2024	0.00	0.00	0.00
2025	0.00	0.00	0.00
2026	0.00	0.00	0.00
2027	0.00	0.00	0.00
2028	0.00	0.00	0.00
2029	0.00	0.00	0.00
2030	0.00	0.00	0.00
2031	0.00	0.00	0.00
2032	0.00	0.00	0.00
2033	0.00	0.00	0.00
2034	0.00	0.00	0.00
2035	0.00	0.00	0.00
2036	0.00	0.00	0.00
2037	0.00	0.00	0.00
2038	0.00	0.00	0.00
2039	0.00	0.00	0.00
2040	0.00	0.00	0.00
2041	0.00	0.00	0.00

2042	0.00	0.00	0.00
2043	0.00	0.00	0.00
2044	0.00	0.00	0.00
2045	0.00	0.00	0.00
2046	0.00	0.00	0.00
2047	0.00	0.00	0.00
2048	0.00	0.00	0.00
2049	0.00	0.00	0.00

In the project area there is no selective extraction of FSC certified wood, so $\Delta C_{P,SelLog,i,t}$, net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area is considered equal to zero (0). Thus, $\Delta C_{P,Deg,i,t}$, the net carbon stock change as a result of degradation in the project area will be equal to zero (0).

<u>Natural Disturbance in the Project Scenario</u>

Where natural disturbances occur *ex-post* in the project area such as tectonic activity (earthquake, landslide, volcano), extreme weather (hurricane), pest, drought, or fire that result in a degradation of forest carbon stocks, the area disturbed shall be delineated and the resulting emissions estimated. Where the disturbance event occur *ex post* in the project area, the area disturbed shall be delineated and the area of each post-disturbance stratum must be delineated. The area disturbed in the with-project scenario shall be tracked directly using the guidance provided in Step 1 of the methodology VMD0015-M-REDD v2.2.

Projections of natural disturbances are made as a function of the historical rate of forest fires observed in the project area between 2010 and 2020, for ex ante estimates. the area of registered forest fires obtained from the MAPBIOMAS fire module.

No fires were detected in the project area during the period from 2010 to 2020.

<u>Non-CO_2 Emissions</u>

Non-CO_2 gas greenhouse emissions occurring within the project boundary is calculated according the equation bellow.

$$GHG_{P,E,i,t} = E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}$$

Where:

$GHG_{P,E,i,t}$: Greenhouse gas emissions as a result of deforestation activities within the project area in the project case in stratum *i* in year *t*; t CO_2-e;

$E_{FC,i,t}$: Emission from fossil fuel combustion in stratum *i* within the project area in year *t*; t CO2-e;

EBiomassBurn,i,t: Non-CO2 emissions due to biomass burning in stratum i in year t; t CO_2-e;

$N_2O_{direct\text{-}N,i,t}$: Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* within the project area in year *t*; t CO_2-e;

i: 1, 2, 3, … *M* strata;

t: 1, 2, 3, … *t** years elapsed since the start of the REDD VCS project activity.

Greenhouse gas emissions due to biomass burning was calculated according to equation 1 of module VMD0013, Version 1.2, as follows.

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

Where:

$E_{biomassburn,i,t}$: Greenhouse gas emissions due to biomass burning in stratum *i* in year *t* of each GHG (CO_2, CH_4, N_2O) (t CO_2e);

$A_{burn,i,t}$: Area burnt for stratum *i* in year *t* (ha);

$B_{i,}t$: Average aboveground biomass stock before burning stratum *i*, year (t d.m. ha^{-1});

$COMF_i$: Combustion factor for stratum *i* (unitless);

$G_{g,i}$: Emission factor for stratum *i* for gas *g* (kg t-1 d.m. burnt);

GWP_g: Global warming potential for gas g (t CO_2/t gas g);

g: 1, 2, 3 … G greenhouse gases including carbon dioxide, methane and nitrous oxide (unitless);

i: 1, 2, 3 … *M* strata (unitless);

t: 1, 2, 3, … *t** time elapsed since the start of the project activity (years).

Table 73. Factor values

GWP_{N20}	265	t CO2/t gas g
GWP_{CH4}	28	t CO2/t gas g
COMF	0.45	
G_{N20}	0.2	kg/t dry matter burnt (dm)
G_{CH4}	6.8	kg/t dry matter burnt (dm)

Table 74. Greenhouse gas emissions in the baseline within the Project boundary

Project year *t*	GHG emissions as a result deforestation activities within the project boundary in the stratum i in year t				Total GHG emissions	
	Open Lowland Tropical Rainforest			Annual	annual TOTAL	cumulative
	$E_{FC,i,t}$	$E_{BiomassBurn,i,t}$	$N_2O_{direct\text{-}N,i,t}$	$GHG_{BSL\text{-}E,t}$	$GHG_{BSL\text{-}E,t}$	$GHG_{BSL\text{-}E,t}$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0	401,493	0	401,493	401,493	401,493
2022	0	0	0	0	0	401,493
2023	0	0	0	0	0	401,493
2024	0	0	0	0	0	401,493
2025	0	0	0	0	0	401,493
2026	0	0	0	0	0	401,493
2027	0	0	0	0	0	401,493
2028	0	0	0	0	0	401,493
2029	0	0	0	0	0	401,493
2030	0	0	0	0	0	401,493
2031	0	0	0	0	0	401,493
2032	0	0	0	0	0	401,493
2033	0	0	0	0	0	401,493
2034	0	0	0	0	0	401,493
2035	0	0	0	0	0	401,493
2036	0	0	0	0	0	401,493
2037	0	0	0	0	0	401,493
2038	0	0	0	0	0	401,493
2039	0	0	0	0	0	401,493
2040	0	0	0	0	0	401,493
2041	0	0	0	0	0	401,493
2042	0	0	0	0	0	401,493
2043	0	0	0	0	0	401,493
2044	0	0	0	0	0	401,493
2045	0	0	0	0	0	401,493
2046	0	0	0	0	0	401,493
2047	0	0	0	0	0	401,493
2048	0	0	0	0	0	401,493
2049	0	0	0	0	0	401,493
2050	0	0	0	0	0	401,493

The average aboveground biomass stock before burning for a particular stratum is estimated as follows.

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

Where:

$B_{i,t}$: Average aboveground biomass stock before burning for stratum i, year t (tonnes d.m. ha^{-1});

$C_{AB\_tree,i,t}$: Carbon stock in aboveground biomass in trees in stratum i in year t (t CO_2e ha^{-1});

$C_{DWi,t}$: Carbon stock in dead wood for stratum stratum i in year t (t CO_2e ha^{-1});

$C_{LI,i,t}$: Carbon stock in litter for stratum i in year t (t CO_2e ha^{-1});

12/44: Inverse ratio of molecular weight of CO_2 to carbon (t CO_2e t C^{-1});

CF: Carbon fraction of biomass (t C t^{-1} d.m.);

i: 1, 2, 3 … M strata (unitless);

t: 1, 2, 3, … t* time elapsed since the start of the project activity (years).

Table 75. Parameters to estimation Emissions Due to Biomass Burning

Initial Forest Class	Parameters							
	$B_{i,t}$	C_{AB_tree}		C_{BB_tree}		$C_{dwi,t}$	$C_{LI,i,t}$	$C_{soc,i}$
Name		C stock	±90% CI	C stock	±90% CI			
	t d.m/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
Open Lowland Tropical Rainforest	7,891	413	35.00	99.20	8.40	0	0	0

For deadwood, litter and soil organic carbon it was decided not to consider for simplicity and in the case of litter, excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the APD project activity. This exclusion is conservative.

<u>Net GHG emissions</u>

The net GHG emissions in the project is equal to the sum of stock changes due to deforestation and forest degradation plus the total GHG emissions minus any eligible forest carbon stock enhancement, according to equation below.

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

Where:

$CW_{PS\text{-}REDD}$:	Net GHG emissions in the REDD project scenario up to year $t*$; t CO_2-e;
$\Delta C_{P,DefPA,i,t}$:	Net carbon stock change as a result of deforestation in the project area in the project case in stratum i in year t; t CO_2-e;
$\Delta C_{P,Deg,i,t}$:	Net carbon stock change as a result of degradation in the project area in the project case in stratum i in year t; t CO_2-e;
$\Delta C_{P,DistPA,i,t}$:	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum i in year t; t CO_2-e;
$GHG_{P\text{-}E,i,t}$:	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum i in year t; t CO_2-e;
$\Delta C_{P,Enh,i,t}$:	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline in stratum i in year t; t CO_2-e;
i: 1, 2, 3, …	M strata;
t: 1, 2, 3, …	$t*$ years elapsed since the start of the project activity.

Table 76. Area potentially impacted by natural disturbances

Year	Open Lowland Tropical Rainforest	$A_{,DistPA,q,i,t}$	$A_{,DistPA,q,i,t}$
	ha	Total	Cumulative
2021	464.54	464.54	464.54
2022	0.00	0.00	464.54
2023	0.00	0.00	464.54
2024	0.00	0.00	464.54
2025	0.00	0.00	464.54
2026	0.00	0.00	464.54
2027	0.00	0.00	464.54
2028	0.00	0.00	464.54
2029	0.00	0.00	464.54
2030	0.00	0.00	464.54
2031	0.00	0.00	464.54

2032	0.00	0.00	464.54
2033	0.00	0.00	464.54
2034	0.00	0.00	464.54
2035	0.00	0.00	464.54
2036	0.00	0.00	464.54
2037	0.00	0.00	464.54
2038	0.00	0.00	464.54
2039	0.00	0.00	464.54
2040	0.00	0.00	464.54
2041	0.00	0.00	464.54
2042	0.00	0.00	464.54
2043	0.00	0.00	464.54
2044	0.00	0.00	464.54
2045	0.00	0.00	464.54
2046	0.00	0.00	464.54
2047	0.00	0.00	464.54
2048	0.00	0.00	464.54
2049	0.00	0.00	464.54
2050	0.00	0.00	464.54

Table 77. Net carbon stock change as a result of natural disturbance in the Project case in the Project Area in stratum i in year t

ΔCP,DistPA,i,t			
Year	Open Lowland Tropical Rainforest	$\Delta C_{P,DistPA,i,t}$	$\Delta C_{P,DistPA,i,t}$
	t CO2-e	Total	Cumulative
2021	225,658.43	225,658.43	225,658.43
2022	0.00	0.00	225,658.43
2023	0.00	0.00	225,658.43
2024	0.00	0.00	225,658.43
2025	0.00	0.00	225,658.43
2026	0.00	0.00	225,658.43
2027	0.00	0.00	225,658.43
2028	0.00	0.00	225,658.43
2029	0.00	0.00	225,658.43
2030	0.00	0.00	225,658.43
2031	0.00	0.00	225,658.43

2032	0.00	0.00	225,658.43
2033	0.00	0.00	225,658.43
2034	0.00	0.00	225,658.43
2035	0.00	0.00	225,658.43
2036	0.00	0.00	225,658.43
2037	0.00	0.00	225,658.43
2038	0.00	0.00	225,658.43
2039	0.00	0.00	225,658.43
2040	0.00	0.00	225,658.43
2041	0.00	0.00	225,658.43
2042	0.00	0.00	225,658.43
2043	0.00	0.00	225,658.43
2044	0.00	0.00	225,658.43
2045	0.00	0.00	225,658.43
2046	0.00	0.00	225,658.43
2047	0.00	0.00	225,658.43
2048	0.00	0.00	225,658.43
2049	0.00	0.00	225,658.43
2050	0.00	0.00	225,658.43

Table 78. Net GHG emissions in the REDD Project scenario

Net GHG emissions in the REDD project scenario			
Idi	1	ΔC_{WPS_REDD}	ΔC_{WPS_REDD}
Name	Open Lowland Tropical Rainforest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	401,957	401,957	401,957
2022	0	0	401,957
2023	0	0	401,957
2024	0	0	401,957
2025	0	0	401,957
2026	0	0	401,957
2027	0	0	401,957
2028	0	0	401,957
2029	0	0	401,957
2030	0	0	401,957
2031	0	0	401,957
2032	0	0	401,957
2033	0	0	401,957

2034	0	0	401,957
2035	0	0	401,957
2036	0	0	401,957
2037	0	0	401,957
2038	0	0	401,957
2039	0	0	401,957
2040	0	0	401,957
2041	0	0	401,957
2042	0	0	401,957
2043	0	0	401,957
2044	0	0	401,957
2045	0	0	401,957
2046	0	0	401,957
2047	0	0	401,957
2048	0	0	401,957
2049	0	0	401,957
2050	0	0	401,957

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.

