



**Verified Carbon
Standard**

JURUENA RIVER REDD+ PROJECT



Ecológica

Document Prepared by Ecológica Assessoria Ltda

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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 territory¹ is covered by forests, representing almost 497 million hectares of forest area² 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 2020³. The expansion of the agriculture frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The State of Mato Grosso is one of the main grain and meat producers in Brazil. Currently, the State is the 5th largest exporter, mainly with soy, cotton and beef⁴. Simultaneously, Mato Grosso also registers high deforestation rates, reaching in 2018 the highest in 10 years⁵; in 2019 in addition to the states of Pará, Amazonas and Rondônia, it accounted for 84.56% of all deforestation observed in the Brazilian Legal Amazon⁶.

The primary objective of the Juruena River REDD+ Project is to avoid the unplanned deforestation (AUD) of the Amazon rainforest, and, as a grouped project, offers the possibility to expand the conservation to other areas in the future. The first instance is composed by 14 private properties, with a project area of 39,885.45 ha, which are located in Cotriguaçu, in the State of Mato Grosso, Southern Amazon. A Sustainable Forest Management Plan is also carried out in some of the properties.

In addition to the pressure of cattle raising and other important activities in the region, the properties are located between a settlement project and a mining area, and have, to the south, an indigenous land. 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.

Beyond the project's ecological and carbon benefits, a proportion of the carbon credits generated will be dedicated to improving the social and environmental conditions in the project region, specifically contributing to improving deforestation control, and developing environmental education and other social activities. The contribution to sustainability is being monitored through the application of the

¹ IBGE – Instituto Brasileiro de Geografia e Estatística. Brazil. 2019. Available at: <<https://www.ibge.gov.br/cidades-e-estados>>.

² FAO and UNEP. 2020. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. Available at: <<https://doi.org/10.4060/ca8642en>>.

³ FAO. 2020. Global Forest Resources Assessment 2020: Main report. Rome. Available at: <<https://doi.org/10.4060/ca9825en>>.

⁴ Available at: <<https://g1.globo.com/mt/mato-grosso/noticia/2021/07/21/valor-de-exportacoes-neste-ano-em-mt-aumenta-26percent-em-comparacao-com-2020.ghtml>>

⁵ Available at: <<https://g1.globo.com/mt/mato-grosso/noticia/2018/12/10/mt-registra-o-maior-indice-de-desmatamento-da-amazonia-nos-ultimos-10-anos.ghtml>>

⁶ Available at: <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5465>

SOCIALCARBON® Standard, which is based on six main indicators: Biodiversity; Natural; Financial; Human; Social and Carbon Resources.

The present REDD project is expected to avoid a predicted 11,160.00 ha of deforestation, equating to 4,108,256 tCO₂e in emissions reductions over the 30-year project lifetime (12-November-2020 to 11-November-2050), with an annual average of 136,942 tCO₂e.

1.2 Sectoral Scope and Project Type

Sectoral Scope: 14 - Agriculture, Forestry, Land Use

Project Category: Avoided Unplanned Deforestation (AUD project activity)

This is a grouped project.

1.3 Project Eligibility

According to the VCS Methodology Requirements v4.17, 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 Version 4.2⁸:

- The project meets all applicable rules and requirements set out under the VCS Program;
- The project applies a methodology eligible under the VCS Program;
- The implementation of this project activity does not lead to the violation of any applicable law;
- This is an eligible AFOLU project category under the VCS Program: reduced emissions from deforestation and degradation (REDD);
- This project is not located within a jurisdiction covered by a jurisdictional REDD+ program;
- Implementation partners are identified in the project activity;
- This project does not convert native ecosystems to generate GHG. The project area only contains native forested land for a minimum of 10 years before the project start date;
- This project does not occur on wetlands and does not drain native ecosystems or degrade hydrological functions;
- Non-performance risk will be analyzed in accordance with the VCS Program document AFOLU Non-Permanence Risk Tool.

1.4 Project Design

This project has been designed as a grouped project activity.

Eligibility Criteria

⁷ Available at: <https://verra.org/wp-content/uploads/2022/01/VCS-Methodology-Requirements_v4.1.pdf>

⁸ Available at: <https://verra.org/wp-content/uploads/2022/02/VCS-Standard_v4.2.pdf>

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 Juruena River REDD+ Project is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15 and 3.5.16 of VCS Standard v4.2.

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	Juruena River Grouped 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, version 1.1, published on 03-December-2012.	The Instance 1 complies with this requirement because it adopts the Methodology VM0015: Methodology for Avoided Unplanned Deforestation, version 1.1, published on 03-December-2012.
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 Juruena River REDD+ Project. Also, this instance is in the same reference region described in the VCS PD.
Projects shall apply the technologies or measures in the same manner as specified in the project description.		Instance 1 applies the same technologies or measures specified in the Project description: forest conservation by avoiding unplanned deforestation, with forest management in project scenario.

<p>Projects are subject to the baseline scenario determined in the project description for the specified project activity and geographic area.</p>	<p>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”</p>	<p>The Instance 1 Project Activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Jurueña River REDD+ Project. Therefore, this instance is in accordance with the same baseline scenario determined in Section 3.4 of the VCS PD.</p>
<p>Projects must have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. For example, the new project activity instances have financial, technical and/or other parameters (such as the size/scale of the instances) consistent with the initial instances, or face the same investment, technological and/or other barriers as the initial instances.</p>	<p>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.</p> <p>In 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.</p> <ol style="list-style-type: none"> 1) Instances may or may not include Sustainable Forest Management Plan. 2) In case the project activity does not involve Sustainable Forest Management Plan: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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. 	<p>Since the PD was developed based on the characteristics, reference region and activity of the initial instance, Instance 1 complies with this additionality criterion.</p> <p>The additionality analysis for Instance 1 was made according to Option II of VCS VT0001 v 3.0, as detailed in section 3.5.</p>

	<p>- In addition, a new AFOLU non-permanence risk analysis shall be provided.</p>	
<p>New Project Activity Instances shall occur within one of the designated geographic areas specified in the project description.</p>	<p>Projects must be located within the Reference Region described in Section 3.4 of the VCS PD. The areas to be included must evidence the ownership of the property in accordance with Brazilian legislation, even if overlapping public areas such as Conservation Units.</p> <p>- As per the VCS Standard, new AFOLU non-permanence shall be assessed 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 risk rating for each area applies only to the GHG emissions reductions generated by project activity instances within the area.</p>	<p>The area referring to instance 1 - project activity is within the project's reference region as described in section 3.4 of the VCS PD.</p>
<p>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.</p>	<p>All instances must comply with the complete set of eligibility criteria for the inclusion of new project activities instances.</p>	<p>Instance 1 complies with all eligibility criteria for the inclusion of new project activity.</p>

<p>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.</p>	<p>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.</p>	<p>Instance 1 complies with this criterion, as it is included in this Joint PD as the first project activity instance.</p>
<p>New Project Activity Instances must be validated at the time of verification against the applicable set of eligibility criteria</p>	<p>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.</p>	<p>Instance 1 complies with this criterion, as it is included in this Joint PD as the first project activity instance.</p>
<p>New Project Activity Instances must have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).</p>	<p>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).</p>	<p>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.</p>
<p>New Project Activity Instances must have a start date that is the same as or later than the grouped project start date</p>	<p>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.</p>	<p>Instance 1 project activity has the same start date of the grouped Project, as described in section 1.8 of the VCS PD.</p>
<p>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</p>	<p>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</p>	<p>Instance 1 project activity crediting period has the same start and end date of the grouped Project, as described in section 1.8 of the VCS PD</p>

<p>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.</p>	<p>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.</p>
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1.5 Project Proponent

Organization name	Beatris Tormena Fabris Gradela Ltda.
Contact person	Beatris Tormena Fabris Gradela Eirieli
Title	Owner of Fazenda Arara Azul, Fazenda Canário, Fazenda Cardeal
Address	Rua Belírio Pereira de Souza, nº 163, Sala A Centro – Navirai – Mato Grosso do Sul – Brazil Postal Code: 79950-000
Telephone	Not available
Email	gradela@terra.com.br

1.6 Other Entities Involved in the Project

Organization name	Elizabeth Tormena Fabris Albuquerque Eireli
Role in the project	Instance 1
Contact person	Elizabeth Tormena Fabris Albuquerque
Title	Owner of Fazenda Pardal, Fazenda Cardeal
Address	Av. Dourados, nº 259 – Sala A Centro – Navirai – Mato Grosso do Sul – Brazil. Zip Code: 79950-000
Telephone	Not available
Email	Not available

Organization name	Cassio Roberto Gradela
Role in the project	Instance 1
Contact person	Cassio Roberto Gradela
Title	Owner of Fazenda Beija Flor, Fazenda Mutum
Address	Rua Samambaia, nº 175 Centro – Navirai – Mato Grosso do Sul – Brazil Zip Code: 79950-000
Telephone	Not available
Email	esc.cassiogradela@gmail.com

Organization name	Beatris Tormena Fabris Gradela
Role in the project	Instance 1
Contact person	Beatris Tormena Fabris Gradela
Title	Owner of Fazenda Águia Branca, Fazenda Curió, Fazenda Fênix, Fazenda Flor do Ypê, Fazenda Jaó, Fazenda Nhuma, Fazenda Sanga My, Fazenda Tico Tico
Address	Rua Samambaia, nº 175 Centro – Navirai – Mato Grosso do Sul – Brazil Zip Code: 79950-000
Telephone	Not available
Email	Not available

Organization name	Ecológica Assessoria Ltda.
Role in the project	Ecológica Assessoria Ltda. prepared this Joint Project Description & Monitoring Report (VCS) and remained as Project Proponent until March 9, 2024, when the Deed of Partial Release was signed formalizing the company's leaving as Project Proponent.
Contact person	Stefano Merlin
Title	CEO
Address	Quadra 103 Norte, Av. LO-2, Lote 56, Sala 14, Ed. Olympia Plano Diretor Norte, Palmas – TO, Brazil Postal Code: 77001-022
Telephone	+55 11 98903 4087
Email	team@ecologica.earth

Organization name	Biofíllica Ambipar Environmental Investments S/A
Role in the project	Biofíllica Ambipar Environmental Investments S/A signed a partnership contract with the proponent of the Juruena River REDD+ Project on April 2, 2024, to continue developing the Project. Therefore, it made the final adjustments to the Joint Project Description and Monitoring Report (VCS) in accordance with the VERRA project review, including the adjustment of the Project Baseline, guaranteeing the adequacy and quality of the document in accordance with the required standards.
Contact person	Plínio Ribeiro
Title	Chief Executive Officer (CEO)
Address	2330, Angelica Avenue, - Ed. New England, 5° floor - Higienópolis, São Paulo – SP, Zip Code 01228-200, Brazil
Telephone	+55 11 3073-0430
Email	verra.ambiparenvironment@ambipar.com

1.7 Ownership

The project area is located at Cotriguaçu, in the State of Mato Grosso, and is composed by the following areas:

1. Fazenda Águia Branca
2. Fazenda Arara Azul
3. Fazenda Beija Flor
4. Fazenda Canário
5. Fazenda Cardeal
6. Fazenda Curió
7. Fazenda Fênix
8. Fazenda Flor do Ipe
9. Fazenda Jaó
10. Fazenda Mutum
11. Fazenda Nhuma
12. Fazenda Sanga My
13. Fazenda Tico Tico
14. Fazenda Pardal

These properties are owned by the individuals listed as Project Proponent and Other Entities in section above. The legal documents proving the land title and ownership of the property were made available to the auditors during the validation process.

1.8 Project Start Date

During 2019 and 2020, the project area underwent two severe events involving illegal deforestation and fire, which marked a change in the conduct of activities in the properties composing the Project Area.

Initially, in August, despite the SFMP activities, an encroachment attempt and illegal deforestation occurred in Fazenda Fenix, probably by illegal miners, which resulted in a formal complaint to the State's Police. Five days later, a criminal fire occurred within the property, possibly as a retaliation for actions previously taken by the project owners. Again, the measure taken was to conduct a new complaint to the State's Police.

This frightening situation experienced by the landowners made them to look for some alternative options, even selling the properties. However, they decided to find new ways to keep the forest standing on the property through the existing SFMP, in addition to being able to generate income from carbon credits to expand the monitoring and surveillance of the area, constantly threatened by the mining located at East of the properties, and the settlement to the West. Thus, they found out about the carbon market and got in touch with Ecológica Assessoria regarding the development of a REDD project in the properties. In the meantime, the landowners contracted a surveillance service with a local team as an initial way of guaranteeing the forest preserved for the project, with the main objective of avoiding new invasions.

Therefore, the contract signature with the local monitoring team defined the project start date, i.e. November 12th, 2020, as it marks the major action to effectively conserve the properties and reduce GHG emissions from illegal deforestation within the project area.

1.9 Project Crediting Period

The project has a crediting period of 30 years, from 12-November-2020 to 11-November-2050.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2021	37.320
2022	29.039
2023	55.221
2024	71.326
2025	76.971
2026	62.703
2027	77.468
2028	129.875
2029	154.305
2030	92.390
2031	119.049
2032	105.381
2033	191.429
2034	138.721
2035	127.386
2036	154.230
2037	221.175
2038	125.810
2039	132.196
2040	228.938
2041	120.038
2042	184.854
2043	202.780
2044	149.092
2045	193.667
2046	176.115
2047	213.480
2048	172.897
2049	193.614
2050	170.786
Total estimated ERs	4,108,256
Total number of crediting years	30
Average annual ERs	136,942

1.11 Description of the Project Activity

The principal objective of the present REDD project is the conservation of 39,885.45 ha of Amazon rainforest area within the first instance of this grouped project. This will be achieved through avoidance of unplanned deforestation. It is important to note that this project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

The present REDD project is expected to avoid a predicted 11,160.00 ha of deforestation, equating to 2,441,654 tCO₂e in emissions reductions over the 30-year project lifetime (12-November-2020 to 11-November-2050), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

The main deforestation agents within the Juruena River REDD+ project region are: cattle ranching, mainly producing beef, and timber harvesters, acting both legally and illegally. The area is also vulnerable to illegal mining, and inspection actions and equipment destruction took place even within protected areas in the region^{9,10}. Some of the properties have frontier with the Garimpo Juruena, a mining area, as presented in figure below:

Figure 1. Location of the Garimpo Juruena



The project will combine conservation with forest management, through a Sustainable Forest Management Plan in some areas. The increased complexity and costs associated with the sustainable operation of the forest as well as other factors such as bureaucratic constraints and price fluctuations of certified timber prices make sustainable forest management less competitive than illegal logging. Thus, revenue from the sales of the Verified Carbon Units (VCUs) is essential for the project activity to compete with profitable alternative land use scenarios. In addition, the carbon credit revenue is important to mitigate encroachment and illegal actions within and around the Project Area. This surveillance allows the management of the environmental situation of the property during the development of the forest

⁹ Illegal mining is deactivated in state park and equipment is destroyed in MT < <https://g1.globo.com/mt/mato-grosso/noticia/2021/04/26/garimpo-ilegal-e-desativado-em-parque-estadual-e-equipamentos-sao-destruido-em-mt.ghtml> > Last visited on March 24th, 2022.

¹⁰ Inspection destroys illegal mine set up in conservation park in MT < <https://g1.globo.com/mt/mato-grosso/noticia/2020/06/11/fiscalizacao-destroi-garimpo-ilegal-montado-em-parque-de-conservacao-em-mt.ghtml> > Last visited on March 24th, 2022.

exploration work, in addition to ensuring compliance with the requirements set out in the current legislation.

Environmental education and other social activities that benefit the local community will be supported, as well as improving the control of deforestation. The SOCIALCARBON® Standard is being applied to assess and monitor the project's contribution to sustainability using six key indicators: Biodiversity; Nature; Financial; Human; Social and Carbon Resources, thus improving the social and environmental conditions in the project region.

Background on Sustainable Forest Management Plan within Juruena REDD Project Area

Sustainable forest management plans (PMFS) have been developed in the project area for a few years, on some of the properties that make it up, exploring 2 types of vegetation: Dense Submontane Tropical Forest and Open Submontane Tropical Forest, with a rotation cycle of 35 years and a harvesting intensity of 30 m³/ha. Currently, the only PMFS in force, located at Fazenda Tico-Tico, has an authorized forest management area of 3,051.8384 ha, and its current Authorization for Forest Exploration (AUTEX-PMFS) (n° 003408/2023) has an Annual Production Unit (UPA) area of 757.1494, and can be explored within a period of up to 2 years.

It is worth noting that, according to Complementary State Law No. 567, of June 1, 2015¹¹, which amends provisions of Complementary Laws No. 233/2005; No. 311/2011; No. 309/2008; and No. 523/2013, which provide for the Sustainable Forest Management Plan - PMFS in the state of Mato Grosso, the term of the AUTEX is 12 (twelve) months and may be extended for another 12 (twelve) months.

Therefore, for calculating the effective average annual logging area, the AUTEX issued from 2015 onwards for the Farms that make up the Project Area were taken into account, dividing the average area of the AUTEX by 2 years (period of exploitation), resulting in an average annual logging area of 392.90 ha.

1.12 Project Location

Instance 1

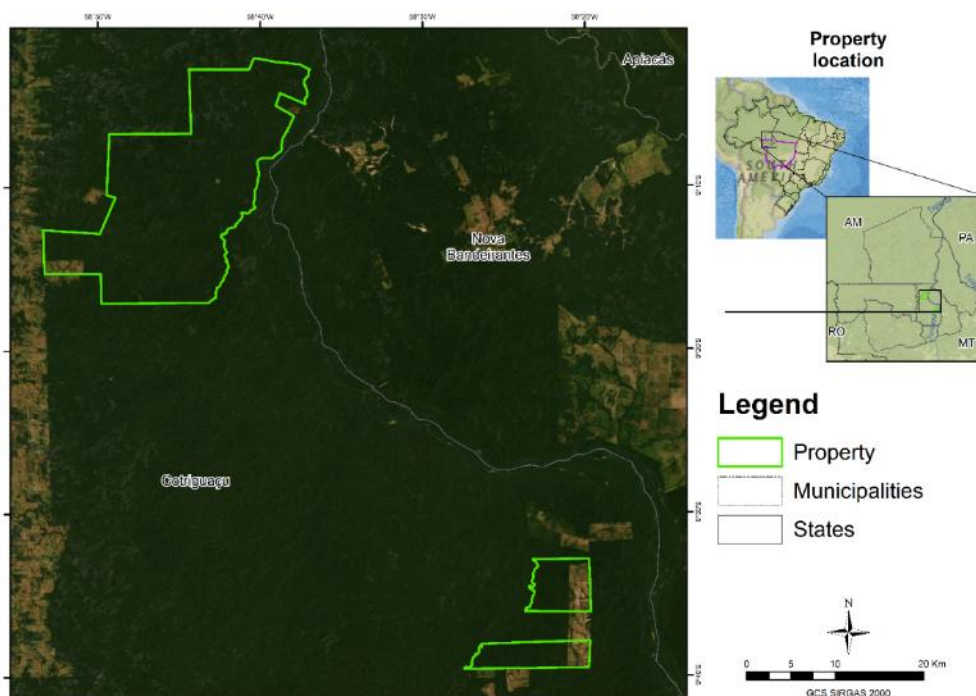
The project area is situated in the municipality of Cotriguaçu, in the State of Mato Grosso, a region known as Southern Amazon. This municipality is located around 1,000 km from Cuiabá, capital of the State of Mato Grosso. The project area is covered 100% by native vegetation, totaling 39,885.45 ha.

The closest access road is BR 174, called Manaus-Boa Vista, highway connecting the Brazilian states of Mato Grosso, Rondônia, Amazonas and Roraima to Venezuela. The properties also make frontier to the Juruena River.

¹¹ Available at <https://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/8a02ecbb7dbad2d684257e58003fe6ff?OpenDocument#LEI%20COMPLEMENTAR%20N%C2%BA%20567%2C%20DE%2001> > Last visited on June 7th, 2024.

In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, the project area may only include areas composed of “forest”¹² for a minimum of ten years prior to the project start date. Therefore, satellite images between 2009 and 2020, were analyzed and classified. The areas within the property that were defined as forest in the historical period were separated and utilized to compose the project area. In addition, some non-forest areas were also excluded, such as rivers, rocks, and non-forest vegetation.

¹² Brazilian Forestry Service. Brazil adopts 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.florestal.gov.br/snif/recursos-florestais/index.php?option=com_k2&view=item&layout=item&catid=14&id=158>. Last visit on: 24 March 2022 .

Figure 2. Project Area location


1.13 Conditions Prior to Project Initiation

General characteristics of the project area and reference region

The Juruena River REDD Project makes an important contribution to the conservation of Southern Amazonia’s biodiversity as well as to climate regulation in Brazil and South America. The region is important agriculture and cattle ranching center, where native forest is vulnerable to the advancement of soy plantation, for example.

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

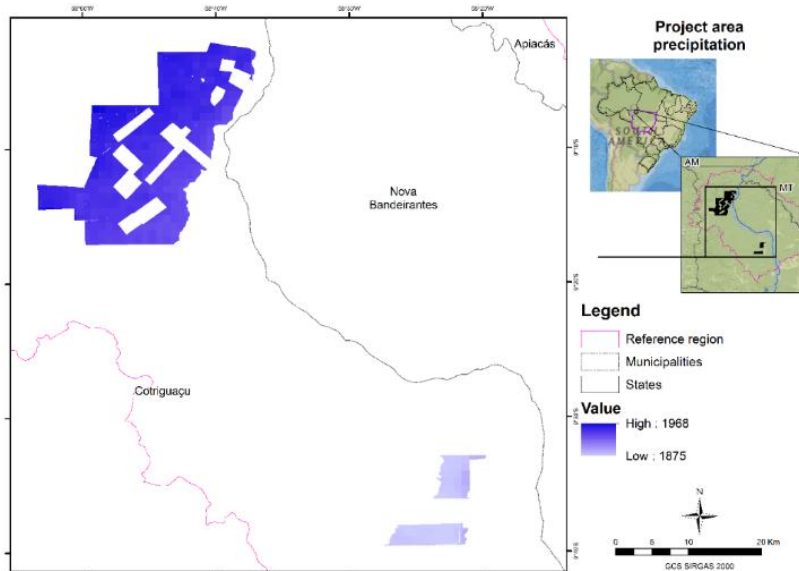
Climate and Hydrography

The project region is classified as Tropical, dry winter climate type – Aw category – according to the Köppen climate classification¹³. This means that it has a rainy season in summer, from November to April, and a distinct dry season in winter, from May to October (July is the driest month). The average temperature of the coldest month is above 18°C¹⁴. Annual precipitation in the project area is on average 1,940.3 mm.

¹³ KÖPPEN, W.; GEIGER, R. *Klimate der Erde*. Gotha: Verlag Justus Perthes. 1928. <https://en.wikipedia.org/wiki/K%C3%B6ppen_climate_classification>

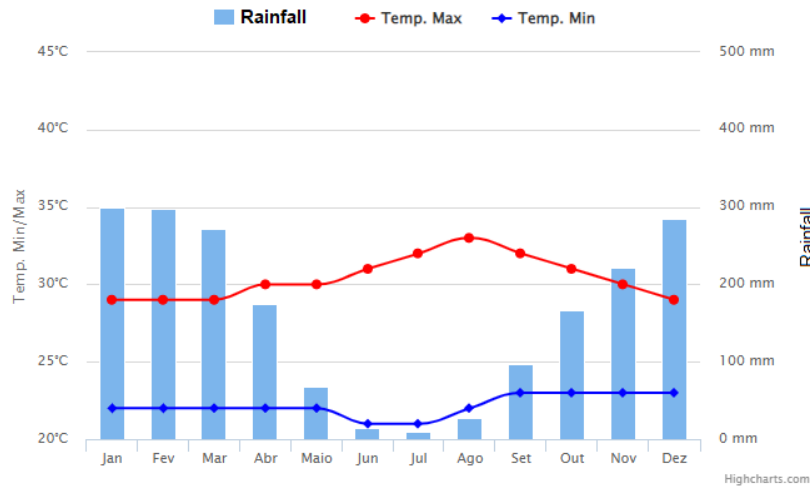
¹⁴ Available in <<https://www.cnpf.embrapa.br/pesquisa/efb/clima.htm>> Last visited on 24 March 2022

Figure 3. Variation of annual precipitation in the Project Area of the Juruena River REDD Project¹⁵



The graph below presents the temperature and rainfall pattern in Cotriguaçu. The period between May and September is the driest, and with the highest temperatures and thermal amplitude. From January to March the rainfalls are up to 300 mm per month, and maximum temperatures up to approximately 27°C.

Figure 4. Cotriguaçu's rainfall and temperature graph¹⁶



As the forest management activities are management activities are directly linked to rainfall and humidity conditions, it may be concluded that between 2009 and 2020, no major changes impacted this parameter, as the productivity period remains the same.

¹⁵ Precipitation Source: <https://www.worldclim.org/data/worldclim21.html>

¹⁶ Available at < <https://www.climatempo.com.br/climatologia/5471/cotriguacu-mt> > Last visited on 13/01/2022

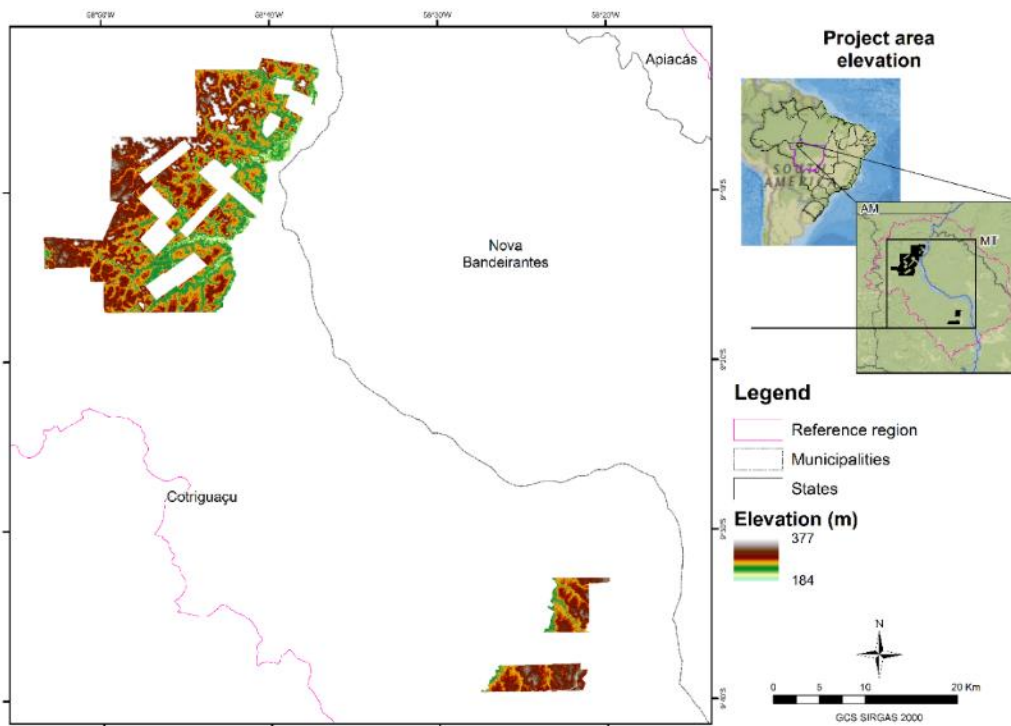
The project area is located within the Amazonica watershed, specifically in the Tapajós sub-basin, Baixo Juruena water management unit. The main river near the Project Area is the Juruena River; smaller rivers are Mureru, São João da Barra, and Bararati Rivers.

Geology, Topography and Soils

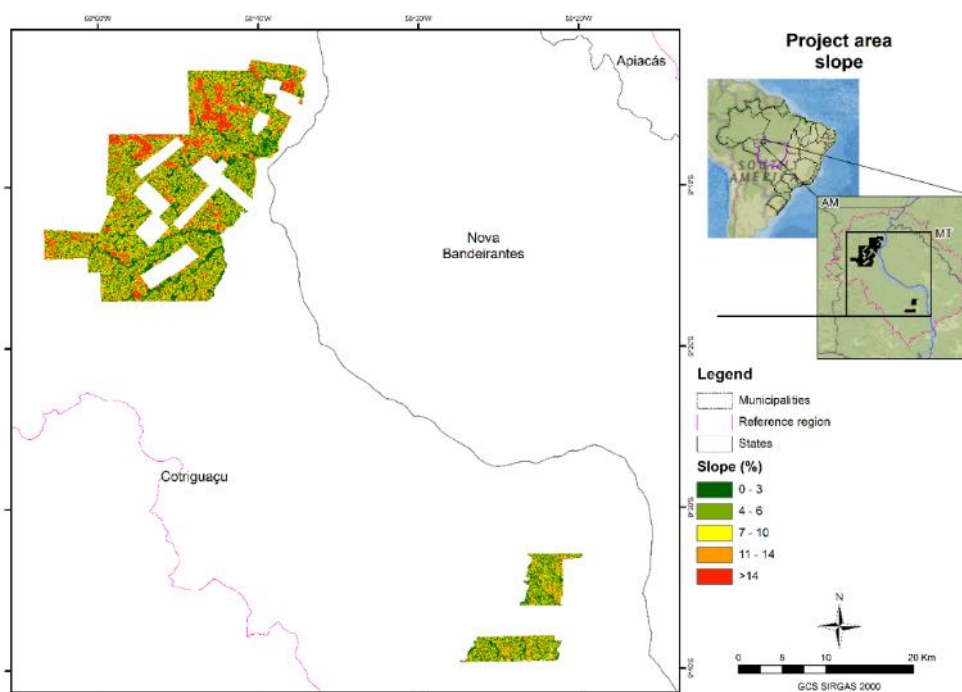
The Mato Grosso has modest altitudes, with large, flattened surfaces, carved in sedimentary rocks. In the north-central portion of the state, the sedimentary plateaus and crystalline plateaus (with altitudes between 400 and 800m) make up the central Brazilian plateau.¹⁷

In the project area, altitude variates from 184 to 377m, as shown in map below:

Figure 5. Project area elevation



¹⁷ Available in < <http://www.mt.gov.br/geografia> > Last visited on 24/03/2022

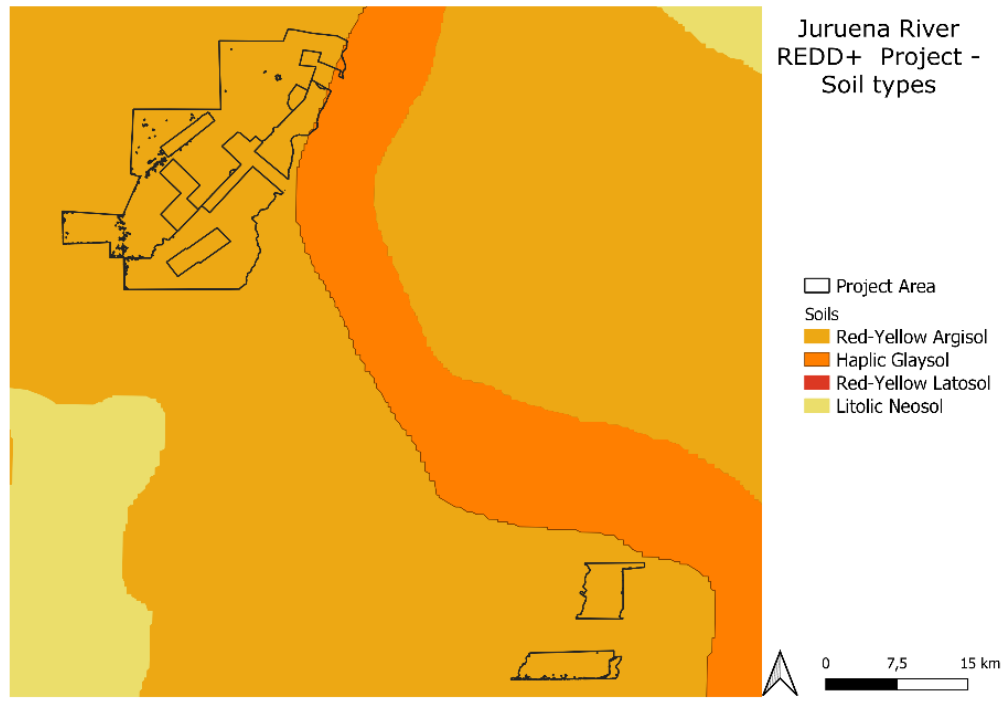
Figure 6. Project Area Slope variation


The predominant soil types within the project area are red-yellow argisoil and haplic gleysol. Red-yellow argisoils have very low to medium natural fertility. In Coastal Tablelands, these soils need correctives and fertilizers to obtain good crop productivity, requiring the use of organic matter in the superficial horizon, especially in sandy-textured soils¹⁸. Haplic Gleysols are mineral, hydromorphic soils, presenting A (mineral) or H (organic) horizons, followed by an olive-gray, greenish or bluish color horizon, called glei horizon, resulting from modifications suffered by the iron oxides existing in the soil in waterlogged conditions all or part of the year. They are poorly drained soils and may present a very variable texture along the profile¹⁹. Figure below presents the main soils in the region.

¹⁸ Available in https://www.agencia.cnptia.embrapa.br/gestor/territorio_mata_sul_pernambucana/arvore/CONT000gt7eon7k02wx7ha087apz2axe8nfr.html > Last visited on 24/03/2022

¹⁹ Available in <https://www.agencia.cnptia.embrapa.br/Agencia16/AG01/arvore/AG01_95_10112005101956.html> Last visited on December 24th, 2022.

Figure 7. Soils in the Project Area



With regard to geomorphology, Colniza and Cotriguaçu are located in the region of crystalline basement on rocks of the Xingu Complex and has as its characteristics the development of podzolized soils in its absolute majority, occurring sparsely less developed soils (Litolic and/or Cambisols) associated with steeply sloped landscapes. The landscape presents great variation, going from flat (river plains or tops of residual hills) to strong undulating. The occurrence of Dark Red Podzolics was also verified, however with little expression. Podzolics with a more yellowish color than normal, are very common and Litolic and Podzolic soils with rocky phase are also common in the region of the hills. The few river plains are made up of Plinthosols, and some islands of the Juruena River are made up of Little Humic Gleis and Alluvial Soils. The soils of Colniza, as mapped by the Socio-Economic-Ecological Zoning Project of the State of Mato Grosso, are represented by Yellow Alkaline Podzolic, which presents a moderate A horizon, medium/clay texture, flat relief. These are mineral soils, well-drained, deep and characterized by the occurrence of a textural B horizon under horizon A, which is of a moderate type.

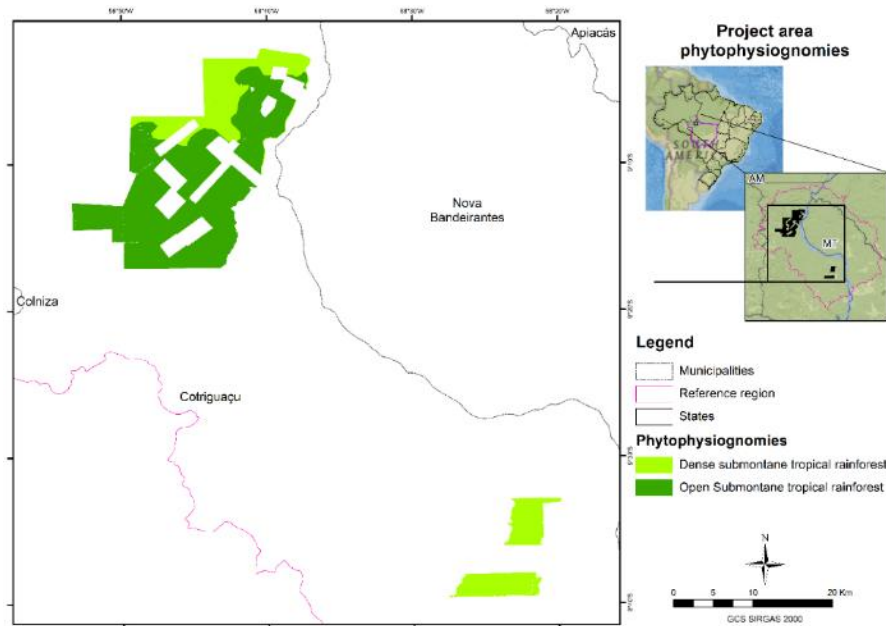
Vegetation cover

Mato Grosso is the only Brazilian state with three biomes: Amazon Rainforest, Cerrado and Pantanal. This makes the state unique, with great diversity and conservation importance. Of 141 municipalities, 86 are covered by the Amazon Rainforest. The Juruena River Project boundaries are 100% covered by Amazon Rainforest and are composed by 16 different phytophysiognomies.

Two vegetation types were found to be present in the project area: Open Submontane Tropical Rainforest, and Dense Submontane Tropical Rainforest. Other vegetation types present within the reference region

are Dense Alluvial Tropical Rainforest, Dense Tropical Rainforest, Open Tropical Rainforest, Seasonal Forested Savana, Seasonal Treed Savana, and Seasonal Deciduous Submontane Forest.

Figure 8. Vegetation cover in the Project Area



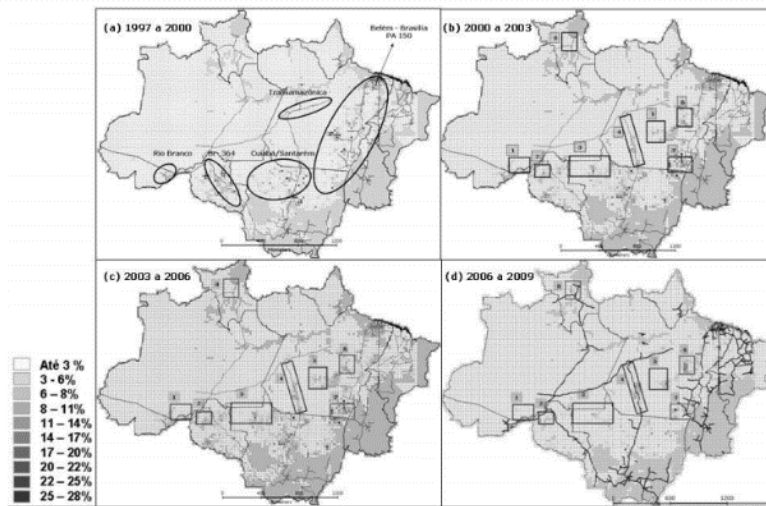
In recent years, the project region has been deforested for the expansion of agricultural and livestock activities, mainly due to the advancement of the so-called arc of deforestation from the south of the Amazon biome. This pressure is expected to continue, given the globalization of markets in the Amazon region and international development policies planned for the region²⁰.

According to NASA, deforestation in the Amazon Rainforest is occurring most rapidly along a curve that hugs the southeastern edge of the forest that scientists and resource managers have come to call the “Arc of Deforestation.” The land is cleared for cattle ranching, small-scale subsistence farming, logging, and, increasingly, soybean production for world markets²¹.

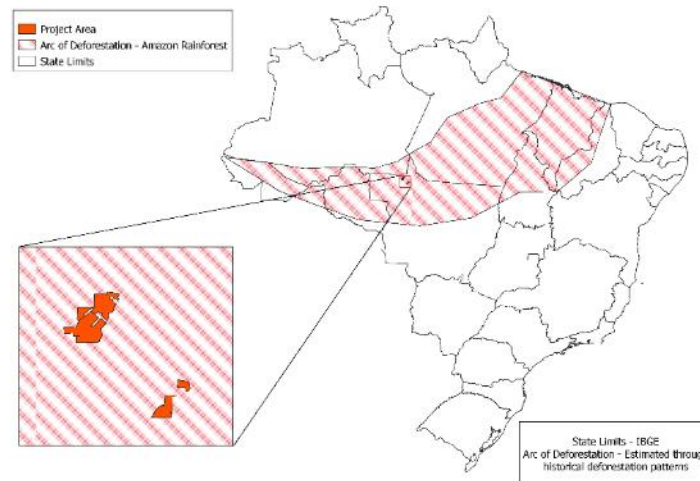
Image below shows that deforestation occurred, in the period of 1997 to 2009, in a concentrated pattern mainly along roads and in colonization projects, covering mainly the states of Pará, Maranhão, Mato Grosso, Rondônia and the south of Amazonas.

²⁰ Nepstad, D. C.; C. M. Stickler e O. T. Almeida. 2006. Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation. *Conservation Biology* 20(6):1595-1603. Available at < http://www.rmpceecologia.com/disciplinas/comunidades/Artigos_2007/nepstad_ecs2007.pdf>

²¹ Deforestation patterns in the Amazon – Available at < <https://www.earthobservatory.nasa.gov/images/4385/deforestation-patterns-in-the-amazon>> Last visited on 24/03/2022.

Figure 9. Arc of Deforestation in the Amazon Rainforest²²


This tendency is still observed nowadays, the region being the main route for cattle raising in the Amazon region. Map below presents the location of the project area in the to the arc of deforestation, estimated from the pattern of deforestation observed in the Amazon.

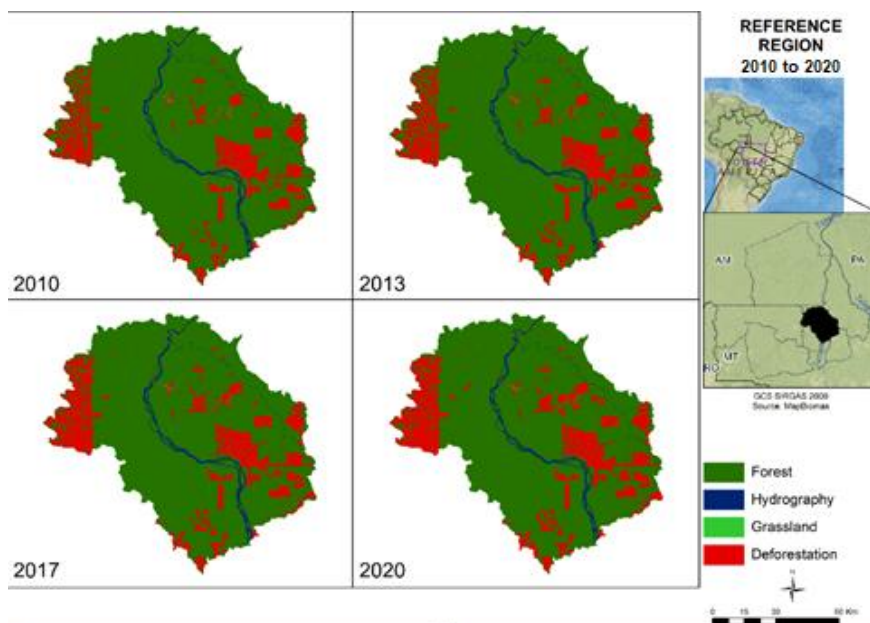
Figure 10. Project area and the Arc of Deforestation


Thus, conservation actions are essential in the region, establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Southern Amazon biodiversity and also to climate regulation in Brazil and South America.

It is possible to assess the conditions of the vegetation coverage throughout the historical period in the figure below:

²² VALERIANO et al., Dimensões do desmatamento na Amazônia Brasileira. In. George Martine, População e Sustentabilidade na era das mudanças ambientais globais: contribuições para uma agenda brasileira. p. 223-238, Inprint, Junho, 2012. Available at <http://www.dpi.inpe.br/geocxnets/wiki/lib/exe/fetch.php?media=urbis:visita-tecnica:inpe_desmatamento_abep_rio_20_mar_2012_revisado.pdf>

Figure 11. Deforestation in the historical reference period²³



Socio-economic conditions

The socio-economic conditions of the 4 municipalities that compose the project area are described below²⁴:

- **Cotriguaçu**

Population	Brazilian Census (2010): 14,983 habitants Estimated (2021): 20,717 habitants
Land occupation	The demographic density is 1,58 hab/km ² .
Economy	The GDP per capita of the municipality is R\$11,481. The average income is of 2.1 minimum wages, and only 6.3% of the population is categorized to carry out a professional activity (formal or informal, paid or not). This puts the city in lower positions in the State ranking, 87/141 and 136/141, respectively. 46.1% of the population lives in families with monthly income of up to half a minimum wage per person.
Education	The municipality has 87.9% of its 6-14 years population in school.

²³ Although the historical reference period is 2009-2020, the presented map includes 2010-2020 for better visualization.

²⁴ All information provided in this section is from IBGE surveys and may be consulted in <<https://cidades.ibge.gov.br/>>

Infrastructure	Only 4.8% of households have adequate sanitation; 1.4% of urban households are located on public roads with trees and 0.3% on public roads with adequate urbanization (presence of manhole, sidewalk, paving and curb).
HDI	0.601, which is considered medium ²⁵ .

- **Colniza**

Population	Brazilian Census (2010): 26,381 habitants Estimated (2021): 41,117 habitants
Land occupation	The demographic density is 0,94 hab/km ²
Economy	The GDP per capita of the municipality is R\$14,598.35. The average income is of 1.9 minimum wages, and 8.5% of the population is categorized to carry out a professional activity (formal or informal, paid or not). This puts the city in lower positions in the State ranking, 129/141 and 124/141, respectively. 45.7% of the population lives in families with monthly income of up to half a minimum wage per person.
Education	The municipality has 95.4% of its 6-14 years population in school.
Health	The average infant mortality rate in the city is 14.71 deaths per thousand live births.
Infrastructure	Only 2.9% of households have adequate sanitation; 6.9% of urban households are located on public roads with trees and 0.3% on public roads with adequate urbanization (presence of manhole, sidewalk, paving and curb).
HDI	0.611, which is considered medium.

- **Nova Bandeirantes**

Population	Brazilian Census (2010): 11,643 habitants Estimated (2021): 16,052 habitants
Land occupation	The demographic density is 1,21 hab/km ² .
Economy	The GDP per capita of the municipality is R\$ 14,653.26. The average income is of 1.9 minimum wages, and 10% of the population is categorized to carry out a professional activity (formal or informal, paid or not). This puts the city in lower positions in the State ranking, 129/141 and 115/141, respectively. 41% of the population lives in families with monthly income of up to half a minimum wage per person.
Education	The municipality has 93.8% of its 6-14 years population in school.

²⁵ UNDP uses five categories: very low (0 to 0.499); low (0.500 to 0.599); medium (0.600 to 0.699); high (0.700 to 0.799) and very high (0.800 to 1). Available at < <https://www.scielo.br/j/rbepid/a/nKC6pFSJnbKQsJHKNJhGMtF/?lang=en&format=pdf> >

Health	The average infant mortality rate in the city is 5.32 deaths per thousand live births.
Infrastructure	23.5% of households have adequate sanitation; 6.6% of urban households are located on public roads with trees and 0.7% on public roads with adequate urbanization (presence of manhole, sidewalk, paving and curb).
HDI	0.650, which is considered medium.

- **Apiacás**

Population	Brazilian Census (2010): 8,567 habitants Estimated (2021): 10,413 habitants
Land occupation	The demographic density is 0.42 hab/km ² .
Economy	The GDP per capita of the municipality is R\$ 16,475.26. The average income is of 2.2 minimum wages, and 10.8% of the population is categorized to carry out a professional activity (formal or informal, paid or not). This puts the city in lower positions in the State ranking, 71/141 and 103/141, respectively. 36.5% of the population lives in families with monthly income of up to half a minimum wage per person.
Education	The municipality has 95% of its 6-14 years population in school.
Health	The average infant mortality rate in the city is 42.11 deaths per thousand live births.
Infrastructure	5.7% of households have adequate sanitation; 1.5% of urban households are located on public roads with trees and 0% on public roads with adequate urbanization (presence of manhole, sidewalk, paving and curb).
HDI	0,675, which is considered medium.

Biodiversity

In addition to have a great value as carbon sinks and flora species, the region's local forests shelter a remarkable fauna diversity. According to the Management Plan of the Juruena National Park^{26,27}, located near the Project Area, there are at least two bird species identified as endangered according to IUCN criteria: the harpy eagle or harpy (*Harpia harpyja*), classified in the "almost threatened" category, and the black-throated brood (*Clytoctantes atrogularis*), in the "critically endangered" category.

²⁶ Information on the Juruena National Park available at < <https://uc.socioambiental.org/pt-br/arp/4252>> Last visited on 13/01/2022.

²⁷ Management Plan of the Juruena National Park available at < <https://www.icmbio.gov.br/portal/images/stories/imgs-unidades-coservacao/Resumo%20Executivo%20-%20PNJu.pdf>> Last visited on 13/01/2022

Figure 12. Harpy eagle or harpy (*Harpia harpyja*) (by Rafael Becker @rafabecker.nature)²⁸



Figure 13. Black-throated brood (*Clytactantes atrogularis*) (by Edson Guilherme)²⁹



Among the species of mammals threatened with extinction, the inventory of the Juruena National Park identified the Giant Anteater (*Myrmecophaga tridactyla*), the Giant armadillo (*Priodontes maximus*), the Ocelot (*Leopardus pardalis*), the Jaguar (*Panthera onca*), the Maracajá-mirim (*Leopardus wiedii*), the Giant otter (*Pteronura brasiliensis*), and the Zogue-zogue (*Callicebus cinerascens*).

Figure 14. Giant Anteater (*Myrmecophaga tridactyla*)³⁰



Figure 15. Giant armadillo (*Priodontes maximus*)³¹



²⁸ <https://www.ufrgs.br/faunadigitalrs/harpia-harpia-harpyja/> (accessed in 06/05/2021)

²⁹ https://www.researchgate.net/publication/290304061_A_range_extension_for_varzea_thrush_turdus_sanchezorum_in_South-West_Amazonia/figures?lo=1 (accessed in 06/05/2021)

³⁰ <https://ala-bie.sibbr.gov.br/ala-bie/species/127145> (accessed in 06/05/2021)

³¹ <https://www.icmbio.gov.br/portal/component/content/article/7093-priodontes-maximus> (accessed in 06/05/2021)

Figure 16. Giant otter (*Pteronura brasiliensis*)³²



Figure 17. Zogue-zogue (*Callicebus cinerascens*) (by Ricardo Sampaio)³³



Of all the species of fish collected, 25 were recorded at only one point, which may indicate that they are endemic to those locations or that studies on their distribution and biology are lacking. Thus, studies to date are still scarce, which indicates the great importance of local conservation.

Regarding reptiles, the Juruena National Park inventory indicated the presence of *Melanosuchus niger* (Black Caiman) as an endangered species, according to the IUCN (2007) list.

Figure 18. Black Caiman (*Melanosuchus niger*)³⁴



In the diagnosis of the Juruena National Park, the communities of Lepidoptera, Isoptera and Hymenoptera (Formicidae) were studied. Outstanding species were found, such as the butterflies *Pyrrhogyra amphiro amphiro*, *Dryas iulia*, *Philaethria dido*, *Morpho menelaus*, *Marpesia furcula*, *Anteos menippe* and *Eunica yburnean*, and the titan beetle *Titanus giganteus*. As an endangered species, the

³² <http://www.zoo.df.gov.br/ariranha/> (accessed in 06/05/2021)

³³

https://www.researchgate.net/publication/256496436_Novos_registros_com_uma_extensao_da_distribuicao_geografica_de_Callicebus_cinerascens_SPIX_1823/figures?lo=1 (accessed in 06/05/2021)

³⁴ <https://www.museu-goeldi.br/assuntos/colecoes/parque-zoobotanico/rpteisjicar.png/view> (accessed in 06/05/2021)

beetle *Macrodonia cervicornis* was mentioned, which is subject to illegal collection for the international clandestine market³⁵.

Figure 19. *Morpho menelaus*, *Marpesia furcula*, and *Eunica yburnean* (Management Plan - Juruena National Park)



Figure 20. Titan beetle (*Titanus giganteus*)³⁶



Figure 21. Endangered beetle *Macrodonia cervicornis*, which is illegally commercialized³⁷



1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law N° 12.651, 25/05/2012³⁸), 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.

³⁵ <http://g1.globo.com/Amazonia/0,,MUL1099738-16052,00-SITES+ESTRANGEIROS+VENDEM+INSETOS+BRASILEIROS+NA+INTERNET.html> (accessed in 07/05/2021)

³⁶ <https://netnature.wordpress.com/2013/10/08/besouro-gigante/> (accessed in 07/05/2021)

³⁷ <http://g1.globo.com/Amazonia/0,,MUL1099738-16052,00-SITES+ESTRANGEIROS+VENDEM+INSETOS+BRASILEIROS+NA+INTERNET.html> (accessed in 07/05/2021)

³⁸ BRASIL. Law n°. 12.651, of 25 May 2012. Forest Code. Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 25 May 2012. Available at < http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>

- 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 Amazon³⁹, eighty percent (80%) of a rural property should be preserved.

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 authorities⁴⁰. 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 Mato Grosso State Government. These management plans were conceived in accordance with Brazilian Forest Code and local regulation.

As the project activity involves planned logging, 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 5,975⁴¹ 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

³⁹ 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.

⁴⁰ MOUTINHO, P. *et al.* REDD no Brasil: um enfoque amazônico: fundamentos, critérios e estruturas institucionais para um regime nacional de Redução de Emissões por Desmatamento e Degradação Florestal – REDD. Brasília, DF: Instituto de Pesquisa Ambiental da Amazônia, 2011. Available at < https://ipam.org.br/wp-content/uploads/2015/12/redd_no_brasil_um_enfoque_amaz%C3%B4nico.pdf>

⁴¹ Available at < http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/decreto/d5975.htm>

24/04/2007⁴², 5, of 11/12/2006⁴³ and 2, of 27/06/2007⁴⁴; in addition to CONAMA's Resolution 406, of 02/02/2009⁴⁵

In the state of Mato Grosso, the Secretariat for the Environment (Sema/MT) is the body responsible for environmental licensing. with laws N°233/2005⁴⁶, N° 8,188/2006⁴⁷ and N°698/2021⁴⁸, and normative instruction IN 02/2018⁴⁹.

For this project activity, the Sustainable Forest Management Plan on a Business Scale (PMFS-EE) is considered, according to the classification of the Government of the State of Mato Grosso. All the documents in their entirety are available for consultation by the audit team.

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+⁵⁰.

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.

⁴² Available at < <https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=113233>>

⁴³ Available at < <https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=112909>>

⁴⁴ Available at < <https://www.ibama.gov.br/component/legislacao/?view=legislacao&force=1&legislacao=113306>>

⁴⁵ Available at < <https://www.ibama.gov.br/component/legislacao/?view=legislacao&legislacao=114762>>

⁴⁶ Available at <

<http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/250a3b130089c1cc042572ed0051d0a1/4f42663cdf699582042570f2004f4aa2?OpenDocument>> Last visited on December 9th, 2021

⁴⁷ Available at <

<http://app1.sefaz.mt.gov.br/Sistema/legislacao/legislacaotribut.nsf/2b2e6c5ed54869788425671300480214/d137b809227f6f4f0425720c00476358?OpenDocument>> Last visited on December 9th, 2021

⁴⁸ Available at <

<http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/d52df8648ccf16c004258712006af1e0?OpenDocument>> Last visited on December 9th, 2021.

⁴⁹ Available at < <https://www.legisweb.com.br/legislacao/?id=363548><https://www.semas.pa.gov.br/2015/09/11/in-05-de-10092015-publicada-no-doe-32969-de-11092015-paginas-de-37-57/>> Last visited on December 9th, 2021.

⁵⁰ The Decree is available in Portuguese at: <http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D10144.htm#art12> Last visited on 13/01/2022.

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 Juruena River project and such Decree.

In addition, the properties make frontier with a demarcated indigenous area. Thus, composing the legislative scope of this document, it is worth mentioning decree No. 10,088, of November 5, 2019⁵¹, which aims to create a binding international instrument dealing specifically with the rights of culturally traditional people. The basic concepts, which guide the interpretation of the provisions of the Convention, are the consultation and participation of the people concerned and their right to decide on their own development priorities as it affects their lives, beliefs, institutions, spiritual values and the land they occupy or use.

Annex LXXII to the decree provides for ILO Convention No. 169 on Indigenous and Tribal Peoples⁵², recognizing the right to possession and property and provides measures to be taken to safeguard the rights related to the land and territory that traditional communities inhabit or use collectively.

Recognizing, thus, the aspirations of these communities to take control of their own institutions and habits and their economic development, and to maintain and strengthen their identities, languages and religions, within the scope of the States where they live.

It is also worth mentioning decree No. 6,040, of February 7, 2007⁵³, which institutes the National Policy for the Sustainable Development of Traditional Peoples and Communities. According to Art. 2 “The PNPCT's main objective is to promote the sustainable development of the Traditional Communities, with an emphasis on recognizing, strengthening, and guaranteeing their territorial, social, environmental, economic and cultural rights, with respect and appreciation for their identity, their forms of organization and their institutions.

With that said, it is worth mentioning that the project respects the provisions of the law and does not interfere with the rights of indigenous people.

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

⁵¹ Available at < http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2019/decreto/D10088.htm#:~:text=DECRETO%20N%C2%BA%2010.088%2C%20DE%205,pela%20Rep%C3%BAblica%20Fed >

⁵² Available at < <https://www.oas.org/dil/port/1989%20Conven%C3%A7%C3%A3o%20sobre%20Povos%20Ind%C3%ADgenas%20e%20Tribais%20Conven%C3%A7%C3%A3o%20OIT%20n%C2%BA%20169.pdf> >

⁵³ Available at http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm >

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 has not sought or received another form of GHG-related environmental credit, including renewable energy certificates.

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

The primary objective of the Juruena River REDD+ Project is to avoid the unplanned deforestation (AUD) of its instances, consisting of 100% Amazon rainforest. The Project also has the function of establishing a barrier against the advancement of deforestation, making an important contribution to the conservation of Amazon biodiversity and also to climate regulation in Brazil and South America.

These measures contribute to several nationally stated sustainable development priorities, such as the objectives from the Brazilian Government related to the UN Sustainable Development Goals (SDGs)⁵⁴ 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 Brazil⁵⁵. 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.

⁵⁴ UN's Sustainable Development Goals and targets available at: <<https://sdgs.un.org/goals>> Last visited on 13/01/2022

⁵⁵ More information on the CNODS available at < <https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/comissao-nacional-para-os-objetivos-do-desenvolvimento-sustentavel-cnods>> Last visited on 13/01/2022.

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 IBGE⁵⁶ and by the IPEA reports⁵⁷. In addition, in 2018 there was the SDG Award, an initiative of the Federal Government whose objective is to encourage, value and give visibility to practices that contribute to achieving the goals of the 2030 Agenda throughout the national territory. The first edition of the Award had 1045 entries to compete in four categories: government; for-profit organizations; non-profit organizations; and teaching, research and extension institutions.

The Juruena River REDD+ Project main contributions to the Brazilian Priority Goals are listed below⁵⁸. These contributions are monitored by the parameters defined by the REDD project, in addition to additional standards, such as CCB and SOCIALCARBON. For more information, please consult the applicable social benefit report:

- SDG 1: No poverty

The project positively impacts people in situations of poverty and vulnerability, mainly through investments in the local community that lives in the vicinity of the project area, thus ensuring access to basic and essential services for human development. This SDG is monitored by the SOCIALCARBON methodology in the Social resource (1. Women inclusion, 2. Expansion of community activities, 3. Associations and Cooperatives), Human (5. Public health, 6. Community education and training), Financial (7. Alternative income sources, 8. Carbon credit benefits) and Natural (11. Social and environmental investments) in the SOCIALCARBON Report. Thus, the project collaborates with targets such as:

- 1.3 “Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable”;
- 1.4 “By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance”;
- 1.5 “By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters”.

- SDG 2: Zero hunger

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

⁵⁶ Available at < <https://odsbrasil.gov.br/relatorio/sintese>> Last visited on 13/01/2022

⁵⁷ Available at < <https://www.ipea.gov.br/ods/publicacoes.html>> Last visited 13/01/2022

⁵⁸ Available at < <https://odsbrasil.gov.br/>> Last visited 13/01/2022.

- 2.4 “By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
- SDG 3: Good health and well-being
Via carbon credits income, the project promotes the community's well-being and helps to solve local common issues. This SDG is monitored in the Social resource (2. Expansion of community activities) and Human (5. Public health) in the SOCIALCARBON Report. Therefore, the project may contribute to the following targets:
 - 3.3 “By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases”.
- SDG 4: Quality education
- The carbon project encourages the local community to participate in courses regarding technical skills and educational basis. Moreover, the carbon project encourages the development of partnerships with educational entities striving for socioenvironmental scholarly initiatives. This SDG is monitored in the Social resource (2. Expansion of community activities), Human (6. Community education and training), Financial (11. Social and environmental investments), and Carbon (17. Stakeholder consultation) in the SOCIALCARBON Report. The targets determined by the UN that will act as a guideline for monitoring actions are:
 - 4.1 “By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes”;
 - 4.4 “By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship”;
 - 4.5 “By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations”;
 - 4.6 “By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy”;
 - 4.7 “By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development”.
- SDG 5: Gender equality
The carbon project expects a continuous improvement concerning women's inclusion, such as through sponsoring events and initiatives which promote a gender equality environment. This SDG is monitored in the Social resource (1. Women inclusion, 2. Expansion of community

activities, 3. Associations and Cooperatives), in the SOCIALCARBON Report. Thus, the project may have initiatives that contribute to the following targets:

- 5.2 “Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation”;
- 5.4 “Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate”;
- **SDG 8: Decent work and economic growth**
 The REDD project aims to offer training and income generation in the project region as a measure to conserve native forest standing and promote economic viability and growth in the local community. This SDG is monitored in the Social resource (3. Associations and Cooperatives), Human (6. Community education and training), Financial (7. Alternative income sources), Natural (11. Social and environmental investments), Biodiversity (Non-timber forest products (NTFPs)) in the SOCIALCARBON Report. Guideline targets are:
 - 8.3 “Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services”;
 - 8.6 “By 2020, substantially reduce the proportion of youth not in employment, education or training”;
- **SDG 12: Ensure sustainable production and consumption patterns**
 The carbon project nurtures a better environmental management system since increases stakeholder awareness concerning the climate changes mitigations, and whichever environmental activity the landowners intend to apply. Alongside, the project is based on encouraging sustainable development and maintaining the standing forest through the sustainable use of its resources, and it aims to optimize access to non-timber forest products and the consumption of local inputs. One of the main objectives is to reduce illegal deforestation and profit from this activity, offering alternatives for income and extraction. This SDG is monitored in the following resources: Human Resource (6. Community education and training), Financial (7. Alternative income sources), Natural (11. Social and environmental investments), Biodiversity (13. Non-timber forest products (NTFPs)), and Carbon (17. Stakeholder consultation). The Juruena River REDD+ Project has the following target and guidelines:
 - 12.2 “By 2030, achieve the sustainable management and efficient use of natural resources”
 - 12.6 “Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
 - 12.8 “By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.”
- **SDG 13: Take urgent action to combat climate change and its impacts**
 Another of the main objectives of the REDD project is to reduce greenhouse gas emissions through the conservation of standing forest. Thus, its activity is already an action to combat

climate change and its effects. In addition, the project stimulates biodiversity monitoring initiatives in a measure to combat climate changes. This SDG is monitored in the Biodiversity (14. Biodiversity monitoring, 15. Impact on remaining flora) and Carbon (16. Buffer reduction, 18. Project performance) resources in the SOCIALCARBON Report. The targets and guidelines for this objective are:

- 13.2 “Integrate climate change measures into national policies, strategies and planning”;
- 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.
- SDG 15: To protect, restore and promote the sustainable use of terrestrial ecosystems, to manage forests sustainably, to combat desertification, to halt and reverse land degradation, and to halt the loss of biodiversity.

The project is based on the conservation and restoration of forests in the Amazon biome, ensuring forest services, preservation of natural resources, and biodiversity. This SDG is monitored in the Natural (11. Social and environmental investments) and Biodiversity (14. Biodiversity monitoring, 15. Impact on remaining flora, 15. Impact on remaining flora) resources in the SOCIALCARBON Report. The targets and guidelines related to this objective are:

- 15.1 “By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements”;
- 15.2 “By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally”;
- 15.5 “Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species”;
- 15.9 “By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts”;
- 15.a “Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems”;
- 15.c “Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities”.

Reducing deforestation and promoting sustainable development in the Amazon is also a key component to Brazil’s Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, Ministério do Meio Ambiente), the implementation of REDD+ activities are an important component to meet the Country’s contribution

under the United Nations Framework Convention on Climate Change while preserving natural forest resources⁵⁹.

The following components of the Brazilian commitments under the Convention are reinforced by the development of the Juruena River REDD+ Project:

- Strengthening and enforcing the implementation of the Forest Code, at federal, state and municipal levels;
- Strengthening policies and measures with a view to achieve, in the Brazilian Amazon, zero illegal deforestation by 2030 and compensate for greenhouse gas emissions from legal suppression of vegetation by 2030;
- Enhancing sustainable native forest management systems, through georeferencing and tracking systems applicable to native forest management, with a view to curb illegal and unsustainable practices.

1.17.2 Sustainable Development Contributions Activity Monitoring

As per guidelines provided in the Updates to VCS Program Released⁶⁰ and 2022 Q1 VCS Program Update: Overview of Substantive Updates to Program Rules & Requirements⁶¹ documents, the requirement of demonstration of contributions to a minimum of three SDGs is valid to all monitoring reports verified after the effective date. As item 4 of the documents mentioned above states, the effective date is "immediately for all projects that request registration with the VCS Program on or after 20 January 2023", or for "projects that request registration with the VCS Program before 20 January 2023 shall demonstrate contributions to at least three SDGs by 20 January 2025". As this project's registration is set to happen by the first semester of 2022, the second scenario will be the most likely on this case.

Therefore, the Sustainable Development Contributions table will be completed during the second monitoring period, within the deadline established by the Standard. Section 1.17.1 above includes detailed information on the contributions to be achieved by the project during the crediting period.

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;

⁵⁹ 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> > Last visited on 13/01/2022

⁶⁰ <https://verra.org/vcs-program-updates-released/>

⁶¹ <https://verra.org/wp-content/uploads/2022/01/VCS-Summary-of-Effective-Dates-2022-Q1.pdf>

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.

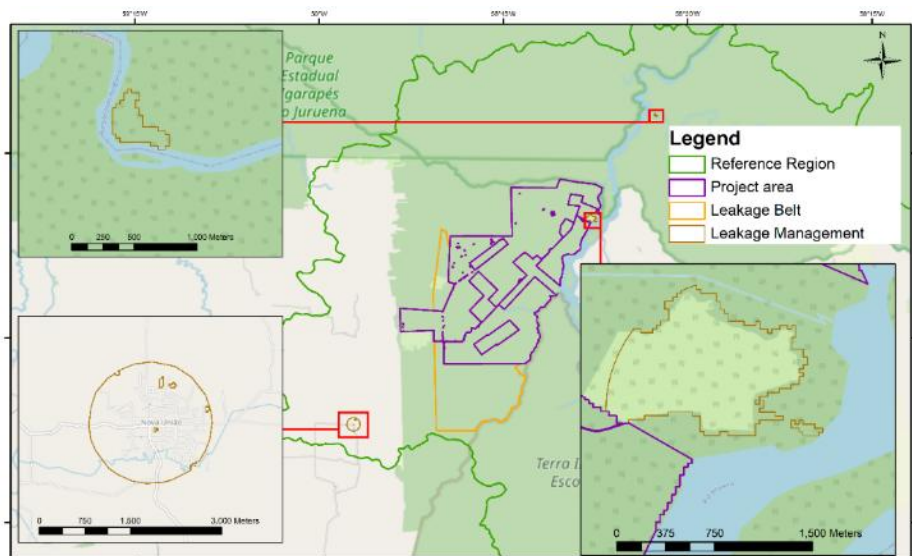
Leakage Management Area

The leakage management area (LMA) comprises non-forest areas located outside the project boundary in which the project proponent intends to implement the activities which reduce the risk of leakage in the project scenario. These activities must include the agents of deforestation and involve seeking new sources of income which contribute to forest conservation. Leakage management could involve agricultural, agroforestry, reforestation, education, or other activities.

To define the Leakage Management Area was defined in the nearest communities of instance 1 region. The defined non-forest area is 427.97 ha.

Figure below presents the location of the LMA:

Figure 22. Leakage Management Area



The Juruena River REDD+ Project has conducted a socio-economic diagnosis of the Leakage Management Area’s communities during the validation visit. More information on the characteristics of these stakeholders is available in section 2.1 and 2.5.

Leakage Management Plan

By means of Project monitoring activities, satellite imaging, and social and governmental cooperation for monitoring the project and its surroundings, the project proponent believes that the success of this

business plan will generate an increased number of sustainably managed areas with REDD+. This Leakage Management plan will be based on the monitoring parameters, in addition to being verified in every SocialCarbon, CCB or similar social-environmental benefit Report.

The main leakage management activities are outlined below:

- Surveillance activities designed to mitigate illegal logging and land occupation in the area will be achieved through the project activity. This process will be further consolidated through combined efforts with private and governmental entities, and NGOs.
- Inclusion of new instances: further areas with potential for REDD+ projects have already been identified around the project site, which will complement financial incentives obtained from credit sales and provide more social and environmental benefits to local communities.
- Combatting illegal land occupation: the local community will be strategic in monitoring illegal land occupation and potential illegal logging. Those who are interested in being trained and carrying out local monitoring will be included in the project, an activity which may also become a new source of income for local communities.
- Additional Social Standard: the SOCIALCARBON methodology is currently being applied and it will serve as a plan and guideline for carrying out activities and achieving goals, in addition to assessing progress in each monitoring period. In this way, the owners are committed and add value to the carbon project with each action taken, encouraging long-term sustainable development. The SocialCarbon methodology drives continuous improvement in the local community through prospects (at least one per resource, totaling 6 improvement actions), in which the project owner undertakes to implement them until the next monitoring period. To guarantee the evolution of the socioenvironmental scenario in the region, SocialCarbon Standard requires that at least 50% of the actions suggested in the previous Point must be implemented, under the risk of losing the Standard. The monitoring period for SocialCarbon should be the same as the monitoring period for the Carbon Accounting Standard.

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

Juruena River REDD Project has conducted a social and environmental assessment within the Leakage Management Area. The performance of the socio-environmental diagnosis and in site consultation with

local stakeholders happened during the project's validation. In addition, literature research was also performed to enhance information collected during the onsite visit that were vague or incomplete.

The social diagnosis includes the communities identified as Leakage Management Area: TI Apiaká do Pontal, Nova União District (located in the Nova Cotriguaçu Settlement), TI Escondido and the Seu João's Inn. Information on the location of these communities and leakage management plan is detailed in section 1.17 above.

Apiaká do Pontal e Isolados Indigenous Land (TI Apiaká do Pontal e Isolados)

During the onsite visit, it was possible to interview representants of the Aldeia Matrinxã, native village within the indigenous land that have direct access to the Project Area. It was stated that 57 people live in the community, and 30 of them are kids. According to official information, 262 people live in the demarcated land⁶²

Their main income is the collection of Brazil Nut and tourism activities. The community also explores and sell Copaíba oil.

They sell the Brazil Nuts in cans, producing between 25 and 30 tons. In 2021, the price of the can was R\$120.00, and they sold it for R\$40.00 to middlemen who take the product to Goiania.

To dispose of the nut production, they travel a long way to the truck, crossing the Juruena River, and Mr. Cassio's properties. During the rainy season, the path becomes impassable.

In the Indigenous Land there is a doctor, nurse, health agent and dentist available, but they communicate that there is a lack of structure within the village for patient care. The lack of basic sanitation is the main health issue. The village's medical care is at the Juara hub, while the indigenous health coordination is at Colíder.

The village has electrical energy, provided by a diesel generator.

Escondido Indigenous Land (TI Escondido)

Due to difficulties to contact a representant of the TI Escondido, the Land Management Plan for the territory⁶³ and official information⁶⁴ was used as social environmental diagnosis.

Latest data inform that 45 people live in the demarcated land, from the Rikbaktsa ethnicity. This area also includes isolated indigenous people (Indigenous groups with no permanent relations with national societies or infrequent interaction, either with non-Indians or with other indigenous peoples.)

According to the social diagnosis, the main activities are hunting, fishing and agriculture, mainly for subsistence, in addition to the Brazil Nut extraction. The diagnosis also states that there was a large flow of people in the demarcated area, since many families from other regions did not adapt to the area.

⁶² Available at < <https://terrasindigenas.org.br/pt-br/terras-indigenas/5001>>

⁶³ Available at < <https://www.icv.org.br/publicacao/plano-de-gestao-territorial-terra-indigena-do-escondido/>> Last visit 16/03/2022

⁶⁴ Available at < <https://terrasindigenas.org.br/pt-br/terras-indigenas/3657>>

Nova Cotriguaçu Settlement (Nova União District)

According to the interviews with Nova União residents it was not possible to state the number of people living in the district since the population fluctuates. However, he stated that the urban center population is greater than in the urban area of Cotriguaçu. It was noted that the timber workers operating in the management areas and the extractivists who collect nuts in the project area are from Nova União.

ICV Developed a social environmental diagnosis in three communities of the Nova Cotriguaçu settlement⁶⁵, with approximately 200 families. Their main activities and income come from cattle ranching (including dairy cattle), working in Nova União and Nova Esperança stores and services and agriculture (mainly subsistence). It also states that the entire settlement contains 1502 lots, comprising ten communities and 2 nuclei, Nova União and Nova Esperança.

Seu João's Inn (Pousada do Seu João)

João and his Family have an inn that that drives tourism and employs indigenous people and residents of the settlement, on a rotating basis.

In addition to the acknowledge of the socioenvironmental conditions of the communities, the application of additional standards, such as the SOCIALCARBON certification will also quantify the main potential environmental and socio-economic risks.

The table below provides details on the identified potential risks:

Table 2. Main social, economic and environmental impacts of the Juruena REDD Project

Activity	Aspect	Impact	Effect		Comments/ Observation
			Beneficial	Adverse	
REDD: Carbon credit project	Environmental - Conservation of Amazon Rainforest	Greenhouse Gas Emissions Reductions	X		Monitored by the Carbon resource: <ul style="list-style-type: none"> Project performance Monitored by the Natural resource: <ul style="list-style-type: none"> Quality control
REDD: Carbon credit project	Environmental - Conservation of Amazon Rainforest	Monitoring and supervision to avoid deforestation of forest within the project area.	X		Monitored by the Biodiversity resource: <ul style="list-style-type: none"> Impact on remaining flora Monitored by the Natural resource: <ul style="list-style-type: none"> Quality control

⁶⁵ Available at < https://www.icv.org.br/drop/wp-content/uploads/2013/08/29132cartilha_cotriguacu.pdf>

REDD: Carbon credit project	Social - Conservation of Amazon Rainforest	Conflict management with communities in the project area, due to banning of timber product extraction.		X	<p>Monitored by the Carbon resource:</p> <ul style="list-style-type: none"> Stakeholder consultation <p>Monitored by the Human resource:</p> <ul style="list-style-type: none"> Conflict management
REDD: Carbon credit project	Social/Economic - Empowerment	Increased independence of the communities in the project area.	X		<p>Monitored by the Social resource:</p> <ul style="list-style-type: none"> Associations and cooperatives Expansion of community activities Women inclusion <p>Monitored by the Human resource:</p> <ul style="list-style-type: none"> Community education and training <p>Monitored by the Financial resource:</p> <ul style="list-style-type: none"> Alternative income sources <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> Social and environmental investments <p>Monitored by the Biodiversity resource:</p> <ul style="list-style-type: none"> Non timber forest products (NTFPs)
REDD: Carbon credit project	Social/economic - Application of the Social Carbon methodology	Encouragement and investment in social, economic and environmental aspects in the project region.	X		<p>Monitored by the Social resource:</p> <ul style="list-style-type: none"> Expansion of community activities <p>Monitored by the Human resource:</p> <ul style="list-style-type: none"> Community education and training <p>Monitored by the Financial resource:</p> <ul style="list-style-type: none"> Carbon credit benefits <p>Monitored by the Natural resource:</p>

					<ul style="list-style-type: none"> • Social and environmental investments <p>Monitored by the Carbon resource:</p> <ul style="list-style-type: none"> • Project performance
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The identified impacts will be monitored through the indicators described on the last column of the table above.