According to the planned interventions proposed by present project activity, no decrease in carbon stocks and/or increase in GHG emissions due to activities implemented in the leakage management area were identified. The leakage prevention measures proposed by the present project do not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. However, if such activities are implemented in the future, changes in carbon stock will be monitored, and if significant, will be accounted. In addition, it is important to note that consumption of fossil fuels is considered insignificant in avoided unplanned deforestation project activities and shall not be considered

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

Table 79. Ex ante estimated net carbon stock change in leakage management areas

Project year	Total carbon stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual	cumulatve	annual	cumulatve	annual	cumulatve
	$\Delta CBSLLK_t$	$\Delta CBSLLK$	$\Delta CPSLK_t$	$\Delta CPSLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00

2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00
2048	0.00	0.00	0.00	0.00	0.00	0.00
2049	0.00	0.00	0.00	0.00	0.00	0.00
2050	0.00	0.00	0.00	0.00	0.00	0.00

No livestock agriculture increase resulting from activities developed by the 1st Instance is predicted to occur in the project scenario compared to the baseline case. However, in case any future instance includes any activity that might result in such increase, in order to estimate the increase in emissions of methane and nitrous oxide from grazing animals in leakage management areas, the GHG emissions are estimated as follows, according to Appendix 4 of the applied Methodology and default values from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 – AFOLU, Chapter 10[164]:

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

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

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

Table 80. 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
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00
2048	0.00	0.00	0.00	0.00	0.00	0.00
2049	0.00	0.00	0.00	0.00	0.00	0.00
2050	0.00	0.00	0.00	0.00	0.00	0.00

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

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted ex-ante would indicate displacement of deforestation activities due to the project.

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

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

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.

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

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

Furthermore, the *ex ante* emissions from forest fires due to activity displacement leakage was calculated by multiplying baseline forest fire emissions in the project area by the same DLF[165] used to estimate the decrease in carbon stocks, as follows.

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

[165] If deforestation agents do not participate in leakage prevention activities and project activities, the Displacement Factor shall be 100%. Where leakage prevention activities are implemented, the factor shall be equal to the proportion of the baseline agents estimated to be given the opportunity to participate in leakage prevention activities and project activities.

$EADLKt_t$	Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_2e
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
DLF	Displacement leakage factor; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

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

Table 81. Ex ante estimated leakage due to activity displacement

Project year	Total ex ante estimated decrease in carbon stocks due to displaced deforestation		Total ex ante estimated increase in GHG emissions due to displaced forest fires	
	annual	cumulative	annual	cumulative
	$\Delta CADLK_t$	$\Delta CADLK$	$EADLK_t$	$EADLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	2,061.42	2,061.42	74.27	74.27
2022	2,084.33	4,145.75	74.27	148.53
2023	2,107.25	6,253.00	74.27	222.80
2024	2,130.17	8,383.17	74.27	297.06
2025	2,153.09	10,536.26	74.27	371.33
2026	2,176.00	12,712.26	74.27	445.59
2027	1,992.78	14,705.04	66.84	512.43
2028	2,013.40	16,718.44	66.84	579.27
2029	2,034.03	18,752.47	66.84	646.11
2030	2,054.65	20,807.12	66.84	712.95
2031	2,026.96	22,834.08	66.84	779.79
2032	2,024.67	24,858.75	66.84	846.63
2033	1,836.85	26,695.60	60.16	906.79
2034	1,832.50	28,528.10	60.16	966.94
2035	1,828.14	30,356.25	60.16	1,027.10
2036	1,823.79	32,180.04	60.16	1,087.25
2037	1,824.27	34,004.30	60.16	1,147.41
2038	1,822.20	35,826.51	60.16	1,207.56
2039	1,653.17	37,479.67	54.14	1,261.70
2040	1,649.25	39,128.92	54.14	1,315.84
2041	1,645.33	40,774.25	54.14	1,369.98
2042	1,641.41	42,415.66	54.14	1,424.12
2043	1,641.84	44,057.50	54.14	1,478.26
2044	1,639.98	45,697.48	54.14	1,532.40
2045	1,487.85	47,185.33	48.73	1,581.13
2046	1,484.32	48,669.66	48.73	1,629.85
2047	1,480.80	50,150.45	48.73	1,678.58
2048	1,477.27	51,627.72	48.73	1,727.30
2049	1,477.66	53,105.38	48.73	1,776.03
2050	1,475.99	54,581.36	48.73	1,824.76

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 fertilizer or fuel use.

Table 82. Ex ante estimated total leakage

Project year	Total ex ante GHG emissions from increased grazing activities		Total ex ante increase in GHG emissions due to displaced forest fires		Total ex ante decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	$EgLK$	$EADLK_t$	$EADLK$	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	0.00	0.00	74.27	74.27	2,061.42	2,061.42	0.00	0.00	2,061.42	2,061.42	74.27	74.27
2022	0.00	0.00	74.27	148.53	2,084.33	4,145.75	0.00	0.00	2,084.33	4,145.75	74.27	148.53
2023	0.00	0.00	74.27	222.80	2,107.25	6,253.00	0.00	0.00	2,107.25	6,253.00	74.27	222.80
2024	0.00	0.00	74.27	297.06	2,130.17	8,383.17	0.00	0.00	2,130.17	8,383.17	74.27	297.06
2025	0.00	0.00	74.27	371.33	2,153.09	10,536.26	0.00	0.00	2,153.09	10,536.26	74.27	371.33
2026	0.00	0.00	74.27	445.59	2,176.00	12,712.26	0.00	0.00	2,176.00	12,712.26	74.27	445.59
2027	0.00	0.00	66.84	512.43	1,992.78	14,705.04	0.00	0.00	1,992.78	14,705.04	66.84	512.43
2028	0.00	0.00	66.84	579.27	2,013.40	16,718.44	0.00	0.00	2,013.40	16,718.44	66.84	579.27
2029	0.00	0.00	66.84	646.11	2,034.03	18,752.47	0.00	0.00	2,034.03	18,752.47	66.84	646.11
2030	0.00	0.00	66.84	712.95	2,054.65	20,807.12	0.00	0.00	2,054.65	20,807.12	66.84	712.95
2031	0.00	0.00	66.84	779.79	2,026.96	22,834.08	0.00	0.00	2,026.96	22,834.08	66.84	779.79
2032	0.00	0.00	66.84	846.63	2,024.67	24,858.75	0.00	0.00	2,024.67	24,858.75	66.84	846.63
2033	0.00	0.00	60.16	906.79	1,836.85	26,695.60	0.00	0.00	1,836.85	26,695.60	60.16	906.79
2034	0.00	0.00	60.16	966.94	1,832.50	28,528.10	0.00	0.00	1,832.50	28,528.10	60.16	966.94
2035	0.00	0.00	60.16	1,027.10	1,828.14	30,356.25	0.00	0.00	1,828.14	30,356.25	60.16	1,027.10
2036	0.00	0.00	60.16	1,087.25	1,823.79	32,180.04	0.00	0.00	1,823.79	32,180.04	60.16	1,087.25
2037	0.00	0.00	60.16	1,147.41	1,824.27	34,004.30	0.00	0.00	1,824.27	34,004.30	60.16	1,147.41
2038	0.00	0.00	60.16	1,207.56	1,822.20	35,826.51	0.00	0.00	1,822.20	35,826.51	60.16	1,207.56
2039	0.00	0.00	54.14	1,261.70	1,653.17	37,479.67	0.00	0.00	1,653.17	37,479.67	54.14	1,261.70
2040	0.00	0.00	54.14	1,315.84	1,649.25	39,128.92	0.00	0.00	1,649.25	39,128.92	54.14	1,315.84
2041	0.00	0.00	54.14	1,369.98	1,645.33	40,774.25	0.00	0.00	1,645.33	40,774.25	54.14	1,369.98
2042	0.00	0.00	54.14	1,424.12	1,641.41	42,415.66	0.00	0.00	1,641.41	42,415.66	54.14	1,424.12
2043	0.00	0.00	54.14	1,478.26	1,641.84	44,057.50	0.00	0.00	1,641.84	44,057.50	54.14	1,478.26
2044	0.00	0.00	54.14	1,532.40	1,639.98	45,697.48	0.00	0.00	1,639.98	45,697.48	54.14	1,532.40
2045	0.00	0.00	48.73	1,581.13	1,487.85	47,185.33	0.00	0.00	1,487.85	47,185.33	48.73	1,581.13
2046	0.00	0.00	48.73	1,629.85	1,484.32	48,669.66	0.00	0.00	1,484.32	48,669.66	48.73	1,629.85
2047	0.00	0.00	48.73	1,678.58	1,480.80	50,150.45	0.00	0.00	1,480.80	50,150.45	48.73	1,678.58
2048	0.00	0.00	48.73	1,727.30	1,477.27	51,627.72	0.00	0.00	1,477.27	51,627.72	48.73	1,727.30
2049	0.00	0.00	48.73	1,776.03	1,477.66	53,105.38	0.00	0.00	1,477.66	53,105.38	48.73	1,776.03
2050	0.00	0.00	48.73	1,824.76	1,475.99	54,581.36	0.00	0.00	1,475.99	54,581.36	48.73	1,824.76

APD – Avoided Planned Deforestation

Net GHG emissions due to leakage from the REDD project activity are determined according to the equation below, present in module VMD0007 v1.6.

$$\Delta C_{LK\text{-}REDD} = \Delta C_{LK\text{-}AS,planned} + \Delta C_{LK\text{-}ME}$$

Where:

$\Delta C_{LK\text{-}REDD}$:	Net GHG emissions due to leakage from the REDD project activity up to year t* (t CO_2e);
$\Delta C_{LK\text{-}AS,planned}$:	Net GHG emissions due to activity shifting leakage for projects preventing planned deforestation up to year t* – from Module LK-ASP (t CO_2e);
$\Delta C_{LK\text{-}M}$:	Net GHG emissions due to market-effects leakage up to year t* – from Module LK-ME (t CO_2e);

<u>**Activity Shifting Leakage**</u>

Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation are calculated according to VMD0009 v1.3 PART 1 and the equation below.

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t*}\sum_{i=1}^{M}\left(LKA_{planned,i,t} \times \Delta C_{BSL,i}\right) + GHG_{LK,E,i,t}$$

Where:

$\Delta C_{LK\text{-}AS,planned}$:	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation up to year *t** (t CO_2e);
$LKA_{planned,i,t}$:	The area of activity shifting leakage in stratum *i* in year *t* (ha);
$\Delta C_{BSL,i}$:	Net carbon stock changes in all pre-deforestation pools in baseline stratum *i* (t CO_2e ha^{-1});
$GHG_{LK,E,i,t}$:	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum *i* in year *t* (t CO_2e);
i: 1, 2, 3, …	*M* strata (unitless);
t: 1, 2, 3, …	*t** time elapsed since the start of the project activity (years).

The area of activity shifting leakage was determined by the following equation.

$$LKA_{planned,i,t} = A_{defLK,i,t} - NewR_{i,t}$$

Where:

$LKA_{planned,i,}t$:	The area of activity shifting leakage in stratum *i* in year *t* (ha);
$NewR_{i,t}$:	New calculated forest clearance by the baseline agent of the planned deforestation in stratum *i* in year *t* where no leakage is occurring (ha);
$A_{defLK,i,t}$:	The total area of monitored deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* (ha);
i:	1, 2, 3, … *M* strata (unitless);
t:	1, 2, 3, … *t** time elapsed since the start of the project activity (years).

Considering the scope of the project, the total area of monitored deforestation by baseline agent of the planned deforestation, $A_{defLK,i,t}$ will always be zero, as there are no forested areas subject to legal suppression across all the lands managed by the identified deforestation agent, disregarding the project boundary. Therefore, GHG emissions due to activity shifting to avoid planned deforestation are set to zero in *ex-ante* and *ex-post* estimates.

The new calculated forest clearance by the baseline agent of the planned deforestation where no leakage is occurring is thus the average number of hectares deforested per year in all of the agent´s concessions, as follows.

$$NewR_{i,t} = (D\%_{planned,i,t,OP} \text{ X } A_{planned,i,OP})$$

Where:

$NewR_{it}$	New calculated forest clearance in stratum I in year t by the baseline agent of the planned deforestation where no leakage is occurring (ha)
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in project stratum I in year t (percent)
$A_{planned,\ i,}$	Total area of planned deforestation over the baseline period for project stratum i (ha)
i:	1, 2, 3, … *M* strata (unitless);
t:	1, 2, 3, … *t** time elapsed since the start of the project activity (years).

According to VMD0009 LK-ASP v1.3, where the specific agent of deforestation can be identified, leakage need not be considered when it can be demonstrated that the management plans and/or land use designations of the agent's other lands of deforestation (which must be identified by location) have not materially changed as a result of the project (e.g., the clearing agent has not designated new land as timber concessions, increased harvest rates on land already managed for timber, clearing of intact forests for agricultural production or increased use of fertilizers to increase agricultural yields).

Greenhouse gas emissions as a result of leakage of avoiding deforestation activities is calculated according to the following equation.

$$GHG_{LK,E,i,t} = E_{biomassburn,i,t} + N_2O_{direct-N,i,t}$$

Where:

$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum i in year t (t CO2e).
$E_{biomassburn,i,t}$	Non-CO2 emissions due to biomass burning in stratum i in year t (t CO2e).
$N2O_{direct-N,i,t}$	Direct N2O emission as a result of nitrogen application on the alternative land use in stratum i in year t (t CO2e).
i	1, 2, 3, … M strata (unitless).
t	1, 2, 3 … t* time elapsed since the start of the project activity (years).

Non-CO2 emissions due to biomass burning in the area of activity by leakage displacement are calculated according to the same procedures used to estimate baseline GHG emissions, therefore, the N2O emission estimate does not apply either to leakage. Thus, the $GHG_{LK,E,i,t}$ will be equal to zero (0) ex-ante and ex-post estimates.

Therefore, there are no current areas of the project to be considered by the deforestation agent as potential areas for the detachment and considering that other areas in the surroundings are preserved and will be destined to forest conservation projects and REDD AUD, and taking considering that the deforestation agent did not designate new lands for forest management or increase the rates of wood harvesting on lands already managed, this project did not present any leakage.

Table 83. Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation

2021 2022 2023	0	464.54	0
	0	0.00	0
	0	0.00	0
2024	0	0.00	0
2025	0	0.00	0
2026	0	0.00	0
2027	0	0.00	0
2028	0	0.00	0
2029	0	0.00	0
2030	0	0.00	0
2031	0	0.00	0
2032	0	0.00	0
2033	0	0.00	0
2034	0	0.00	0
2035	0	0.00	0
2036	0	0.00	0
2037	0	0.00	0
2038	0	0.00	0
2039	0	0.00	0
2040	0	0.00	0
2041	0	0.00	0
2042	0	0.00	0
2043	0	0.00	0
2044	0	0.00	0
2045	0	0.00	0
2046	0	0.00	0
2047	0	0.00	0
2048	0	0.00	0
2049	0	0.00	0
2050	0	0.00	0
2021	0	464.54	0
2022	0	0.00	0
2023	0	0.00	0

Market Effects Leakage

Total GHG emissions due to market-leakage effects through decreased timber harvest are calculated according to the equation below, present in module VMD0011 v1.0.

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

Where:

$\Delta C_{LK\text{-}ME}$	Net greenhouse gas emissions due to market-effects leakage; t CO_2-e.
$LK_{MarketEffects,timber}$	Total GHG emissions due to market-effects leakage through decreased timber harvest; t CO_2-e.
$LK_{MarketEffects,FW/C}$	Total GHG emissions due to market leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets; t CO_2-e.

Leakage due to market effects is equal to the baseline emissions from logging multiplied by a leakage factor.

$$LK_{MarketEffects,timber} = \sum_{i=1}^{M} \left(LF_{ME} * AL_{T,i} \right)$$

Where:

$LK_{MarketEffects,timber}$	Total GHG emissions due to market-effects leakage through decreased timber harvest; t CO_2-e.
LF_{ME}	Leakage factor for market-effects calculations; dimensionless
$AL_{T,i}$	Summed emissions from timber harvest in stratum I in the baseline case potentially displaced through implementation of carbon project; t CO2-e
i	1,2,3…M strata

The leakage factor (LF_{ME}) was adopted as 0.2 taking into account that the biomass of total aboveground tree is considered equal to PMP_i, it is possible to conclude that the amount of leakage will be very close to what should occur in the project area.

Table 84. Leakage factor

Stratum/forest class	PMPi	PML
Open Lowland Tropical Rainforest	45%	56%

The following deduction factors (LF_{ME}) were considered:

Where:

PML_{FT} is equal (± 15%) to PMPi:	LF_{ME} = 0.4
PML_{FT} is > 15% less than PMPi	LF_{ME} = 0.7
PML_{FT} is > 15% greater than PMPi	LF_{ME} = 0.2

The total volume to be suppressed at baseline in the Project Area is estimated as follows.

$$AL_{T,i} = \sum_{t=1}^{t} \left(C_{BSL,XBT,i,t} \right)$$

Where:

$AL_{T,I}$	Summed emissions from timber harvest in stratum i in the baseline case potentially displaced through implementation of carbon project; tCO_2-e
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in stratum i in time t; tCO_2-e
i	1, 2, 3, ….M strata
t	1, 2, 3, ….t* years elapsed since the projected start of the REDD project activity

The carbon emission due to the displaced logging has two components: the biomass carbon of the extracted timber and the biomass carbon in the forest damaged in the process of timber extraction:

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

Where:

$C_{BSL,XBT,i,t}$	Carbon emission due to timber harvests in the baseline scenario in stratum *i* at time *t*; t CO2-e
$V_{BSL,EX,i,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum *i* at time *t*; m^3
D_{mn}	Mean wood density of commercially harvested species; t d.m.m-3. The value must be the same as that used in the module CP-W if this pool is included in the baseline.

CF Carbon fraction of biomass for commercially harvested species *j*; t C t d.m.-1 . The value must be the same as that used in the module CP-W if this pool is included in the baseline.

LDF Logging damage factor; t C m-3 (default 0.53 t C m-3 for broadleaf and mixed forests; 0.25 t C m-3 for coniferous forests)

LIF Logging infrastructure factor; t C m-3 (default 0.29 t C m-3)

i 1, 2, 3, … *M* strata

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

Table 85. Net greenhouse gas emissions due to market-effects leakage

Year	$LK_{MarketEffects,timber}$	$LK_{MarketEffects,FW/C}$	$\Delta C_{LK\ ME}$
	tCO_2e	tCO_2e	tCO_2e
2021	7,935.18	0.00	7,935.18
2022	0.000	0.000	0.000
2023	0.000	0.000	0.000
2024	0.000	0.000	0.000
2025	0.000	0.000	0.000
2026	0.000	0.000	0.000
2027	0.000	0.000	0.000
2028	0.000	0.000	0.000
2029	0.000	0.000	0.000
2030	0.000	0.000	0.000
2031	0.000	0.000	0.000
2032	0.000	0.000	0.000
2033	0.000	0.000	0.000
2034	0.000	0.000	0.000
2035	0.000	0.000	0.000
2036	0.000	0.000	0.000
2037	0.000	0.000	0.000
2038	0.000	0.000	0.000
2039	0.000	0.000	0.000
2040	0.000	0.000	0.000
2041	0.000	0.000	0.000
2042	0.000	0.000	0.000

2043	0.000	0.000	0.000
2044	0.000	0.000	0.000
2045	0.000	0.000	0.000
2046	0.000	0.000	0.000
2047	0.000	0.000	0.000
2048	0.000	0.000	0.000
2049	0.000	0.000	0.000
2050	0.000	0.000	0.000

Table 86. Net greenhouse gas emissions due to activity shifting leakage

Year	$\Delta C_{LK\text{-}AB,planned}$	$\Delta C_{LK\ ME}$	$\Delta C_{LK\text{-}REDD}$
	tCO2	tCO2	tCO2
2021	0	7,935	7,935
2022	0	0	0
2023	0	0	0
2024	0	0	0
2025	0	0	0
2026	0	0	0
2027	0	0	0
2028	0	0	0
2029	0	0	0
2030	0	0	0
2031	0	0	0
2032	0	0	0
2033	0	0	0
2034	0	0	0
2035	0	0	0
2036	0	0	0
2037	0	0	0
2038	0	0	0
2039	0	0	0
2040	0	0	0
2041	0	0	0
2042	0	0	0
2043	0	0	0
2044	0	0	0
2045	0	0	0

2046	0	0	0
2047	0	0	0
2048	0	0	0
2049	0	0	0
2050	0	0	0

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; tCO_2e

ΔCBSLPAt Sum of baseline carbon stock changes in the project area at year t; tCO_2e

EBBBSLPAt Sum of baseline emissions from biomass burning in the project area at year t; tCO_2e

ΔCPSPAt Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO_2e

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; tCO_2e

ΔCLKt Sum of ex ante estimated leakage net carbon stock changes at year t; tCO_2e

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; tCO_2e

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

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

$$VCU_t = \Delta REDD_t - VBC_t$$

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

Where:

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
RFt	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless.

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value was 15%.

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

The present REDD project is expected to avoid a predicted 11,105 ha of deforestation, equating to 5,478,348 tCO_2e in emissions reductions over the 30-year project lifetime, with an annual average of 182,612 tCO_2e.

Table 87. 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	cumulat.	annual	cumulative	annual	cumulat	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2021	13,743	13,743	495	495	251	251	9	9	2,061	2,061	74	74	11,842	11,842	9,143	9,143	2,698	2,698
2022	13,896	27,638	495	990	254	506	9	18	2,084	4,146	74	149	11,969	23,811	9,240	18,383	2,728	5,427
2023	14,048	41,687	495	1,485	257	762	9	27	2,107	6,253	74	223	12,096	35,907	9,337	27,720	2,758	8,185
2024	14,201	55,888	495	1,980	260	1,022	9	36	2,130	8,383	74	297	12,223	48,130	9,434	37,154	2,788	10,973
2025	14,354	70,242	495	2,476	263	1,285	9	45	2,153	10,536	74	371	12,350	60,480	9,531	46,685	2,818	13,791
2026	14,507	84,748	495	2,971	265	1,550	9	54	2,176	12,712	74	446	12,477	72,957	9,628	56,313	2,848	16,640
2027	13,285	98,034	446	3,416	243	1,793	8	62	1,993	14,705	67	512	11,420	84,377	8,811	65,124	2,608	19,248
2028	13,423	111,456	446	3,862	246	2,039	8	71	2,013	16,718	67	579	11,534	95,911	8,898	74,022	2,635	21,884
2029	13,560	125,016	446	4,307	248	2,287	8	79	2,034	18,752	67	646	11,649	107,560	8,986	83,008	2,662	24,546
2030	13,698	138,714	446	4,753	251	2,537	8	87	2,055	20,807	67	713	11,763	119,323	9,073	92,081	2,689	27,235
2031	13,513	152,227	446	5,199	247	2,784	8	95	2,027	22,834	67	780	11,610	130,932	8,956	101,037	2,653	29,889
2032	13,498	165,725	446	5,644	247	3,031	8	103	2,025	24,859	67	847	11,597	142,529	8,946	109,983	2,650	32,539
2033	12,246	177,971	401	6,045	224	3,255	7	111	1,837	26,696	60	907	10,518	153,048	8,114	118,097	2,404	34,943
2034	12,217	190,187	401	6,446	223	3,479	7	118	1,832	28,528	60	967	10,494	163,542	8,095	126,192	2,399	37,342
2035	12,188	202,375	401	6,847	223	3,702	7	125	1,828	30,356	60	1,027	10,470	174,012	8,077	134,269	2,393	39,735
2036	12,159	214,534	401	7,248	222	3,924	7	133	1,824	32,180	60	1,087	10,446	184,458	8,058	142,327	2,387	42,122
2037	12,162	226,695	401	7,649	222	4,146	7	140	1,824	34,004	60	1,147	10,449	194,907	8,060	150,387	2,388	44,510
2038	12,148	238,843	401	8,050	222	4,369	7	147	1,822	35,827	60	1,208	10,437	205,344	8,052	158,439	2,385	46,895
2039	11,021	249,864	361	8,411	202	4,570	7	154	1,653	37,480	54	1,262	9,467	214,810	7,302	165,741	2,164	49,059
2040	10,995	260,859	361	8,772	201	4,771	7	160	1,649	39,129	54	1,316	9,445	224,255	7,286	173,027	2,159	51,218
2041	10,969	271,828	361	9,133	201	4,972	7	167	1,645	40,774	54	1,370	9,423	233,678	7,269	180,296	2,154	53,371
2042	10,943	282,771	361	9,494	200	5,172	7	174	1,641	42,416	54	1,424	9,401	243,080	7,252	187,548	2,149	55,520
2043	10,946	293,717	361	9,855	200	5,372	7	180	1,642	44,058	54	1,478	9,404	252,483	7,254	194,802	2,149	57,669
2044	10,933	304,650	361	10,216	200	5,572	7	187	1,640	45,697	54	1,532	9,393	261,877	7,246	202,048	2,147	59,816
2045	9,919	314,569	325	10,541	181	5,754	6	193	1,488	47,185	49	1,581	8,520	270,397	6,572	208,620	1,948	61,763
2046	9,895	324,464	325	10,866	181	5,935	6	199	1,484	48,670	49	1,630	8,500	278,897	6,557	215,177	1,943	63,706
2047	9,872	334,336	325	11,191	181	6,115	6	205	1,481	50,150	49	1,679	8,481	287,378	6,542	221,719	1,938	65,644
2048	9,848	344,185	325	11,515	180	6,295	6	211	1,477	51,628	49	1,727	8,461	295,839	6,527	228,246	1,934	67,578
2049	9,851	354,036	325	11,840	180	6,476	6	217	1,478	53,105	49	1,776	8,463	304,302	6,529	234,775	1,934	69,512
2050	9,840	363,876	325	12,165	180	6,656	6	223	1,476	54,581	49	1,825	8,454	312,757	6,522	241,297	1,932	71,444