In addition to the risks described above, Ecológica Assessoria has identified other risks that could affect the project activity, which are also described by the SOCIALCARBON indicators. These risks are described on Table below:

Table 3. Significant risks to the project

Activity	Aspect	Risk	SOCIALCARBON Indicators that will monitor the identified potential risks
REDD carbon project	Environmental - Uncertainties relating to standing forest in the future.	Non permanence of carbon: Time which carbon will remain stocked in live biomass, without being emitted into the atmosphere. Due to the uncertainties related to what will happen to the forest in future, there is a risk of non-permanence of forest carbon.	<p>Monitored by the Carbon resource:</p> <ul style="list-style-type: none"> • Buffer reduction

<p>REDD carbon project</p>	<p>Environmental/Social - Land demarcation process</p>	<p>Risk of land invasion by deforestation agents</p>	<p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> • Land Tenure <p>Monitored by the Human resource:</p> <ul style="list-style-type: none"> • Conflict management
<p>REDD</p>	<p>Environmental - Sustainable forest management plan</p>	<p>Risk of non-performance of the sustainable forest management plan</p>	<p>Monitored by the Financial resource:</p> <ul style="list-style-type: none"> • Alternative income sources <p>Monitored by the Biodiversity resource:</p> <ul style="list-style-type: none"> • Non timber forest products (NTFPs)

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, this risk will also be assessed by the SOCIALCARBON Indicator described on the last column of the table above, in addition to any other applicable social-environmental additional standard.

2.2 Local Stakeholder Consultation

As preconized in VCS standard 4.2 (item 3.16.11), the project proponent conducted an assessment of the local stakeholders that are potentially impacted by the project. Information on local stakeholders at the start of the project are included in this section of the VCS PD.

Local entities having some influence, activities and impact on the Reference Region were chosen through a process to identify them. Stakeholders chosen for local consultation also included potentially impacted communities and neighbors. Thus, the output list of stakeholders from this analysis is described below:

- Nova União District (Nova Cotriguaçu Settlement)
- Apiaká do Pontal e Isolados Indigenous
- Escondido Indigenous
- ICV – Instituto Centro Vida

- APVA MT – Associação de Proteção da Vida e Meio Ambiente de Mato Grosso
- Prefeitura Municipal de Cotriguaçu
- EMPAER MT – Empresa Mato-Grossense de Pesquisa, Assistência e Extensão Rural
- SEAF – Secretaria de Estado da Agricultura Familiar
- SEDEC – Secretaria de Desenvolvimento Econômico do Estado do Mato Grosso
- UFMT – Universidade Federal de Mato Grosso
- UNEMAT – Universidade do Estado do Mato Grosso
- SEMA – Secretaria de Estado do Meio Ambiente do Mato Grosso
- GDR – Gabinete de Articulação e Desenvolvimento Regional
- Associação Mato-Grossense dos Municípios
- Secretaria Municipal de Meio Ambiente de Cotriguaçu
- ISA – Instituto Socioambiental
- IPAMR – Instituto de Pesquisa Ambiental da Amazônia
- ICMBIO – Instituto Chico Mendes de Conservação da Biodiversidade
- FUNAI – Fundação Nacional do Índio
- FORMAD – Fórum Mato-Grossense de Meio Ambiente e Desenvolvimento
- OPAN – Operação Amazônia Nativa
- Embrapa Agrossilvipastoril
- INCRA – Instituto Nacional da Colonização e Reforma Agrária – Superintendência Regional do Mato Grosso
- Instituto Ação Verde
- FAMATO – Federação da Agricultura e Pecuária do Estado do Mato Grosso
- Sindicato Rural de Colniza
- Sindicato Rural de Cotriguaçu
- SENAR – Serviço Nacional de Aprendizagem Rural
- Secretaria Municipal de Desenvolvimento Econômico, Agricultura, Assuntos Fundiários e Meio Ambiente de Cotriguaçu
- Secretaria Municipal de Agricultura e Meio Ambiente de Nova Bandeirantes
- Programa de Saúde da Família Rural de Nova Bandeirantes
- Associação de Agricultores Comunitária Rural Nova União
- WWF Brasil
- IPAM – Instituto de Pesquisa Ambiental da Amazônia
- PCI – Produzir, Conservar e Incluir
- INTERMAT – Instituto de Terras do Mato Grosso

- FEC – Fundação Ecológica Cristalino
- IFPDS – Instituto Florestal de Pesquisa e Desenvolvimento Sustentável
- FEPOIMT – Federação dos Povos e Organizações Indígenas do Mato Grosso
- Instituto Kurâdomôdo Cultura Sustentável
- Sistema Estadual de REDD+ de Mato Grosso/Programa REM-MT

As required in VCS standard 4.2, item 3.16.15, the management teams involved in the project have expertise and prior experience implementing land management and carbon projects with community engagement at the project scale. Information on project team is further detailed as part of the Non-permanence Risk Analysis.

As required in VCS standard 4.2, item 3.16.17, for the “Local stakeholder consultation”, a comprehensive project summary was actively presented to the communities and other stakeholders in Portuguese in the field, by project agents. In both consultation modalities, the project proponent communicated in a didactic way:

- 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 project design, implementation, monitoring and evaluation throughout the project lifetime. Therefore, complying with VCS Standard 4.2 (item 3.16.18), 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 Proponent’s own e-mail address, which is gradela@terra.com.br.

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 Feedback and Grievance Redress Procedure has three stages (VCS Standard 4.2; item 3.16.18):

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

- 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 is dependent on local jurisdiction delays.)

Due to the worldwide Corona Virus pandemic that was established in 2020, security and protection measures had to be taken to carry out the consultation with stakeholders. Regarding the stakeholders located in urban areas, which are mostly government agencies, an invitation letter and e-mail were sent, briefly presenting the project and inviting them to the remote consultation. This presentation was a detailed summary of the proposed activities regarding project implementation and monitoring.

The on-site consultation with stakeholders (riverside communities) took place where the presence of housing is located. The meeting had a simplified presentation about the project, a map was used to explain where all project activities and its repercussions are and/or will be located, exposing the risks and benefits resulting from the project activities for the population.

The riverside communities were consulted individually and on site by project proponent and Ecológica's team, and a simple and accessible language was adopted, appropriate to the colloquial discourse used by these communities, in order to facilitate their understanding. During the consultation, comments, suggestions, and criticisms made by these parties were collected.

Furthermore, in general, these consultations also communicated:

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

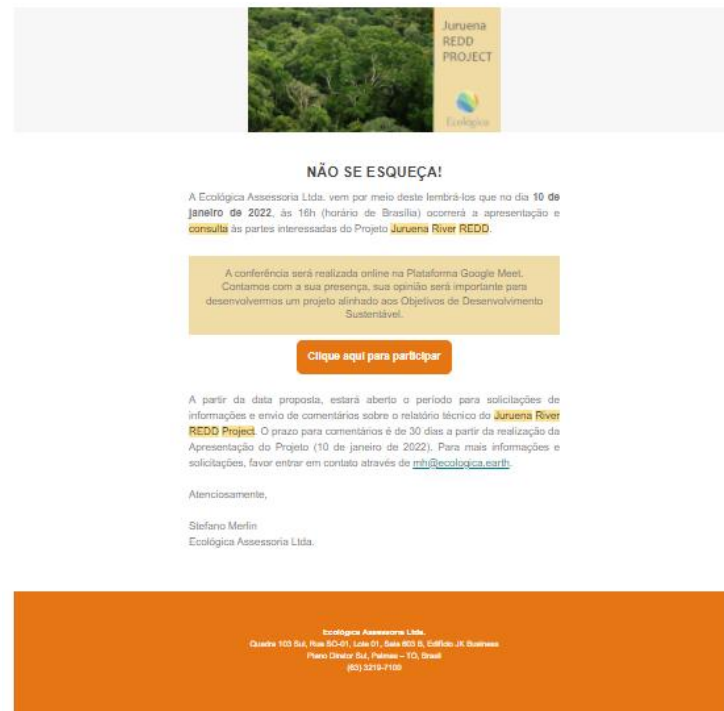
During the Local Stakeholder Consultations, no comments or suggestions regarding the project design were made, and thus, no modifications were made in the PDD after the meetings. A detailed description of each consultation is provided below:

Online consultation

Figure 23. Invitation letter sent for the online consultation.



Figure 24. Invitation e-mail sent for the online consultation



The online local stakeholders' consultation was held on 10-January-2022, at 4pm (Brasília time zone) on a Virtual Conference Platform.

The presentation detailed a summary of the proposed activities of the project implementation and monitoring.

The presentation described the information of the carbon project. In addition to the introduction of the forest management information, the carbon project development process, deforestation monitoring and projection methods, project area, reference region, leakage belt, etc. were also explained. The Social Carbon Standard, its co-benefits, monitoring methods and methodology were also explained, as well as the relationship with the UN's Sustainable Development Goals.

Contact information for Ecológica Assessoria was made available at the end of the meeting. Communication can be carried out via letter, email or telephone.

Although the invitations were sent 30 days prior to the scheduled date, in addition to several reminder e-mails, no stakeholders attended the meeting. Thus, the presentation was recorded and, together with the pdf with the information presented was sent through e-mail.

Communities' consultation

The onsite consultation took place from 10 –20 February 2022, visiting the communities close to the Project Area and official government agencies. The meeting had a simplified presentation about the project, exposing the risks and benefits resulting from the project activities for region. The project's location, context of climate change and the threat of deforestation were discussed with the communities in an informal conversation, with the consulted sharing their perceptions and experiences on the subject. The report with the summary of the meeting and comments from the stakeholders will be made available to the VVB.

- **Nova União Settlement**

The Community leader was consulted and shared that they have a few social projects that may be helped by the project, such as sports and environmental education for the kids and Brazil Nut collection programs.

A representant of the nut collectors was also consulted and suggested that the project contributed to the planting of Brazil Nut Trees in other areas, to guarantee future harvesting.

- **Apiaká do Pontal e Isolados Indigenous – Matrinxã indigenous village**

The Community stated that they live in the indigenous land for approximately 4 years, with 57 people and over 30 kids. Their main income is the collection of Brazil Nuts and tourism. After the presentation of the project, they commented on their main demands, suggesting some points where the carbon project could benefit the tribe: Technical instruction to optimize the nut collection (mapping the trees, sustainable production, etc); construction of a shed for nut storage, to avoid rodents and roads for transport. It was concluded by them that they needed environmental and social resources. The community was very interested in the project, wanting to know more information, and commented that all decisions were made together with the rest of the indigenous community.

- Questions about the project:
 - o Will it be good for the indigenous? – It was explained that one of the main objectives of the project is to contribute with the sustainable development of the surrounding community as a strategy to avoid illegal deforestation. The landowner and project developers are available to receive their suggestions and complaints about the project, including their needs so that the project is better designed.
 - o Is the project safe? – The project is done according to all the international Standard requirements, and it goes through third party audit in every validation and verification step.

- **Juruena Settlement Brazil Nut Collectors Association (ACCPAJ)**

The organization has 26 associates, 21 of them active. The consultation included comments about their activities and how the project will be able to contribute with their organization, mainly with training and infrastructure.

- **State Park Igarapés do Juruena**

The park manager was consulted to present the project and its importance to the conservation of the forest in the region.

- **Cotriguaçu’s City Hall**

The mayor and the Economic development, agriculture, land affairs and environment secretary were consulted to present the project and its importance to the conservation of the forest in the region.

Figure 25. Pictures of the Local Stakeholder Consultation





In addition, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. During the visit, an informative folder will be distributed, containing address, e-mail and telephone number of Ecológica Assessoria. Thus, the channel is available for any comment, suggestion or criticism. These will be registered and forwarded to the responsible part.

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

All comments will be received, and outcomes will be documented and stored in digital format. The SOCIALCARBON methodology will also analyze the frequency and methods used for addressing the outcomes of each local stakeholder consultation, which will be analyzed at each verification event.

2.3 Environmental Impact

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

The Amazon Biome, the location of a hugely diverse fauna and flora, spreads over almost 50% of the Brazilian territory⁶⁶. 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 destruction⁶⁷. To quantify further, this biome holds the biggest variety of species in the world, and deforestation and degradation of tropical forests are the main causes of global biodiversity loss⁶⁸.

A further benefit, as mentioned in previous sections of this PD, is that the Juruena River 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 high-pressure cattle ranching region. This creates a high urgency situation in which levels of pressure and priority for conservation are high.

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

2.4 Public Comments

The public comments period was available in the Verra website from 23 November 2021 - 23 December 2021. The project received 3 comments, addressed below:

- 1) Is this Project is falling in Ocean?

The VCS Project Database coordinates were updated to correct the project location. The Project is located in the State of Mato Grosso, in Brazil.

- 2) Geographic coordinates missing in Figure 1.

Geographic coordinates were corrected in the VCS Project database and included in the PD.

- 3) Since this project area is located next to highly deforested area. How proponent maintain the deforestation levels?

The project aims to reduce deforestation and external pressure in the region through mitigating activities, such as greater monitoring of the areas, socio-environmental activities and income generation with the surrounding community, motivated by the sharing of benefits generated by the carbon project, monitored and guided by social-environmental additional standards, such as the SOCIALCARBON Standard.

⁶⁶ 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_biomass/>.

⁶⁷ Margulis S. Causas do Desmatamento da Amazônia Brasileira. BANCO MUNDIAL. Brasil. July, 2003. Available at: <<http://www.terrabrazilis.org.br/ecotecadigital/pdf/causas-do-desmatamento-da-amazonia-brasileira.pdf>>.

⁶⁸ 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.terrabrazilis.org.br/ecotecadigital/index.php/estantes/diversos/2115-serie-biodiversidade-28-inter-relacoes-entre-biodiversidade-e-mudancas-climaticas>>.

2.5 AFOLU-Specific Safeguards

Local Stakeholder Identification and Background

According to the VCS Standard, version 4.2, 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 and previous visits in the project region. As detailed in section 2.2, stakeholders were identified considering the Reference Region and Project Area communities, government agencies and protection and research entities in the Pará State and the Amazon biome, in addition to NGOs. Sustainable development and Rural development agencies were also contacted. The list is available at section Local Stakeholders Consultation above.

The project and actions involving the community will be monitored by SOCIALCARBON indicators or any other applicable social-environmental standard at each verification event, which will analyze the extent of alternative income generation sources and further programs and alternative income sources, 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. The landowner recognizes the presence of the communities around the project area and takes efforts to maintain a healthy relationship with them. These communities have no land ownership inside the project area or conflicts with the owner.

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

The Decree No. 6,040 of February 7, 2007⁶⁹, 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 institutions⁷⁰.

The Policy is structured around four strategic axes:

1. Access to Traditional Territories and Natural Resources
2. Infrastructure

⁶⁹ Available at <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/decreto/d6040.htm> Last visited on 05/01/2021.

⁷⁰ Available at <<https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf>> Last visited on 05/01/2021

3. Social Inclusion and
4. Promotion and Sustainable Production.

As previously described in section 1.17, these are also the objectives 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)⁷¹.

Specially regarding indigenous people's rights, Brazil has the Indigenous Statute (Law 6.001/73), which regulates the legal situation of indigenous communities, with the purpose of preserving their culture and integrating them, progressively and harmoniously, with the national communion. The Statute guarantees that the protection of the country's laws is extended to the Indians and the indigenous communities, in the same terms as they apply to other Brazilians, safeguarding indigenous uses, customs and traditions, as well as their peculiar conditions, recognized by Law.

It is important to highlight that in Brazilian constitution, it is defined in article 231 that indigenous people are recognized for their social organization, customs, languages, beliefs and traditions, and their original rights over the lands they traditionally occupy, which the Union is responsible for demarcating, protecting and ensuring respect for all their assets. Demarcated indigenous lands are owned by the Federal Government, and, according to the federal constitution, inalienable and unavailable, and the rights over them, imprescriptible.

In addition, in the internal regulations of the National Indigenous Foundation (FUNAI), isolated tribes are guaranteed "the exercise of their freedom and traditional activities without the obligation to contact them". In this sense, it is up to the Official Indigenist Body, in the exercise of police power, to discipline the entry and transit of third parties in areas where the presence of isolated Indians is found, as well as to take the necessary measures to protect these groups (art. 7, Decree No. 1,775 / 96), by restricting the entry of third parties in these areas.

Studies on the location and monitoring of isolated indigenous people follow some basic guidelines, in the context of the constitutional guarantee of their protection, which is the basis of the Policy for Isolated Indians, namely⁷²:

- a) To guarantee isolated and recently contacted indigenous the full exercise of their freedom and traditional activities;
- b) Ensure that the finding of the existence of isolated indigenous people does not determine the obligation to contact them;

⁷¹ Available at <<https://direito.mppr.mp.br/arquivos/File/DireitodospovosedascomunidadesradicionaisnoBrasil.pdf>> Last visited on 05/01/2021.

⁷² Available in <<https://www.gov.br/funai/pt-br/atuacao/povos-indigenas/povos-indigenas-isolados-e-de-recente-contato-2/povos-isolados-1>> Last visited on December 03rd, 2021.

- c) Promote systematic field actions aimed at geographically locating and obtaining information about isolated indigenous people;
- d) Promote the regularization and protection of lands inhabited by isolated indigenous people, including all the natural resources existing in them;
- e) Ensure priority and special attention to the health of isolated and recently contacted indigenous, due to their situation of particular vulnerability;
- f) Ensure the protection and preservation of the culture of isolated people, in their various forms of manifestation;
- g) Prohibit, within areas inhabited by isolated people, any and all economic and/or commercial activity (Ordinance No. 281 / PRES / FUNAI, of April 20, 2000).

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

Thus, the project is not based on or planning the removal or alteration of these people's way of life, guaranteeing land use and subsistence production, in addition to traditional customs and methodologies.

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 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 agencies and NGOs, communication was carried out in writing and orally, with the presentation of the project, its impacts and monitoring methodologies, accounting for credits and actions in the region via online. In a different way, for the communication of the project to the traditional communities located in the reference region and project area, a consultation was carried out considering their particularities for planning the future of the project.

These communities have their rights guaranteed by federal, state and municipal legislation, in addition to assistance from NGOs and various agencies, which is 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.

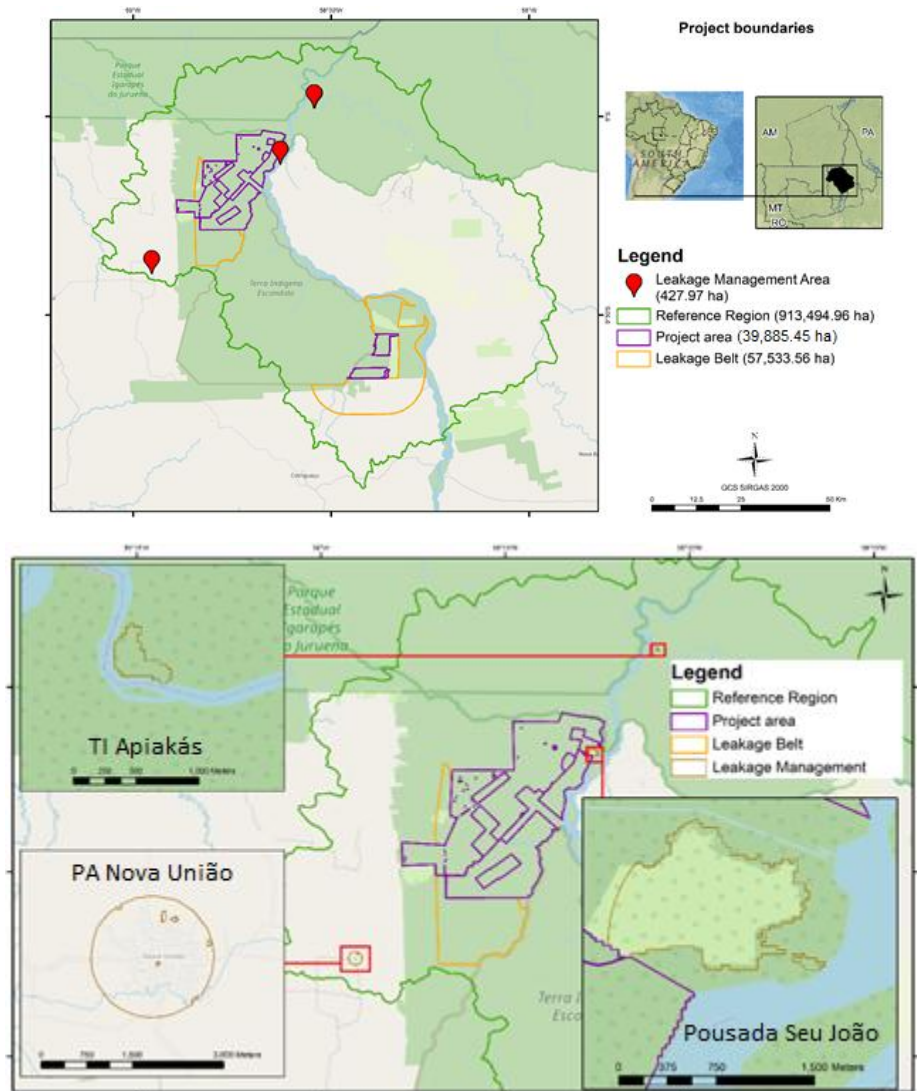
5. The expected changes in well-being and other stakeholders' characteristics under the baseline scenario, including changes to ecosystem services identified as important to local stakeholders:

The risks and impacts of the project are analyzed in the No Net Harm section, designing mitigation strategies for each impact observed. No alteration of the community area, methodology or way of life in general is predicted. It is planned that the project's revenue will be invested in more socio-environmental programs to involve the local community and minimize 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:

As presented in section 1.18, location of the communities is presented in figure below:

Figure 26. Project boundaries and communities' location



The location of the communities is described below:

Figure 27. PA Nova União - 9°22'3.38"S 58°57'13.39"W



Figure 28. TI Apiakas - 8°56'56.35"S 58°32'38.30"W



Figure 29. Pousada Seu João - 9° 5'25.89"S 58°37'48.40"W



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

The area used by the communities is included on the Leakage Management Area and 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 stakeholder’s doubts. 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	
Sustainable Forest Management Plan	Logging		X	<p>The properties have a Sustainable Forest Management Plan, exploring a volume within the authorized by the Exploitation License.</p> <p>Monitored by the Biodiversity resource:</p> <ul style="list-style-type: none"> ● Impact on remaining flora <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Quality Control

Sustainable Forest Management Plan	Reduced access to land due to expansion of exploration		X	<p>The region where the communities live is not within the Management Plan, and therefore will not be affected by logging activities. In any case, the expansion of the exploration is not foreseen, and, if any, it will be communicated and carried out in order to avoid the displacement of residents or limitation of land access.</p> <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Quality Control ● Land Tenure
Resources	Withdrawal of natural, economic and cultural resources (water, food, alternative income, cultural events, etc.) from families		X	<p>The region where the communities live is not within the Management Plan, and therefore will not be affected by logging activities. The project's objective is to guarantee financial resources to maintain sustainable and certified wood management and also to expand the socio-environmental benefits for the communities within and around the Project Area. Thus, certifications and the use of Social Carbon are a guarantee that there will be no reduction in access and/or withdrawal of resources from impacted families.</p> <p>Monitored by the Biodiversity resource:</p> <ul style="list-style-type: none"> ● Non-timber forest products (NTFPs) <p>Monitored by the Carbon resource:</p> <ul style="list-style-type: none"> ● Stakeholder consultation <p>Monitored by the Financial Resource:</p> <ul style="list-style-type: none"> ● Alternative income sources

<p>Land access</p>	<p>Reduced access to traditional areas</p>		<p>X</p>	<p>The management plan area does not include communities' access regions, and therefore, they will not be affected by the maintenance of activities. There are no plans to expand the management area, and communities are guaranteed access to customary land.</p> <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Quality Control ● Land Tenure
<p>Land use</p>	<p>Displacement of families due to project activity</p>		<p>X</p>	<p>Families will not be removed from the area currently used. The project owner maintains a relationship with the families, and one of the objectives of the carbon project is to expand social and environmental benefits. The owner recognizes the permanence and land use of the families in the project area, and any changes will be previously communicated.</p> <p>Monitored by the Human resource:</p> <ul style="list-style-type: none"> ● Conflict management <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Land Tenure
<p>Food Security</p>	<p>Withdrawal of land used for food production or income generation</p>		<p>X</p>	<p>The management plan area does not include communities' access regions, and therefore, they will not be affected by the maintenance of activities. The areas for planting / ranching for subsistence or for selling for income generation will not be included in the management plan and the removal of these lands is not planned.</p> <p>Monitored by the Biodiversity resource:</p> <ul style="list-style-type: none"> ● Non-timber forest products (NTFPs) <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Land Tenure

Climate change adaptation	Adaptations and impacts related to the climate crisis	X	<p>The main objective of the project is forest conservation, avoiding 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 population. The project also contributes to achieving climate justice, since the groups that suffer most from climate change are the vulnerable and traditional communities.</p> <p>Monitored by the Financial resource:</p> <ul style="list-style-type: none"> ● Carbon Credit Benefits <p>Monitored by the Natural resource:</p> <ul style="list-style-type: none"> ● Social and environmental investments <p>Monitored by the Carbon resource:</p> <ul style="list-style-type: none"> ● Project performance
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Respect for Local Stakeholder Resources

The project recognizes, respects, and supports local stakeholders’ customary tenure/access rights to territories and resources. The project will never encroach on private property or relocate people off their lands without consent. In the event there are any ongoing or unresolved conflicts over property rights, usage or resources, the project shall undertake no activity that could exacerbate the conflict or influence the outcome of an unresolved dispute.

The project owner intends to offer benefits and training for the local community, including health related benefits, in addition to providing education for children and women, as established and monitored by the Social Carbon methodology.

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

Communication and Consultation

The project will take all appropriate measures to communicate and consult with local stakeholders in an ongoing process for the life of the project. As described above, the project intends to carry out local stakeholders consultations (to be held on site after the end of the pandemic), which will be monitored by social-environmental certification by additional standards. 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 stakeholders consultations.

For validation and verification, two consultations were held, one online and one on site.

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 received Ecológica's contacts 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

Approved VCS Methodology VM0015 "Methodology for Avoided Unplanned Deforestation", Version 1.1, 3 December 2012⁷³

Tool for the demonstration and assessment of additionality in VCS agriculture, forestry and other land use (AFOLU) project activities Version 3.0, 1 February 2012⁷⁴

AFOLU "Non-Permanence Risk Tool" VCS Version 4, Procedural Document, 19 September 2019, v4.0⁷⁵

3.2 Applicability of Methodology

VM0015

⁷³ Available at < <https://verra.org/wp-content/uploads/imported/methodologies/VM0015-Methodology-for-Avoided-Unplanned-Deforestation-v1.1.pdf>>

⁷⁴ Available at < <https://verra.org/wp-content/uploads/2017/11/VT0001v3.0.pdf>>

⁷⁵ Available at < https://verra.org/wp-content/uploads/2019/09/AFOLU_Non-Permanence_Risk-Tool_v4.0.pdf>

Applicability Conditions	Instance 1 Project Activity Justification of Applicability
<p>a) Baseline activities may include planned or unplanned logging for timber, fuel-wood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.</p>	<p>None of the baseline land-use conversion activities are legally designated or sanctioned for forestry or deforestation, and hence the project activity qualifies as avoided unplanned deforestation. This is in accordance with the definition of unplanned deforestation under the VCS Standard v4.2.</p> <p>The primary land uses in the baseline scenario are: cattle ranching, mainly for producing beef cattle; and timber harvesters, acting both legally and illegally. These unplanned deforestation and degradation agents have been attracted due to infrastructure expansion, such as waterways and roads. Therefore, the present criteria are fulfilled.</p>
<p>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).</p>	<p>The instance 1 project activity falls within category B, “Avoided Deforestation with Logging in the Project Case”. The project area contains 100% native vegetation, and a sustainable forest management plan is implemented. In addition, it is important to note that degradation is not included in either the baseline or project scenario.</p>
<p>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 agro-forestry systems meeting the definition of “forest”.</p>	<p>The forest classes that compose the project area are named as per Technical Manual for</p>

	<p>Brazilian Vegetation⁷⁶. The area is considered forest as per the definition of forest adopted by FAO⁷⁷: 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.</p> <p>No deforested, degraded or areas otherwise modified by humans were included in the project area at Project Start Date.</p>
<p>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.</p>	<p>The project area consisted of 100% tropical rainforest in 2009 – over 10 years prior to the project start date – all of which conformed to the Brazilian definition of forest⁷⁸. This was ascertained using satellite images, as described in the section Project Location of the present VCS PD.</p>
<p>e) The project area can include forested wetlands (such as bottomland forests, flood plain 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 a forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.</p>	<p>Project Area is composed of Red-Yellow Argisol and Haplic Gleysol. Therefore, none of the project region grows on peat, satisfying this applicability criterion. Project area does not contain any wetlands, as detailed in section 3.3 Project Boundary.</p>

VT0001

⁷⁶ Available at <<https://www.terrabrasilis.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf>>

⁷⁷ Available at <

[https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20\(FRA%202000%20Main,of%20other%20predominant%20land%20uses.>](https://www.fao.org/3/y4171e/y4171e10.htm#:~:text=FAO%202000a%20(FRA%202000%20Main,of%20other%20predominant%20land%20uses.>)

⁷⁸ 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>>.

Applicability Conditions	Instance 1 Project Activity Justification of Applicability
<p>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;</p>	<p>The activities in the proposed project boundary does not lead to violation of any applicable law even if the law is not enforced. The sustainable forest management plan is an activity authorized and endorsed in Brazil, and the landowner has all the environmental and legal authorizations necessary to conduct the activity.</p>
<p>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.</p>	<p>The methodology provides a stepwise approach to justify determination of the most plausible baseline scenario.</p>

3.3 Project Boundary

Spatial Boundaries

Table below presents the Project Area, Leakage Belt and Reference Region measurements:

Table 5. Project Area, Reference Region and Leakage Belt

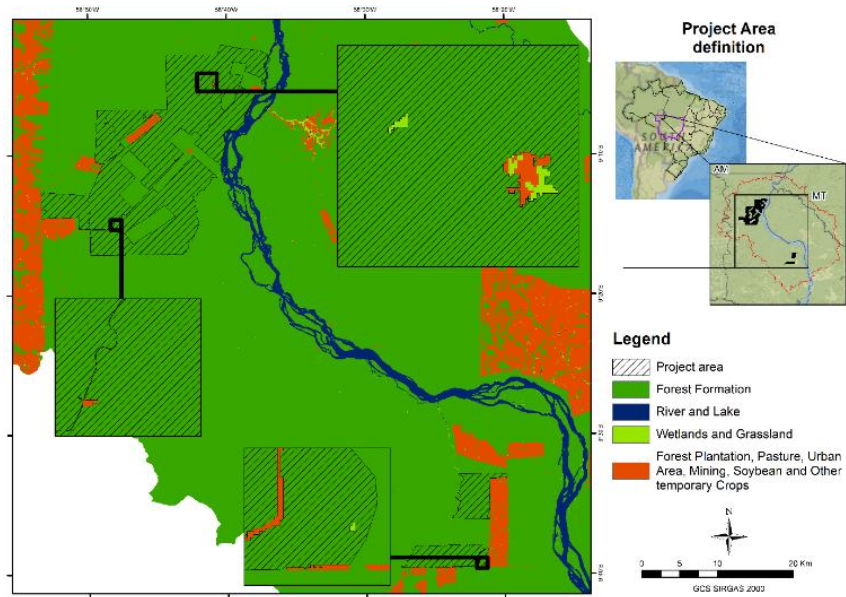
Name	Area (ha)
Project Area – Instance 1	39,885.45
Leakage Belt	95,954.86
Reference Region	913,611.33

- Project Area – Instance 1

The Instance 1 Project area is formed by 14 properties, which has a total area of approximately 49,675.75 ha, covered almost in its totality by native vegetation. 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.

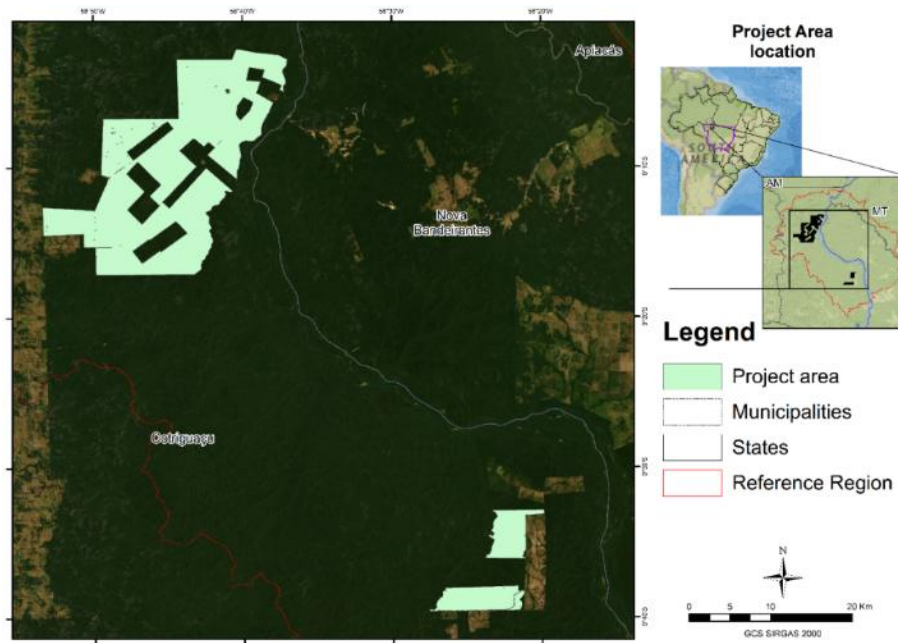
The figure below details the non-forest areas that were removed from the project area:

Figure 30. Project Area definition



From the property's area, the areas of planned deforestation were subtracted, adding a 25m buffer to avoid accounting for deforestation related to the mapping of planned deforestation. Areas deforested up to the project start date, vegetation areas classified as rural formation and areas of water bodies were also excluded. As a result, the project area had an extension of 39,885.45 ha.

Figure 31. Juruena River REDD Project Area



Further characteristics of the Project Area are described in section 1.13.

- **Reference Region**

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

According to the applied methodology, as no applicable sub-national or national baseline is available, and the country or subnational region has not been divided in spatial units for which deforestation baselines will be developed, a baseline must be developed for a 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 two criteria:

- The methodology recommends that projects under 100,000 ha in size should have RRs 20 – 40 times bigger than the project area.
- 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 more accurately represent the land-use dynamics. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the principal means of human and product transportation in the region. As such, from the areas directly surrounding the project, the RR was expanded to meet the nearest main waterways and roads.

In addition, according to the methodology, three main criteria are relevant to demonstrate that the conditions determining the likelihood of deforestation within the project area are similar or expected to become similar to those found within the reference region:

- **Agents and drivers of deforestation:** Timber logging (both legal and illegal) and cattle ranching are important economic activities within the reference region. As detailed in section 1.13 and to be presented in section 3.4, the main agents of deforestation, timber harvesting and cattle ranching, are considered threats throughout the southern Amazon region. Thus, the analysis of the Reference Region definition includes these factors.
- **Socio-economic and cultural conditions:** The methodology implies that “The legal status of the land (private, forest concession, conservation concession, etc.) in the baseline case within the project area must exist elsewhere in the reference region. If the legal status of the project area is a unique case, demonstrate that legal status is not biasing the baseline of the project area.” This is complied with the areas surrounding the Properties that are not public or part of any protected area, such as 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 is the private areas available at Brazil’s Environmental Rural Registration⁷⁹, National Protected Areas⁸⁰:

⁷⁹ Available at < <https://www.car.gov.br/publico/imoveis/index>>

⁸⁰ Available at <<http://mapas.mma.gov.br/i3geo/datadownload.htm>>

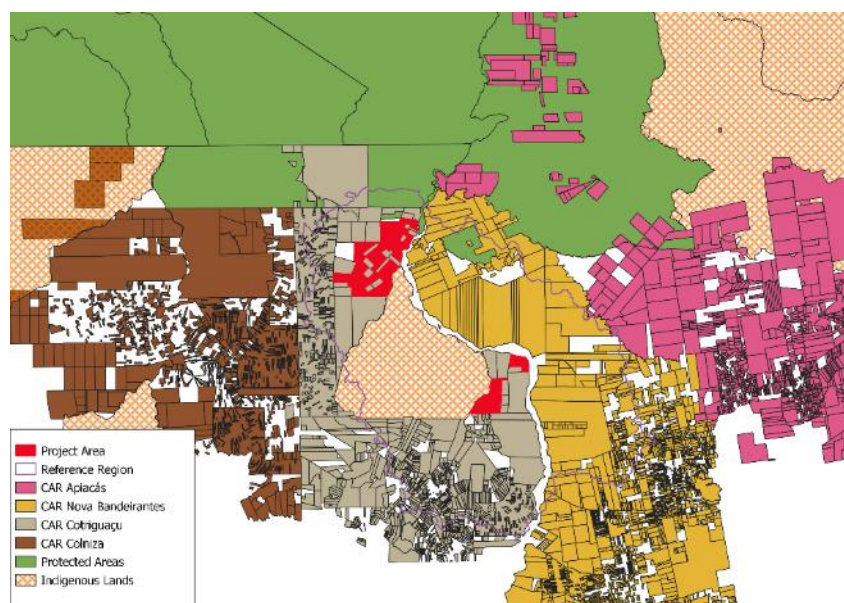
Figure 32. Private and state areas surrounding the project properties


Table below illustrates the protected areas within the reference region. It was noted that even if these areas are institutionally protected, deforestation can still occur within them⁸¹ and the probability of future deforestation should vary according to the weights of evidence calculated in the historic period. It is also noted that over 50% of the remaining extension has land conditions similar to the project area:

Table 6. Assessment of overlap of the Reference Region with Public Areas

Area	Settlement	Indigenous Land	Protected Area – Sustainable Use	Protected Area – Full protection
Reference Region (ha)	58,417.63	174,612.70	599.36	185,019.30
Reference Region (%)	6.69%	19.99%	0.07%	21.18%

- **Landscape configuration and ecological conditions:** To define the Reference Region, hydrographic basins were used within an area of 17.851.280 hectares around the project area, from the drainage network produced by the SRTM digital elevation model. For each of these basins, the average values of elevation, slope and precipitation and the percentages of different types of vegetation were determined. Based on these values, basins that presented values close to these parameters to the values of the project area were selected.

⁸¹ Deforestation within protected areas rises 315% in May, 2021. Available in <
<https://sustentabilidade.estadao.com.br/noticias/geral,desmatamento-em-unidades-de-conservacao-aumenta-312-em-maio,70003748646>>

Then, an attempt was made to select basins until reaching an extension of approximately twenty times the size of the project area.

From the definition of this area, which has 913,611.33 ha, the criteria related to the type of vegetation, elevation, slope and precipitation were tested to verify the similarity to the project area and the rest of the reference region. For the four variables, the values meet the criteria, indicating the adequacy of the reference region. The results are presented below:

Vegetation cover

Two vegetation types were found to be present in the project area: Open Submontane Tropical Rainforest, and Dense Submontane Tropical Rainforest. In the reference region, these phytophysiognomies occupy 90.47%. Other vegetation types present within the reference region are Dense Alluvial Tropical Rainforest, Dense Tropical Rainforest, Open Tropical Rainforest, Seasonal Forested Savana, Seasonal Treed Savana, and Seasonal Deciduous Submontane Forest.

Figure 33. Vegetation cover of the Reference Region. Source: IBGE

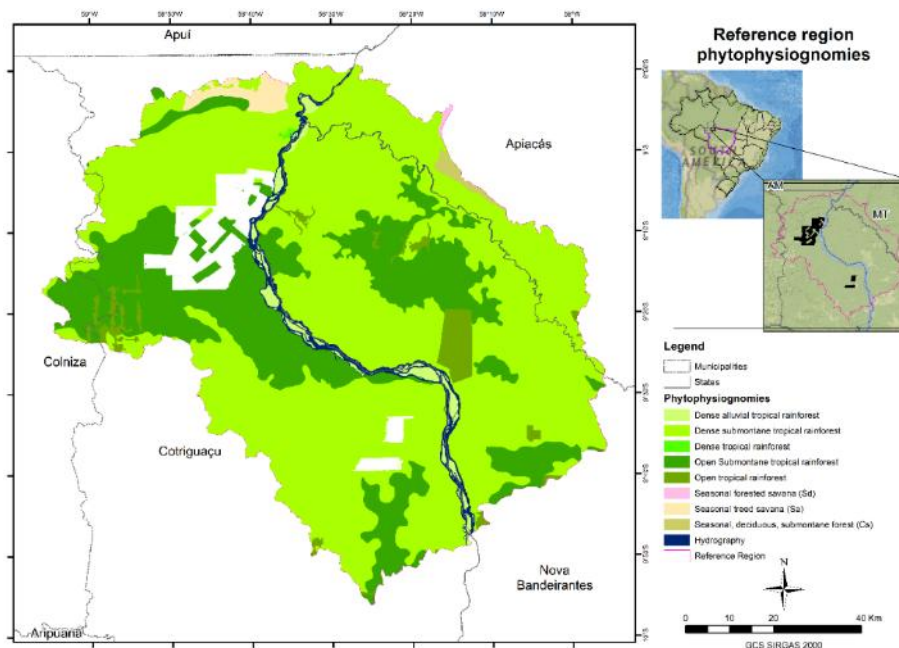
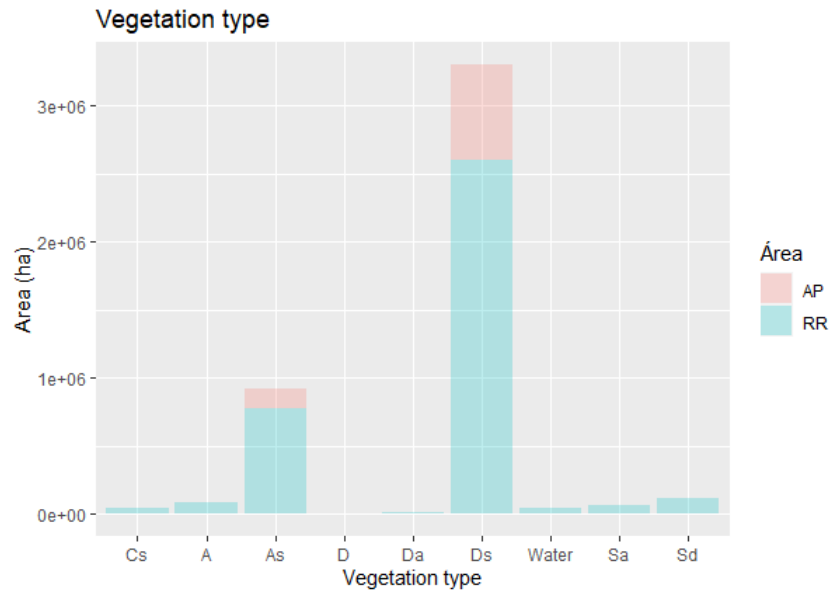


Figure 34. Distribution of vegetation types, in hectares, in the Reference Region and in the Project Area



Altitude

The altitude in the project area ranges from 184 to 377 m and these values are within 94.50% of the variation in the rest of the reference region, as show in figures below.

Figure 35. Altitude variation in the Reference Region of the Juruena REDD Project. Source: SRTM

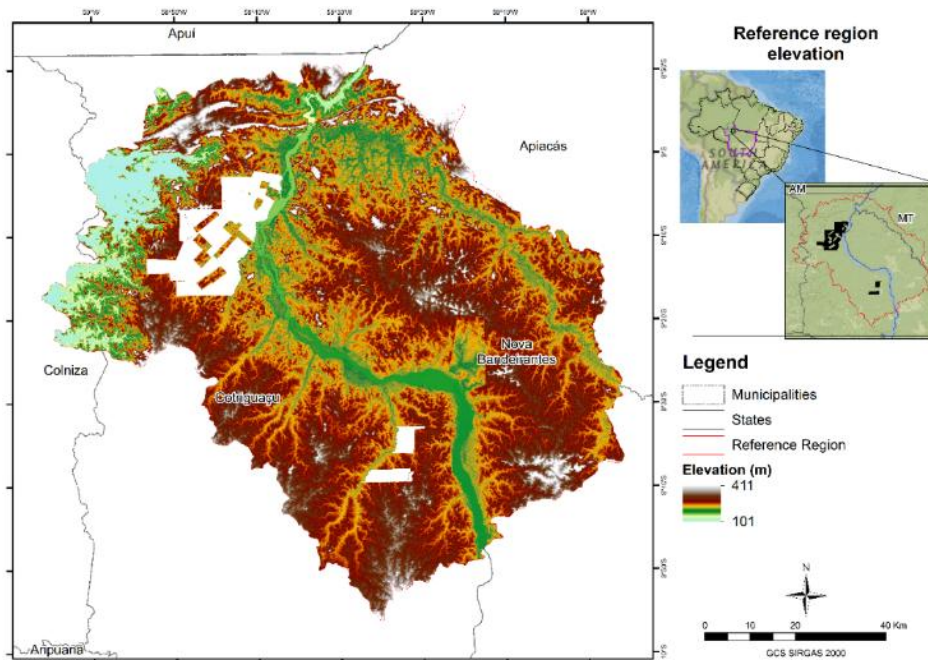
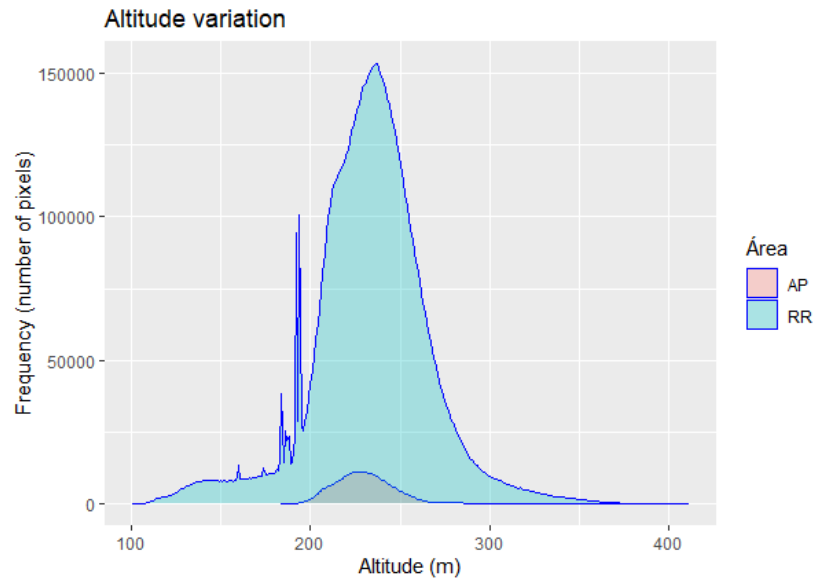


Figure 36. Altitude distribution (m), in number of pixels, in the Reference Region (RR) and in the



Slope

The average slope in the project area is 7.41% while in the rest of the reference region it is 7.70% (Figure 10). Therefore, the mean value of 100% of the project area is within the range of $\pm 10\%$ of the mean in the reference region, which is between 6.93 and 8.47%.

Figure 37. Slope variation in the Juruena River REDD reference region. Altitude source: SRTM

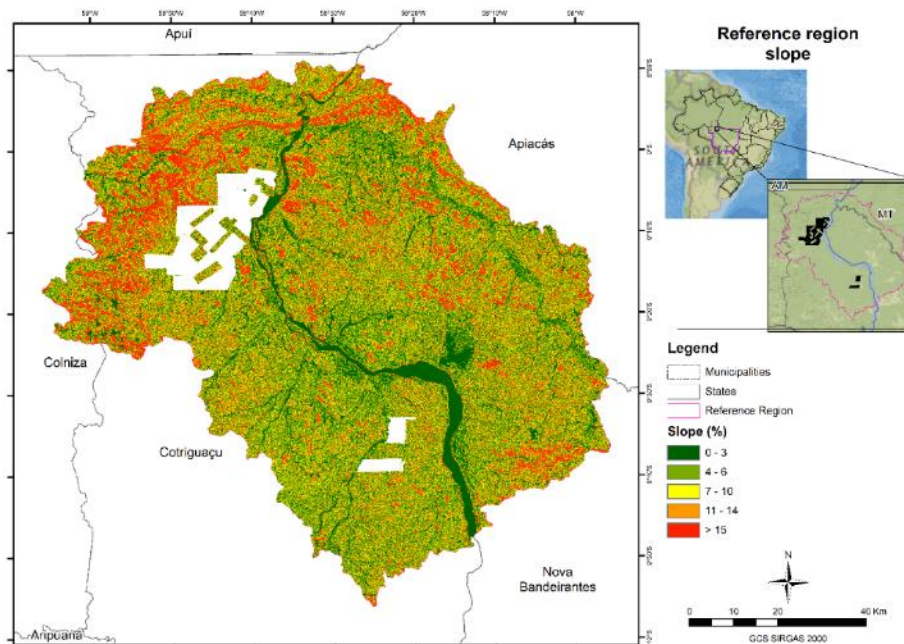
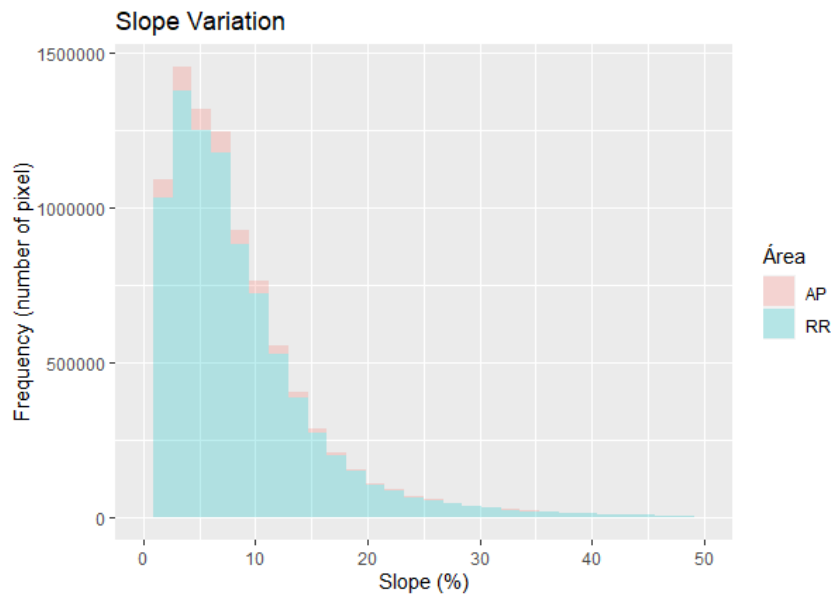


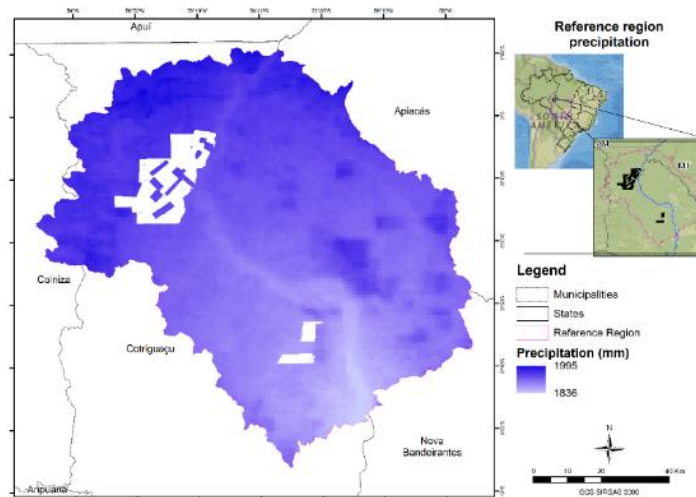
Figure 38. Slope distribution (degrees), in number of pixels, in the Reference Region and in the Project Area



Rainfall

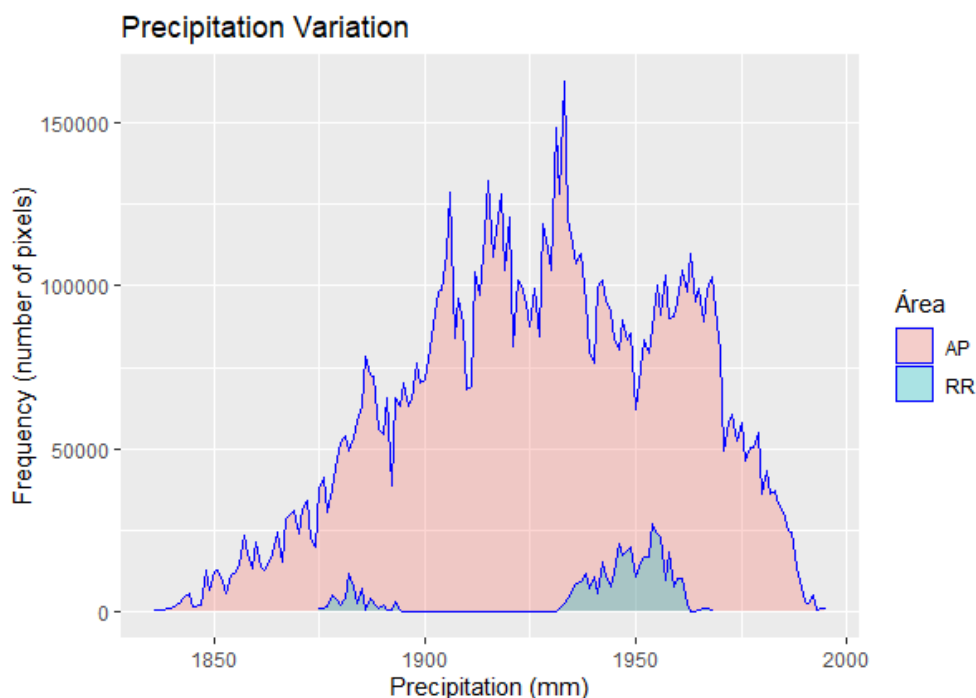
The annual rainfall in the project area is, on average, 1,940.3 mm, while in the rest of the reference region it is 1,927.7 mm. Thus, it is verified that the amount of rainfall in the project area remains within the variation of $\pm 10\%$ of 100% of the average of the rest of the reference region, which varies between 1,734.6 and 2,120.4 mm.

Figure 39. Variation of annual precipitation in the Reference Region⁸²



⁸² Rainfall data available at < <https://www.worldclim.org/data/worldclim21.html> > Last visited on November 26th, 2021.

Figure 40. Distribution of annual precipitation (mm), in number of pixels, in the Reference Region (RR) and in the Project Area (PA)



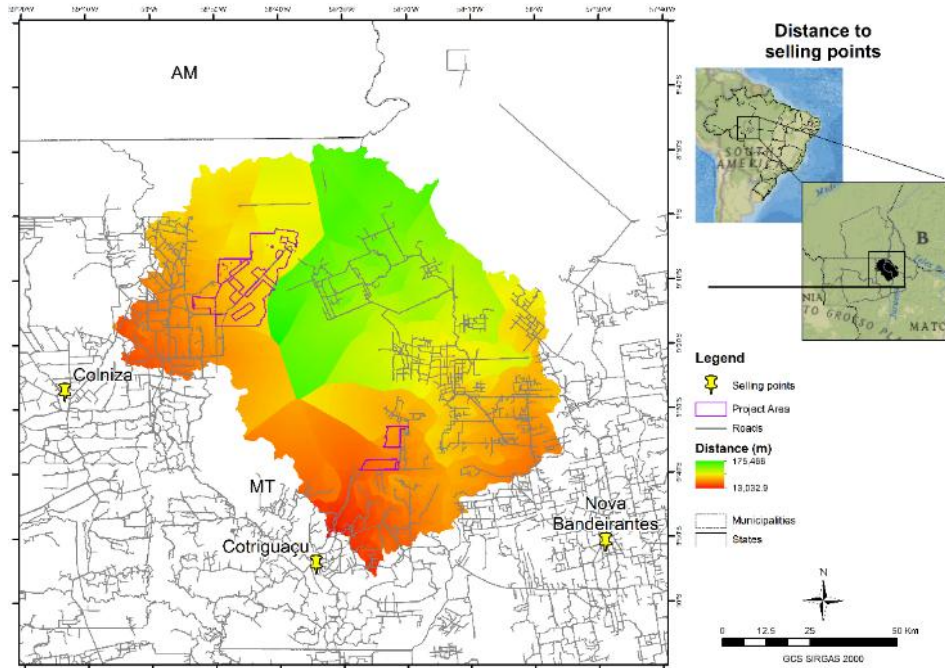
- **Leakage Belt**

To determine the leakage belt area, was carried out the methodology of opportunity cost. Therefore, the economic viability of livestock production was spatialized in the Reference Region of the project, which consists of the difference between the sale price of the cattle (per ton) and the average cost of production (per ton) plus the cost of transportation to take the product to the nearest consumer center. The inclusion of pressure from the wood market in the region was also evaluated as an opportunity, as this market had great growth in recent years. However, as will be described later on, livestock farming is viable throughout the region, and it is quite likely that timber will follow this pattern. As the spatialization is based on distance, the inclusion of the two factors should not interfere in the definition of the leakage area, and therefore, the region was delimited based on livestock data. This activity is one of the main agents of deforestation, since in addition to its possible economic gains, it is closely associated with land grabbing, one of the greatest threats in the region⁸³.

The methodology for calculating road transport costs for livestock in the region considered the sum of the distance that would be travelled in a straight line between the pasture areas and the open accesses (local highways and roads) with the distance traveled to the nearest commercial center. Figure below represents the total distance in the reference region.

⁸³ Information available at < <https://www.climatepolicyinitiative.org/pt-br/publication/a-economia-da-pecuaria-na-amazonia-grilagem-ou-expansao-da-fronteira-agropecuaria/>>

Figure 41. Surface distances (m) to the nearest commercial centers in the Reference Region and Project Area.

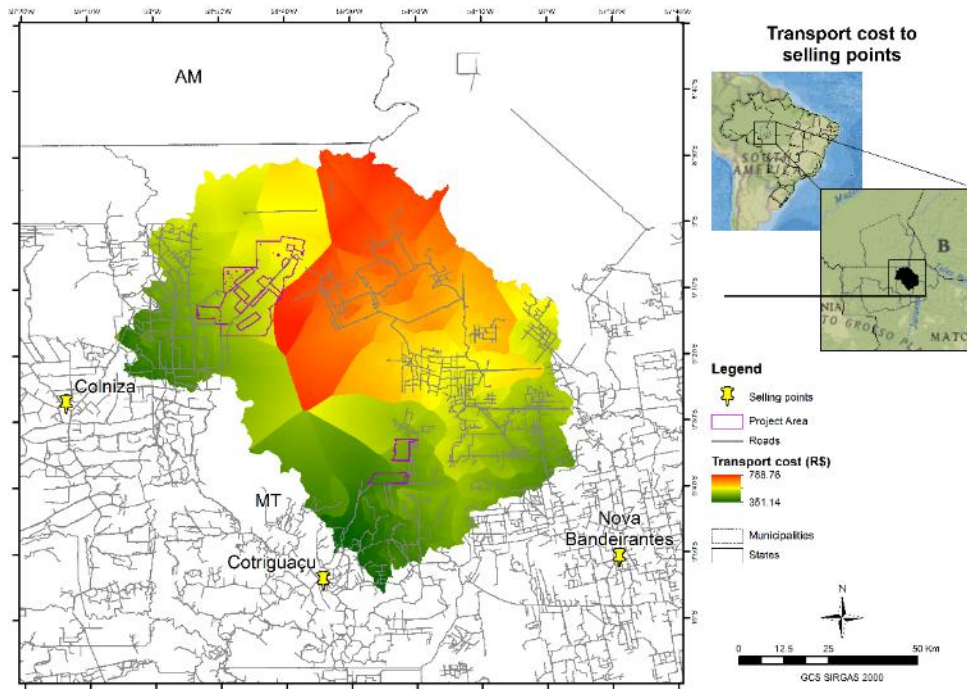


For monetary costs, the freight table for road transportation of cargo capacity⁸⁴ was considered. Each animal weighs an average of 13 arrobas⁸⁵ (unit of weight corresponding to 15 kilograms), so it was considered one 3-axle truck carrying an average of 72 cattle heads at the price of R\$ 2,6941/km + R\$316.03 for loading and unloading. Figure below illustrates the freight values that would be paid at each point in the reference region.

⁸⁴ Freight table available in Resolution nº 5,890, of May 26th, 2020. Available in <<https://www.in.gov.br/en/web/dou/-/resolucao-n-5.890-de-26-de-maio-de-2020-258705401>> . Last visited on November 26th, 2021.

⁸⁵ CARRERO, G.C; ALBUJA, G; FRIZO, P; HOFFMANN, E. K; ALVES, C; BEZERRA, C. S. A Cadeia Produtiva da Carne Bovina no Amazonas. IDESAM, 2015. Available in: <<http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>> . Last visited on November 26th, 2021.

Figure 42. Surface costs (R\$) for road transportation to the nearest commercial centers in the Reference Region and Project Area.



Combining these two data, the economically viable areas for livestock production would be where the sum of revenues minus total costs are positive. In the region, the costs per animal considering a productive area of 20 hectares and an extensive breeding system are on average approximately R\$ 906.00⁸⁶. The average price of the arroba varies between R\$ 80 and R\$ 92⁸⁷. The analysis used the minimum value of R\$ 80. Thus, for an average of 13 arrobas per animal, R\$ 1,040.00.

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:

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

Where:

PPx_i: Potential profitability of product Px at location I (pixel or polygon); \$/t

S\$_x: Selling price of product Px; \$/t

⁸⁶ The costs of animal production are described in <<https://idesam.org/publicacao/relatorio-viabilidade-pecuaria.pdf>> . The value of R\$906.00 is accounted considering these costs, and is available in table 7 of <<http://www.idesam.org.br/publicacao/cadeia-productiva-corte-amazonas.pdf>>. Links last visited on November 26th, 2021

⁸⁷ CARRERO, G.C; ALBUJA, G; FRIZO, P; HOFFMANN, E. K; ALVES, C; BEZERRA, C. S. A Cadeia Produtiva da Carne Bovina no Amazonas. IDESAM, 2015. Available in: <<http://www.idesam.org.br/publicacao/cadeia-productiva-corte-amazonas.pdf>> Last visited on November 26th, 2021.

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

The location of these areas is illustrated in the Figure below.

Figure 43. Potential profitability areas for cattle ranching within the Reference Region (RR) and the Project Area (PA)

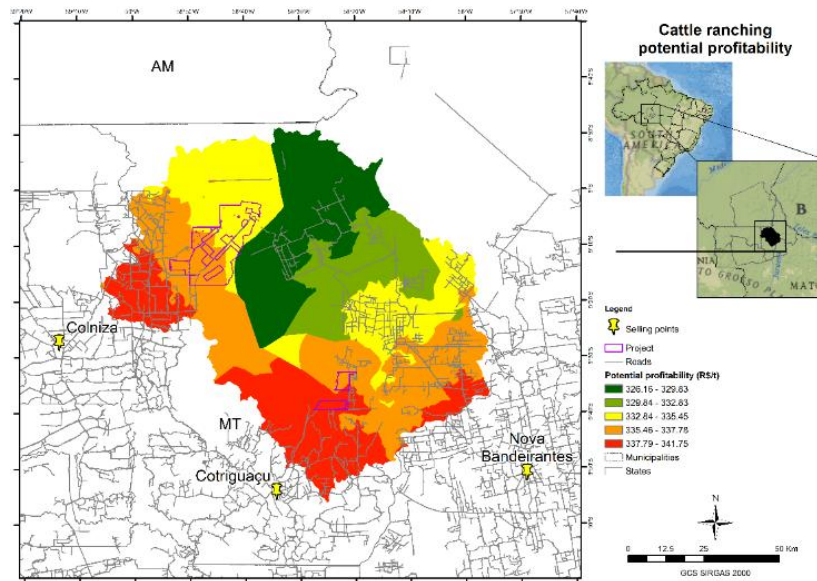
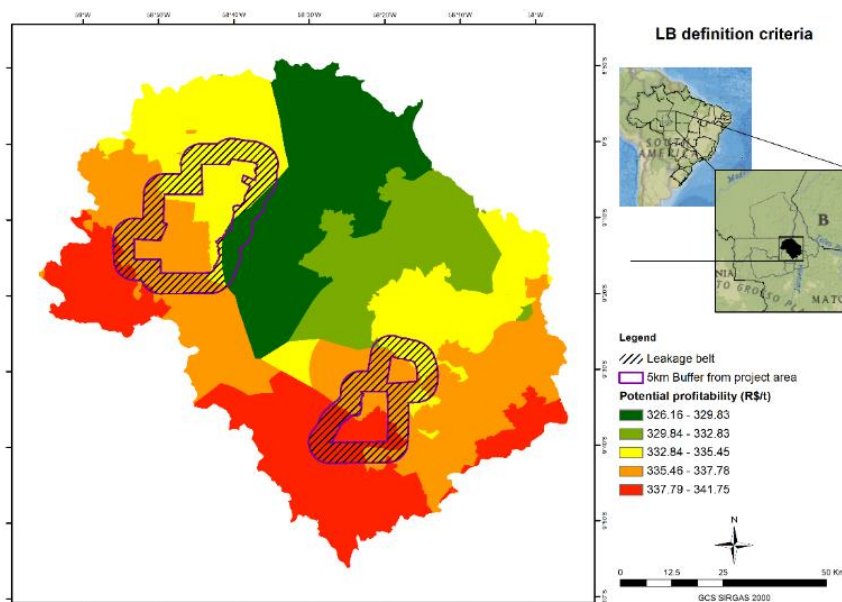


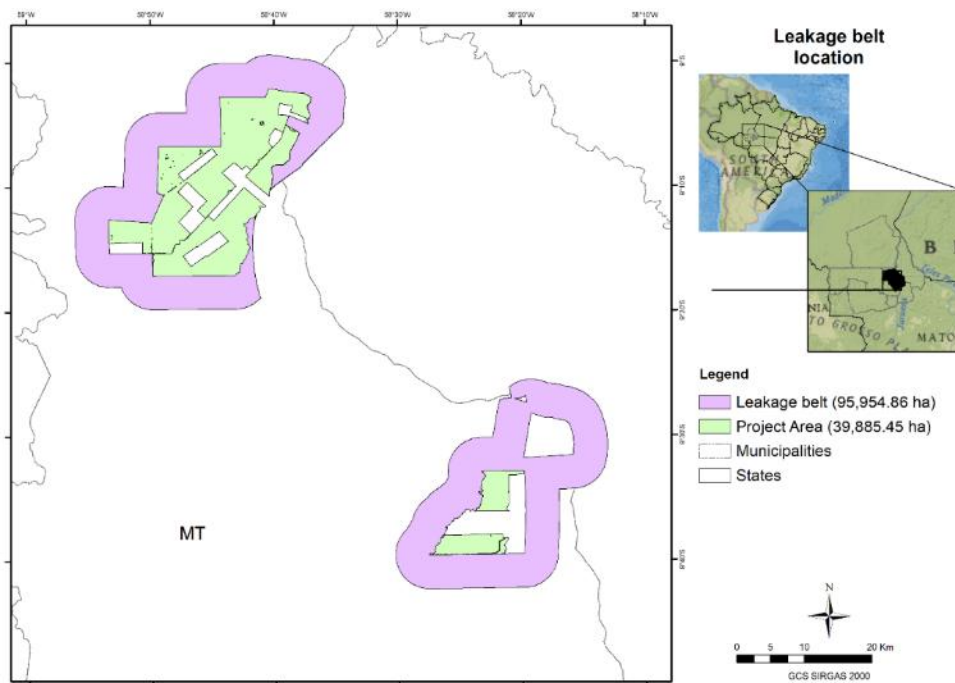
Figure 44. Leakage Belt definition criteria



With these considerations taken, the remaining areas with the highest profitability value would be more attractive for the activity. Thus, a classification into 5 natural breaks in profitability values was made, highlighting the 3rd break value (R\$332.84/t) as areas with the greatest probability of leakage. Furthermore, it was considered that areas adjacent to the project area that are viable according to the opportunity cost analysis, within a radius of 5 km⁸⁸, would be where the deforestation could occur directly due to project actions. In more distant areas, the increase in deforestation, as it is already happening, is probably associated with the proximity to rivers and roads.

Finally, overlapping the project area buffer with the areas with the greatest profitability potential, a leakage belt area of 95,954.86 ha was defined.

Figure 45. Leakage Belt Area



After delineating the Leakage Belt boundary, we conducted a verification on October 30, 2024, to identify any potential overlaps with other projects registered in Verra. During this analysis, we identified an overlap of 2,199.82 ha with the area of project ID 3451 (Figure 46). However, this project is currently listed in the Verra Registry with the status "Registration and verification approval requested", meaning it has not yet been registered.

According to VM0015 v1.1 (section 1.1.3, page 23), the exclusion of overlapping areas from the Leakage Belt of an AFOLU project with the Project Area of another AFOLU project is only required when the second project is already registered in Verra. Since this is not the case for project 3451, we have maintained the Leakage Belt as originally delineated.

⁸⁸ "Using a 5-km buffer in a geospatial analysis, we found that over 90% of deforestation occurred in close proximity to those areas deforested before 2002, which indicated the degree of anthropogenic activities driving the spatial dynamics of deforestation expansion (forest loss) in the Brazilian Amazon" Available at <<https://escholarship.org/content/qt02n6c542/qt02n6c542.pdf?t=q0i10h>>

From now on, we will monitor the status of this overlap. If project 3451 is registered before the next verification, a Forward Action Request (FAR) will be issued to adjust the Leakage Belt boundary, ensuring compliance with VM0015 guidelines, thereby preventing double counting of emissions for the same area. This FAR will also specify that any changes to the Leakage Belt must be validated by the VVB.

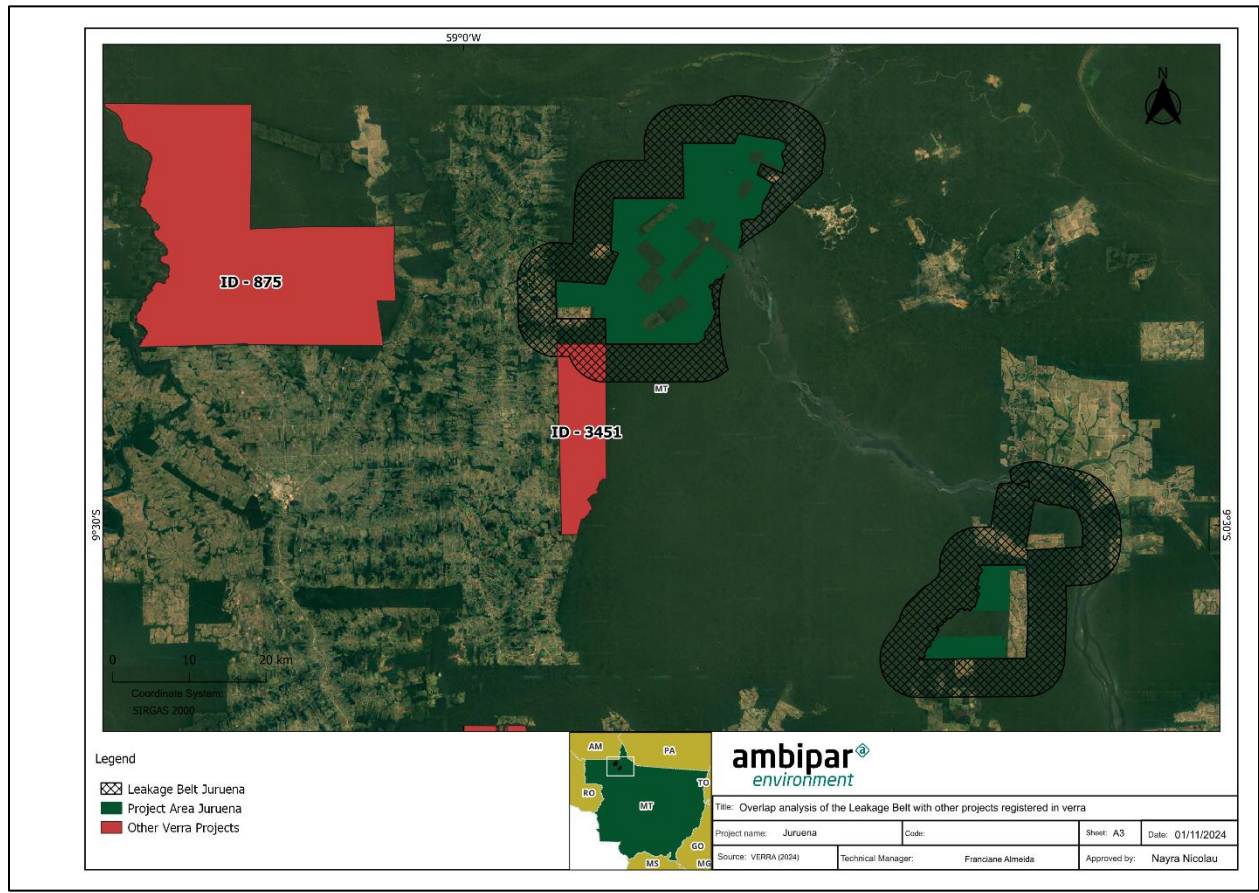
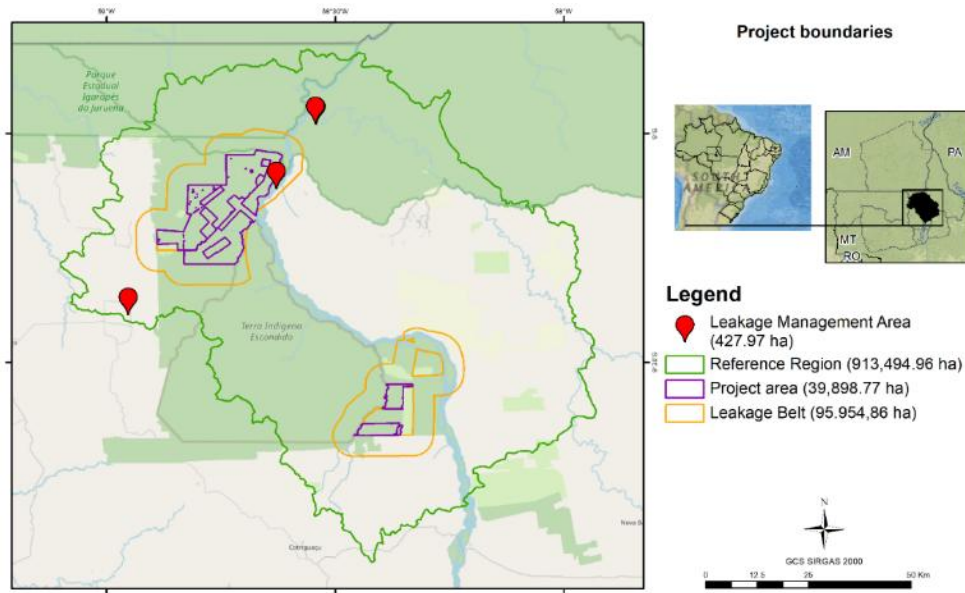


Figure 46. Overlap analysis of the Juruena River REDD+ Project Leakage Belt with other projects registered in Verra.

Project boundaries

Figure 47. Project Boundaries



Forest

According to the Brazilian Forests at a Glance 2019⁸⁹, 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 project⁹⁰. 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. The compliance of the project area with these definitions is further explained in section 1.13.