Table 88. 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)
2021	14,238	260	2,136	2,698	9,143
2022	14,391	263	2,159	2,728	9,240
2023	14,543	266	2,182	2,758	9,337
2024	14,696	269	2,204	2,788	9,434
2025	14,849	272	2,227	2,818	9,531
2026	15,002	274	2,250	2,848	9,628
2027	13,731	251	2,060	2,608	8,811
2028	13,868	254	2,080	2,635	8,898
2029	14,006	256	2,101	2,662	8,986
2030	14,143	259	2,121	2,689	9,073
2031	13,959	255	2,094	2,653	8,956
2032	13,943	255	2,092	2,650	8,946
2033	12,647	231	1,897	2,404	8,114
2034	12,618	231	1,893	2,399	8,095
2035	12,589	230	1,888	2,393	8,077
2036	12,560	230	1,884	2,387	8,058
2037	12,563	230	1,884	2,388	8,060
2038	12,549	230	1,882	2,385	8,052
2039	11,382	208	1,707	2,164	7,302
2040	11,356	208	1,703	2,159	7,286
2041	11,330	207	1,699	2,154	7,269
2042	11,304	207	1,696	2,149	7,252
2043	11,307	207	1,696	2,149	7,254
2044	11,294	207	1,694	2,147	7,246
2045	10,244	187	1,537	1,948	6,572
2046	10,220	187	1,533	1,943	6,557
2047	10,197	187	1,530	1,938	6,542
2048	10,173	186	1,526	1,934	6,527
2049	10,176	186	1,526	1,934	6,529
2050	10,165	186	1,525	1,932	6,522
TOTAL	**376,041**	**6,878**	**56,406**	**71,444**	**241,297**

APD – Avoided Planned Deforestation

Net GHG emission reduction estimates are based in VM0007 v1.6 according to the equation below:

$$NER_{REDD} = \Delta C_{BSL\text{-}REDD} - \Delta C_{WPS\text{-}REDD} - \Delta C_{LK\text{-}REDD}$$

Where:

NER_{REDD} Total net GHG emission reductions of the REDD project activity up to year t (t CO2e).

$\Delta C_{BSL\text{-}REDD}$ Net GHG emissions in the REDD baseline scenario up to year t* (t CO2e).

$\Delta C_{WPS\text{-}REDD}$ Net GHG emissions in the REDD project scenario up to year t* (t CO2e).

$\Delta C_{LK\text{-}REDD}$ Net GHG emissions due to leakage from the REDD project activity up to year t*(t CO_2e).

Table 89. Net GHG emission reduction estimates

Year	Estimated baseline emissions or removals	Estimated project emissions or removals	Estimated leakage emissions	Estimated net GHG emission reductions or removals
	$\Delta C_{BSL\text{-}REDD}$	$\Delta C_{WPS\text{-}REDD}$	$\Delta C_{LK\text{-}REDD}$	NER_{REDD}
	t CO2-e	t CO2-e	t CO2-e	t CO2-e
2021	599,847	401,957	0.00	197,890
2022	0	0	0.00	0
2023	0	0	0.00	0
2024	0	0	0.00	0
2025	0	0	0.00	0
2026	0	0	0.00	0
2027	0	0	0.00	0
2028	0	0	0.00	0
2029	0	0	0.00	0
2030	0	0	0.00	0
2031	0	0	0.00	0
2032	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00

2047	0.00	0.00	0.00	0.00
2048	0.00	0.00	0.00	0.00
2049	0.00	0.00	0.00	0.00
2050	0.00	0.00	0.00	0.00
Total	**599,847**	**401,957**	**0**	**197,890**

The number of credits to be retained in the AFOLU Pooled Buffer Account is determined as a percentage of the total carbon stock benefits via the VCS-Risk-Report-Calculation-Tool-v4.0. The overall non-permanence risk rating of the Rio Branco Grouped REDD Project is 15%.

The uncertainty in the baseline estimates was estimated through an assessment of deforestation rates, stocks and changes in carbon stocks.

Step 1: Assess Uncertainty in Projection of Baseline Rate of Deforestation or Degradation.

For the uncertainty in the projection, it is assumed that there are no uncertainties in the reference rate of deforestation or degradation where the numbers are based on actual deforestation plans (BL-PL) as per the suppression permits for land use change.

$$Uncertainty_{BSL,rate} = 0$$

Step 2: Assess Uncertainty of Emissions and Removals in Project Area in Baseline.

Uncertainty in combined carbon stocks and sources of greenhouse gas in the baseline:

$$U_{REDD-BSL,SS,i} = \frac{\sqrt{\sum_1^n (U_{REDD-BSL,SS,i,pool\#} \times E_{REDD-BSL,SS,i,pool\#})^2}}{\sum_1^n E_{REDD-BSL,SS,i,pool\#}}$$

Where:

$U_{REDD\_BSL\_SS,I,}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline scenario in stratum *i* (%)
$U_{REDD\_BSL\_SS,I,pool\#}$	Percentagem uncertainty for carbon stocks and greenhouse gas sources in the REDD baseline scenario in stratum *i* (%)
$E_{REDD\_BSL\_SS,I,pool\#}$	Carbon stock or GHG sources in the REDD baseline scenario (tCO2e)
I	1,2,3…M strata (unitless)

Step 3: Estimate Total Uncertainty in REDD baseline scenario.

$$Uncertainty_{REDD-BSL,t*} = \sqrt{Uncertainty_{BSL,RATE,t*}{}^2 + Uncertainty_{REDD-BSL,SS}{}^2}$$

$Uncertainty_{REDD-BSL,t*}$	Cumulative uncertainty in REDD baseline scenario up to year $t*$ (%)
$Uncertainty_{REDD-BSL,RATEt*}$	Cumulative uncertainty in the baseline rate of deforestation up to year *t* (%)
$Uncertainty_{REDD-BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline scenario (%)
t	1,2,3.....t* time elapsed since the start of the project activity (years)

Uncertainty E*x Post* in the REDD Project Scenario

Area of deforestation or degradation in the project scenario should be tracked directly using the same accuracy assessment criterion as used in the baseline.

Where no *ex post* (re-)measurements of carbon pools or GHG sources have been made, ie, uncertainty from these sources is already included in *UncertaintyREDD-BSL,t**, is set equal to zero.

Total Error in the REDD Project Activity

Total project uncertainty is therefore equal to the combined uncertainty in baseline and project estimates for the REDD.

$$NER_{REDD+ERROR} = \sqrt{\left(Uncertainty_{REDDBSL,t*} \times \Delta C_{BSL-REDD,t*}\right)^2 \times (\frac{1}{\Delta C_{BSL-REDD,t*}})}$$

Where:

$NER_{REDD+ERROR}$	Cumulative uncertainty for the REDD+project activities up to year $t*$ (%)
$Uncertainty_{REDD-BSL,t*}$	Cumulative uncertainty in REDD baseline scenario up to year $t*$ (%)
$\Delta C_{BSL-REDD,t*}$	Net GHG emissions in the REDD baseline scenario up to year $t*$ (tCO2e)

Where uncertainty exceeds 15% of *NERREDD+* at the 95% confidence level then the deduction must be equal to the amount that the uncertainty exceeds the allowable level.

$$Adjusted\_NER_{REDD+} = NER_{REDD} \times (100\% - NER_{REDD+ERROR} + 15\%)$$

$Adjusted\_NER_{REDD+}$	Total net GHG emission reductions of the REDD+ project activities up to year $t*$ adjusted to account for uncertainty (tCO2e)
NER_{REDD}	Total net GHG emission reductions of the REDD project activity up to year $t*$ (tCO2e)
$NER_{REDD+ERROR}$	Cumulative uncertainty for the REDD+project activities up to year $t*$ (%)

Table 90. Total net GHG emission reductions adjusted to account for uncertainty and Verified Carbon Units (ex-ante)

Year	Estimated net GHG emission reductions or removals	Total net GHG emission reductions adjusted to account for uncertainty	*ex ante buffer credits*	Verified Carbon Units
	NER REDD	$Adjusted\_NER_{REDD+}$	$Buffer_{planned}$	VCUt
	t CO2-e	t CO2-e	t CO2-e	t CO2-e
2021	197,890	169,991	25,499	144,492
2022	0	0	0	0
2023	0	0	0	0
2024	0	0	0	0
2025	0	0	0	0
2026	0	0	0	0
2027	0	0	0	0
2028	0	0	0	0
2029	0	0	0	0
2030	0	0	0	0
2031	0	0	0	0
2032	0	0	0	0
2033	0	0	0	0
2034	0	0	0	0
2035	0	0	0	0
2036	0	0	0	0
2037	0	0	0	0
2038	0	0	0	0
2039	0	0	0	0
2040	0	0	0	0
2041	0	0	0	0
2042	0	0	0	0
2043	0	0	0	0
2044	0	0	0	0
2045	0	0	0	0
2046	0	0	0	0
2047	0	0	0	0
2048	0	0	0	0
2049	0	0	0	0
2050	0	0	0	0
Total	**197,890**	**169,991**	**25,499**	**144,492**

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	According to VCS requirements, where the applied methodology requires the quantification of activity-shifting leakage, projects may apply the optional default activity-shifting leakage deduction of 15 percent to the gross GHG emission reductions and/or removals.
Value applied	15%
Justification of choice of data or description of measurement methods and procedures applied	The DLF was estimated as 15%, based on default value of the VCS requirements, where the applied methodology requires the quantification of activity-shifting leakage.
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 estimates the percentage 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	405.50 (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 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. 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 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. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t).
Purpose of data	This parameter is used to calculate non-CO_2 emissions due to forest fires within the project area in the baseline scenario, providing an ex-ante estimation.
Comments	Ex post monitoring of forest fires and non-CO_2 emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$Fburnt_{icl}$
Data unit	%
Description	Proportion of forest area burned during the historical reference period in the forest class.
Source of data	Measured or estimated from literature. *Fburnt data source:* - Heat spots: Data from the municipalities within the reference region during the historical reference period. <https://queimadas.dgi.inpe.br/queimadas/bdqueimadas> - Deforestation:

	<http://terrabrasilis.dpi.inpe.br/downloads/>
Value applied	73%
Justification of choice of data or description of measurement methods and procedures applied	The Fburnt analysis was carried out on the municipalities of the reference region, as it is where the Project Area is fully inserted in. Heat spots were considered during the historical reference period (prior to 2014, the data has no fire risk classification, and therefore, was not taken into account). For the assessed years, the fire risk predicted for the day of detection of the outbreak was considered, contemplating only outbreaks with a fire risk of >= 0.5 as, according to INPE's methodology, fire risk higher than 0.4 is considered as medium to critical (=1). By overlapping these fire outbreaks with the deforestation mapping of the same time period, it was possible to verify the tendency of fire outbreaks being directly related to areas with recent and/or consolidated deforestation. This can also be verified by the proximity of deforestation detection dates by satellite and the close or overlapping heat spots. Thus, it is possible to assume that these outbreaks are related to anthropic actions to open pastures/crops. Thereby, there was an overlap of 89.94% of the pixels analysed during the reference period in the municipalities.
Purpose of data	This parameter is the average percentage of the area which contemplates the three municipalities within the reference region 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	78.00
Justification of choice of data or description of measurement methods and procedures applied	Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m^3/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%. However, due to the lack of literature estimates, a study from the Brazilian Amazon in the Cerrado vegetation was used for the comparison. This study reported that the total biomass consumed by fires varies from 72% to 84% (average 78%) in denser Cerrado types, which is a forest vegetation. The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%. It is important to note that slash and burn practices are commonly used in the Amazon region to clear the area for other land uses thus, when burning an area, the main objective is to completely remove all the remaining biomass. Therefore, assuming that 78% of the biomass is combusted, there would still be a 22% remaining biomass that shall be left to decompose, which also emits GHG to the atmosphere in this process.
Purpose of data	This parameter is the average of biomass that has commercial value, and could be removed prior to clear cutting and burning, and is used to calculate baseline and project non-CO_2 emissions from forest fire at year t in the project area (parameter EBBBSLPAt).
Comments	Monitoring is done only once at project start.