In addition, as per 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 30 m resolution LANDSAT images used for mapping have the minimum mapping unit defined at 30x30m (0.09ha), therefore falling easily to the methodology requirement. Details on data and image processing can be verified in Appendix II.

Análise de Conformidade Territorial e Sobreposição Espacial da Área do Projeto REDD+ Rio Juruena

⁸⁹ Available at <https://www.florestal.gov.br/documentos/publicacoes/4262-brazilian-forests-at-a-glance-2019/file> Last visit 26/07/2021

⁹⁰ 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.terrabrasil.org.br/ecotecadigital/pdf/manual-tecnico-da-vegetacao-brasileira.pdf>; SIVAM Project: <https://www.camara.leg.br/noticias/55929-o-que-e-o-sivam/>.

The overlap analysis carried out for the Juruena River REDD+ Project area confirms that the project was properly delimited, ensuring the absence of relevant conflicts with private or public areas or protected territories. The assessment meets the requirements set forth by VCS Standard 4.5, ensuring that there are no significant impacts on the legal or customary rights of stakeholders associated with the analyzed area. Key aspects evaluated include:

Rural Environmental Registry (CAR):

There is no overlap with external properties, except for records related to the properties that are part of the project, which belong to the same owner.

Data from INCRA (SIGEF and SNCI):

Registrations related exclusively to the properties of the project were identified, without overlapping with quilombola settlements or territories.

Conservation Units:

An insignificant overlap of 0.31 hectares with the Juruena National Park was identified, attributed to technical variations in the spatial data.

Indigenous Lands:

Small overlaps (between 0.30 ha and 0.37 ha) were identified at the edges of the project area, totaling 1.65 ha (0.0041% of the total project area), considered technically irrelevant.

Temporal Boundaries

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

The adopted historical reference period is 2009-2020

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

The project has a crediting period of 30 years, from 12-November-2020 until 11-November-2050.

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

The first baseline period is from 12-November-2020 to 11-November-2026.

- **Monitoring period**

1st Monitoring Period – 12-November-2020 to 11-November-2021

The next monitoring periods will comply with the criteria established in the applied methodology, which states that the minimum duration of a monitoring period is one year and the maximum duration is one fixed baseline period.

Carbon Pools

The applied Methodology considers six carbon pools. Their inclusion or exclusion within the boundary of the proposed AUD project activity, as well as the respective justification/explanation, are described in 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: Excluded	No existence of perennial crops as final class.
Below-ground	Included	Stock change in this pool is significant.
Dead wood	Excluded	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. ⁹¹
Harvested wood products	Excluded	Stock change in this pool is not considered in baseline and project scenarios. This is conservative as project scenario includes logging through a sustainable forest management plan, and the amount of timber harvested in the baseline scenario is lower than the project scenario.
Litter	Excluded	Excluded as it does not lead to a significant over-estimation of the net anthropogenic GHG emission reductions of the AUD project activity. This exclusion is conservative.
Soil organic carbon	Excluded	Recommended when forests are converted to cropland. Not to be measured in conversions to pasture grasses and perennial crop according to VCS Methodology Requirements, 4.1.

⁹¹ Deadwood is commonly left to be used as fuel for burning after land clearing, as it does not have commercial value. References available at < <https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.14872>>, < <https://www.jstor.org/stable/2388588?origin=JSTOR-pdf>>, < <https://piaui.folha.uol.com.br/materia/floresta-em-chamas/>>, < <https://amazoniareal.com.br/o-desmatamento-da-amazonia-brasileira-13-degradacao-extrema/>> .

As harvested wood products exists in both baseline and project scenarios, two criteria were assessed:

- Amount of harvested timber in baseline x project scenarios: In the baseline scenario, harvesting was illegally conducted and targeted the most commercially valuable species⁹², 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, after harvesting the most valuable species in the baseline scenario, the area was abandoned for illegal deforestation.

On the other hand, in the project scenario, a larger number of species are harvested under a certified sustainable forest management plan, avoiding the overexploitation and extinction of a single species, in a proper way for the forest management be sustainable and balanced.

Thus, it can be concluded that logging in the baseline scenario, harvested a lower number of species per hectare. Furthermore, the total amount of harvested timber in the baseline is lower than harvested by the sustainable forest management in the project scenario, complying with the methodology requirement to exclude the pool in the baseline case.

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. An analysis was developed comparing the estimation in the harvested wood products carbon pool in the baseline and project scenarios, and the result is presented in table below:

⁹² Available at < <https://amazonia.org.br/2022/11/madeira-de-lei-fora-da-lei/> >

Harvested wood products (tCO2e)	
Baseline Scenario	Project Scenario
95,845	183,300

As harvested wood product carbon pool is lower in the baseline compared to the project scenario, harvested wood products in the baseline and project scenarios were conservatively excluded in baseline and project scenarios, according to the methodology requirements.

For baseline logging activities, 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 allowed to conclude that the sum of decreases in carbon pools and increases in emissions due to baseline logging activities represents less than 5% of the total decrease in carbon pools and increase in emissions (4.10%) and less than 5% of net anthropogenic removals by sinks (4.45%).

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

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 project activity, as well as the respective justification/explanation, are described in the Table below.

Table 8. Sources and GHG included or excluded within the boundary of the proposed AUD project activity

Source	Gas	Included / Excluded	Justification / Explanation of choice	
Baseline scenario	Biomass burning	CO ₂	Excluded	Excluded as recommended by the applied methodology. Counted as carbon stock change.
		CH ₄	Included	Included as non-CO ₂ emissions from biomass burning in the baseline scenario, according to the methodology.
		N ₂ O	Included	Included as non-CO ₂ 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 ₂ O	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	Excluded	Excluded, according to methodology VM0015, version 1.1 (pages 28 and 29), as they are not significant (they account for less than 5% of the total GHG benefits generated)
		N ₂ O	Excluded	Excluded, according to methodology VM0015, version 1.1 (pages 28 and 29), as they are not significant (they account for less than 5% of the total GHG benefits generated)
		Other	Excluded	No other GHG gases were considered in this project activity.
	Livestock emissions	CO ₂	Excluded	Not a significant source
		CH ₄	Included	Included as non-CO ₂ emissions from livestock in the leakage management area
		N ₂ O	Included	Included as non-CO ₂ emissions from livestock in the leakage management area
		Other	Excluded	No other GHG gases were considered in this project activity.

3.4 Baseline Scenario

In the baseline scenario, forest is expected to be converted to non-forest by the agents of deforestation acting in the reference region, project area and leakage belt, as described below. Therefore, the project falls into the AFOLU-REDD category, specifically: Avoided unplanned deforestation (AUD). The revenue from the present REDD project is essential to maintain this area as standing forest, as described under additionality of the Project (section 3.5), as well as to carry out the present project's leakage management activities.

Degradation was not considered in the present REDD project, in accordance with methodology requirements, which define “forest” and “non-forest” as the minimum land-use and land-cover classes.

Analysis of historical land-use and land-cover change

- **Collection of appropriate data sources**

GIS MAPPING, REMOTE SENSING TECHNIQUES

To carry out the assessment of land use and land cover (LU/LC) for the baseline period (2009-2020), remote sensing satellite analysis was carried out, which is described below.

The historical reference period is the period in which analysis of LU/LC-change within the reference region and project area is carried out. The historical reference period for the present project during the assessment of the baseline period comprised analysis of images from 2009 - 2020. In accordance with the methodology, the analysis shall be made using the data obtained from monitoring LU/LC changes in the reference region during the historical reference period.

To map the dynamics of land use in the reference region, images from 2009 to 2019 produced by MapBiomass (collection 6.0) were used, made available in raster format on the program's website⁹³, and supervised classifications using Google Earth Engine for the period of September 2020. This classifier is the same one used in MapBiomass, allowing a closer approximation of the methodology.

In order to compose the entire reference region, three Landsat scenes per year (orbit/point: 229/67, 229/66 and 228/67) from the reference period were required. The final mapping resolution was 30 m pixel.

MapBiomass is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System⁹⁴ promoted by the Climate Observatory. The MapBiomass creation involves NGOs, universities, and technology companies. In MapBiomass, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat

⁹³ Available at <<http://www.mapbiomas.org>> Last visited on November 30th, 2021

⁹⁴ SEEG website. Available at: <http://seeg.eco.br/en/> Last visited on 19/04/2021

images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

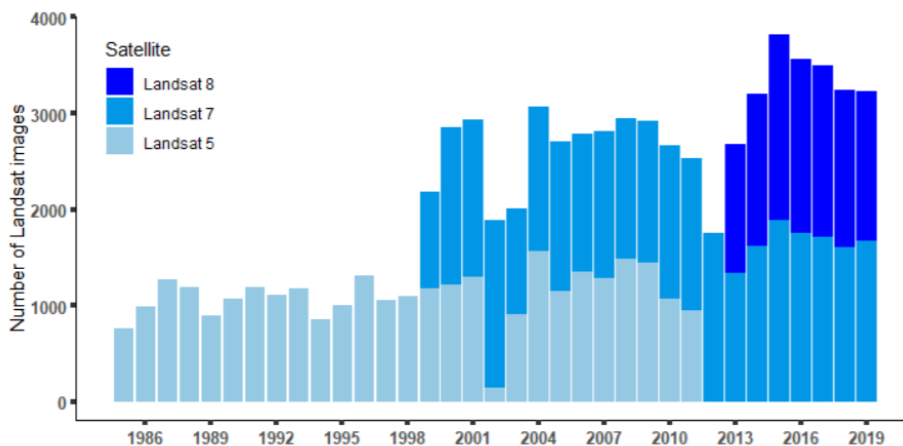
The algorithm uses samples obtained by reference maps, generation of stable collections from previous MapBiomass series and direct collection by visual interpretation of Landsat images to classify as a single map per class. This classification then goes through the stages of the spatial filter, applying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

For the supervised classification of November 2020, this same algorithm was used, but without the use of metrics, temporal filters and neighborhood rules applied in the MapBiomass methodology. In order to obtain an image suitable for direct sample classification, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance collection with a 5% cloud cover limit were collected within the Reference Region and an average of these images was generated. Training samples were generated for each land use class (forest, water and deforestation) and the Random Forest automatic classifier was applied via Google Earth Engine. Then the spatial filter with the Majority Filter tool from ArcGIS was applied using an 8-pixel neighborhood. This filter is used in MapBiomass in order to avoid unwanted modifications on the edges of pixel groups (blobs).

Table 9. Data used for historical LU/LC change analysis

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(km ²)	DD/MM/YYYY	Path	Row
Satellite	Landsat TM	30	0.45-2.35	34,225	2007 - 2020	229	67
Satellite	Landsat TM	30	0.45-2.35	34,225	2007 - 2020	229	66
Satellite	Landsat TM	30	0.45-2.35	34,225	2007-2020	229	67

Figure 48. Number of Landsat images for mapping the Amazon. Source: MapBiomass



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

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

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

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

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

Eight vegetation types were found within the project boundaries, and, according to this analysis, the Open Submontane Tropical Rainforest is the main forest type present within the project area, with around 67% of the total forest cover. Thus, considering the percentage and carbons stocks (table below), the mapping and modeling of the project proceeded without stratification.

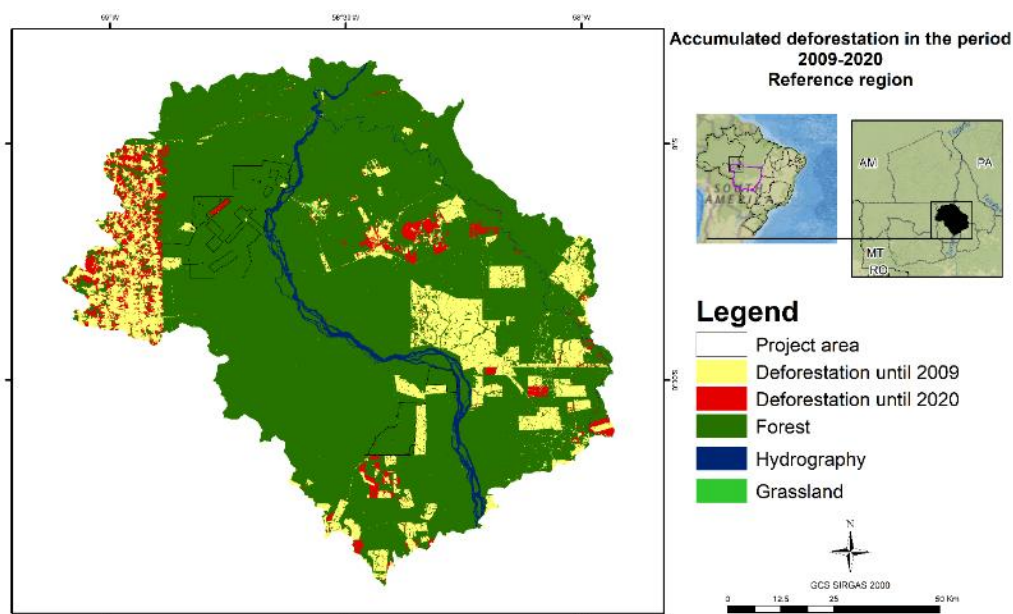
Table 10. Vegetation types found in the project boundaries.

Forest class	Presence in the RR (%)	Presence in the PA (%)	Presence in the LB (%)
Dense Alluvial Tropical Rainforest	2%	-	6%
Dense Submontane Tropical Rainforest	70%	33%	64%
Dense Tropical Rainforest	0%	-	-
Open Submontane Tropical Rainforest	26%	67%	31%
Open Tropical Rainforest	0%	-	0%
Seasonal Forest Savanna	0%	-	-
Seasonal treed Savanna	1%	-	-
Seasonal deciduous submontane forest	0%	-	-

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

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

Figure 49. Land use and land cover map over the historical reference period



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 11. 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, LB	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	Non forest	constant	RR, LB	no	no	no	Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification
3	Hydrography	constant	RR, PA, LB	no	no	no	Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA

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

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

It is shown that deforestation could occur in the baseline and project scenarios within both the PA and LK areas; the hectares show the quantities of deforestation during the crediting period associated with each identifier. The deforestation presented within the PA and LK are shown in the LU/LC-change map comparing 2009 with 2020. It is important to note that while the latter shows only deforestation from 2009–2020, the Tables below display deforestation across the whole crediting period.

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

Table 12. Land use change matrix in the reference region between 2009 and 2020

		Initial LU/LC class		
		IDcl	Forest	Non forest
Final Class	Forest		I1/F1	0
	Non forest		I1/F2	I2/F2

BASELINE SCENARIO

		PA	Initial LU/LC class	
		IDcl	Forest	Non forest
Final Class	Forest		23,691.40	0.00
	Non forest		16,194.05	0.00

		LB	Initial LU/LC class	
		IDcl	Forest	Non forest
Final Class	Forest		45,330.02	0.00
	Non forest		33,633.01	11,375.16

PROJECT SCENARIO

		PA	Initial LU/LC class	
		IDcl	Forest	Non forest
Final Class	Forest		38,601.22	0.00
	Non forest		1,284.23	0.00

		LB	Initial LU/LC class	
		IDcl	Forest	Non forest
Final Class	Forest		42,900.9	0.00
	Non forest		36,062.1	11,375.2

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.

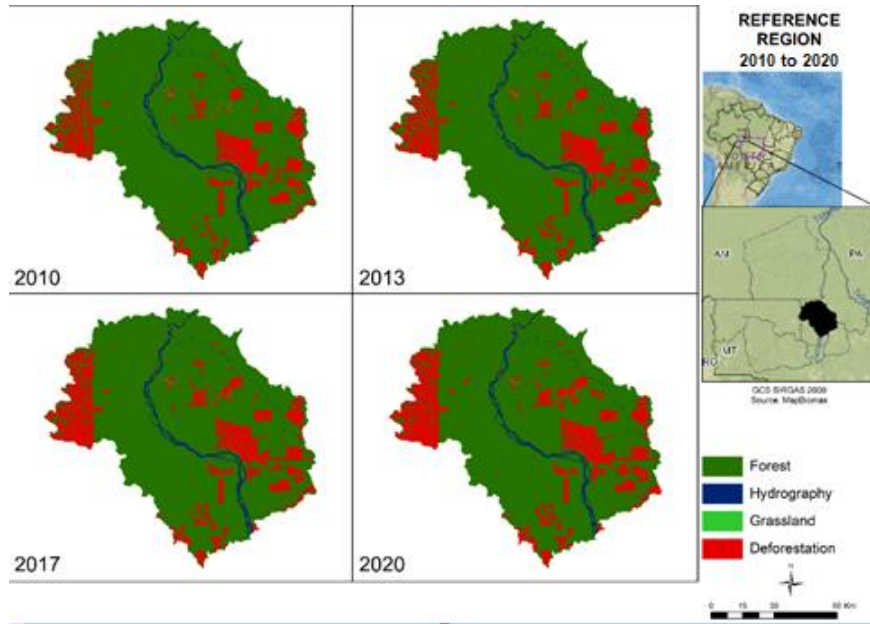
Table 13. List of land use and land cover change categories

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, LB	yes	no	no	Forest	constant	RR, PA, LB	yes	no	no
I1/F2	Forest	constant	RR, PA, LB	yes	no	no	Non Forest	constant	RR, PA, LB	yes	no	no
I2/F2	Non forest	constant	RR, LB	no	no	no	Non forest	constant	RR, PA, LB	no	no	no

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

According to the GIS analysis, between 2009 and 2020, there was a deforestation of 38,133.36 ha within the reference region, with an average oscillation of approximately 3,466.67 ha/year. The location of these areas is presented in figure below:

Figure 50. Deforestation dynamics during the historical reference period in the reference region and project area⁹⁵. Source: MapBiomas and IPE data



The annual deforestation values in the Reference Region during the historical reference period can be seen in the table below.

Table 14. Annual deforestation in the Reference Region between 2009-2020 (November-2009 to November-2020)

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2009	119,490.84	2,441.07
2010	121,470.03	1,979.19
2011	123,906.24	2,436.21
2012	127,313.19	3,406.95
2013	130,399.38	3,086.19
2014	133,957.17	3,557.79
2015	137,407.68	3,450.51
2016	140,391.09	2,983.41
2017	144,964.62	4,573.53

⁹⁵ Although the historical reference period is 2009-2020, the presented map includes 2010-2020 for better visualization.

2018	148,309.56	3,344.94
2019	153,780.03	5,470.47
2020	157,624.2	3,844.17

- **Map accuracy assessment**

The results of MapBiomass 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 for the years 2007 to 2019.

To assess the accuracy of the maps produced by the MapBiomass 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, and it was possible to determine the land use of the sample points drawn.

For the supervised classification in November 2020, 240 random points were drawn over the reference region, 80 in each class (forest, hydrography and deforestation). It is noteworthy that for this year only the deforestation classification information was considered.

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

Table 15. Summary of confusion matrices from the evaluation of MapBiomass from 2007 to 2020⁹⁶

Year	Producer accuracy				User accuracy			
	Forest	Hydrography	Pioneer vegetation	Deforestation	Forest	Hydrography	Pioneer vegetation	Deforestation
2007	86.52%	94.74%	81.48%	94.59%	96.25%	90.00%	82.50%	87.50%
2008	88.89%	96.25%	82.19%	82.56%	90.00%	96.25%	75.00%	88.75%
2009	91.25%	100.00%	79.52%	84.62%	91.25%	98.75%	82.50%	82.50%
2010	94.81%	94.81%	80.23%	88.75%	91.25%	91.25%	86.25%	88.75%
2011	94.94%	93.75%	82.50%	91.36%	93.75%	93.75%	82.50%	92.50%
2012	92.94%	97.30%	79.31%	91.89%	98.75%	90.00%	86.25%	85.00%

⁹⁶ Although the assessment was developed through 2009-2020, years 2007 and 2008 were used for calibration of the model and to ensure that the forested areas in 2020 are at least 10 years old, as defined by the methodology.

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

ANALYSIS OF AGENTS, DRIVERS, AND UNDERLYING CAUSES OF DEFORESTATION

As specified in the methodology, it is necessary to understand “who” the deforesting agent is and what drives land-use decisions (“drivers” and “underlying causes”). This analysis is important for two main reasons: (i) Estimating the quantity and location of future deforestation; and (ii) Designing effective measures to address deforestation, including leakage prevention measures⁹⁷.

- **Identification of agents of deforestation**

As previously mentioned in “1.13 Conditions Prior to Project Initiation” of this VCS-PD, pasture accounts for virtually all the deforested land occupation in the project region.

Thus, it is important to understand that illegal deforestation in the Brazilian Amazon occurs by two major agents – Cattle Ranchers and Loggers. Unplanned deforestation can occur in public and private areas, caused by landowners or encroachers.

These economic activities are the main reason for deforestation, since the standing forest without activity is seen as a loss or without an owner, vulnerable to encroachment. According to a MapBiomas survey⁹⁸, the area deforested with evidence of illegality was 98.9% in Brazil. More than a third of deforestation in 2020 overlapped with legal reserve areas (LR), APP or springs, all protected by the Forest Code. 67.2% of the deforestation in the year took place in areas registered in the Rural Environmental Registry (CAR).

a) Ranchers (Cattle Ranching)

⁹⁷ 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>>.

⁹⁸ Available at <https://s3.amazonaws.com/alerta.mapbiomas.org/rad2020/RAD2020_FactSheet_FINAL_PT.pdf>

- **Main social, economic, cultural and other relevant features of agent group:**

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 encroachment in unguarded areas. The final use of virtually all occupied lands would be cattle ranching (pasture).

The representativeness of livestock in Mato Grosso is large both in terms of culture and economy. The colonization process in the region took place during the depletion of mines in central Brazil, and livestock was the main agent of formation and restructuring of the Mato Grosso's territory, especially in the south, where today is the state of Mato Grosso do Sul.

In addition, after the Paraguay War, the region began to be restructured, receiving new residents who sought to rebuild areas affected by the war and to occupy pastures for raising cattle. The activity also helped to reduce the distance that separated the State from the large population centers, as the expansion of large cattle ranches and the occupation of fertile areas for agriculture created new population centers⁹⁹. Thus, the economic base of the state gradually transmuted from mining to agro-pastoral activity.

The northern region of the state gained greater relevance in the livestock sector in the 70s, when the Brazilian military government decided to occupy the Amazon, and cattle once again accompanied the colonizers, resulting in an explosive expansion of pastures and herds. While the Brazilian herd increased by 60% between 1987 and 2013, the herd in the Amazon states (Mato Grosso, Pará, Acre, Rondônia, Roraima, Amazonas, Tocantins, Amapá, and Maranhão) practically tripled (280%), because livestock became the cheapest means of occupying the cleared land¹⁰⁰.

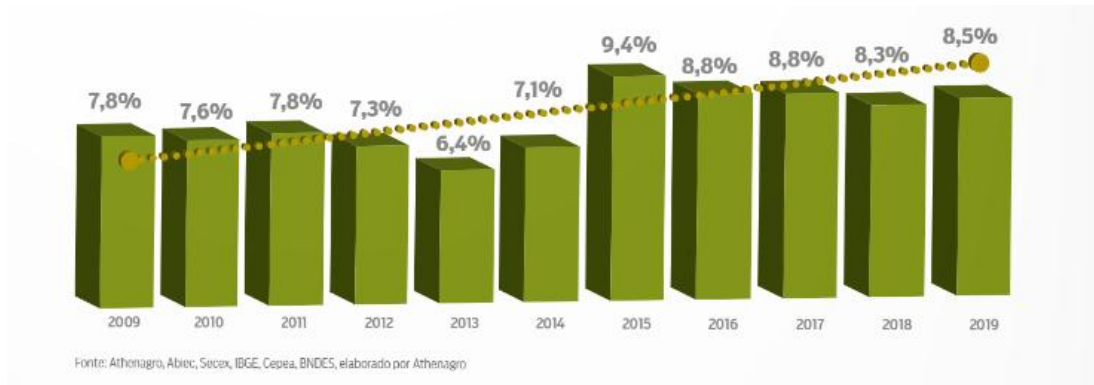
In summary, Brazilian beef cattle farming developed through the expansion of the agricultural frontier (which occurs through deforestation in regions lacking infrastructure) and through the use of lands depleted by agriculture. The activity has contributed decisively, since colonial times, to the occupation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

Given the historical context, it is relevant to emphasize the economic importance of livestock in Brazil, as a whole, and especially in the state of Mato Grosso. In 2019, Brazil's GDP was R\$ 7.3 trillion, a nominal growth of 6.8% compared to the previous year. Part of this growth was due to the GDP of livestock, which in the same period registered a slight growth, from 8.3% to 8.5% of the total GDP, with this participation in an increasing trend since 2013, as shown in the graph below.

⁹⁹ Available in <<https://periodicos.ufms.br/index.php/AlbRHIS/article/download/5100/3781/>> Last visited on December 3rd, 2021

¹⁰⁰ Available in <https://csr.ufmg.br/pecuaria/portfolio-item/historico-3/> Last visited on December 3rd, 2021

Figure 51. Evolution of the participation of the GDP of beef cattle on the total GDP of Brazil¹⁰¹



The state of Mato Grosso is the largest producer of cattle in Brazil, with a share of 13.98% of the total Brazilian herd, with a growth of 9.20% in the last 10 years¹⁰².

In this sense, with the increase in the price of the dollar and exports, in addition to domestic consumption, the forecast is for an increase in animal production¹⁰³.

- **Brief assessment of the most likely development of the population size of the identified main agent groups in the reference region, project area and leakage belt:**

Thus, as commented in previous sections, cattle ranching is of great importance in the formation of the Mato Grosso territory, as a result of profitability and convenience, and pasture is the most common land use in deforested areas. The figure below shows the growth of the cattle herd in the municipalities of PA and RR:

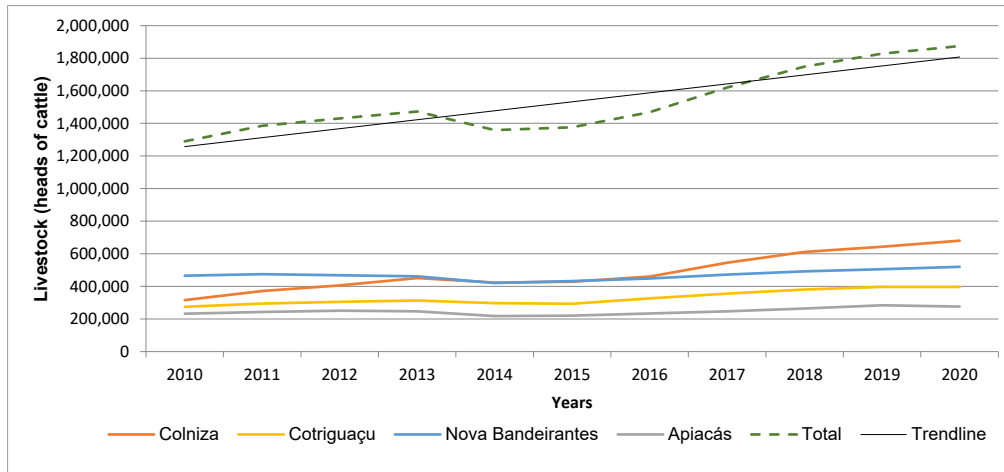
Figure 52. Cattle herd in the municipalities of the project between 2010 and 2020¹⁰⁴

¹⁰¹ Available in < <http://abiec.com.br/publicacoes/beef-report-2020/>> Last visited on December 03rd, 2021.

¹⁰² Available in < <http://abiec.com.br/publicacoes/beef-report-2020/>> Last visited on December 03rd, 2021.

¹⁰³ Available in < https://www.imea.com.br/imea-site/view/uploads/relatorios-mercado/R405_Apresentacao%20MT_e_Outlook_Portugu%C3%AAs.pdf> Last visited on December 03rd, 2021.

¹⁰⁴ Available in < <https://cidades.ibge.gov.br/brasil/mt/colniza/pesquisa/18/16459?tipo=grafico&indicador=16533>> Last visited on December 03rd, 2021.



Considering the prices of livestock and economic tendency¹⁰⁵, and the increased tendency in cattle herd numbers, it is possible to conclude that the likely development in the region is the increase in livestock activity. In addition, as this is the main activity in the region, population increase is also linked with the increase in the activity, as will be described in the Drivers of deforestation section.

- **Statistics on historical deforestation attributable to each main agent group in the reference region, project area and leakage belt:**

As presented above, the municipalities in the Reference Region are important players in livestock activities in the north of Mato Grosso. In addition to this being the main activity in the state, it is the main activity in the RR and surroundings of the project area.

Brazil provides between 25% and 40% of EU beef imports. In a study analyzing the livestock production chain, the following assumptions were made¹⁰⁶: By matching GTAs¹⁰⁷ issued in the states of Pará and Mato Grosso in 2017 with CAR data, it is identified the origin of 4.1 million heads traded to slaughterhouses. Of this total, it is estimated that $12 \pm 2\%$ (0.5 ± 0.1 million heads) come directly from properties with potentially illegal deforestation. In addition, $48 \pm 10\%$ of all slaughtered heads may be contaminated with potentially illegal deforestation from indirect suppliers, as the cattle pass from one property to another before being slaughtered.

This information is important as, although beef exports from Pará are minor, Mato Grosso state is the third largest Brazilian source of EU imports. By tracing cattle between properties and slaughterhouses, and tracing beef exports from the latter to EU countries, the authors estimate that of 17.7 ± 1.2 thousand metric tons of beef exported from Mato Grosso and Pará in 2017, about 46

¹⁰⁵ Increase in prices and exportation between 2020 and 2021. Available at < https://www.conab.gov.br/info-agro/analises-do-mercado-agropecuaria-e-extrativista/analises-do-mercado/historico-mensal-de-agroconab/item/download/37236_3f08a9c29047aa1ff45f88ec641e3198>

¹⁰⁶ Available at < <https://www.science.org/doi/10.1126/science.aba6646>>

¹⁰⁷ Guia de transporte animal – cattle transport permit

± 7% may have been contaminated with potentially illegal deforestation, including both direct and indirect suppliers.

Other national data allows to conclude the same. The dynamics of land use demonstrates that the conversion of forests occurs, in the majority, to prepare the land for cattle raising.

Maps and data from MapBiomas show that Brazil lost 87.2 million hectares of native vegetation areas, from 1985 to 2019. This is equivalent to 10.25% of the national territory. The pace of native vegetation loss accelerated in Brazil between 2018 and 2020. Of all the loss of natural vegetation in Brazil, including forest, savannah, fields and mangroves, at least 90% was occupied by agriculture and pasture use, whose expansion was 78 million hectares (43% growth since 1985)¹⁰⁸. Pasture is the main rural land use in the municipalities within the Reference Region, as presented below:

Table 16. Rural land use in the RR municipalities¹⁰⁹

	Forest (ha)	Agriculture (ha)	Pasture (ha)	Agroforestry System (ha)	Area (ha)
Apiacás	347,401	708	193,746	29,543	571,398
Colniza	470,571	6,727	299,469	3,848	780,615
Cotriguaçu	356,520	2,767	170,828	3,715	533,830
Nova Bandeirantes	335,302	2,192	300,065	16,051	653,610

In Mato Grosso, there are 55,909,831 ha registered rural areas, and a registered legal reserve (LR) of 29,372,675 ha. Although it represents only 8.5% of the total State area, the Legal Reserve deficit accumulates to 4,776,959 ha, which represents 16% of the current registered Legal Reserve¹¹⁰.

In addition, CAR voids should also be considered, that is, areas that are not public lands and do not have a link with the government and that could be registered. In the State of Mato Grosso, this number represents 10% of the areas eligible for registration and accumulates 9,144,205 ha. According to a survey by Imaflora, 23% of the land use in the state's nonregistered areas is cattle ranching¹¹¹.

Therefore, it is possible to conclude that over 2 million non-registered hectares are related to cattle ranching in the State and are not being accounted for.

The situation of the municipalities in the Reference Region for these parameters is described in the table below:

¹⁰⁸ Available at <

<https://mapbiomas.org/noticias#:~:text=De%20toda%20a%20perda%20de,%25%20de%20crescimento%20desde%201985>>

¹⁰⁹ Information from Agricultural Census 2017. Available at < <https://cidades.ibge.gov.br/>>

¹¹⁰ Data on the status of the rural lands of Brazil, States and Municipalities is available at < <http://termometroflorestal.org.br/plataforma>> Last visited on 13/01/2022

¹¹¹ Available at < https://www.imaflora.org/public/media/biblioteca/5b7ea062689cd_sustentabilidade_codigo_florestal.pdf> Last visited on 14/01/2022

Municipality	Registered Area	CAR deficit	LR deficit	Total LR area
Apiacás	449,717	116,408	5,107	364,025
Colniza	1,164,320	363,085	13,277	1,043,632
Cotriguaçu	516,675	100,344	8,373	259,913
Nova Bandeirantes	703,435	171,567	25,673	381,114

b) Loggers (Timber harvesting)

- **Main social, economic, cultural and other relevant features of agent group:**

As aforementioned in section 1 above, timber logging (both legal and illegal) is an important economic activity within the reference region. The logging area in Mato Grosso between August 2019 and July 2020 was 234,290 hectares. This area represents half of the total areas explored for timber purposes in the whole Amazon Biome during this period.

Although in Mato Grosso most of the exploration (62%) was done legally, that is, with valid authorization and within the authorized area, of the total area illegally exploited in 2020, 70% took place in rural properties already registered with the environmental agency¹¹².

Economic data sources between 2010 and 2020 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.

¹¹² Available in < https://imazon.org.br/wp-content/uploads/2021/10/Simex_MT_Agosto2019-Julho2020.pdf > Last visited on December 22nd, 2021.

Figure 53. Extraction Production Value (R\$) - Cotriguaçu/MT

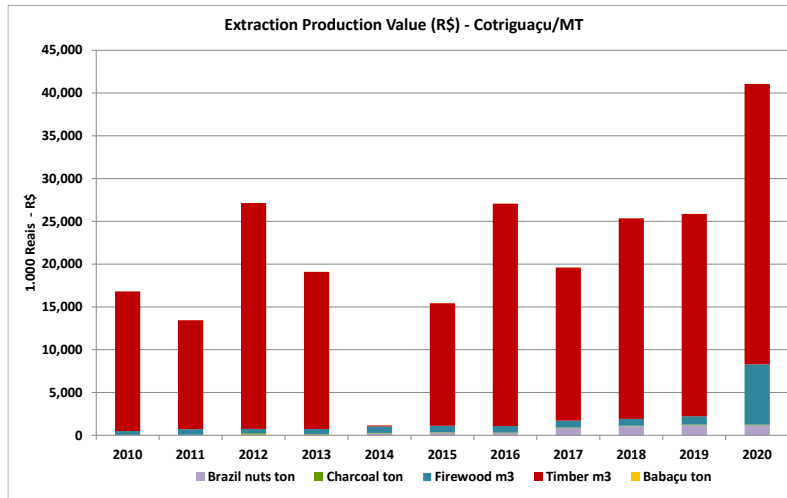


Figure 54. Extraction Production Value (R\$) - Colniza/MT

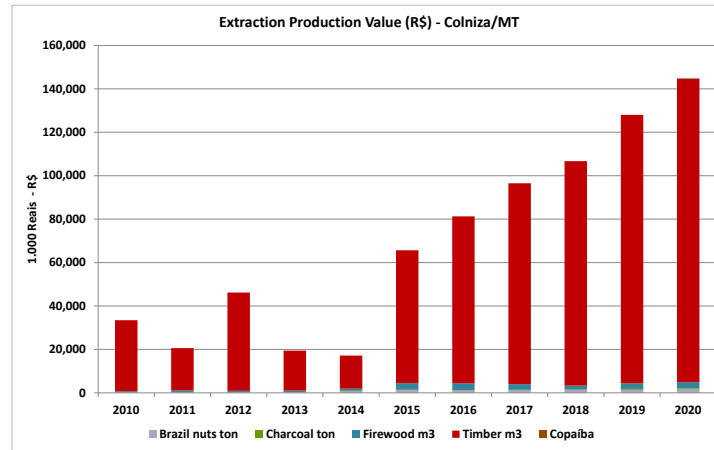


Figure 55. Extraction Production Value (R\$) - Nova Bandeirantes/MT

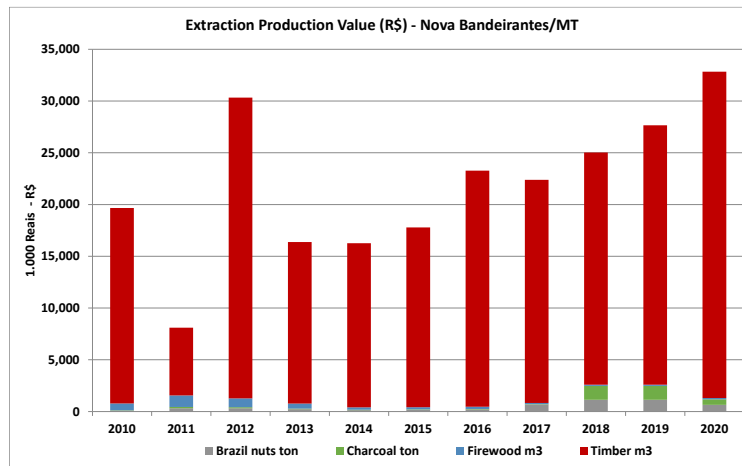
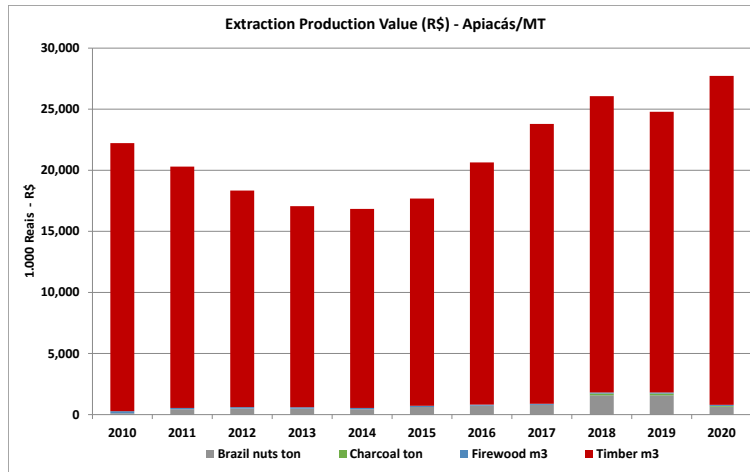


Figure 56. Extraction Production Value (R\$) - Apicás/MT



As can be seen, wood (timber and firewood) has a higher production value than the other main products in the 4 cities of the reference region, in addition to being on an upward trend in recent years. Illegal wood harvesting is known to take place within the reference region, being transported to the sawmills by riverboat and roads. 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.

The Figures below show the annual quantity of timber logging produced, separated in firewood and roundwood, in the municipalities of the project area.

Figure 57. Firewood - Produced quantity¹¹³

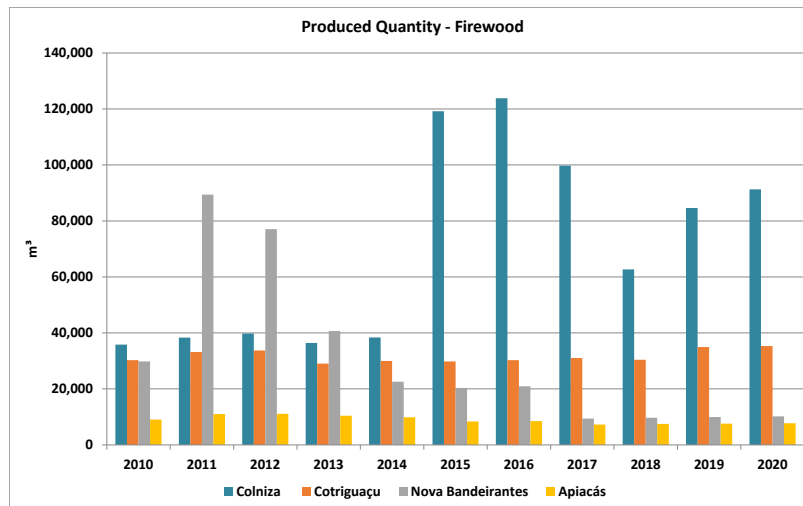
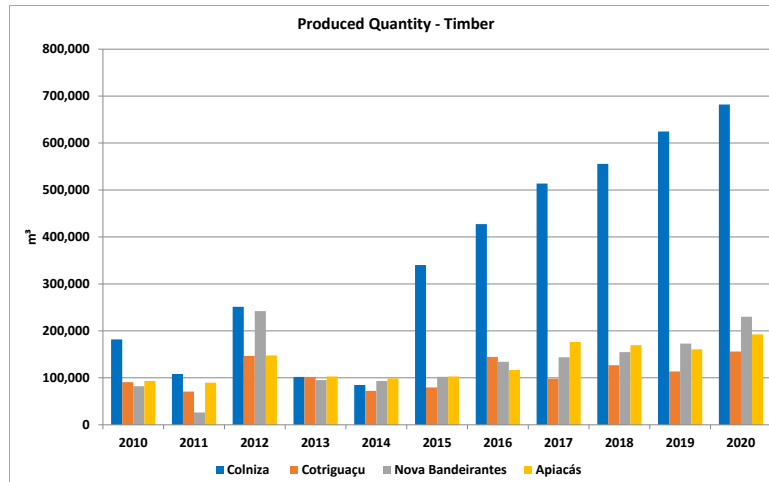


Figure 58. Timber - Produced quantity¹¹⁴

¹¹³ IBGE Cidades – Extração vegetal e silvicultura. Available at: <https://cidades.ibge.gov.br>. Last visited on 13/01/2022.

¹¹⁴ IBGE Cidades – Extração vegetal e silvicultura. Available at: <https://cidades.ibge.gov.br>. Last visited on 13/01/2022.



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

- **Brief assessment of the most likely development of the population size of the identified main agent groups in the reference region, project area and leakage belt:**

As presented, Timber and firewood represent a valuable product. As this activity is also linked to the area clearing to produce pasture (Exploitation of commercial species -> clearance of area -> burning -> Pasture for cattle ranching), its value is increased when the area is illegally owned and deforested.

Although around 60% of the logging in Mato Grosso has been authorized, the area with prohibited activity grew by 17% compared to previous surveys, which analyzed the period from August 2019 to July 2020. Only in the state's indigenous lands, there was a 70% increase in illegal logging¹¹⁵.

According to the Figures above, production values and quantities have been increasing in recent years in the municipalities composing the reference region, both for timber and firewood. Therefore, this means that more areas are becoming accessible for the next linked land use, which is deforestation for the establishment of pasturelands. This situation also corroborates that the increasing trend of deforestation in the region will most likely continue in the future.

In addition, as this is the main extractivism activity in the region, population increase is also linked with the increase in the activity, as will be described in the Drivers of deforestation section.

- **Statistics on historical deforestation attributable to each main agent group in the reference region, project area and leakage belt:**

As presented above, the production and prices of wood favor the activity. However, seven out of ten hectares of forests with unauthorized logging in the Amazon are in Mato Grosso. Between August 2020 and July 2021, irregular activity covered 103,000 hectares in the state, 73% of

¹¹⁵ Available at <https://www.icv.org.br/2021/10/mato-grosso-soma-883-mil-hectares-de-florestas-exploradas-ilegalmente-em-2020/>

illegal extraction in the Amazon region. Colniza, part of the Reference Region is the 4th municipality with more unauthorized wood harvesting in the State¹¹⁶.

The survey points out that, although with a downward trend in recent years, the proportion of illegality remains at a worrying level of 38% of the total areas explored in the period – that is, of every ten hectares explored in the State to serve the national and international markets, around four were not authorized by the State Environment Secretariat (Sema/MT). The illegality value represents a 10% increase compared to last year, which added up to 37% of the total illegal logging between 2018 and 2020. This indicates that the current command and control and inspection actions are not being enough, indicating a trend towards an increase in deforestation.

- **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 population growth rate; the low cost of the forested area; soil fertility and favorable weather; well-structured soil and mainly flat conditions of the area; tradition of farming existing in the municipalities and the meat market of the region.

Key driver variables are detailed in the section below:

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

- 1) **Population growth**

This deforestation driver is associated with the dynamics of the local cattle market, as well as with the increase of potential deforestation agents working in the region.

Several studies for the Amazon biome^{117,118,119} 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

¹¹⁶Available at < <https://www.icv.org.br/2022/09/mato-grosso-concentra-70-da-exploracao-ilegal-de-madeira-na-amazonia/>>

¹¹⁷ ANGELSEN; KAIMOWITZ. Rethinking the Causes of Deforestation: Lessons from Economic Models. The World Bank Research Observer, vol. 14, no. 1 (February 1999), pp. 73–98. Available at < https://www.researchgate.net/publication/11117669_Rethinking_the_Causes_of_Deforestation_Lessons_from_Economic_Models>

¹¹⁸ ASHOK K.; JAGDISH C.; DAVID K. Understanding the Role of Population in Deforestation. Journal of Sustainable Forestry Vol. 7, Iss. 1-2, 1997 Available at < https://doi.org/10.1300/J091v07n01_03>

¹¹⁹ MEYERSON, F. A. B. Population Growth and Deforestation: A Critical and Complex Relationship. Population Bulletin 58, no. 3. 2003 Available at < <https://www.prb.org/resources/population-growth-and-deforestation-a-critical-and-complex-relationship/>>

migrant families arrive at the forest frontier and clear land to provide more area for subsistence and commercial farming.

From 2010 Census and the 2021 estimate provided by IBGE¹²⁰, it is possible to note that the population in all municipalities grew, Cotriguaçu and Colniza at a higher rate than Nova Bandeirantes and Apicás. The four municipalities grew at a higher rate than Brazil.

¹²⁰ Available at < <https://cidades.ibge.gov.br/>>

Table 17. Population growth in the municipalities within the RR

City	Population – 2010	Population – 2021	Average increase rate (%/year)
Cotriguaçu	14,983	20,717	3.83%
Colniza	26,381	41,117	5.59%
Nova Bandeirantes	11,643	16,052	3.79%
Apiacás	8,567	10,431	2.18%
Brazil	190,755,799	213,317,639	1.18%

- **Briefly describe how the key driver variables have and will most likely impact on each agent group’s decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

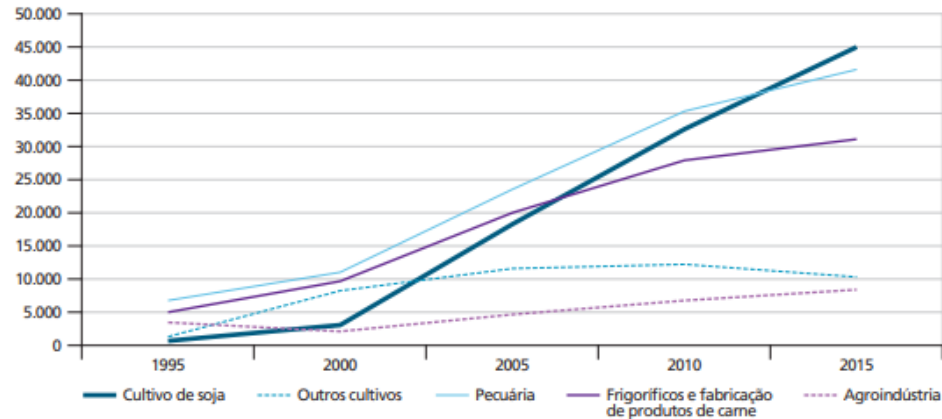
The increase in population indicates an increase in labor for the main activities in the region. In this case, as it is a mostly rural region, with low population density and an economy based on livestock and forestry, migration becomes attractive for the purchase of land and employment in the production chain.

According to analysis, the introduction of slaughterhouses, as an establishment requiring labor, tends to attract migratory flows¹²¹. In summary, the changes observed in the recent productive structure of the state of Mato Grosso show that there has been a significant expansion in the number of employment relationships related to the cultivation of soy and livestock. This growth is mainly explained by the expansion of activities in the state, which significantly increased the number of establishments with these activities.

The same study concludes that this growth can also be related to the indirect effects of these industrial plants on the municipal economies, generating a potential for “migratory attractiveness” for these municipalities.

¹²¹ Available at <https://repositorio.ipea.gov.br/bitstream/11058/8154/1/BRU_n17_Agroneg%C3%B3cio.pdf>

Figure 59. Comparison between absolute volumes of active employment relationships, by selected activities in Mato Grosso State (1995 – 2000 and 2010 – 2015) (legend in order: Soy production, Other crops, Livestock, Slaughterhouses and manufacturing of meat products, Agro industry)¹²²



Thus, it is possible to see that, in addition to the need for infrastructure and food, which drives deforestation to support population growth in the municipalities of the RR, the drivers also influence the migratory movement, due to the financial interest and opportunities of the activities, expanding the need to open new areas.

- **Project measures that will be implemented to address them, if applicable:**

The project has no means to address population growth directly, however, the proposed activities will work on raising awareness and generating alternative sources of income with non-timber forest products and job creation for the region's population, aiming at independence from deforestation.

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, reaching in 2020 more than 1,800,000 animals in the municipalities composing the reference region. In addition, during the same period, the timber logging also increased, being one of the main produced products in the municipalities.

It is important to note that timber stands out as having the highest values among the total annual production in the project area municipalities¹²³. In addition, as detailed in previous sections and in the description of deforestation agents above, timber prices have much higher value than other products exploited in the region.

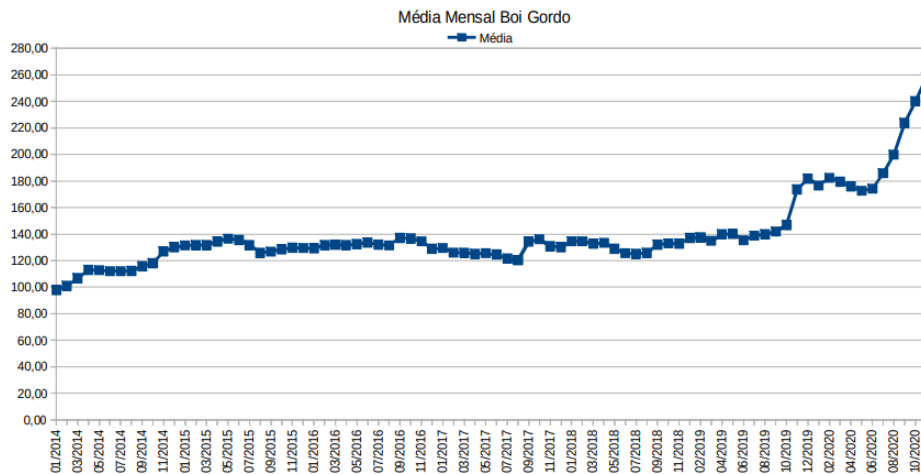
¹²² Available at <https://repositorio.ipea.gov.br/bitstream/11058/8154/1/BRU_n17_Agroneg%C3%B3cio.pdf>

¹²³ IBGE Cidades – Extração vegetal e silvicultura. Available at: <https://cidades.ibge.gov.br/brasil/>. Last visited on 13/01/2022

Furthermore, forested property values are almost 4 times cheaper than established pasturelands¹²⁴. Thus, this disparity promotes the purchase of new forested areas, deforestation, and further creation of new pasturelands.

In Mato Grosso, the monthly average price of cattle soared in 2019, an overvaluation that made the “arroba” (unit use to count the animal’s weight, around 15 kg) to reach 260 reais in 2020.

Figure 60. Average cattle price in Mato Grosso, in R\$¹²⁵.



Thus, partly due to the expansion of globalization, deforestation rates in Amazonia appear to be linked to the growth of the international market, especially of beef¹²⁶.

- **Briefly describe how the key driver variables have and will most likely impact on each agent group’s decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

As previously discussed, livestock is the main activity in the state and region, associated with the exploitation of wood to clear areas, in addition to forest management. The increase in the price of the main products that cause deforestation directly impacts the decision to deforest, since it becomes increasingly advantageous for the agents of deforestation.

- **Project measures that will be implemented to address them, if applicable:**

The project has no means to address cattle and wood prices directly, however, the proposed activities will work on raising awareness and generating alternative sources of income with non-

¹²⁴ REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. Economia Verde: Desafios e Oportunidades, Campinas, v. 8, p.143-155, jun. 2011. Available at:

<https://web.archive.org/web/20171031104223/http://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: July 7th, 2021.

¹²⁵ Available in <https://www.conab.gov.br/info-agro/analises-do-mercado-agropecuario-e-extrativista/analise-regional-do-mercado-agropecuario/analise-regional-mt-pecuaria> Monthly conjuncture – February 2021. Last Visited on December 03rd, 2021.

¹²⁶ Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. *Conservation Biology* 19(3):680-688. Available at < <https://www.jstor.org/stable/3591054>>

timber forest products and job creation for the region's population, aiming at independence from deforestation.

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 and deforestation in the Amazon biome and their spatio-temporal dynamics are highly influenced by annual deforestation patterns. Degradation may not be a precursor to deforestation in that exact location, but it can serve as an alert that that region will be the target of deforestation practices coming soon. There are indications that the portion of degradation that occurs through local deforestation or in the surroundings grew between 2013 and 2015 (final years of the study sample) in all land categories. This can point to a growing relevance of degradation as a precursor and, therefore, an indicator of deforestation¹²⁷.

In addition, forest fragmentation results from deforestation and disturbance, with subsequent edge effects extending deep into remaining forest areas^{128,129}.

- **Briefly describe how the key driver variables have and will most likely impact on each agent group's decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

Previously deforested areas are also related to the accessibility of the area. They usually precede infrastructure – buildings, roads, yards, etc. When assessing an accessibility zone within a radius of previously deforested areas for official and unofficial roads across the Amazon, this zone was approximately 1.4 million km², 35.2% of the Brazilian Amazon, and encompassed 94.9% of all deforestation.

- **Project measures that will be implemented to address them, if applicable:**

The conservation of the project area itself will be a form of mitigation, with the maintenance of the forest area in order to minimize the fragmentation caused by deforestation. Monitoring more vulnerable regions, such as property boundaries and rivers, will also contribute to the reduction of encroachments, protecting access areas to the property. In addition, socio-environmental activities involve raising awareness and generating alternative income with

¹²⁷ Available at < <https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/DQ-Degradacao-Florestal-Amazonia.pdf>>

¹²⁸ BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. *Biological Conservation*. Volume 141, Issue 7, July 2008, Pages 1745–1757 Available at <

https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

¹²⁹ IMAZON. Carbon emissions from deforestation and forest fragmentation in the Brazilian Amazon. 2011. Available at: <<http://amazon.org.br/publicacoes/carbon-emissions-from-deforestation-and-forest-fragmentation-in-the-brazilian-amazon/?lang=en>>. Last visit on: August 6th, 2021.

non-timber forest products, highlighting the importance of the forest for the region's population.

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 already plentiful rivers in the region, increases anthropogenic pressure and, consequently, the intensity of deforestation^{130,131,132}. It is broadly recognized that deforestation is accelerated in regions that have denser road networks (IMAZON, 2021¹³³).

- **Briefly describe how the key driver variables have and will most likely impact on each agent group's decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

Waterways remain the overwhelmingly predominant means of transport and access to forest products in the Amazon Biome. 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.

Furthermore, other analysis allows to conclude that that 94.9% of all deforestation in the Brazilian Amazon has occurred in a well-defined accessible zone within 5.5 km of some type of roadway or 1.0 km of a navigable river¹³⁴. Proximity to open areas and infrastructure enables greater flow of products and logistics, which favors livestock and logging activities.

The Juruena River is a navigable river that has been used to access the eastern portion of the Project Area and is a valuable way for land-grabbers to easily invade the property and clear forests for logging and pasture. In the case of navigable rivers, the number of paths

¹³⁰ BROADBENT et al. Forest fragmentation and edge effects from deforestation and selective logging in the Brazilian Amazon. *Biological Conservation*. Volume 141, Issue 7, July 2008, Pages 1745–1757. Available at <
https://www.researchgate.net/publication/285152230_Forest_fragmentation_and_edge_effects_from_deforestation_and_selective_logging_in_the_Brazilian_Amazon>

¹³¹ GENELETTI, D. Biodiversity Impact Assessment of roads: an approach based on ecosystem rarity. *Environmental Impact Assessment Review*, v.23, n.3, p.343-365, 2003 Available at <
<https://www.sciencedirect.com/science/article/abs/pii/S0195925502000999>>

¹³² Fearnside, P.M. e P.M.L.A. Graça. 2006. BR-319: Brazil's Manaus-Porto Velho Highway and the Potential Impact of Linking the Arc of Deforestation to Central Amazonia. *Environmental Management* 38:705-716. Available at <
https://www.researchgate.net/publication/6803490_BR-319_Brazil's_Manau-Porto_Velho_Highway_and_the_Potential_Impact_of_Linking_the_Arc_of_Deforestation_to_Central_Amazonia>

¹³³ <https://imazongeo.org.br/> (accessed in 31/05/2021)

¹³⁴ Roads, deforestation, and the mitigating effect of protected areas in the Amazon. Available at <
<https://www.sciencedirect.com/science/article/abs/pii/S000632071400264X?via%3Dihub>>

will be invariable across the project lifetime, as the creation of new navigable rivers is highly unlikely.

In the analysis, highway proximity emerged as the single most important predictor of deforestation. Because they promote efficient, year-round access to forests, highways tend to have considerably larger-scale impacts than roads. It must be noted, however, that major highways tend to spawn secondary road networks, as has occurred extensively in the southern and eastern Amazon (for example, around the Belém-Brasília, TransAmazon, and BR-364 highways)¹³⁵.

The closest access road is BR 174, called Manaus-Boa Vista, highway connecting the Brazilian states of Mato Grosso, Rondônia, Amazonas and Roraima to Venezuela.

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

- **Project measures that will be implemented to address them, if applicable:**

The monitoring more vulnerable regions, such as property boundaries and rivers, will contribute to the reduction of encroachments, protecting access areas to the property. In addition, socio-environmental activities involve raising awareness and generating alternative income with non-timber forest products, highlighting the importance of the forest for the region's population.

3) Presence of protected areas (UCs and indigenous lands)

There are protected areas and indigenous lands within and around the Reference Region. The closest areas are listed below:

- TI Escondido (Indigenous land)
- TI Apiaká do Pontal e Isolados (Indigenous land)
- Parque Nacional do Juruena (Protected Area - UC)
- Parque Estadual Igarapés do Juruena (Protected Area - UC)

There is a duality in the pattern of deforestation observed in protected areas. The presence of protected areas in the surroundings of the project area would in theory decrease the likelihood of deforestation, affecting the location of future deforestation. As a result, the deforestation that would have occurred in such protected areas occurs in non-protected areas in the region (leakage from displaced deforestation). On the other hand, an increase in deforestation within protected areas has also been verified.

¹³⁵ Roads, deforestation, and the mitigating effect of protected areas in the Amazon. Available at <
<https://www.sciencedirect.com/science/article/abs/pii/S000632071400264X?via%3Dihub>>

Between 2012 and 2015, 237.3 thousand hectares were deforested within Conservation Units (UCs) in the Amazon. During that period, the occupants may have obtained a gross income of R\$ 300 million from the sale of timber illegally harvested from the protected areas, which created an enormous investment potential for deforestation, with logging being the main agent of deforestation¹³⁶.

- **Briefly describe how the key driver variables have and will most likely impact on each agent group's decision to deforest provide information about its likely future development, by providing any relevant source of information.**

Deforestation has increased within some protected areas and the percentage share of deforestation in conservation units in the total deforested in the Legal Amazon doubled from 6% to 12% between 2008 and 2015. In 2015, deforestation within conservation units was 79% higher than in 2012. In the last 4 years, the area of devastated forest in conservation units in the Legal Amazon rose 80%, against 35% of deforestation in general.

In more recent years, between 2018 and 2019, deforestation within conservation units grew 35% between August 2018 and July 2019 (going from 767 km² to 1,035 km²). The growth rate of deforestation in these protected areas was higher than the amount recorded for the entire Amazon biome (29.5%).¹³⁷

The year of 2020 was the second worst year for Indigenous Lands and Conservation Units since 2008. The 188 thousand hectares of forests destroyed in these territories are second only to the almost 200 thousand hectares registered in 2019. In addition, they represent 90% more than the average between 2009 and 2018¹³⁸.

Therefore, it is concluded that, although in theory the presence of conservation units is an indication of areas extremely protected by law, it has been demonstrated that, in practice, the opposite occurs, leaving large areas of native forests exposed to invasions, exploitation and illicit sales, facilitated by lack of inspection and public policies, and making the area around it also vulnerable to this type of activity.

In view of the analysis of underlying agents and the Brazilian environmental political scenario, the trend is for an increase and maintenance of high deforestation rates in these regions¹³⁹.

- **Project measures that will be implemented to address them, if applicable:**

The monitoring more vulnerable regions, such as property boundaries and rivers, will contribute to the reduction of encroachments, protecting access areas to the property. In

¹³⁶ Available in <<https://imazon.org.br/imprensa/novo-estudo-do-imazon-alerta-para-tendencia-de-aumento-do-desmatamento-em-unidades-de-conservacao-da-amazonia-e-identifica-as-50-mais-desmatadas-entre-2012-e-2015/>>

¹³⁷ Available in <<https://oeco.org.br/reportagens/desmatamento-em-unidades-de-conservacao-atinge-maior-indice-dos-ultimos-10-anos/>>

¹³⁸ Available in <<https://www.socioambiental.org/pt-br/noticias-socioambientais/destruicao-de-areas-protegidas-na-amazonia-explode-com-bolsonaro>>

¹³⁹ Deforestation in Conservation Units reaches the highest rate in the last 10 years. Available at <<https://oeco.org.br/reportagens/desmatamento-em-unidades-de-conservacao-atinge-maior-indice-dos-ultimos-10-anos/>>

addition, socio-environmental activities involve raising awareness and generating alternative income with non-timber forest products, highlighting the importance of the forest for the region's population.

4) Slope, altitude, and terrain conditions

Slope and altitude can also be considered relevant significant factors, since the establishment of pasture and agriculture operations are more likely on flat landscapes, as pointed by Marchesan (2016)¹⁴⁰. Moreira and Valeriano (2013)¹⁴¹ also observed that the agroindustry is more likely to establish its borders in flat lands for several reasons, including productivity, machinery access, and legal compliance. It is worth mentioning the Brazilian Forest Code establishes 45° slope as Permanent Preservation Areas (APP)¹⁴², thus the land use is more competitive in flatter and lower lands.

- **Briefly describe how the key driver variables have and will most likely impact on each agent group's decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

Slope is a geographic variable that is present in Brazilian legislation as a limiting factor for agricultural use. In the agricultural land use capacity system, slope levels are directly related to the permissible use intensity class¹⁴³. The relief can influence the quality of the pasture in many aspects, among which mechanization (feasibility of using machines) and erosion stand out¹⁴⁴. Altitude can influence the growth of grasses and cattle management.

In this way, it is understood that flatter areas and at mild altitudes are more sought after for cattle raising and agriculture, in addition to the influence of their accessibility.

- **Project measures that will be implemented to address them, if applicable:**

Not applicable.

5) Distance to urban areas

As well as the accessibility drivers (rivers and roads) and proximity to deforested areas, the distance to urban centers is an important parameter as it provides infrastructure and

¹⁴⁰ MARCHESAN, J. et al. Análise da relação entre a evolução florestal e a declividade utilizando imagens Landsat. UFSM, 2016. Available at <https://periodicoscientificos.ufmt.br/ojs/index.php/nativa/article/view/3247/pdf>. Last visit on 27/January/2023.

¹⁴¹ MOREIRA, E.P., VALERIANO, M.M. Relação entre diferentes usos e coberturas da terra e declividade do terreno: implicações em conservação do solo. Instituto Nacional de Pesquisas Espaciais – INPE. Available at <http://marte2.sid.inpe.br/archive.cgi/dpi.inpe.br/marte2/2013/05.29.00.10> Last visit on 27/January/2023.

¹⁴² BRASIL. Law nº. 12.651, of 25 May 2012. Forest Code. Diário Oficial da República Federativa do Brasil, Brasília, DF, 25 May 2012.

¹⁴³ Eder Paulo Moreira, Márcio de Morisson Valeriano. **Relação entre diferentes usos e coberturas da terra e declividade do terreno: implicações em conservação do solo** - Anais XVI Simpósio Brasileiro de Sensoriamento Remoto - SBSR, Foz do Iguaçu, PR, Brasil, 13 a 18 de abril de 2013, INPE.

¹⁴⁴ Available at < https://www.teses.usp.br/teses/disponiveis/8/8135/tde-10112009-143737/publico/LEONARDO_RODRIGUES_A_C.pdf>

drainage for the area that will suffer deforestation. Urban centers act as an agglomeration of other drivers, and therefore collaborate with the location of deforestation.

The analyzed studies showed that urban sprawl occurs mostly in portions that have already been deforested, specifically in areas of cultivation. Not being an immediate cause of change in forest cover, therefore not having a causal link, urbanization is at the same time a land use class and a propelling space of underlying factors that circumstantial decision-making, inciting multiscale dynamics that are structured in a cyclical and retroactive system. Urban driving forces for deforestation are guided, in some way, by a spatial relationship, increasing in intensity and impact with the proximity from urban centers¹⁴⁵.

- **Briefly describe how the key driver variables have and will most likely impact on each agent group's decision to deforest and provide information about its likely future development, by providing any relevant source of information.**

By encompassing a series of other drivers, urban centers act in such a way that the degree of connection with the urban is the guiding element for the expansion of agricultural activities – the type of agricultural crop, the cultivated area, the intensity of growth. According to the analysis, with regard to deforestation, urbanization acts through the propagation of underlying factors, reproducing driving forces that act synergistically in decision-making and, subsequently, in the materialization of action, which in the medium-long term may become an urban class land use¹⁴⁶.

The influence of proximity to urban areas can be evaluated in two ways: the direct association with deforestation, with the construction of roads, reservoirs and infrastructure, or the indirect one, with the ex-ante and ex-post effects of urbanization in the region. As evaluated in other drivers, the ex-ante impact is due to the attractiveness of job creation during the works, in addition to the new economic network created by other economic activities that also exert an effect of attraction on the population of other municipalities. And the ex-post effect, which occurs largely due to the dynamism of the municipal economy when they acquire operating conditions, as well as the population that migrated and was absorbed as labor during the work, but which starts to reside in the municipality and create other economic activities for their survival. In addition to enhancing the attraction for future immigrants¹⁴⁷.

The studies also showed that the inclusion of this factor in deforestation projections to estimate its location was significant and with a positive sign, as initially expected, corroborating the hypothesis that the further the municipality is from the capital, the lower

¹⁴⁵The interface between deforestation and Urbanization in the Brazilian Amazon. Available at < <https://www.scielo.br/j/asoc/a/ns5jQPmxbPFdy79PckdGXvv/?format=pdf&lang=pt>>

¹⁴⁶ The interface between deforestation and Urbanization in the Brazilian Amazon. Available at < <https://www.scielo.br/j/asoc/a/ns5jQPmxbPFdy79PckdGXvv/?format=pdf&lang=pt>>

¹⁴⁷ Short term dynamics of deforestation the Legal Amazon: Analysis of the role of public policies in the period from 2000 to 2010. Available at < <https://www.revistas.usp.br/ecoa/article/download/141292/160766/407969>>

its availability of access to urban infrastructure, as well as the institutional apparatus, which regulates activities that promote deforestation¹⁴⁸.

Thus, the proximity to urbanization and infrastructure tends to be an important driver of deforestation, contributing to the increase tendency observed in the region.

- **Project measures that will be implemented to address them, if applicable:**

The monitoring more vulnerable regions, such as property boundaries and rivers, will contribute to the reduction of encroachments, protecting access areas to the property. In addition, socio-environmental activities involve raising awareness and generating alternative income with non-timber forest products, highlighting the importance of the forest for the region's population.

- **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 democratic 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.

According to the definition of the section in the methodology, the agents' characteristics and decisions are themselves determined by broader forces, the underlying causes of deforestation, such as: Land-use policies and their enforcement; Population pressure; Poverty and wealth; War and other types of conflicts; Property regime. In Brazil, the political scenario is crucial to define agents and drivers of deforestation, since both environmental protection measures and the definition of prices for products such as wood and meat, social actions and public policies are directly influenced by the characteristics of the current government. Despite the country's strong environmental legislation, it is evidenced in its timeline attempts to extinguish restrictions in anti-environmentalist governments.

Due to being located in a region of large cattle ranchers, miners, settlements and indigenous lands, the reference region has a considerable social conflict issue, primarily land conflict. Land is occasionally illegally occupied by squatters and illegal loggers^{149,150,151}. 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 low presence of Governance and lack of land-tenure documentation, with thousands of rural producers owning non-documented properties, promotes a scenario of forest destruction for

¹⁴⁸ Short term dynamics of deforestation the Legal Amazon: Analysis of the role of public policies in the period from 2000 to 2010. Available at < <https://www.revistas.usp.br/ecoa/article/download/141292/160766/407969>>

¹⁴⁹ Available at <<https://g1.globo.com/natureza/noticia/2019/09/04/invasoes-grilagem-e-queimadas-ameacam-areas-protegidas-na-amazonia.ghtml>>

¹⁵⁰ Available at < https://acervo.socioambiental.org/sites/default/files/documents/prov0227_0.pdf>

¹⁵¹ Available at <<https://www.bbc.com/portuguese/brasil-56211156>>

exploration of natural resources and creation of pastureland, driving the tendency for the frontier to grow¹⁵².

Environmental governance in Brazil can be divided into three major periods: 2000 - 2008, where the main improvements in environmental governance were established, 2009 – 2012, period of main decrease in deforestation and the start of the weakening of the Forest Code; 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 following years.

The deforestation rates in the country, which had been declining since 2005, increased again in the Brazilian Amazon¹⁵³. The impact of the change in the country's ideology after the alteration of the forest code, and mainly evidenced after the impeachment (which began with the governmental stagnation in 2014 and was concluded in 2016) can be seen in the biomes' deforestation charts.

From 2016 onwards, Brazil has been in the midst of a severe political and ethical crisis after suffering a putsch that removed the democratically elected president from the federal government. Since then, the country suffered consecutive attacks on the environmental agenda, resulting in the dismantling of the national environmental policy.

The post impeachment period 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 party, 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, reduce the environmental policies that prevented it from occur.

The Brazilian National Congress has approximately 500 parliamentarians, which means that obtaining support from the ruralist party (which has around 350 parliamentarians) guarantees a strategic advantage for the approval of provisional measures and decrees.

¹⁵² INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM). Reduções de Emissões do Desmatamento e Degradação Florestal (REDD+): Estudo de Oportunidades para a Região Sul do Amazonas. Manaus: Idesam, 2011. 45 p. (Relatórios Técnicos nº1). 141 Available in <
https://idesam.org/publicacao/REDD_Estudo_de_Oportunidades_Sul_Amazonas.pdf> Last visited on March 23, 2022.

¹⁵³ ROCHEDO, P. RR; SOARES-FILHO, B; SCHAEFFER, R. VIOLA, E. SZKLO, A; LUCENA, A.F.P; KOBERLE, A; DAVIS, J.L; RAJÃO, R; RATHMANN, R. The threat of political bargaining to climate mitigation in Brazil. **Nature Climate Change**, vol 8, August 2018, pg. 695–69.

During this period, Brazil was the stage for a series of acts against the environmental area, such as cutting budgets for protected areas monitoring, reducing the protection of more than 600,000 ha of Amazon and Atlantic Forest biomes¹⁵⁴, and reduction of federal agents responsible for tackling deforestation.

Therefore, after the impeachment of Dilma Rouseff in 2016, the Temer's Government clearly opened the threat of political bargaining to forest conservation in order to attract the rural party in the Congress. In exchange of political support, the government offered landholders to increase deforestation, and the signature of provisional measures 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 areas¹⁵⁵.

Following the anti-environmental trend, Jair Bolsonaro was elected in 2019, along with other right wing politicians, making it clear in the first few months what the profile of his government would be like, with major changes and cuts in the environmental agenda.

In the beginning of 2019, the fusion of Environment and Agriculture Ministries was a clear attempt to obtain more rights for the expansion of agriculture and livestock. The decision was canceled a few days later, after pressure from environmentalists and others in the sector; however, major changes occurred in the ministerial office, limiting the reach and autonomy of the Environmental Ministry, with the absence of resources to combat deforestation¹⁵⁶.

In addition, the transference of policies and instruments of water resources, including the National Water Agency (ANA) to the Ministry of Regional Development¹⁵⁷ 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 Supply¹⁵⁸ 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 Supply¹⁵⁹.

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

¹⁵⁴ CROUZEILLES, R., FELTRAN-BARBIERI, R., FERREIRA, M. S. & STRASSBURG, B. B. N. Hard times for the Brazilian environment. *Nat. Ecol. Evol.* 1, 1213 (2017).

¹⁵⁵ ROCHEDO, P. RR; SOARES-FILHO, B; SCHAEFFER, R. VIOLA, E. SZKLO, A; LUCENA, A.F.P; KOBERLE, A; DAVIS, J.L; RAJÃO, R; RATHMANN, R. The threat of political bargaining to climate mitigation in Brazil. *Nature Climate Change*, vol 8, August 2018, pg. 695–69.

¹⁵⁶ Available in < <https://www.socioambiental.org/pt-br/blog/blog-do-isa/a-anatomia-do-desmonte-das-politicas-socioambientais>> Last visited on December 06th, 2021

¹⁵⁷ Available in < <https://oeco.org.br/reportagens/ana-muda-de-pasta-e-atribuicao-mas-incertezas-continuam/>>

¹⁵⁸ Available in < <https://oglobo.globo.com/brasil/bolsonaro-transfere-concessao-de-florestas-publicas-para-ministerio-da-agricultura-24427684>>

¹⁵⁹ Available in < <https://politica.estadao.com.br/noticias/geral,ministerio-da-agricultura-sera-responsavel-por-reforma-agraria-terras-indigenas-e-quilombos,70002663895>>

km² were deforested during that year¹⁶⁰. 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 Amazon¹⁶¹, the government tried to deviate attention from the fires, claiming they were fake news¹⁶². 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%¹⁶³.

Also, during August 2019, 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 Fund¹⁶⁴.

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 2020¹⁶⁵.

Deforestation also accompanied this increase, reaching an increase of 9.5% between August 2019 and July 2020. The area deforested in the period was 11,000 km², according to INPE¹⁶⁶.

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 forest¹⁶⁷.

Government agencies such as INPE and IBAMA, responsible for deforestation monitoring had suffered funding cutoffs, dismissals and had their functions and increasing deforestation data publicly questioned and denied by the government¹⁶⁸.

¹⁶⁰ Available in < http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294> Last visited on December 6th, 2021

¹⁶¹ Available in < <https://www.economist.com/the-americas/2019/08/22/forest-fires-in-the-amazon-blacken-the-sun-in-sao-paulo>> Last visited on December 6th, 2021

¹⁶² Available in < <https://www.theguardian.com/environment/2019/sep/09/amazon-fires-brazil-rainforest>> Last visited on December 6th, 2021

¹⁶³ 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>> Last visited on December 6th, 2021

¹⁶⁴ Available in https://brasil.elpais.com/brasil/2019/08/15/politica/1565898219_277747.html> Last visited on December 6th, 2021

¹⁶⁵ Available in <<https://g1.globo.com/natureza/noticia/2020/09/12/em-um-ano-governo-bolsonaro-corta-verba-para-brigadistas-em-58.ghtml>> Last visited on December 6th, 2021

¹⁶⁶ Available at <https://g1.globo.com/natureza/noticia/2020/11/30/amazonia-teve-11-mil-km-de-desmatamento-entre-agosto-de-2019-e-julho-de-2020-aponta-inpe.ghtml>

¹⁶⁷ 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>> Last visited on December 6th, 2021

¹⁶⁸ 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>> Last visited on December 6th, 2021

The quantity of national parks protected areas and indigenous lands in the country was already questioned by Bolsonaro, that intended to extinguish those by decree¹⁶⁹, an unconstitutional action, after announcing the intention to review the protected areas' law (SNUC) and the existing units¹⁷⁰. In addition, the Minister of the Environment promoted a publicly speech about his intention to take advantage of the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and justice processes¹⁷¹.