Data / Parameter	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	Estimate from project proponent based on verified reports of similar VM0015 REDD projects in Brazil up to date. Available in VERRA database.
Value applied	98.17%

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.

APD – Avoided Planned Deforestation

Data / Parameter	AAplanned,i,t
Data unit	ha
Description	Annual area of baseline planned deforestation for stratum i in year t.
Source of data	Calculated based on VMD0006 v1.3 equation 4
Value applied	see table below

Year	Open Lowland Tropical Rainforest	$AA_{planned,i,t}$
	ha	ha
2021	464.54	464.54
2022	0.00	0.00
2023	0.00	0.00
2024	0.00	0.00
2025	0.00	0.00
2026	0.00	0.00
2027	0.00	0.00
2028	0.00	0.00
2029	0.00	0.00
2030	0.00	0.00
2031	0.00	0.00

	<table><tr><td>2032</td><td>0.00</td><td>0.00</td></tr><tr><td>2033</td><td>0.00</td><td>0.00</td></tr><tr><td>2034</td><td>0.00</td><td>0.00</td></tr><tr><td>2035</td><td>0.00</td><td>0.00</td></tr><tr><td>2036</td><td>0.00</td><td>0.00</td></tr><tr><td>2037</td><td>0.00</td><td>0.00</td></tr><tr><td>2038</td><td>0.00</td><td>0.00</td></tr><tr><td>2039</td><td>0.00</td><td>0.00</td></tr><tr><td>2040</td><td>0.00</td><td>0.00</td></tr><tr><td>2041</td><td>0.00</td><td>0.00</td></tr><tr><td>2042</td><td>0.00</td><td>0.00</td></tr><tr><td>2043</td><td>0.00</td><td>0.00</td></tr><tr><td>2044</td><td>0.00</td><td>0.00</td></tr><tr><td>2045</td><td>0.00</td><td>0.00</td></tr><tr><td>2046</td><td>0.00</td><td>0.00</td></tr><tr><td>2047</td><td>0.00</td><td>0.00</td></tr><tr><td>2048</td><td>0.00</td><td>0.00</td></tr><tr><td>2049</td><td>0.00</td><td>0.00</td></tr><tr><td>2050</td><td>0.00</td><td>0.00</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on total area of planned deforestation over baseline period.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	Aplanned, i
Data unit	ha
Description	Total area of planned deforestation
Source of data	Remote Sensing data and Official document AUTEX
Value applied	<table><tr><th>Year</th><th>Open Lowland Tropical Rainforest</th><th>$AA_{planned,i,t}$</th></tr><tr><td></td><td>ha</td><td>ha</td></tr></table>

	2021	464.54	464.54
	2022	0.00	0.00
	2023	0.00	0.00
	2024	0.00	0.00
	2025	0.00	0.00
	2026	0.00	0.00
	2027	0.00	0.00
	2028	0.00	0.00
	2029	0.00	0.00
	2030	0.00	0.00
	2031	0.00	0.00
	2032	0.00	0.00
	2033	0.00	0.00
	2034	0.00	0.00
	2035	0.00	0.00
	2036	0.00	0.00
	2037	0.00	0.00
	2038	0.00	0.00
	2039	0.00	0.00
	2040	0.00	0.00
	2041	0.00	0.00
	2042	0.00	0.00
	2043	0.00	0.00
	2044	0.00	0.00
	2045	0.00	0.00
	2046	0.00	0.00
	2047	0.00	0.00
	2048	0.00	0.00
	2049	0.00	0.00
	2050	0.00	0.00
Justification of choice of data or description of measurement methods and procedures applied	VMD0006 BL-PL: the suitability of the project area for conversion to alternative non-forest land use, the government approval for deforestation and a management plan for deforesting the project area.		
Purpose of Data	Calculation of baseline emissions		
Comments	N/A		

Data / Parameter	$\Delta C_{AB\_tree,i}$
Data unit	t CO_2eha^{-1}
Description	Baseline carbon stock change in aboveground tree biomass in stratum i
Source of data	Calculated based on VMD0006 v1.3
Value applied	<table><tr><td rowspan="2">Stratum/forest class</td><td>$C_{AB\_tree,bsl,i}$</td><td>$C_{AB\_tree,post,i}$</td><td>$\Delta C_{AB\_tree,i}$</td></tr><tr><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td></tr><tr><td>Open Lowland Tropical Rainforest</td><td>413.34</td><td>7.57</td><td>405.77</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3, estimated based on the forest carbon stock in aboveground tree biomass in stratum I (CAB_tree,bsl,i) and the post-deforestation carbon stock in aboveground tree biomass in stratum I (CAB_tree,post,i),
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$\Delta C_{BB\_tree,i}$
Data unit	t CO_2eha^{-1}
Description	Baseline carbon stock change in belowground tree biomass in stratum i
Source of data	Calculated based on VMD0006 v1.3
Value applied	<table><tr><td rowspan="2">Stratum/forest class</td><td>$C_{BB\_tree,bsl,i}$</td><td>$C_{BB\_tree,post,i}$</td><td>$\Delta C_{BB\_tree,i}$</td></tr><tr><td>tCO2e/ha</td><td>tCO2e/ha</td><td>tCO2e/ha</td></tr><tr><td>Open Lowland Tropical Rainforest</td><td>99.20</td><td>6</td><td>93.20</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3, estimated based on the forest carbon stock in belowground tree biomass in stratum I ($C_{BB\_tree,bsl,i}$) and the post-deforestation carbon stock in belowground tree biomass in stratum I ($C_{AB\_tree,post,i}$),

Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$\Delta C_{AB\_non\text{-}tree,i}$
Data unit	t CO_2eha^{-1}
Description	Baseline carbon stock change in aboveground non-tree biomass in stratum i
Source of data	Calculated based on VMD0006 v1.3
Value applied	<table><tr><th rowspan="2">Stratum/forest class</th><th>$C_{AB\_non\text{-}tree,bsl,i}$</th><th>$C_{AB\_non\text{-}tree,post,i}$</th><th>$\Delta C_{AB\_non\text{-}tree,i}$</th></tr><tr><th>tCO2e/ha</th><th>tCO2e/ha</th><th>tCO2e/ha</th></tr><tr><td>Open Lowland Tropical Rainforest</td><td>16.53</td><td>8.6</td><td>7.93</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3, estimated based on the forest carbon stock in aboveground non-tree biomass in stratum I ($C_{AB\_non\text{-}tree,bsl,i}$) and the post-deforestation carbon stock in aboveground non-tree biomass in stratum I ($C_{AB\_non\text{-}tree,post,i}$),
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$\Delta C_{BB\_non\text{-}tree,i}$
Data unit	t CO_2eha^{-1}
Description	Baseline carbon stock change in belowground non-tree biomass in stratum i
Source of data	Calculated based on VMD0006 v1.3
Value applied	<table><tr><th rowspan="2">Stratum/forest class</th><th>$C_{BB\_non\text{-}tree,bsl,i}$</th><th>$C_{BB\_non\text{-}tree,post,i}$</th><th>$\Delta C_{BB\_non\text{-}tree,i}$</th></tr><tr><th>tCO2e/ha</th><th>tCO2e/ha</th><th>tCO2e/ha</th></tr><tr><td>Open Lowland Tropical Rainforest</td><td>9.92</td><td>8.6</td><td>1.32</td></tr></table>

Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3, estimated based on the forest carbon stock in belowground non-tree biomass in stratum I ($C_{BB\_non\text{-}tree,bsl,i}$) and the post-deforestation carbon stock in belowground tree biomass in stratum I ($C_{BB\_non\text{-}tree,post,i}$),
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	CF
Data unit	t C t d.m.$^{-1}$
Description	Carbon fraction of dry matter in t C t^{-1} d.m.
Source of data	Value from literature IPCC, 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003
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 and project emissions from deforestation occurred in the baseline and project scenarios.
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	$C_{AB\_tree,i}$
Data unit	t CO2eha^{-1}
Description	Carbon stock in aboveground biomass in trees in the baseline in stratum i
Source of data	Values from FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020, Report, Rome, 2020
Value applied	Stratum/forest class | Cab

	<table><tr><td></td><td>tCO2e/ha</td></tr><tr><td>Open Lowland Tropical Rainforest</td><td>413.34</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	The values for the carbon stock in aboveground biomass were adopted based on the literature, adopting the values obtained by FAO because the field results have presented values very different from those found in bibliographic references.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$C_{BB\_tree,i}$
Data unit	t CO2eha-1
Description	Carbon stock in belowground biomass in trees in the baseline in stratum i
Source of data	Values from FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020, Report, Rome, 2020
Value applied	<table><tr><td rowspan="2">Stratum/forest class</td><td>Cbb</td></tr><tr><td>tCO2e/ha</td></tr><tr><td>Open Lowland Tropical Rainforest</td><td>99.20</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	The values for the carbon stock in belowground biomass were adopted based on the literature, adopting the values obtained by FAO because the field results have presented values very different from those found in bibliographic references.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	D%planned,i,t
Data unit	% year-1

Description	Projected annual proportion of land that will be deforested in stratum *i* at year *t*
Source of data	Data obtained from IMAC - environmental agency responsible for issuing permits for deforestation in Acre
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3, where a valid verifiable plan exists for rate at which deforestation is projected to occur and must be used.
Purpose of Data	Calculation of baseline emissions
Comments	Parameter values to be updated if new empirically based peer-reviewed findings become available.

Data / Parameter	$C_{wp,i}$
Data unit	$tCO_2e.ha^{-1}$
Description	Baseline carbon stock change in wood in stratum i
Source of data	Calculated based on mean stock of extracted biomass carbon by class of wood product *ty* and wood waste. VMD0005 v1.1 equation 2
Value applied	Stratum/forest class: Open Lowland Tropical Rainforest; $C_{WP,i}$ (tCO2e/ha): 3.99
Justification of choice of data or description of measurement methods and procedures applied	Calculated the biomass carbon extracted that enters the wood products pool at the time of deforestation.
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Stratum/forest class	$C_{WP,i}$ tCO2e/ha
Open Lowland Tropical Rainforest	3.99

Data / Parameter	$C_{XB,ty,i}$

Data unit	$tCO_2e.ha^{-1}$
Description	Mean stock of extracted biomass carbon by class of wood product *ty* from stratum *i*; t CO_2-e ha^{-1}
Source of data	Calculated based on biomass carbon data and wood to be extracted from within stratum i. VMD0005 v1.1 equation 1
Value applied	<table><tr><th></th><th>$CXB_{High\ density\ wood}$</th><th>$CXB_{medium\ density\ wood}$</th><th>$CXB_{Low\ density\ wood}$</th></tr><tr><td>**Total**</td><td>14.52</td><td>3.13</td><td>2.33</td></tr></table>
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on wood product class ($V_{ex,ty,i}$), volume of timber extracted from stratum I by species j, mean of wood density j (Dj), carbon fraction (CF) and the area of stratum.
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	OF_{ty}
Data unit	Dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product *ty*
Source of data	Winjun et al. 1998
Value applied	0.8
Justification of choice of data or description of measurement methods and procedures applied	The source of data is the published paper of Winjum *et al*. 1998
Purpose of Data	Calculation of baseline emissions

Comments	N/A

Data / Parameter	$V_{ex,ty,i}$
Data unit	m^3
Description	The volume of timber in m^3 extracted from within the stratum (does not include slash left onsite), reported by wood product class and preferably species.
Source of data	Timber harvest records derived from suppression authorization
Value applied	2,174.56
Justification of choice of data or description of measurement methods and procedures applied	Data from the Forest Inventory and measurements of wood logs made for the request for the authorization of suppression of vegetation.
Purpose of Data	This parameter is used to calculate project emissions in the project scenario, specifically for calculations of harvested wood products carbon pool. Provides the *ex post* value of the final wood products volume due to planned logging activities in the project area.
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}E,i,t}$
Data unit	t CO_2e.yr^{-1}
Description	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum i in year t.
Source of data	Calculated based on biomass emission by burn, N_2O and fossil fuel emission. VMD0006 v1.3 equation 15
Value applied	(see table below)

Project year *t*	Total GHG emissions	
	annual TOTAL	cumulative

		$GHG_{BSL-E,t}$	$GHG_{BSL-E,t}$
		tCO_2e	tCO_2e
	2021	401,493	401,493
	2022	0	401,493
	2023	0	401,493
	2024	0	401,493
	2025	0	401,493
	2026	0	401,493
	2027	0	401,493
	2028	0	401,493
	2029	0	401,493
	2030	0	401,493
	2031	0	401,493
	2032	0	401,493
	2033	0	401,493
	2034	0	401,493
	2035	0	401,493
	2036	0	401,493
	2037	0	401,493
	2038	0	401,493
	2039	0	401,493
	2040	0	401,493
	2041	0	401,493
	2042	0	401,493
	2043	0	401,493
	2044	0	401,493
	2045	0	401,493
	2046	0	401,493
	2047	0	401,493
	2048	0	401,493
	2049	0	401,493
	2050	0	401,493
Justification of choice of data or description of measurement methods and procedures applied	The GHG emissions in the baseline within the project boundary calculated based on the other non-CO_2 emissions that may be emitted according to the activities carried out by the project.		
Purpose of Data	Calculation of baseline emissions		
Comments	For net CO_2e emissions from fossil fuel combustion in stratum i in year t ($E_{FC,i,t}$) and direct N_2O emissions as a result of nitrogen		

	application in alternative land use within the project boundary in stratum i in year t ($N_2O_{direct-N,i,t}$) are conservatively excluded from the project scope and calculation of baseline estimates following the criteria of VM0007 v1.6 in section 5.4, table 7.

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	t CO2-e
Description	Greenhouse gas emissions due to biomass burning in stratum *i* in year *t* of each GHG (CO_2, CH_4, N_2O) (t CO_2e)
Source of data	Calculated based on data from area burnt and combustion factors, according to VMD0013 v1.3 equation 1
Value applied	see table below
Justification of choice of data or description of	Calculated based on: • Area burnt

Project year *t*	Open Lowland Tropical Rainforest $E_{BiomassBurn,i,t}$ tCO_2e
2021	401.493
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0

measurement methods and procedures applied	• Average aboveground biomass stock before burning stratum i, year • Combustion factor for stratum i • Emission factor for stratum i for gas g
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$A_{burn,i.t}$
Data unit	ha
Description	Area burnt for stratum I in year t
Source of data	Equal to $AA_{planned,i,t}$ in the baseline case
Value applied	see table below

Aburn	Open Lowland Tropical Rainforest
Project year *t*	$Area_{burn,i,t}$
	ha
2021	464.54
2022	0.00
2023	0.00
2024	0.00
2025	0.00
2026	0.00
2027	0.00
2028	0.00
2029	0.00
2030	0.00
2031	0.00
2032	0.00
2033	0.00
2034	0.00
2035	0.00
2036	0.00
2037	0.00
2038	0.00

	2039	0.00	
	2040	0.00	
	2041	0.00	
	2042	0.00	
	2043	0.00	
	2044	0.00	
	2045	0.00	
	2046	0.00	
	2047	0.00	
	2048	0.00	
	2049	0.00	
	2050	0.00	
Justification of choice of data or description of measurement methods and procedures applied	The burned area is considered equivalent to the annual deforested area $AA_{planned,i,t}$ considering that all deforestation is preceded by a fire to clear the land in the baseline case.		
Purpose of Data	Calculation of baseline emissions		
Comments	N/A		

Data / Parameter	$COMF_i$
Data unit	Dimensionless
Description	Combustion factor for stratum i
Source of data	Table 2.6 - 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied	0.45
Justification of choice of data or description of measurement methods and procedures applied	Combustion factor for stratum i
Purpose of Data	Calculation of baseline emissions
Comments	The combustion factor is a measure of the proportion of the fuel that is burned, which varies depending on the proportion of the

	matter that is burned, as tree stems will be burned compared to grass leaves. It also considers the moisture content of the fuel and the type of fire (ie, intensity and rate of spread).

Data / Parameter	$B_{i,t}$
Data unit	t d.m/ha
Description	Average aboveground biomass stock before burning stratum *i*, year
Source of data	Calculated based on carbon stock according to VMD0013 v1.3 equation 2
Value applied	Initial Forest Class / Name: Open Lowland Tropical Rainforest; Parameters $B_{i,t}$ (t d.m/ha): 7,891
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0013 v1.3 equation 2, the average aboveground biomass stock before burning was calculated based on carbon stock in aboveground biomass in trees in stratum i in year t ($C_{AB\_tree,i,t}$), Carbon stock in dead wood for stratum i in year t ($C_{DWi,t}$), Carbon stock in litter for stratum i in year t ($C_{LI,i,t}$) and Carbon fraction of biomass (CF).
Purpose of Data	Calculated of baseline emissions
Comments	For the three phytophysiognomies the values of $B_{i,t}$ was the same as they are open tropical rainforest.

Value applied (nested table):

Initial Forest Class	Parameters
	$B_{i,t}$
Name	t d.m/ha
Open Lowland Tropical Rainforest	7,891

Data / Parameter	$G_{g,i}$
Data unit	kg t^{-1} d.m. burnt
Description	Emission factor for stratum *i* for gas *g*
Source of data	Table 2.5 - 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied	G_{N2O} 0.2

	G_{CH4} 6.8
Justification of choice of data or description of measurement methods and procedures applied	Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Appendix 2: emission factors for various types of burning for CH4 and N2O). Default values must be updated whenever new guidelines are produced by the IPCC.
Purpose of Data	Calculations of baseline emissions
Comments	N/A

Data / Parameter	GWP_g
Data unit	t CO_2/t gas g
Description	Global warming potential for gas *g*
Source of data	Fifth Assessment Report (AR5), IPCC
Value applied	GWP_{N2O} 265 GWP_{CH4} 28
Justification of choice of data or description of measurement methods and procedures applied	Default factor from Global Warming Potentials (GWP)
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$\Delta C_{BSL,i,t}$
Data unit	t CO_2e
Description	Net carbon stock changes in all pools in the baseline stratum i in year t.
Source of data	Calculated based on annual area of planned deforestation from forest suppression authorization.
Value applied	

Year	$\Delta C_{BSL, i,t}$	$\Delta C_{BSL, i,t}$

		annual	cumulative
		tCO_2e	tCO_2e
	2021	198,354	198,354
	2022	0	198,354
	2023	0	198,354
	2024	0	198,354
	2025	0	198,354
	2026	0	198,354
	2027	0	198,354
	2028	0	198,354
	2029	0	198,354
	2030	0	198,354
	2031	0	198,354
	2032	0	198,354
	2033	0	198,354
	2034	0	198,354
	2035	0	198,354
	2036	0	198,354
	2037	0	198,354
	2038	0	198,354
	2039	0	198,354
	2040	0	198,354
	2041	0	198,354
	2042	0	198,354
	2043	0	198,354
	2044	0	198,354
	2045	0	198,354
	2046	0	198,354
	2047	0	198,354
	2048	0	198,354
	2049	0	198,354
	2050	0	198,354
Justification of choice of data or description of measurement methods and procedures applied	According to VMD0006 v1.3 equation 14, estimated based on the annual area of baseline planned deforestation for stratum i in year t ($AA_{planned,i,t}$), the baseline carbon stock change in aboveground tree biomass in stratum i ($\Delta C_{AB\_tree,i}$), the baseline carbon stock change in belowground tree biomass in stratum i ($\Delta C_{BB\_tree,i}$), the baseline carbon stock change in aboveground non-tree biomass in stratum ($\Delta C_{AB\_non\text{-}tree,i}$), the baseline carbon stock change in belowground non-tree biomass in stratum i ($\Delta C_{BB\_non\text{-}tree,i}$), the baseline carbon stock change in wood products in stratum i ($\Delta C_{WP,i}$), the baseline carbon stock change in dead wood in stratum i ($\Delta C_{DW,i}$), the baseline carbon stock change in litter in stratum i ($\Delta C_{LI,i}$) and the baseline carbon stock change in soil organic carbon in stratum i.		

Purpose of Data	Calculation of baseline emissions
Comments	For this project, carbon stock change values in dead wood, litter and soil organic carbon were not considered, as informed in the carbon pools spreadsheet.

Data / Parameter	$\Delta C_{BSL,planned}$
Data unit	t CO_2e
Description	Net greenhouse gas emissions in the baseline from planned deforestation up to year *t*
Source of data	According to equation 1 from VMD0006 v1.3. Calculated based on net carbon stock changes in all pools in the baseline stratum i and greenhouse gas emissions as a result of deforestation
Value applied	(see table below)

	$\Delta C_{BSL, planned}$	$\Delta C_{BSL, planned}$
Project year	annual	cumulative
	tCO_2e	tCO_2e
2021	599,847	599,847
2022	0	599,847
2023	0	599,847
2024	0	599,847
2025	0	599,847
2026	0	599,847
2027	0	599,847
2028	0	599,847
2029	0	599,847
2030	0	599,847
2031	0	599,847
2032	0	599,847
2033	0	599,847
2034	0	599,847
2035	0	599,847
2036	0	599,847
2037	0	599,847
2038	0	599,847
2039	0	599,847
2040	0	599,847
2041	0	599,847
2042	0	599,847
2043	0	599,847
2044	0	599,847

	2045	0	599,847
	2046	0	599,847
	2047	0	599,847
	2048	0	599,847
	2049	0	599,847
	2050	0	599,847
Justification of choice of data or description of measurement methods and procedures applied	Estimated based on the net carbon stock changes in all pools in the baseline ($\Delta C_{BSL,i,t}$) and GHG emissions as a result of deforestation activities within the project boundary in the baseline stratum i in year t ($GHG_{BSL\text{-}E,i,t}$).		
Purpose of Data	Calculation of baseline emissions		
Comments	N/A		

Data / Parameter	L-Di
Data unit	%
Description	Likelihood of deforestation in stratum *i*
Source of data	Analysis of land tenure, “matrículas”.
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	For all other planned deforestation areas (i.e. areas not both under government control and zoned for deforestation), L-Di must be equal to 100%.
Purpose of Data	Determination of baseline scenario
Comments	

Data / Parameter	SLFty
Data unit	Dimensionless
Description	Fraction of wood products that will be emitted to the atmosphere within 5 years of production by class of wood product *ty*

<table>
<tr><td>Source of data</td><td>Winjum et al, 1998. VMD0005 v1.1</td></tr>
<tr><td>Value applied</td><td>0.2 sawnwood</td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied</td><td>
<table>
<tr><th>Winjum et al. 1998 give the following proportions for wood products with short-term (<5 yr) uses after which they are retired and oxidized (applicable internationally): Wood Product Class</th><th>SLF</th></tr>
<tr><td>Sawnwood</td><td>0.2</td></tr>
<tr><td>Woodbase panels</td><td>0.1</td></tr>
<tr><td>Other industrial roundwood</td><td>0.3</td></tr>
<tr><td>Paper and paperboard</td><td>0.4</td></tr>
<tr><td>Other classes of wood products</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>Purpose of Data</td><td>Calculation of baseline emission</td></tr>
<tr><td>Comments</td><td>N/A</td></tr>
</table>

Data / Parameter	WWty
Data unit	Dimensionless
Description	WW = Fraction of extracted biomass effectively emitted to the atmosphere during production by class of wood product *ty.*
Source of data	Default value for developing countries: VMD0005 - CP-W -page 14. The source of data is the published paper of Winjum *et al*. 1998
Value applied	1.599
Justification of choice of data or description of measurement methods and procedures applied	VMD0005 CP-W: Winjum *et al*. 1998 indicate that the proportion of extracted biomass that is oxidized (burning or decaying) from the production of commodities to be equal to 19% for developed countries, 24% for developing countries. *WW* is therefore equal to *CXB,ty* multiplied by 0.19 for developed countries and 0.24 for developing countries

Purpose of Data	Calculation of baseline emissions
Comments	Parameter values to be updated if new empirically based peer-reviewed findings become available.

5.2 Data and Parameters Monitored

Data / Parameter	ab_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the above-ground biomass were taken from the following study: HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	See 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

Above-ground biomass ab_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Open Lowland Tropical Forest	225.46	225.46	225.46

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 this study was used because it accurately represents the values of vegetation within the project reference region.
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.