Specialists affirm that, with the current pace of dismantling of the inspection structure and environmental legislation demonstrated since the first 6 months of the Bolsonaro's 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 coverage¹⁷²

The development of REDD projects and a new culture of sustainable management 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 having since 2015 the National Commission for REDD+, established by decree, which is responsible for coordinating and monitoring the implementation of the National REDD+ Strategy in Brazil, it can be noticed 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.

Another important underlying agent of deforestation is the poverty and wealth inequality, also influenced by the political situation. According to statistics on the municipality of Colniza/MT¹⁷³, in 2018, the average monthly salary was 1.9 minimum wages. The proportion of occupied people in relation to the total population was 8.8%. In comparison with other municipalities in the state, it ranked 132 out of 141, while in comparison with cities nationwide, it ranked 3834 out of 5570. Considering households with monthly incomes of up to half a minimum wage per person, it had 45.7% of the population in these conditions. For Cotriguaçu/MT (IBGE, 2021)¹⁷⁴, an average

¹⁶⁹ Available in < <http://www.ihu.unisinos.br/78-noticias/589958-em-live-bolsonaro-reclama-que-nao-consegue-extinguir-parques-por-decreto>> Last visited on December 6th, 2021

¹⁷⁰ Available in < <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.>>> Last visited on December 6th, 2021

¹⁷¹ Available in < <https://g1.globo.com/politica/noticia/2020/05/22/ministro-do-meio-ambiente-defende-passar-a-boiada-e-mudar-regramento-e-simplificar-normas.ghtml>> Last visited on December 6th, 2021

¹⁷² Available in <https://www.bbc.com/portuguese/brasil-48805675> > Last visited on December 6th, 2021

¹⁷³ <https://cidades.ibge.gov.br/brasil/mt/colniza/panorama> (accessed in 01/06/2021)

¹⁷⁴ <https://cidades.ibge.gov.br/brasil/mt/cotriguacu/panorama> (accessed in 30/06/2021)

monthly salary of 2.1 minimum wages was reported in 2019, and the proportion of occupied people in relation to the total population was 6.3%. Considering households with monthly incomes of up to half a minimum wage per person, it had 46.1% of the population in these conditions in 2010. These data show that the region faces poverty issues.

This key underlying cause has a major impact on deforestation decisions, as the main agents (cattle ranchers, operationally supported by loggers and land-grabbers) can easily recruit cheap manpower, consisting of workers seeking to sustain their families by means of this profitable activity, despite it being illegal, due to the inconsistency of law enforcement.

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

Although the project activity cannot solve the poverty issue, it aims to provide new jobs for local agents, who will be able to generate revenues for their families by means of a legal and sustainable initiative.

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

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 led and most likely will lead to deforestation within the reference region.

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*.

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 region), 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.

Furthermore, deforestation will probably increase due to setbacks in environmental legislation and deforestation control occurred in in the period after 2012, namely reduction in control programs to reduce deforestation in the Amazon, reduction of protected areas and the amnesty to deforesters. The recent history of polemics and anti-environmentalism actions of the Brazilian government, in addition to not tackling the direct causes, minimizing monitoring and restrictions

in critical environmental areas, and no investments in sustainable management and farming methods end up influencing and even motivating deforestation, illegal occupation and non-compliance with environmental laws.

There is no strong environmental policy, and even with good advances, Brazilian laws have gaps that are taken in advantage by landowners, intensified by weakened controlling mechanisms that have been dismantled by the Government, making the conservation of the extensive Brazilian biomes even more difficult.

- **Conclusion**

The conduction of the VM0015 Step 3 –ANALYSIS OF AGENTS, DRIVERS AND UNDERLYING CAUSES OF DEFORESTATION AND THEIR LIKELY FUTURE DEVELOPMENT and available evidence allows to analyze that the most likely future deforestation trend within the reference region and project area is conclusive and increasing.

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, the population growth rate increase, the more accessible areas due to roads, illegal logging and other deforested areas, and also due to the lack of effective governmental control and environmental planning are clear evidence that the overall deforestation trend is increasing and will continue to increase in future baseline deforestation rates, and this demonstrates the need for conservation measures that encourage a change in the business and production model in the region.

PROJECTION OF FUTURE DEFORESTATION

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

- **Selection of Baseline Approach**

As per the VM0015 methodology, to project future deforestation, three baseline approaches are available: historical average, time function and modelling approach.

According to the GIS analysis, between 2007 and 2017, there was a deforestation of 38,133.36 ha within the reference region, with an average oscillation of approximately 3,466.67 ha/year (Figure 61).

As described in sections above, the deforestation rates measured in different historical sub-periods in the reference region reveal a clear trend, and this trend is an increase of the deforestation rate. The analysis of presented evidence related to deforestation agents and drivers, in addition to

underlying causes, allows to conclude that the deforestation rate is increasing, and it is likely that this trend will continue in the future.

Thus, the selected baseline approach is the Time function approach. With this approach, the rate of baseline deforestation is estimated by extrapolating the historical trend observed within the reference region (or its strata) as a function of time using either linear regression, logistic regression or any other statistically sound regression technique. It requires multiple deforestation measurements during the past 10-15 years.

A linear regression model of absolute annual deforestation rates on time was fitted. Its estimated coefficients are shown below:

$$\hat{A}_t = -430261.6 + 215.2 \times t$$

Where \hat{A}_t is estimated deforestation at year t . The model was statistically significant (the p-value for the predictor was 0.00786 and 0.007863 for the F-Statistic) and had a good fit ($R^2 = 0.5137$).

Moreover, the procedure suggested by the VM0015 1.1, pg 45-46, was applied to avoid non-conservative projections. The following parameters were estimated:

$$A_{optimal} = \sum_{\{t=1\}}^{\{t_{optimal}\}} ABSLRR_t$$

$$A_{average} = \sum_{\{t>t_{optimal}\}}^{\{t_{average}\}} ABSLRR_t$$

Where:

$ABSLRR_t$: Annual baseline area in the reference region in year t ;

$t_{optimal}$: year by which conversion from forest to non-forest will be “optimal”;

$t_{average}$: year by which the conversion from forest to non-forest will be “medium”;

$A_{optimal}$: forest area where conversion to non-forest is “optimal”;

$A_{average}$: forest area where conversion to non-forest is “medium”.

To find the values of $t_{optimal}$, $t_{average}$, $A_{optimal}$ and $A_{average}$ the following procedure was used:

- i) Identified all land use changes occurred during the historical reference period (Figure 50);
- ii) A logistic regression was fit of land use and cover change on variables that constrain/encourage the use of cleared land: land category, elevation, and slope, and used the model to estimate the “probability” of deforestation for each pixel covering the reference region. The results of this model are in Table 18;
- iii) 0.01% quantiles of predicted probabilities from the logistic model above were used in as input of a cluster analysis to “naturally” divide the amplitude of predicted probabilities into 3 subintervals of suitability for conversion.

- iv) Areas with scores within each subinterval were considered areas where conversion is “optimal”, “medium” and “sub-optimal”.
- v) The value of *toptimal* was the first value where the remaining forest area is smaller than the forest area where the conversion conditions are “optimal”, obtained by the above procedure (forest < *Aoptimal*).
- vi) The value of *taverage* was equal to the first value where the remaining forest area is smaller than the forest area where the conversion conditions are “medium”, obtained by the above procedure (forest < *Aaverage*).

Table 18 - Logistic regression to determine viability scores for forest conversion in the reference region.

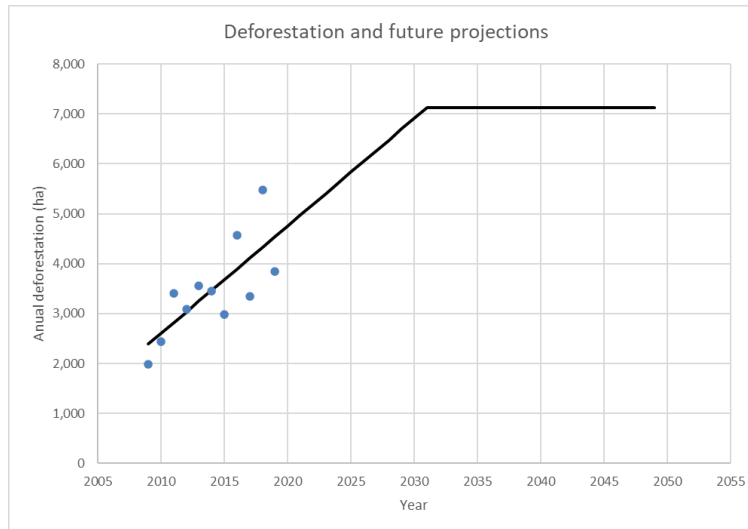
Predictor	Coefficient	Standard error	z-value	p-value
(Intercept)	-1.32924	0.0161268	-82.424	<2e-16
Soil order				
Oxisols	-2.41204	0.0040097	601.555	<2e-16
Gleisols and Neosols	-4.94295	0.0207095	-238.68	<2e-16
Oxisols and Neosols	-0.04142	0.0499348	-0.829	0.407
Neosols and Argisols	-0.44282	0.0163716	-27.048	<2e-16
Others	-1.79308	0.1966306	-9.119	<2e-16
$l(\log(d_rios^4 + 1))$	0.118858	0.0018663	63.685	<2e-16
Slope	-0.01044	0.0002292	-45.546	<2e-16
Conservation Unit	-3.90856	0.0144189	271.071	<2e-16

Table 19 shows the forest area thresholds for the different levels of conditions for conversion found by the method above. According to the results, c.a. 66.900 hectares (9.1%) of forest can still be deforested in the Reference Region under “optimal” conditions. Another 401.625 hectares (54.9%) can be deforested under “sub-optimal” conditions. The estimated value of *toptimal* is 11 years, so the “optimal” period entirely covers the first 10-year crediting period.

Table 19 - Forest area and conversion conditions estimated from a logistic regression of deforestation and soil type, elevation and slope

Period	Starting year	Ending year	Cumulative deforestation	% of original cover deforested by the end of the period
optimal	2021	2032	66,900	9.1%
average	2033	2072	468,525	63.9%
suboptimal	2072	-	733,148	100.0%

Figure 61. Deforestation rate in the reference region¹ during the HRP and future projections² up to 2050.



¹ Data source for deforestation in the HRP is the *Mapbiomas* project.

² Projections are based on our regression model of absolute deforestation rates on time, with trend restraint based on a conversion suitability model indicating optimal, average and suboptimal suitability for conversion.

The projected deforestation rates are therefore calculated using the results of this model:

$$\widehat{ABSLRR}_t = -430261.6 + 215.2 \times t, \quad \text{if } 2020 < t < 2032 \text{ and}$$

$$\widehat{ABSLRR}_t = 7126, \quad \text{if } (t > 2032)$$

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

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

Table 20. Annual areas of baseline deforestation in the reference region (Table 9a of Methodology VM0015 version 1.1)

Project year t	Stratum i in the reference region (ha)	Total (ha)	
	ABSLRR ₁ Forest	annual ABSLRR _t	cumulative ABSLRR
2021	4,758.04	4,758.04	4,758.04
2022	4,973.29	4,973.29	9,731.33
2023	5,188.54	5,188.54	14,919.87
2024	5,403.79	5,403.79	20,323.65
2025	5,619.04	5,619.04	25,942.69
2026	5,834.29	5,834.29	31,776.98
2027	6,049.54	6,049.54	37,826.51
2028	6,264.79	6,264.79	44,091.30
2029	6,480.04	6,480.04	50,571.34
2030	6,695.29	6,695.29	57,266.62
2031	6,910.54	6,910.54	64,177.16
2032	7,125.79	7,125.79	71,302.94
2033	7,341.04	7,341.04	78,643.98
2034	7,556.28	7,556.28	86,200.26
2035	7,771.53	7,771.53	93,971.80
2036	7,986.78	7,986.78	101,958.58
2037	8,202.03	8,202.03	110,160.62
2038	8,417.28	8,417.28	118,577.90
2039	8,632.53	8,632.53	127,210.43
2040	8,847.78	8,847.78	136,058.22
2041	9,063.03	9,063.03	145,121.25
2042	9,278.28	9,278.28	154,399.53
2043	9,493.53	9,493.53	163,893.06
2044	9,708.78	9,708.78	173,601.85
2045	9,924.03	9,924.03	183,525.88
2046	10,139.28	10,139.28	193,665.16
2047	10,354.53	10,354.53	204,019.69
2048	10,569.78	10,569.78	214,589.47
2049	10,785.03	10,785.03	225,374.50
2050	11,000.28	11,000.28	236,374.78

Table 21. Annual areas of baseline deforestation in the project area (Table 9b of Methodology VM0015 version 1.1)

Project year t	Stratum i in the project area (ha)	Total (ha)	
	ABSLPA ₁ Forest	annual ABSLPA _t	cumulative ABSLPA
2021	126.00	126.00	126.00
2022	98.00	98.00	224.00
2023	179.00	179.00	403.00
2024	227.00	227.00	630.00
2025	238.00	238.00	868.00
2026	190.00	190.00	1,058.00
2027	233.00	233.00	1,291.00
2028	387.00	387.00	1,678.00
2029	456.00	456.00	2,134.00
2030	259.00	259.00	2,393.00
2031	334.00	334.00	2,727.00
2032	289.00	289.00	3,016.00
2033	548.00	548.00	3,564.00
2034	378.00	378.00	3,942.00
2035	342.00	342.00	4,284.00
2036	420.00	420.00	4,704.00
2037	609.00	609.00	5,313.00
2038	324.00	324.00	5,637.00
2039	345.00	345.00	5,982.00
2040	621.00	621.00	6,603.00
2041	299.00	299.00	6,902.00
2042	488.00	488.00	7,390.00
2043	534.00	534.00	7,924.00
2044	377.00	377.00	8,301.00
2045	505.00	505.00	8,806.00
2046	447.00	447.00	9,253.00
2047	556.00	556.00	9,809.00
2048	437.00	437.00	10,246.00
2049	488.00	488.00	10,734.00
2050	426.00	426.00	11,160.00

Table 22. Annual areas of baseline deforestation in the leakage belt (Table 9c of Methodology VM0015 version 1.1)

Project year t	Stratum i in the leakage belt (ha)	Total (ha)	
	ABSLK ₁ Forest	annual ABSLLK _t	cumulative ABSLLK
2021	550.00	550.00	550.00
2022	974.00	974.00	1,524.00
2023	912.00	912.00	2,436.00
2024	862.00	862.00	3,298.00
2025	1,002.00	1,002.00	4,300.00
2026	1,186.00	1,186.00	5,486.00
2027	1,046.00	1,046.00	6,532.00
2028	1,114.00	1,114.00	7,646.00
2029	1,015.00	1,015.00	8,661.00
2030	1,276.00	1,276.00	9,937.00
2031	1,001.00	1,001.00	10,938.00
2032	1,247.00	1,247.00	12,185.00
2033	1,075.00	1,075.00	13,260.00
2034	1,143.00	1,143.00	14,403.00
2035	1,037.00	1,037.00	15,440.00
2036	902.00	902.00	16,342.00
2037	1,125.00	1,125.00	17,467.00
2038	1,122.00	1,122.00	18,589.00
2039	1,083.00	1,083.00	19,672.00
2040	1,191.00	1,191.00	20,863.00
2041	1,346.00	1,346.00	22,209.00
2042	873.00	873.00	23,082.00
2043	831.00	831.00	23,913.00
2044	872.00	872.00	24,785.00
2045	823.00	823.00	25,608.00
2046	1,017.00	1,017.00	26,625.00
2047	992.00	992.00	27,617.00
2048	831.00	831.00	28,448.00
2049	868.00	868.00	29,316.00
2050	675.00	675.00	29,991.00

- **Projection of the location of future deforestation**

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

- (i) Definition of the model assumptions, which consists of defining the modelled deforestation;
- (ii) Organization of the spatial and non-spatial database that represents the selection and standardization of the variables used;

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

(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2009 to 2019) through the Business-as-usual scenario.

- **Assigning weightings to change agents**

The predictive variables considered to have the potential to influence the risk of deforestation in the region are the proximity to roads, proximity to cities, slope, altitude, proximity to settlements, presence of protected areas, proximity to small rivers, proximity to large rivers and location of active sustainable forest management plans.

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 Software¹⁷⁵, 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

¹⁷⁵ Dinamica Ego Software. Available at: <<https://csr.ufmg.br/dinamica/>>. Last visited on august 5th, 2021.

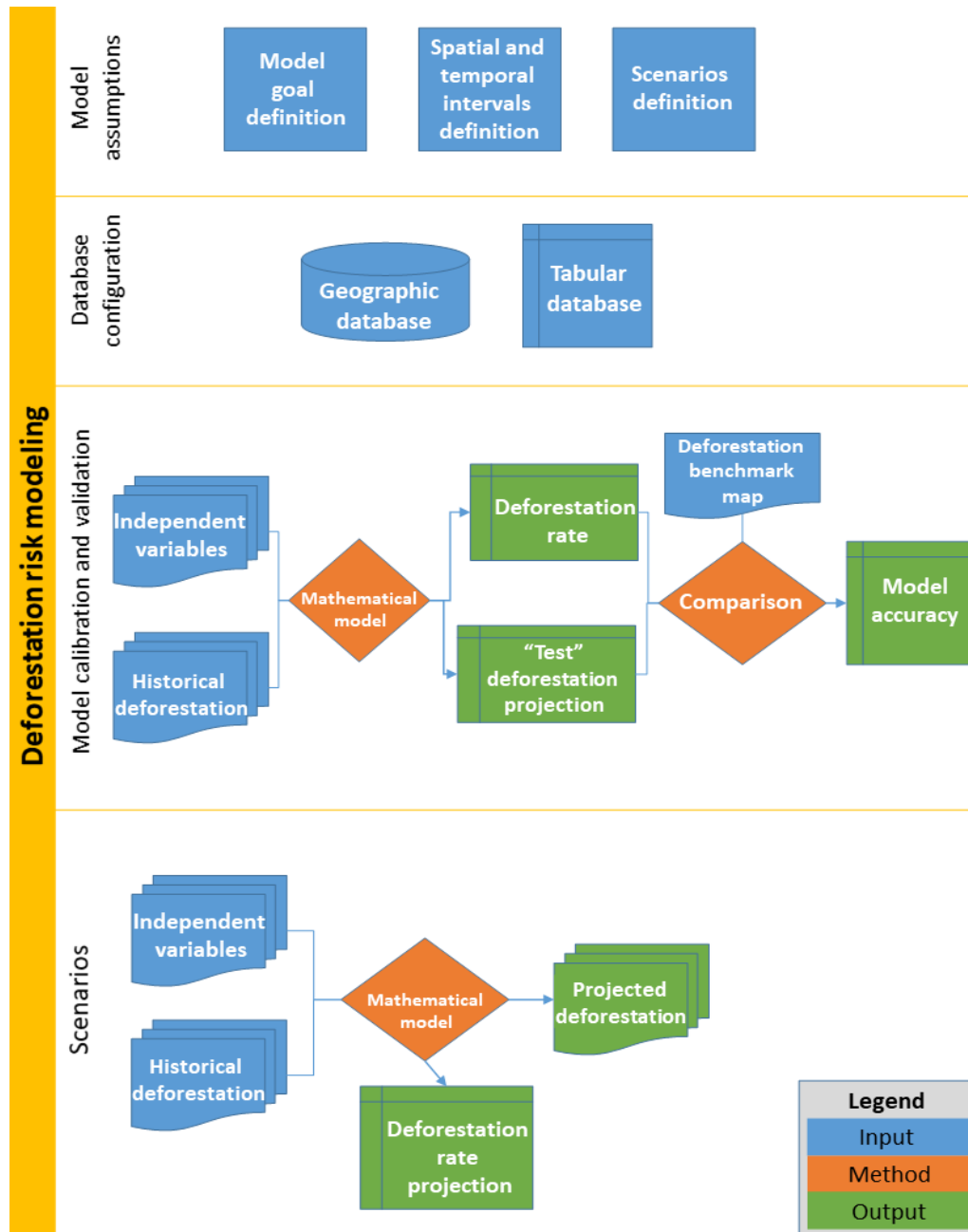
the weights of evidence that overlap on a given pixel and are dependent on the combinations of all static and dynamic maps¹⁷⁶.

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.

¹⁷⁶ 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>>. Last visited on August 5th, 2021.

Figure 62. 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:

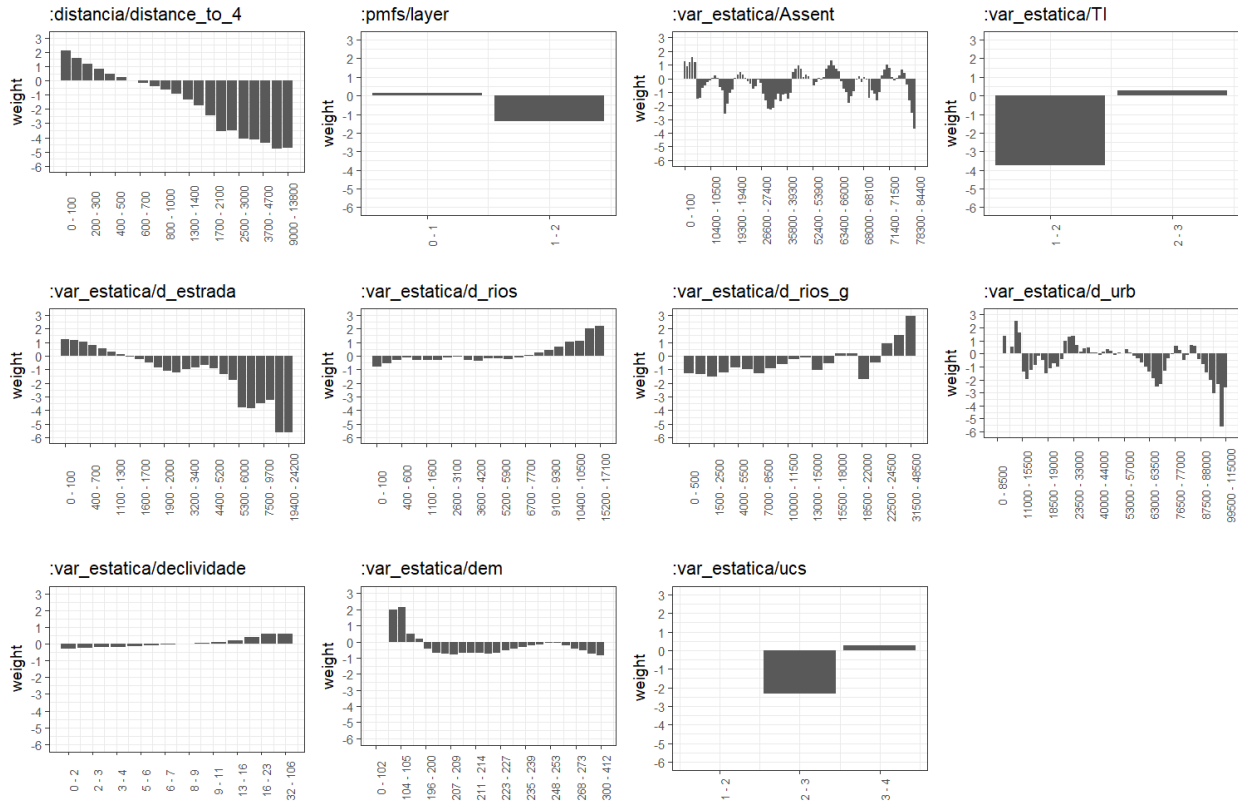
Table 23. List of variables, maps and factor maps

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	24,188	Lower values indicate greater proximity	_1_MergeTransporteViario	Euclidean Distance (ArcGIS 10.8)	Quantitative variable
2	UCs.tif	MMA		Sustainable use conservation units						Categorical variable
3	TIs.tif	FUNAI		Indigenous lands						Categorical variable
4	d_assentamentos.tif	INCRA		Distances to rural settlements	0	84,331.9	Lower values indicate greater proximity	Assentamento_INCRA	Euclidean Distance (ArcGIS 10.8)	Quantitative variable
5	d_rios_grrd.tif	ANA	Meters	Distance to water bodies	0	39,389.7	Lower values indicate greater proximity	RiosGrandes_ANA	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
6	d_rios_mbiomas.tif	MapBiomias	Meters	Distance to rivers mapped by MapBiomias	0	48,378.9	Lower values indicate greater proximity	RiosGrandes_MapBiomias2	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
7	d_rios.tif	ANA	Meters	Distance to rivers	0	17,054	Lower values indicate greater proximity	Rios_ANA	Euclidean Distance (ArcGIS 10.6)	Quantitative variable
8	d_urbana.tif	IBGE	Meters	Distance to urban centers	8,144.6	114,642	Lower values indicate greater proximity	Cidades_IBGE	Euclidean Distance (ArcGIS 10.6)	Quantitative variable

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		
9	dem.tif	SRTM	Meters	Average altitude change	101	411	Lower values indicate lower altitude			Quantitative variable
10	slope_perc.tif	SRTM	Percentage	Average variation of land slope	0	105.843	Lower values indicate less slope		Slope (ArcGIS 10.8)	Quantitative variable
11	pmfs	Geoportel Acre		Area of active PMFS	0	1	1 is a PMFS	AUTORIZACAO_DESMATE_SEMA.shp	Rasterization (R package 'Terra' v1.7.71)	Categorical 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.

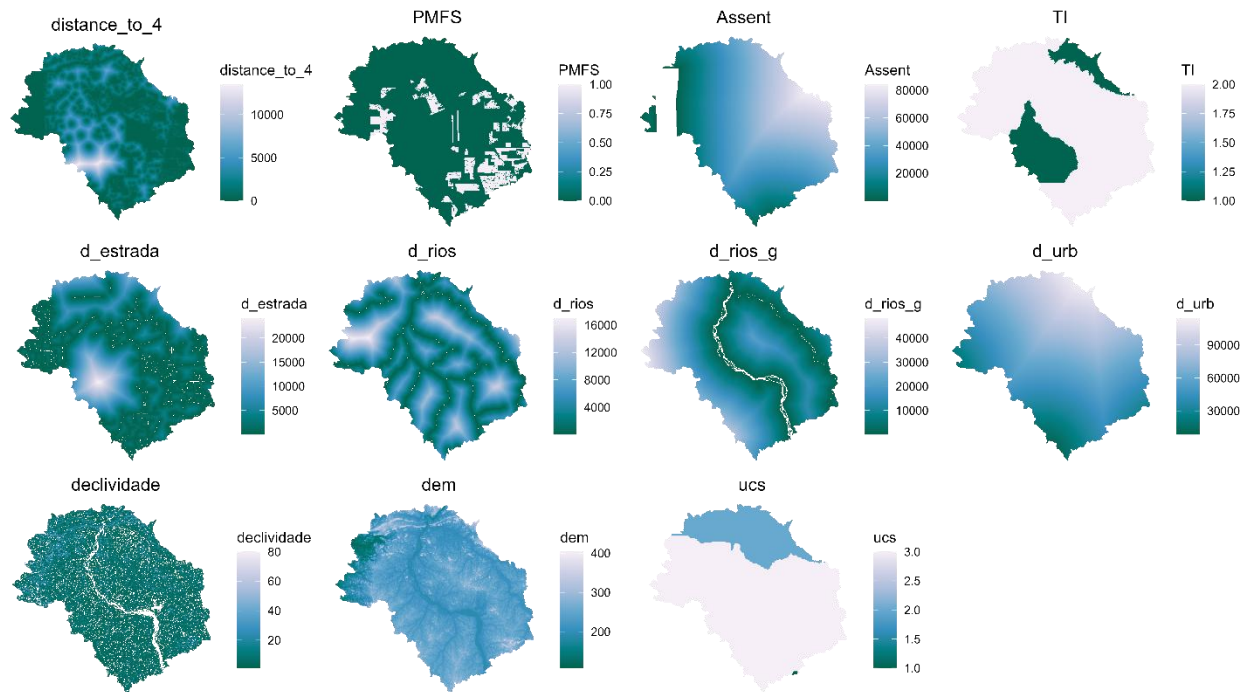
Figure 63: Variation of the weights of evidence for each variable¹ in the spatial deforestation allocation model



¹In the Figure: distance_to_4: distance to nearest deforestation; pmfs: presence of a sustainable forest management plan; Assent: distance to nearest rural settlement; TI: presence of indigenous land; d_estrada: distance to nearest road; d_rios: distance to the nearest river; d_rios_g: distance to nearest major river; d_urb: distance to nearest urban center; declividade: slops; dem: digital elevation model; ucs: presence of conservation unit.

Furthermore, the factor maps used to create the deforestation risk map are presented below.

Figure 64: Simplified maps of all variables¹ used in the deforestation risk model



¹In the Figure: distance_to_4: distance to nearest deforestation; pmfs: presence of a sustainable forest management plan; Assent: distance to nearest rural settlement; TI: presence of indigenous land; d_estrada: distance to nearest road; d_rios: distance to the nearest river; d_rios_g: distance to nearest major river; d_urb: distance to nearest urban center; declividade: slopes; dem: digital elevation model; ucs: presence of conservation unit.

In addition, we incorporated the binary variable "*Legal Reserve status (LR)*" into the spatial allocation model to assess its influence on the probability of deforestation. To ensure a valid comparison, conservation units and indigenous territories were excluded from the non-LR category, given that these areas are subject to different deforestation pressures compared to private lands.

After the removal of these protected areas, the remaining non-LR area within the Reference Region became minimal. The results confirm that the estimated probability of deforestation—calculated as the proportion of forest cover lost during the historical reference period—is virtually the same inside and outside Legal Reserves.

This supports the conclusion that, in the context of the Juruena River REDD+ Project, the presence or absence of Legal Reserve status does not significantly influence the likelihood of historical deforestation within the Reference Region, when other spatial predictors such as proximity to roads, presence of PMFS, and land use practices are accounted for.

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

To assess the quality of the spatial deforestation allocation model, option "a" available in methodology VM0015 version 1.1 was used: calibration and confirmation using two historical sub-periods. Deforestation data that occurred between November 2009 and November 2015, and the variables listed in were used to calibrate the model, while the deforestation map mapped of 2020 was used for the

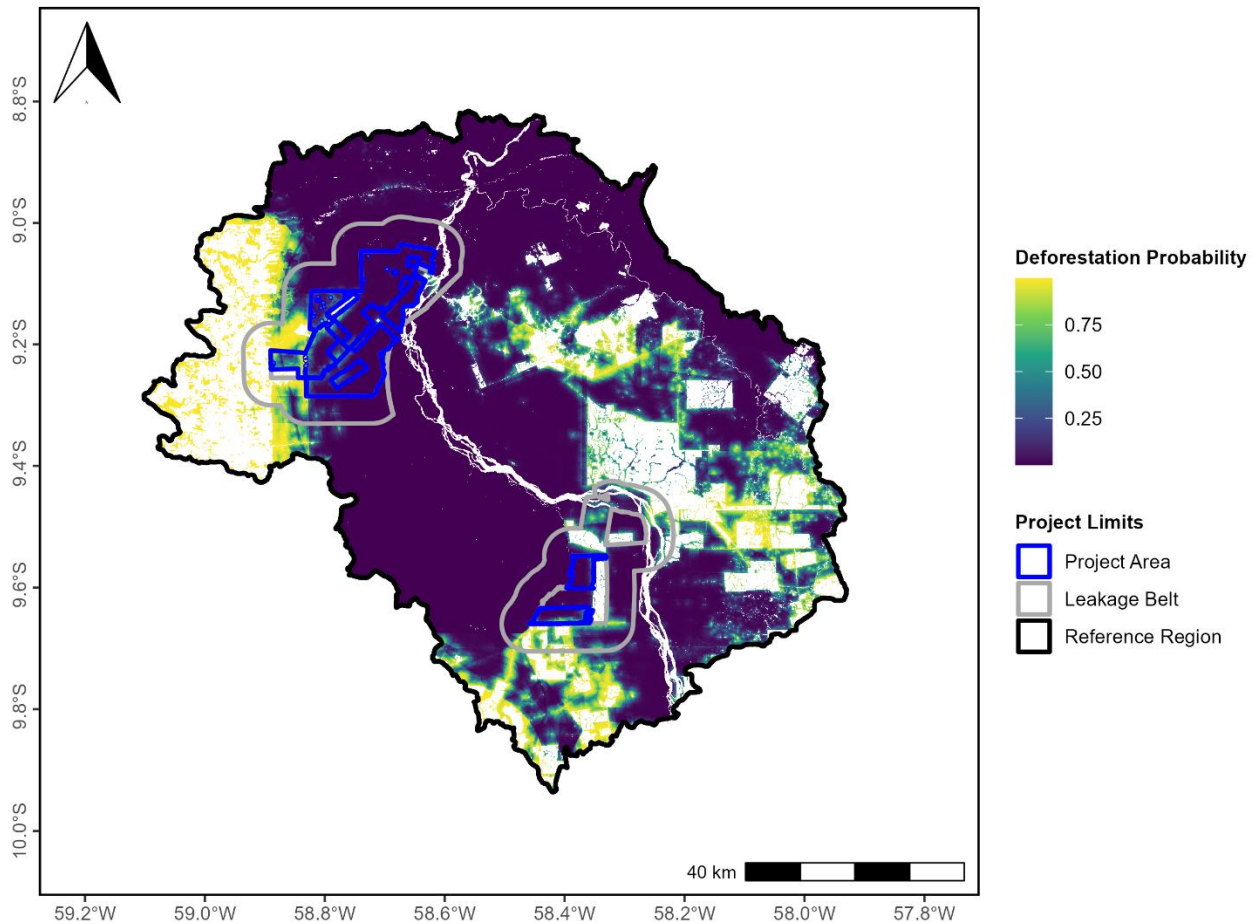
confirmation process. In this process, a 2020 deforestation map was simulated from data observed between 2009 and 2015.

FOM (Figure of Merit) technique was used to assess the accuracy of the simulated map in 2021. The FOM result is the ratio of the intersection of the observed changes (changes between the reference map at time 1 and time 2) and the simulated changes (changes between the reference map at time 1 and the reference map at time 2) to the union of the observed change and the predicted variation, as defined in equation 9 of methodology VM0015 v 1.1.

Methodology VM0015 v 1.1 indicates that the minimum threshold for the best fit measured by the FOM should be defined by the net change observed in the reference region for the model calibration period. The observed net change shall be calculated as the total area of modeled change in the reference region during the calibration period (percentage of total area of the reference region), and the FOM value shall be at least equivalent to this value. If the FOM value is below this threshold, the project proponent must demonstrate that at least three models have been tested (three deforestation risk maps), and the one with the best FOM should be used.

The net change observed in the Reference Region was 3.7%, and the FOM value obtained by applying equation 9 of VM0015 was 45.0%. Thus, the FOM of the risk map produced is greater than the required threshold (Step 4.2.4 of VM0015). Thus, the deforestation risk map developed in the calibration step (Figure 18) offers good performance for spatially projecting changes in land use until 2050 in the Reference Region of the Juruena REDD+ Project.

Figure : Deforestation probability map



○ Mapping of locations of future deforestation

The mapping of the location of future deforestation until 2050 was carried out through Dinamica Ego. Figures below show the results in the reference region, project area and leakage belt.