Data / Parameter	bb_{icl}
Data unit	Mg/ha
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories
Frequency of monitoring/recording	At each monitoring report.
Value applied	(see 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

Below-ground biomass bb_{icl} (Mg/ha)			
Vegetation	Reference Region	Project Area	Leakage Belt
Open Lowland Tropical Forest	54.11	54.11	54.11

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, the following sources will also be monitored: - INMET[166] - INPE[167]
Frequency of monitoring/recording	At each time a catastrophic event occurs.
Value applied	The value will be calculated ex-post at each time a catastrophic event occurs, when significant.
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS. Furthermore, the following sources will be also monitored to confirm the data obtained from remote sensing and GIS: - INMET - INPE - Field data from the management team
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an ex post estimation of the area affected by catastrophic events within the project area.

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

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	11.97 (annual average deforestation projected in the leakage belt during the crediting period).
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Data / Parameter	ABSLPAt

Data unit	Ha
Description	Annual area of deforestation in the project area at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the project area.
Frequency of monitoring/recording	Annually
Value applied	26.59 (annual average projected deforestation in the project area during the crediting period).
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the ex ante and ex post values of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$ABSLRR_t$
Data unit	Ha
Description	Annual area of deforestation in the reference region at year t
Source of data	Remote sensing and GIS
Description of measurement methods and procedures to be applied	Forest cover change due to deforestation will be monitored through periodic assessment of classified satellite imagery covering the reference region.
Frequency of monitoring/recording	Annually
Value applied	1,013.01 (annual average projected deforestation within the reference region during the crediting period).

Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in both baseline and project scenarios. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the reference region.
Calculation method	Analysis of satellite images and maps.
Comments	N/A

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	1,819.38 (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 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	The 1st project activity instance does not include sustainable forest management plan activities.

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	221.85 (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	60.83 (Annual average increase in GHG emissions due to displaced forest fires within the leakage belt 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 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	7.42 (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 municipalities within the RR that was cleared by burning for other land uses

	involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. These average percentage values are assumed to remain the same in the future, according to the applied methodology
Frequency of monitoring/recording	Annually
Value applied	15.25
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter is used to calculate the baseline, project and leakage non-CO_2 emissions from biomass burning occurred in the baseline and project scenarios
Calculation method	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology.
Comments	GWP for CH_4 and N2O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS Field assessment data

QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	The 1st project activity instance does not include any activity that could result in GHG emissions from grazing animals in leakage management areas. GWP for CH_4 and N2O should be 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

APD – Avoided Planned Deforestation

Data / Parameter	$A_{DefPA,i,u,t}$
Data unit	ha
Description	Area of recorded deforestation in the project area in stratum I converted to land use u in year t.
Source of data	Mapbiomas database and Landsat
Description of measurement methods and procedures applied	The annual deforestation is carried out with remote sensing methods, using images generated by Mapbiomas, INPE (PRODES) 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
Frequency of monitoring/recording	Annual
Value applied:	Ex-ante:

Year	$\Delta C_{P,DefPA,i,t}$
	Total
2021	0.00
2022	0.00
2023	0.00
2024	0.00
2025	0.00
2026	0.00
2027	0.00
2028	0.00
2029	0.00
2030	0.00
2031	0.00
2032	0.00
2033	0.00
2034	0.00
2035	0.00
2036	0.00
2037	0.00

	<table><tr><td>2038</td><td>0.00</td></tr><tr><td>2039</td><td>0.00</td></tr><tr><td>2040</td><td>0.00</td></tr><tr><td>2041</td><td>0.00</td></tr><tr><td>2042</td><td>0.00</td></tr><tr><td>2043</td><td>0.00</td></tr><tr><td>2044</td><td>0.00</td></tr><tr><td>2045</td><td>0.00</td></tr><tr><td>2046</td><td>0.00</td></tr><tr><td>2047</td><td>0.00</td></tr><tr><td>2048</td><td>0.00</td></tr><tr><td>2049</td><td>0.00</td></tr><tr><td>2050</td><td>0.00</td></tr></table> Ex-post: N/A
Monitoring equipment	Mapbiomas database (http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes)
QA/QC procedures applied	The MapBiomas results undergo an accuracy assessment, which for the entire Amazon Biome is on average 95%. However, to meet the particularities of the project region, an independent evaluation was carried out for the reference region between 2008-2018. In order to assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated by calculating the user's and producer's percentage of correct answers, errors of omission and commission. For that, 320 sample points were randomly drawn on the reference region, 80 in each class (forest, hydrography, pioneer vegetation 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.
Purpose of data	Calculation of project emissions
Calculation method	MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System promoted by the Climate Observatory. Its creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology uses, for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]), with a cloud cover less than or equal to 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its

	behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).
Comments	N/A

Data / Parameter	$C_{P,post,u,i}$
Data unit	t CO_2-e
Description	Carbon stock in all pools in post-deforestation land use u in stratum i.
Source of data	Calculated based on carbon stocks in the selected pools according to VMD0015, equation 6
Description of measurement methods and procedures applied	Calculated based on Carbon stock in aboveground tree biomass in stratum i (CAB_tree,i), carbon stock in belowground tree biomass in stratum i (CBB_tree,i), carbon stock in aboveground non-tree vegetation in stratum (CAB_non-tree,i), carbon stock in belowground non-tree vegetation in stratum i (CBB_non-tree,i), carbon stock in dead wood in stratum i (CDW,i), carbon stock in litter in stratum i (CLI,i), mean post-deforestation stock in soil organic carbon in the post deforestation stratum i (CSOC,PD-BSL,i),
Frequency of monitoring/recording	In each baseline revalidation (6 years)
Value applied:	Ex-ante: Stratum (i) | $C_{P,post,u,i}$ (t CO2-e) Open Lowland Tropical Rainforest | 31 Ex-post: N/A
Monitoring equipment	N/A
QA/QC procedures applied	-
Purpose of data	Calculation of project emissions
Calculation method	Through the equation 6, VMD 0015 v2.2

Comments	-

Data / Parameter	$C_{WP,i}$
Data unit	t CO_2-e ha^{-1}
Description	Carbon stock sequestered in wood products from harvests in stratum i
Source of data	Suppression authorization for land use change
Description of measurement methods and procedures applied3.99	Calculated based on biomass carbon of the commercial volume extracted by wood product type *ty* from within the project boundary
Frequency of monitoring/recording	When another verification event is to be carried out, minimum frequency of 5 years
Value applied:	Ex-ante: 3.99 Ex-post: N/A
Monitoring equipment	.
QA/QC procedures applied	-
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 05.
Comments	N/A

Data / Parameter	$\Delta C_{pools,Def,u,i,t}$
Data unit	t CO_2-e
Description	Net carbon stock changes in all pools as a result of deforestation in the project case in land use u in stratum i at time t.
Source of data	According to VMD0015 v2.2, equation 05

<table>
<tr><td>Description of measurement methods and procedures applied</td><td>Calculated based on carbon stock in all pools in the baseline case in stratum I ($C_{BSL,i}$), carbon stock in all pools in post-deforestation land use u in stratum I ($C_{P,post,u,i}$) and carbon stock sequestered in wood products from harvests in stratum I ($C_{WP,i}$), according to VMD0015 v2.2, equation 05.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>06 years (in each baseline revalidation)</td></tr>
<tr><td>Value applied:</td><td>Ex-ante:
<table><tr><th rowspan="2">Stratum (i)</th><th>ΔCpools, Def,u,i.t</th></tr><tr><th>t CO2-e</th></tr><tr><td>Open Lowland Tropical Rainforest</td><td>485.76</td></tr></table>
Ex-post: N/A</td></tr>
<tr><td>Monitoring equipment</td><td>N/A</td></tr>
<tr><td>QA/QC procedures applied</td><td>-</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Calculation method</td><td>See VMD0015 v2.2, equation 05.</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

Data / Parameter	$\Delta C_{P,DefPA,i,t}$
Data unit	t CO_2-e
Description	Net carbon stock change as a result of deforestation in the project case in the project area in stratum i at time t.
Source of data	Calculated according to VMD0015 v2.2, equation 03
Description of measurement methods and procedures applied	Calculated based on the area of recorded deforestation in the project area stratum i converted to land use u at time t ($A_{DefPA,u,i,t}$) and the net carbon stock changes in all pools in the project case in land use u in stratum i at time t ($\Delta C_{pools,Def,u,i,t}$), according to VMD0015 v2.2, equation 03.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.
Value applied:	Ex-ante: 0.00 Ex-post:
Monitoring equipment	-

QA/QC procedures applied	.
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 03.
Comments	The area of recorded deforestation in the project area is zero because there was no record of deforestation according to the mapping carried out.

Data / Parameter	$\Delta C_{P,DegW,i,t}$
Data unit	t CO_2-e
Description	Net carbon stock changes as a result of degradation in stratum i in the project area in year t.
Source of data	Calculated according to VMD0015 v2.2, equation 08.
Description of measurement methods and procedures applied	Based on the area potentially impacted by degradation processes in stratum I (ADegW,i) and carbon from the biomass of trees cut and removed by the degradation process of plots measured in stratum i in year t (CDegW,i,t) and sample from total area of degradation plots in stratum I (APi), according to VMD0015 v2.2, equation 08.
Frequency of monitoring/recording	Annual
Value applied:	Ex-ante: 0.00 Ex-post: N/A
Monitoring equipment	N/A
QA/QC procedures applied	.
Purpose of data	Calculation of project emissions
Calculation method	See VMD0015 v2.2, equation 08.
Comments	$A_{,Deg,w,i}$ - the area was not delimited because the APD project will also have borders with the AUD project and with that there will be the action of the two projects to avoid illegal deforestation in the areas. The value is zero and therefore the net carbon stock changes as a result of degradation

Data / Parameter	$\Delta C_{P,SelLog,i,t}$

Data unit	t CO_2-e
Description	Net carbon stock change as a result of degradation through selective logging of FSC certified forest management areas in the project area in the project case in stratum i in year t.
Source of data	Calculated - VMD0015 v2.2, equation 09.
Description of measurement methods and procedures applied	Calculated based on actual net project emissions arising in the logging gap in stratum i in year t ($C_{LG,i,t}$), actual net project emissions arising from logging infrastructure in stratum i in year t ($C_{LR,i,t}$) and the carbon stock in wood products pool from stratum i, in year t ($C_{WPi,t}$), according to VMD0015 v2.2, equation 09.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.
Value applied:	Ex-ante: 0 Ex-post: N/A
Monitoring equipment	N/A
QA/QC procedures applied	.
Purpose of data	Calculation of project emissions
Calculation method	See section 4.2
Comments	GHG emissions due to selective logging in the project scenario are set as zero in ex-ante estimates

Data / Parameter	Aburn,i,t
Data unit	ha
Description	Area burnt for stratum i in year t.
Source of data	Equal to $A_{DistPA,q,i,t}$ + $A_{DefPA,i,u,t}$ in the project case.
Description of measurement methods and procedures applied	For the calculation of project emissions, the burned area is considered equivalent to burn scars monitored plus annual deforested area monitored, assuming that all deforestation is preceded by a fire to clear the land in the project case.
Frequency of monitoring/recording	Annual
Value applied:	Ex-ante: <table><tr><th>Aburn</th><th>Open Lowland Tropical Rainforest</th></tr></table>

	<table><tr><th rowspan="2">Project year t</th><th>$Area_{burn,i,t}$</th></tr><tr><th>ha</th></tr><tr><td>2021</td><td>464.54</td></tr><tr><td>2022</td><td>0.00</td></tr><tr><td>2023</td><td>0.00</td></tr><tr><td>2024</td><td>0.00</td></tr><tr><td>2025</td><td>0.00</td></tr><tr><td>2026</td><td>0.00</td></tr><tr><td>2027</td><td>0.00</td></tr><tr><td>2028</td><td>0.00</td></tr><tr><td>2029</td><td>0.00</td></tr><tr><td>2030</td><td>0.00</td></tr><tr><td>2031</td><td>0.00</td></tr><tr><td>2032</td><td>0.00</td></tr><tr><td>2033</td><td>0.00</td></tr><tr><td>2034</td><td>0.00</td></tr><tr><td>2035</td><td>0.00</td></tr><tr><td>2036</td><td>0.00</td></tr><tr><td>2037</td><td>0.00</td></tr><tr><td>2038</td><td>0.00</td></tr><tr><td>2039</td><td>0.00</td></tr><tr><td>2040</td><td>0.00</td></tr><tr><td>2041</td><td>0.00</td></tr><tr><td>2042</td><td>0.00</td></tr><tr><td>2043</td><td>0.00</td></tr><tr><td>2044</td><td>0.00</td></tr><tr><td>2045</td><td>0.00</td></tr><tr><td>2046</td><td>0.00</td></tr><tr><td>2047</td><td>0.00</td></tr><tr><td>2048</td><td>0.00</td></tr><tr><td>2049</td><td>0.00</td></tr><tr><td>2050</td><td>0.00</td></tr></table> Ex-post: N/A
Monitoring equipment	-
QA/QC procedures applied	-
Purpose of data	Calculation of project emissions

Calculation method	-
Comments	-

Data / Parameter	$GHG_{BSL,E,i,t}$
Data unit	t CO_2e
Description	Greenhouse gas emissions as a result of deforestation activities within the within the project area in stratum i in year t.
Source of data	Based on VMD0006 v1.3 equation 15.
Description of measurement methods and procedures applied	Calculated based on the non-CO2 emissions due to biomass burning in stratum i in year t (EBiomassBurn,i,t), according to VMD0006 v1.3 equation 15.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.
Value applied:	Ex-ante:

Project year *t*	Total GHG emissions	
	annual TOTAL	cumulative
	$GHG_{BSL-E,t}$	$GHG_{BSL-E,t}$
	tCO_2e	tCO_2e
2021	401,493	401,493
2022	0	401,493
2023	0	401,493
2024	0	401,493
2025	0	401,493
2026	0	401,493
2027	0	401,493
2028	0	401,493
2029	0	401,493
2030	0	401,493
2031	0	401,493
2032	0	401,493
2033	0	401,493
2034	0	401,493
2035	0	401,493
2036	0	401,493

	<table><tr><td>2037</td><td>0</td><td>401,493</td></tr><tr><td>2038</td><td>0</td><td>401,493</td></tr><tr><td>2039</td><td>0</td><td>401,493</td></tr><tr><td>2040</td><td>0</td><td>401,493</td></tr><tr><td>2041</td><td>0</td><td>401,493</td></tr><tr><td>2042</td><td>0</td><td>401,493</td></tr><tr><td>2043</td><td>0</td><td>401,493</td></tr><tr><td>2044</td><td>0</td><td>401,493</td></tr><tr><td>2045</td><td>0</td><td>401,493</td></tr><tr><td>2046</td><td>0</td><td>401,493</td></tr><tr><td>2047</td><td>0</td><td>401,493</td></tr><tr><td>2048</td><td>0</td><td>401,493</td></tr><tr><td>2049</td><td>0</td><td>401,493</td></tr><tr><td>2050</td><td>0</td><td>401,493</td></tr></table> Ex-post: N/A
Monitoring equipment	-
QA/QC procedures applied	.
Purpose of data	Calculation of project emissions
Calculation method	Calculated based on VMD0006 v1.3 equation 15
Comments	For $E_{FC,i,t}$ the value considered was Zero (0), it is conservative to exclude according to VM0007 v1.6, table 7. The same for $N_2O_{direct\text{-}N,i,t}$

Data / Parameter	$E_{BiomassBurn,i,t}$
Data unit	t CO_2e
Description	Greenhouse gas emissions due to biomass burning in stratum i in year t of each GHG (CO_2, CH_4, N_2O)
Source of data	Calculated based on VMD0013 v1.3 equation 1.
Description of measurement methods and procedures applied	Calculated based on area burnt for stratum i in year t ($A_{burn,i,t}$), average aboveground biomass stock before burning stratum i, in year t ($B_{i,t}$), combustion factor for stratum i (unitless) ($COMF_i$), emission factor for stratum i for gas g ($Gg_{,i}$) and the Global warming potential for gas g (GWP_g), according to VMD0013 v1.3 equation 1.
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.

Value applied:	Ex-ante:

Project year t	Open Lowland Tropical Rainforest
	$E_{BiomassBurn,i,t}$
	tCO_2e
2021	401,493
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0

	Ex-post: 0.0
Monitoring equipment	-
QA/QC procedures applied	.
Purpose of data	Calculation of project emissions
Calculation method	Calculated based on VMD0013 v1.3 equation 1.
Comments	

Data / Parameter	$\Delta C_{WPS-REDD}$
Data unit	t CO_2-e
Description	Net GHG emissions in the REDD project scenario up to year t.
Source of data	Calculated
Description of measurement methods and procedures applied	Calculated based on net carbon stock change as a result of deforestation in the project area in the project case in stratum i in year t ($\Delta C_{P,DefPA,i,t}$), Net carbon stock change as a result of degradation in the project area in the project case in stratum i in year t ($\Delta C_{P,Deg,i,t}$), Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum i in year t ($\Delta C_{P,DistPA,i,t}$) and Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum i in year t ($GHG_{P-E,i,t}$).
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 05 years.
Value applied:	Ex-ante:

Idi		ΔC_{WPS_REDD}	ΔC_{WPS_REDD}
Name	Open Lowland Tropical Rainforest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2021	401,957	401,957	401,957
2022	0	0	401,957
2023	0	0	401,957
2024	0	0	401,957
2025	0	0	401,957
2026	0	0	401,957
2027	0	0	401,957
2028	0	0	401,957
2029	0	0	401,957
2030	0	0	401,957
2031	0	0	401,957
2032	0	0	401,957
2033	0	0	401,957
2034	0	0	401,957
2035	0	0	401,957
2036	0	0	401,957
2037	0	0	401,957
2038	0	0	401,957
2039	0	0	401,957

	<table><tr><td>2040</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2041</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2042</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2043</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2044</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2045</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2046</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2047</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2048</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2049</td><td>0</td><td>0</td><td>401,957</td></tr><tr><td>2050</td><td>0</td><td>0</td><td>401,957</td></tr></table> Ex-post: N/A
Monitoring equipment	N/A
QA/QC procedures applied	
Purpose of data	Calculation of project emissions
Calculation method	VMD0015 v2.2, equation 01.
Comments	-

Data / Parameter	$\Delta C_{LK-REDD}$
Data unit	t CO_2e
Description	Net GHG emissions due to leakage from the REDD project activity up to year t*
Source of data	Calculated
Description of measurement methods and procedures applied	Calculated based on net GHG emissions due to activity shifting leakage for projects preventing planned deforestation up to year t (ΔCLK-AS,planned), and the Net GHG emissions due to market-effects leakage up to year t*(ΔCLK-ME),
Frequency of monitoring/recording	Before every verification event with a minimum frequency of 5 years.
Value applied:	Ex-ante: <table><tr><th>Year</th><th>$\Delta C_{LK-AB,planned}$</th><th>$\Delta C_{LK\ ME}$</th><th>$\Delta C_{LK-REDD}$</th></tr></table>

		tCO2	tCO2	tCO2
	2021	0	7,935	7,935
	2022	0	0	0
	2023	0	0	0
	2024	0	0	0
	2025	0	0	0
	2026	0	0	0
	2027	0	0	0
	2028	0	0	0
	2029	0	0	0
	2030	0	0	0
	2031	0	0	0
	2032	0	0	0
	2033	0	0	0
	2034	0	0	0
	2035	0	0	0
	2036	0	0	0
	2037	0	0	0
	2038	0	0	0
	2039	0	0	0
	2040	0	0	0
	2041	0	0	0
	2042	0	0	0
	2043	0	0	0
	2044	0	0	0
	2045	0	0	0
	2046	0	0	0
	2047	0	0	0
	2048	0	0	0
	2049	0	0	0
	2050	0	0	0
	Ex-post: N/A			
Monitoring equipment	-			
QA/QC procedures applied	.			

Purpose of data	Calculation of leakage.
Calculation method	Calculated according to VMD0007 v1.6 equation 4.
Comments	

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 social reports 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 as well as complying with the social activities.

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.
The APD area will serve as a buffer zone for the AUD area, keeping the area preserved and thus avoiding the risk of degradation.

In turn, for sustainable forest management, the AUD area will continue to demonstrate occupation and activities in areas where the management team is present, preventing invasions and illegal deforestation both in the AUD area and in the APD.

Baseline monitoring task will be done in accordance with the applied methodology for each project area, VM0015, version 1.1, VM0007, version 1.6, and VMD0015, version 2.2, or the most recent.

Data to be collected
Data will be collected to comply with the parameters used in both methodology 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, VM0007 and VMD0015 methodologies.

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 methodologies. 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)[168] 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 Methodologies for both project areas.

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

Procedures for handling internal auditing and non-conformities

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

A project information quality management system will be implemented, the main purpose of which is to minimize the risk of error, obtaining reliable data on which to base the monitoring results, and thus, minimizing non-conformities. It includes the training of general staff in the different roles to play within the framework of the present REDD Project; In-field verification,

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

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), MapBiomas data, and satellite images (LANDSAT, Sentinel, CBRES).

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

Security procedures

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

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

- **Monitoring of carbon stock changes and non-CO2 emissions from fires**

In addition to the mentioned above, the instance owner is responsible for training monitoring, management, safety and health personnel. This may include periodic fire brigade training, including first aid, fire procedures, training of new monitoring personnel and those responsible for management during harvests.

If forest fires occur, these non-CO2 emissions will be subject to monitoring and accounting, when significant.

- **Monitoring of impacts of natural disturbances and other catastrophic events**

The monitoring of natural impacts and other catastrophic events is responsibility of the instance owner. The landowner shall notify Future Carbon so that it can include the related impacts in the carbon project reports, updating the related parameters, including the non-permanence risk report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

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

- **Monitoring of Leakage**

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

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

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

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

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

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

- **Monitoring Proxy Areas**

Monitoring of the Proxy Areas will be carried out as in the project area to verify whether changes have occurred and whether it should be reassessed at the end of each baseline period. Baseline will be updated considering the methodological procedures.

- **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 91. Type of Monitoring and Party Responsible

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Future Carbon and external institutions qualified for the GIS analysis and monitoring	Every 6 years
Monitoring Deforestation and Project Emissions	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring Leakage emissions	Instance owner together with Future Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of Natural Disturbance and catastrophic events	Instance owner and Future Carbon	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Future Carbon	At least, every 10 years, only if necessary.

APPENDIX I – METHODOLOGICAL PROCEDURES FOR LU/LC CHANGE ANALYSIS

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

Data sources and pre-processing

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

Table 92. Source of the remotely sense data used for historical reference period

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km²)		Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	225	62
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	225	61
Satellite	Landsat TM	30	0.45 - 2.35	34,225	2010 - 2020	224	62

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

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

Figure 29. List, description and reference of bands, fractions and indexes available in the feature space

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

Where,

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

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

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

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

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

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

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

<u>Data classification and post-processing</u>

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

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

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

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

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

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

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

Gap Fill

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

Spatial Filter

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

Temporal Filter

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

Frequency Filter

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

Incident Filter

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

<u>Classification accuracy assessment</u>

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

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

A total of 300 random points was drawn on the reference region (100 points for each land use class – Forest, Non-Forest and Hydrography) and the degree of correctness of the classification was verified. High resolution images from Google Earth should also be used as reference, in which land use was visually possible at the drawn points.

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

Table 93. Summary of confusion matrices from the evaluation of MapBiomas

	Producer Accuracy				User Accuracy			
Year	Forest	Hydrography	Pioneer Formation	Deforestation	Forest	Hydrography	Pioneer Formation	Deforestation
2010	97.96%	97.96%	94.00%	92.31%	96.00%	96.00%	94.00%	96.00%
2011	97.78%	100.00%	94.23%	88.68%	88.00%	100.00%	98.00%	94.00%
2012	95.74%	98.04%	88.89%	89.58%	90.00%	100.00%	96.00%	86.00%
2013	97.62%	96.15%	90.38%	87.04%	82.00%	100.00%	94.00%	94.00%
2014	97.83%	98.04%	95.74%	85.71%	90.00%	100.00%	90.00%	96.00%
2015	91.67%	92.31%	85.45%	88.89%	88.00%	96.00%	94.00%	80.00%
2016	95.24%	96.15%	88.68%	81.13%	80.00%	100.00%	94.00%	86.00%
2017	93.88%	96.00%	96.08%	92.00%	92.00%	96.00%	98.00%	92.00%
2018	88.00%	92.45%	95.65%	86.27%	88.00%	98.00%	88.00%	88.00%
2019	97.62%	98.00%	85.71%	80.77%	82.00%	98.00%	96.00%	84.00%

2020	98.77%	95.15%		86.21%	80.00%	98.00%		100.00%