Figure 65. Projection of deforestation in the reference region, using Dinamica EGO

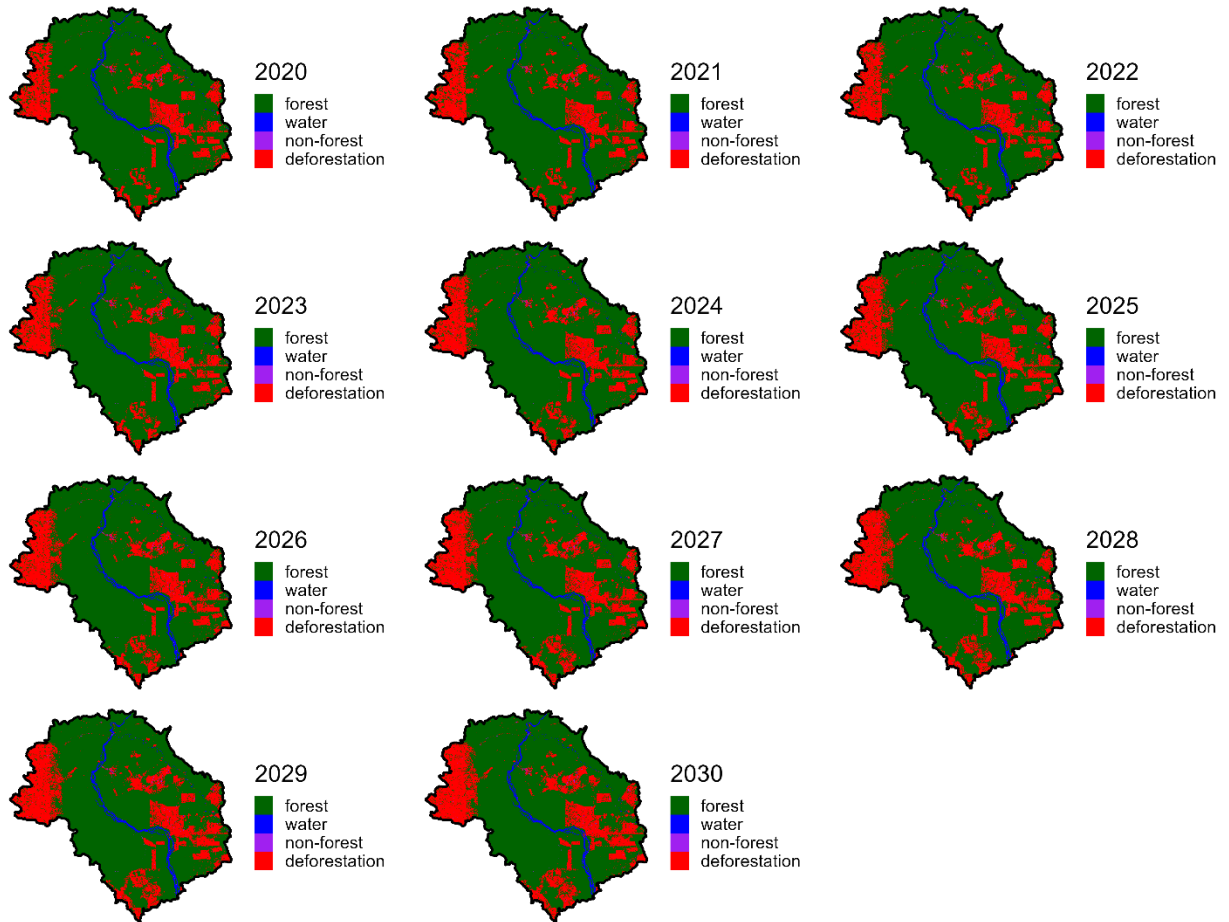


Figure 66. Projection of deforestation in the Project Area, using Dinamica EGO

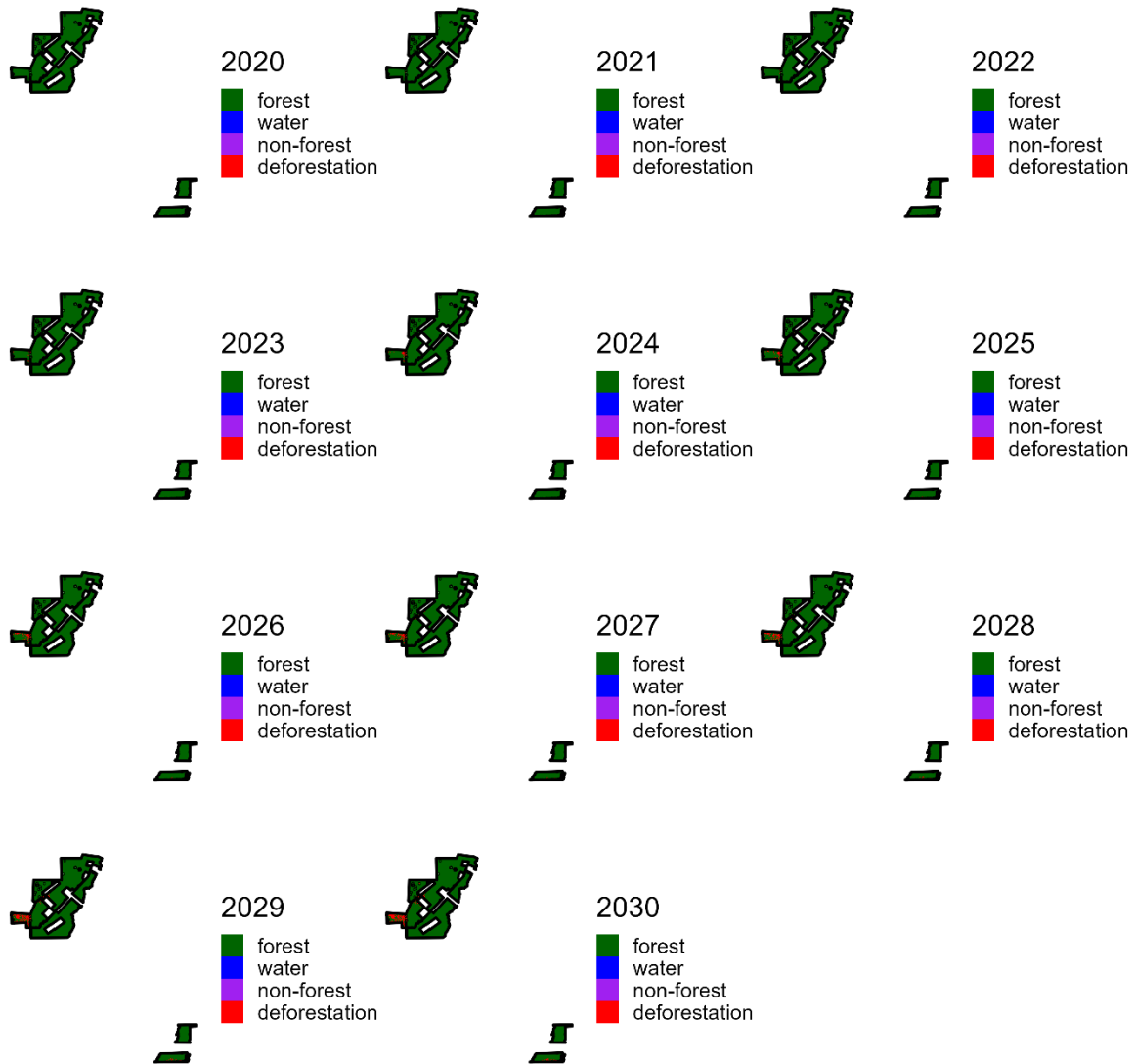
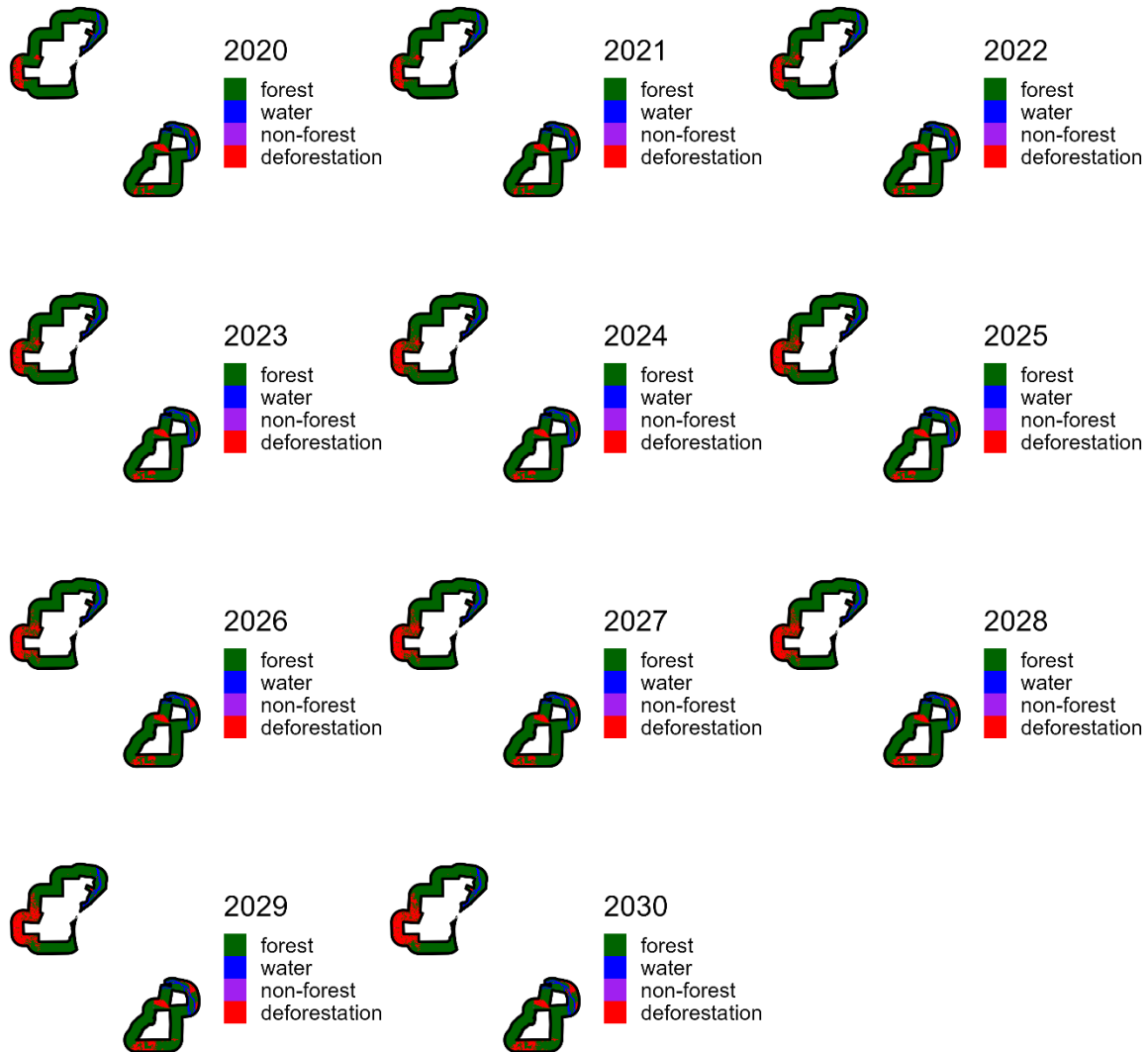


Figure 67. Projection of deforestation in the leakage belt, using Dinâmica EGO



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

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

In accordance with analysis achieved through the procedure described above, the quantity of baseline LU/LC-change was projected throughout the 1st baseline period, in the reference region, project area and leakage belt in each stratum. This is in accordance with step 5 of the methodology “Definition of the land-use and land-cover change component of the baseline”.

- **Calculation of baseline activity data per forest class**

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

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

Table 24. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class) (Table 11b of Methodology VM0015 version 1.1)

Area deforested per forest class icl within the project area		Total baseline deforestation in the project area	
<i>IDicl</i>	1	annual ABSLPA _t (ha)	ABSLPA cumulative (ha)
Name	Forest		
Project year <i>t</i>	ha		
2021	126	126	126
2022	98	98	224
2023	179	179	403
2024	227	227	630
2025	238	238	868
2026	190	190	1,058
2027	233	233	1,291
2028	387	387	1,678
2029	456	456	2,134
2030	259	259	2,393
2031	334	334	2,727
2032	289	289	3,016
2033	548	548	3,564
2034	378	378	3,942
2035	342	342	4,284
2036	420	420	4,704
2037	609	609	5,313
2038	324	324	5,637
2039	345	345	5,982
2040	621	621	6,603
2041	299	299	6,902
2042	488	488	7,390
2043	534	534	7,924
2044	377	377	8,301
2045	505	505	8,806
2046	447	447	9,253
2047	556	556	9,809
2048	437	437	10,246
2049	488	488	10,734
2050	426	426	11,160

Table 25. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class) (Table 11c of Methodology VM0015 version 1.1)

Area deforested per forest class icl within the leakage belt		Total baseline deforestation in the leakage belt	
<i>IDicl</i>	1	annual ABSLLKt (ha)	ABSLLK cumulative (ha)
Name	Forest		
Project year <i>t</i>	ha		
2021	550	550	550
2022	974	974	1,524
2023	912	912	2,436
2024	862	862	3,298
2025	1,002	1,002	4,300
2026	1,186	1,186	5,486
2027	1,046	1,046	6,532
2028	1,114	1,114	7,646
2029	1,015	1,015	8,661
2030	1,276	1,276	9,937
2031	1,001	1,001	10,938
2032	1,247	1,247	12,185
2033	1,075	1,075	13,260
2034	1,143	1,143	14,403
2035	1,037	1,037	15,440
2036	902	902	16,342
2037	1,125	1,125	17,467
2038	1,122	1,122	18,589
2039	1,083	1,083	19,672
2040	1,191	1,191	20,863
2041	1,346	1,346	22,209
2042	873	873	23,082
2043	831	831	23,913
2044	872	872	24,785
2045	823	823	25,608
2046	1,017	1,017	26,625
2047	992	992	27,617
2048	831	831	28,448
2049	868	868	29,316
2050	675	675	29,991

o **Calculation of baseline activity data per post deforestation forest class**

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

According to the methodology VM00145, the Historical LU/LC-change (Method 1) was used to calculate the LU/LC class that will replace the forest cover in the baseline scenario. The table below shows the area of Zone 1 that encompasses areas of possible post-deforestation LU/LC-class within the reference region.

Table 26. Zone of the Reference Region encompassing potential post deforestation LU/Lc class (Table 12 of Methodology VM0015 version 1.1)

Zone		Name		Total area of each zone	
		Non-forest			
IDz	Name	<i>ID_{fcl}</i>	1	Area	% of zone
		Area	% of zone		
		ha	%	ha	%
1	Reference region	136,268	100%	136,268	100%
Total area of each class <i>fcl</i>		136,268	100%	136,268	100%

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 27 - Annual areas deforested in each zone within the reference region in the baseline case (baseline activity data per zone) (Table 13a of Methodology VM0015 version 1.1)

Area established after deforestation per zone within the reference region		Total baseline deforestation in the reference region	
<i>ID_{fcl}</i>	1	<i>ABSLPA_t</i>	<i>ABSLPA</i>
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	4,758	4,758	4,758
2022	4,973	4,973	9,731
2023	5,189	5,189	14,920
2024	5,404	5,404	20,324
2025	5,619	5,619	25,943
2026	5,834	5,834	31,777
2027	6,050	6,050	37,827
2028	6,265	6,265	44,091
2029	6,480	6,480	50,571
2030	6,695	6,695	57,267
2031	6,911	6,911	64,177
2032	7,126	7,126	71,303
2033	7,341	7,341	78,644
2034	7,556	7,556	86,200
2035	7,772	7,772	93,972
2036	7,987	7,987	101,959
2037	8,202	8,202	110,161

2038	8,417	8,417	118,578
2039	8,633	8,633	127,210
2040	8,848	8,848	136,058
2041	9,063	9,063	145,121
2042	9,278	9,278	154,400
2043	9,494	9,494	163,893
2044	9,709	9,709	173,602
2045	9,924	9,924	183,526
2046	10,139	10,139	193,665
2047	10,355	10,355	204,020
2048	10,570	10,570	214,589
2049	10,785	10,785	225,375
2050	11,000	11,000	236,375

Table 28. Annual areas deforested in each zone within the Project Area in the baseline case (baseline activity data per zone) (Table 13b of Methodology VM0015 version 1.1)

Area established after deforestation per zone within the project area		Total baseline deforestation in the project area	
<i>ID_{fcl}</i>	1	<i>ABSLPA_t</i>	<i>ABSLPA</i>
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	126	126	126
2022	98	98	224
2023	179	179	403
2024	227	227	630
2025	238	238	868
2026	190	190	1,058
2027	233	233	1,291
2028	387	387	1,678
2029	456	456	2,134
2030	259	259	2,393
2031	334	334	2,727
2032	289	289	3,016
2033	548	548	3,564
2034	378	378	3,942
2035	342	342	4,284
2036	420	420	4,704
2037	609	609	5,313
2038	324	324	5,637
2039	345	345	5,982
2040	621	621	6,603
2041	299	299	6,902
2042	488	488	7,390
2043	534	534	7,924
2044	377	377	8,301
2045	505	505	8,806
2046	447	447	9,253
2047	556	556	9,809
2048	437	437	10,246
2049	488	488	10,734
2050	426	426	11,160

Table 29. Annual areas deforested in each zone within the Leakage Belt in the baseline case (baseline activity data per zone) (Table 13c of Methodology VM0015 version 1.1)

Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
<i>ID_{fcl}</i>	1	<i>ABSLLK_t</i>	<i>ABSLLK</i>
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2021	550	550	550
2022	974	974	1,524
2023	912	912	2,436
2024	862	862	3,298
2025	1,002	1,002	4,300
2026	1,186	1,186	5,486
2027	1,046	1,046	6,532
2028	1,114	1,114	7,646
2029	1,015	1,015	8,661
2030	1,276	1,276	9,937
2031	1,001	1,001	10,938
2032	1,247	1,247	12,185
2033	1,075	1,075	13,260
2034	1,143	1,143	14,403
2035	1,037	1,037	15,440
2036	902	902	16,342
2037	1,125	1,125	17,467
2038	1,122	1,122	18,589
2039	1,083	1,083	19,672
2040	1,191	1,191	20,863
2041	1,346	1,346	22,209
2042	873	873	23,082
2043	831	831	23,913
2044	872	872	24,785
2045	823	823	25,608
2046	1,017	1,017	26,625
2047	992	992	27,617
2048	831	831	28,448
2049	868	868	29,316
2050	675	675	29,991

3.5 Additionality

The last version of the VT0001 VCS Tool for the demonstration and assessment of additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) must be applied for all project activities instances.

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

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

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 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.

For the purpose of the present analysis, the VCS Tool for the Demonstration and Assessment of Additionality in VCS Agricultural, Forestry and Other Land Use (AFOLU) Project Activities - VT0001 version 3.0¹⁷⁷ was applied for the first project instance project activity. This instance does have a Sustainable Forest Management Plan.

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

According to the tool, this step shall identify realistic and credible land-use scenarios that would have occurred on the land within the proposed project boundary in the absence of the AFOLU project activity under the VCS. The scenarios should be feasible for the project area taking into account relevant national and/or sectoral policies and circumstances, such as historical land uses, practices and economic trends. The identified land use scenarios shall at least include:

- I. The continuation of the current (pre-project) land use scenario:** in this scenario, no REDD project is undertaken. The deforestation pattern identified in section 3.4 above, which describes the relationship among the agents, drivers and underlying causes present in the region during the historical period, will most likely continue to cause deforestation in the future.

This scenario involves the implementation of a sustainable forest management plan within the project boundaries of the proposed VCS REDD project, however without carrying out additional social and environmental activities, as well as activities to reduce unplanned deforestation. This scenario also complies with item iii of the methodological tool (activities similar to the proposed project activity on at least part of the land within

¹⁷⁷ Available in <<https://verra.org/wp-content/uploads/2017/11/VT0001v3.0.pdf>>

the project boundary of the proposed VCS AFOLU project at a rate resulting from legal requirements).

Although this is a similar activity proposed by the present project, i.e. avoiding deforestation through conducting sustainable forest management activities, no other complementary activities to improve monitoring of deforestation would be carried out, such as: increased surveillance, monitoring and control by satellite images, REDD+ technical studies, social and environmental activities promoted by the SOCIALCARBON Standard, among others.

Many scientific articles conclude that sustainable forest management plans (SFMP), namely those certified, can be considered a tool for forest conservation, maintenance of forest carbon stocks, and decrease of deforestation rates in the region where they are implemented. This mainly occurs due to the use of reduced impact logging techniques, reduced social and environmental operational impacts, greater surveillance in the area, and generation of economic value for forests. On the other hand, there is a belief that forest is a non-productive natural resource and needs replacing with productive activities, such as livestock farming and agriculture, primarily in areas that require social and economic development^{178, 179, 180, 181, 182}.

However, the complexity and costs of a sustainable timber operation, added to factors such as bureaucratic constraints and fluctuation of certified timber prices, make SFMP less competitive than illegal logging. Thus, investment in additional practices to what is required by law is risky and may affect the survival of the operation. This includes activities that are complementary to the operation, specifically avoidance or reduction of unplanned deforestation/degradation and increase of monitoring of forest management areas.

Therefore, despite the contribution to forest preservation and carbon stock maintenance, SFMP areas are subject to unplanned deforestation and loss of carbon stock due to external agents. In addition, there are incentives for the local population to perform activities that result in unplanned deforestation, such as the expansion of low

¹⁷⁸ BRASIL. Ministério do Meio Ambiente (MMA). Plano de ação para prevenção e controle do desmatamento na Amazônia. Brasília, 2012. Available at <<http://redd.mma.gov.br/pt/acompanhamento-e-a-analise-de-impacto-das-politicas-publicas/ppcdam>>

¹⁷⁹ SCHULZE, M., GROGAN, J., & VIDAL, E. 2008. O manejo florestal como estratégia de conservação e desenvolvimento socioeconômico na Amazônia: quanto separa os sistemas de exploração madeireira atuais do conceito de manejo florestal sustentável? In N. Bensusan & G. Armstrong (Eds.), *O Manejo da Paisagem e a Paisagem do Manejo* (1ª ed., pp. 161-213). Brasil: IEB Available at <<https://imazon.org.br/publicacoes/o-manejo-florestal-como-estrategia-de-conservacao-e-desenvolvimento-socioeconomico-na-amazonia-quanto-separa-os-sistemas-de-exploracao-madeireira-atuais-do-conceito-de-manejo-florestal-sustentavel/>>

¹⁸⁰ VIEIRA, I. C. G.; SILVA, J. M. C.; TOLEDO, P. M. Estratégias para evitar a perda de biodiversidade na Amazônia. *Estud. av.*, São Paulo, v. 19, n. 54, Aug. 2005. Available at <<https://www.scielo.br/j/ea/a/yf6MQVWvKWGD33jN3jqw47n/?lang=pt>>

¹⁸¹ HOLMES, T.P. et al. Custos e benefícios financeiros da exploração de impacto reduzido em comparação à exploração florestal convencional na Amazônia Oriental. Belém: Fundação Floresta Tropical, 2002, 66p, 2nd edition. Available at <http://ift.org.br/wp-content/uploads/2015/05/Holmes_Custos_Beneficios_2002.pdf>

¹⁸² VERWEIJ, P. et al. Keeping the Amazon Forests standing: a matter of values. Zeist: WWF, 2009. 72p. Available at <https://www.researchgate.net/publication/43977210_Keeping_the_Amazon_forests_standing_a_matter_of_values>

productivity agricultural activities, resulting in an ongoing necessity of cutting down the forest to maintain production.

There are many challenges to guarantee the consolidation of these areas and their effective social and environmental protection. The result is intense deforestation and pressure in the legal Amazon, primarily because of wood harvesting activities, agriculture, road construction and mining¹⁸³

- 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. This scenario would include avoiding deforestation activities combined with the conduction of sustainable forest management activities.

Additionally, complementary activities to improve the monitoring of deforestation caused by the agents (identified in section 3.4 above) would have to be carried out, such as: increased surveillance, monitoring and control by satellite images, REDD+ technical studies, social and environmental activities promoted by the SOCIALCARBON or CCB Standard, among others. These investments are usually not made or required by the Brazilian Government, nor are part of sustainable forest management plans, as they are financially unattractive and not necessary to legally perform the timber harvest. Therefore, the economic feasibility of this scenario would be reduced without additional revenues from the sale of VCUs.

- III. If applicable, activities similar to the proposed project activity on at least part of the land within the project boundary of the proposed VCS AFOLU project at a rate resulting from:**
- A. Legal requirements; or**
 - B. Extrapolation of observed similar activities in the geographical area with similar socioeconomic and ecological conditions to the proposed VCS AFOLU project activity occurring in the period beginning ten years prior to the project start date.**

Not applicable. There is no legal requirement to conduct activities similar to the proposed activity on at least part of the land within the project boundary of the proposed VCS AFOLU project. The activities proposed in this project are voluntary and are not related to any legal obligation (such as TAC – Termo de Ajustamento de Conduta Ambiental, Environmental Conduct Adjustment Term in free translation, or any other Brazilian term).

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

¹⁸³ VERÍSSIMO, A. *et al* (Org.). *Áreas Protegidas na Amazônia brasileira: avanços e desafios*. Belém : Imazon ; São Paulo : Instituto Socioambiental, 2011. 90 p. Available at < <https://imazon.org.br/publicacoes/2673-2/>>

Scenarios I and II - The application of a sustainable forest management plan is regulated in Brazil by the laws N° 12,651¹⁸⁴, decree N° 5,975¹⁸⁵, in addition to Mato Grosso's legislation, with laws N°233/2005¹⁸⁶, N° 8,188/2006¹⁸⁷ and N°698/2021¹⁸⁸, and normative instruction IN 02/2018¹⁸⁹.

Despite the requirement to mitigate social impacts, social and environmental activities for the communities surrounding the management plan area are not required by law. According to Ribeiro¹⁹⁰, the main obstacles related to the approval of the sustainable forest management plan in the Amazon are: a) low investment capacity, financial and fiscal incentives, b) bureaucracy and lack of control in the SFMP approval procedure and c) lack of participation of traditional communities in the process of elaboration of the SFMP, when they are involved. Thus, it is common to see the exclusion of the surrounding community from management activities in private areas.

As it does not contain social and environmental activities to control deforestation coming from communities surrounding the property, scenario I may contain activities that are illegal or of uncertain legal status, not being enforced namely due to the lack of control¹⁹¹ and government capacity. This type of illegal deforestation, apart from planned deforestation, occurs mainly due to social pressure and low HDI in the Amazon regions. Although not being in compliance with applicable mandatory laws and regulations, this scenario results from systematic lack of enforcement of applicable laws and regulations. One of the goals of the present REDD project is to contribute to a solution to this problem by promoting the sustainable management of forest resources through increased monitoring and surveillance to avoid unplanned, illegal deforestation.

For instance, Government conservation units such as parks and sustainable use areas are also affected by advancing deforestation and increased accessibility of the region to economic activities due to creation or improvement of infrastructure. Between 2000 and 2008, 2.25 million hectares were deforested in protected areas in Legal Amazon, and illegal exploitation of wood (degradation) has occurred in many of them.

¹⁸⁴ Available at <https://www.planalto.gov.br/ccivil_03/ Ato2011-2014/2012/Lei/L12651.htm> Last visit: 02/07/2021

¹⁸⁵ Available at <http://www.planalto.gov.br/ccivil_03/ ato2004-2006/2006/decreto/d5975.htm> Last visit: 02/07/2021

¹⁸⁶ Available at <

<http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/250a3b130089c1cc042572ed0051d0a1/4f42663cdf699582042570f2004f4aa2?OpenDocument>> Last visited on December 9th, 2021

¹⁸⁷ Available at <

<http://app1.sefaz.mt.gov.br/Sistema/legislacao/legislacaotribut.nsf/2b2e6c5ed54869788425671300480214/d137b809227f6f4f0425720c00476358?OpenDocument>> Last visited on December 9th, 2021

¹⁸⁸ Available at <

<http://app1.sefaz.mt.gov.br/sistema/legislacao/LeiComplEstadual.nsf/9733a1d3f5bb1ab384256710004d4754/d52df8648ccf16c004258712006af1e0?OpenDocument>> Last visited on December 9th, 2021.

¹⁸⁹ Available at < <https://www.legisweb.com.br/legislacao/?id=363548>> Last visited on December 9th, 2021.

¹⁹⁰ RIBEIRO, A.C.F. et al. O PLANO DE MANEJO FLORESTAL COMO INSTRUMENTO DE DESENVOLVIMENTO SUSTENTÁVEL NA AMAZÔNIA. Direito & Desenvolvimento, ISSN 2236-0859, 2020. Available at

<<https://periodicos.unipe.br/index.php/direitoedesenvolvimento/article/download/875/715/#:~:text=O%20Plano%20de%20Manejo%20Florestal%20sustent%C3%A1vel%20%2D%20PMFS%20est%C3%A1%20intimamente%20relacionado,forma%20alcan%C3%A7amos%20um%20desenvolvimento%20ambiental>>.

¹⁹¹ 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. Available at < https://ipam.org.br/wp-content/uploads/2015/12/redd_no_brasil_um_enfoque_amaz%C3%B4nico.pdf>

One way to avoid increased accessibility and illegal exploitation of protected areas would be to increase the effectiveness of sanctions in cases of environmental malpractice.

The creation of protected areas is proven to be one of the most effective tools in forest conservation and the fight against deforestation. However, without management and investment, these important reserves do not attain their sustainable development goals, leaving them vulnerable to criminal activity such as land squatting, illegal wood harvesting and deforestation. This underlines the importance of REDD+ projects for forest conservation, despite being located in protected areas, because they are capable of contributing to the improvement of deforestation monitoring and control, promoting social, economic and environmental benefits in the region.

As Scenario II is the implementation of the SFMP with the addition of social environmental activities, as presented above, it is also in compliance with all applicable legal and regulatory requirements. Thus, there are no restrictions for SFMP within the areas where the Juruena River REDD project's properties are located.

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.

The continuation of the pre project activity, that is, a SFMP without any socio-environmental activity is the most profitable alternative land use, and thus, the most plausible baseline scenario.

STEP 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

The Juruena River REDD Project generates financial benefits other than the revenue from the sale of VCUs, primarily through the commercialization of timber, as a result of the sustainable forest management plan. Thus, investment analysis comparison (Option II) will be carried out in order to determine the project's additionality, i.e, whether the proposed project activity, without the revenue from the sale of GHG credits, is economically or financially less attractive than the other land use scenarios.

Sub-step 2b. - Option II. Apply investment comparison analysis

An investment comparison analysis was performed to demonstrate which of the scenarios identified above is more financially attractive. For such analysis, the Net Present Value (NPV) was considered the most appropriate financial indicator. Many articles on profitability of alternative land uses in areas under similar conditions to the project region applied the Net Present Value

(NPV) for financial analysis, such as Amaral et al. (1998)¹⁹², Barreto et al. (1998)¹⁹³, Schneider (2000)¹⁹⁴, Razera (2005)¹⁹⁵, Young et al. (2007)¹⁹⁶ and IDESAM (2014)¹⁹⁷.

Sub-step 2c. - Calculation and comparison of financial indicators

The following scenarios were analyzed as part of the investment analysis:

1. The implementation of a sustainable forest management plan within the project boundaries of the proposed VCS REDD project, however without carrying out additional social and environmental activities, as well as activities to reduce unplanned deforestation.
2. Implementation of a sustainable forest management plan, combined with the implementation of additional activities to reduce deforestation and generation of social benefits.

Under Scenario I, expenses are mostly related to sustainable forest management plan, while revenues derive from the commercialization of timber. Under scenario II, the same revenues and expenses are expected. However, scenario II involves additional expenses to reduce deforestation, such as the cost of monitoring the Project Area and promoting social and environmental activities with local communities. The key parameters considered on each scenario are described on the Table below.

¹⁹² AMARAL, P. et al. Floresta para Sempre: um Manual para Produção de Madeira na Amazônia. Belém: Imazon, 1998. p. 130. Available at < <https://imazon.org.br/publicacoes/floresta-para-sempre-um-manual-para-a-producao-de-madeira-na-amazonia/>>

¹⁹³ BARRETO, P. et al. Custos e Benefícios do Manejo Florestal para Produção de Madeira na Amazônia Oriental. Série Amazônia N°10 - Belém: Imazon, 1998. Available at < <https://imazon.org.br/publicacoes/custos-e-beneficios-do-manejo-florestal-para-a-producao-de-madeira-na-amazonia-oriental-n-10/>>

¹⁹⁴ SCHNEIDER, R. R. et al. Amazônia sustentável: limitantes e oportunidades para o desenvolvimento. Belém: Instituto do Homem e Meio Ambiente da Amazônia (IMAZON), 2000. 58 p. Available at < <https://imazon.org.br/PDFimazon/Portugues/livros/amazonia-sustentavel-limitantes-e-oportunidades.pdf>>

¹⁹⁵ RAZERA, Allan. 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. Available at < <https://bdtd.inpa.gov.br/handle/tede/1852>>

¹⁹⁶ ARIMA, E.; BARRETO, P.; BRITO, M. Pecuária na Amazônia: tendências e implicações para a conservação ambiental. Belém: Instituto do Homem e Meio Ambiente da Amazônia (IMAZON), 2005. 76 p. Available at < <https://imazon.org.br/publicacoes/pecuaria-na-amazonia-tendencias-e-implicacoes-para-a-conservacao/>>

¹⁷³ YOUNG, C. E. F. et al. Rentabilidade da pecuária e custo de oportunidade privado da conservação no estado do Amazonas. 2007. Available at < https://www.academia.edu/3393168/Rentabilidade_da_pecu%C3%A1ria_e_custo_de_oportunidade_privado_da_conserva%C3%A7%C3%A3o_no_Estado_do_Amazonas>

¹⁹⁷ INSTITUTO DE CONSERVAÇÃO E DESENVOLVIMENTO SUSTENTÁVEL DO AMAZONAS (IDESAM).

Viabilidade econômica da pecuária semi-intensiva no sul do Amazonas: uma oportunidade para reduzir o avanço do desmatamento. Manaus: IDESAM, 2014. 48 p. Available at < <http://www.idesam.org.br/publicacao/relatorio-viabilidade-pecuaria.pdf>>

Table 30. Main parameters used for the investment comparison analysis

Parameter	Investment Analysis Comparison - 30 years project lifetime (in Brazilian Reais)	
	Scenario I	Scenario II
TOTAL REVENUES	R\$ 20,863,511.98	R\$ 20,863,511.98
Timber	R\$ 20,863,511.98	R\$ 20,863,511.98
Other (cattle ranching)	R\$ 0.00	R\$ 0.00
TOTAL EXPENSES	-R\$ 11,704,435.35	-R\$ 18,215,050.04
SFMP costs	-R\$ 11,704,435.35	-R\$ 11,704,435.35
Forest conservation and socio environmental activities	R\$ 0.00	-R\$ 6,510,614.69
Other (cattle ranching)	R\$ 0.00	R\$ 0.00

The Table below provides the results of the investment comparison analysis.

Table 31. Results from the investment analysis comparison between scenarios¹⁹⁸

Investment Analysis Comparison - 30 years project lifetime (Brazilian Reais)		
Land use scenarios Variables	I - Sustainable Forest Management Plan (SFMP)	II – SFMP combined with the implementation of additional activities to reduce deforestation
Total costs	-R\$ 11,704,435.35	-R\$ 18,215,050.04
Total Revenues	R\$ 20,863,511.98	R\$ 20,863,511.98
Accumulated cashflow	R\$ 9,159,076.63	R\$ 2,648,461.94
NPV	R\$ 3,427,117.58	R\$ 1,238,248.02

Through this analysis, it can be concluded that scenario I would have a higher Net Present Value than what was calculated for scenario II. The implementation of the present VCS AFOLU project over the project lifetime (30 years) would represent a decrease on the expected NPV that would be generated by the sustainable forest management activity alone.

This represents a significant barrier for adopting additional deforestation reduction practices. Scenario I, where no REDD activities are undertaken together with the SFMP, is a more economically attractive scenario than the measures proposed by the project activity.

Therefore, all the additional costs to monitor and reduce deforestation would not be needed if the REDD project did not occur, thus making the proposed VCS AFOLU project without the financial benefits from VCU substantially less attractive when comparing to other land use scenarios.

¹⁹⁸ A spreadsheet with a detailed calculation of financial indicators and the comparison of scenarios was made available for the auditing team.

Sub-step 2d. - Sensitivity analysis

The objective of this sub-step is to demonstrate that the conclusion regarding the financial attractiveness of the project is robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument in favor of additionality only if it consistently supports the conclusion that the proposed VCS AFOLU project without the financial benefits from carbon credits is unlikely to be financially attractive.

To carry out the sensitivity analysis, the following variables were subject to reasonable variation of $\pm 20\%$:

- Cost of SFMP activities, including the SFM Plan, Yearly operational Plan and other documents (Brazilian Reais/year);
- Cost for forest conservation measures and social and environmental activities required by the REDD Project (Brazilian Reais/year);

Revenues from SFMP will not be subjected to variations in this analysis, as the land owner has a leasing agreement with a Third Party. Such agreement establishes a fixed annual revenue from the leasing of harvesting activities on the Project Area.

The sensitivity analysis demonstrates that even with a variation of $\pm 20\%$ on the assumptions described above, the Scenario II would only be the least feasible option compared to Scenario I.

Regarding the comparison between Scenario I and Scenario II, this indicates that forest conservation costs would need to be completely eliminated or be combined with a significant reduction in the cost of SFMP activities to be comparable with the Scenario I's NPV.

Figures below show the sensitivity analysis described above.

Figure 68. Sensitivity analysis comparing the project activity and alternative land use scenarios

Scenario II analysis			Variation on cost of forest conservation measures				
Revenues from sustainable forest management and costs for forest conservation measures			-20%	-10%	0%	10%	20%
			R\$ 168,016	R\$ 189,018	R\$ 210,020	R\$ 231,022	R\$ 252,024
Variation on costs of Sustainable forest management plan	-20%	R\$136,660	R\$ 2,029,288	R\$ 1,831,403	R\$ 1,633,518	R\$ 1,435,633	R\$ 1,237,748
	-10%	R\$153,743	R\$ 1,851,250	R\$ 1,653,365	R\$ 1,455,480	R\$ 1,257,595	R\$ 1,059,710
	0%	R\$170,825	R\$ 1,673,213	R\$ 1,475,328	R\$ 1,277,443	R\$ 1,079,558	R\$ 881,673
	10%	R\$187,908	R\$ 1,495,175	R\$ 1,297,290	R\$ 1,099,405	R\$ 901,520	R\$ 703,635
	20%	R\$204,990	R\$ 1,317,138	R\$ 1,119,253	R\$ 921,368	R\$ 723,483	R\$ 525,598

It is not expected that any large variation of project costs will occur, as the average inflation during 2007-2017 period was 6%/year¹⁹⁹. Preventing deforestation is a complex and resource demanding activity, which involves personnel, technology and the engagement with local communities in a broad area surrounding the project. Therefore, the magnitude of these costs is a reflection of the complexity of developing an AFOLU REDD Project and maintaining measures to prevent deforestation and degradation. Such activities need to be performed either by for-profit organizations (such as consultancy companies) or by internal staff, that must be compensated for their services.

The conditions to allow Scenario II to be more financially attractive than Scenario I are considered unlikely by the Project Proponents. Hence, the landowner would hardly invest in activities to prevent deforestation beyond what is required by the applicable legislation in the absence of the REDD project.

Since the sensitivity analysis allows determining the VCS AFOLU project without the financial benefits from the VCS is unlikely to be financially attractive, a common practice analysis will be demonstrated next.

STEP 4. Common practice analysis

The previous steps shall be complemented with an analysis of the extent to which similar activities have already diffused in the geographical area of the Juruena River REDD project activity. Similar activities to the proposed REDD project, i.e., that are of similar scale, take place in a comparable environment, inter alia, with respect to the regulatory framework and are undertaken in the relevant geographical area, shall be analyzed. Other registered VCS AFOLU Project activities shall not be included in this analysis.

The practice of conservation of privately-owned forest areas located in the project region is extremely rare. The conservation of native forest is far from being the most attractive economic scenario, and it is often threatened by the noncompliance of the law, as presented in previous sections.

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 deforestation²⁰⁰. As previously detailed, Mato Grosso is the main producer of cattle and agriculture in the country, and this sector represents most of the State and Brazil's GDP.

According to files available at the SEMA-MT portal²⁰¹, until 2020, Mato Grosso had 4,159 active Sustainable Forest Management Plans. The logging area in the country between August 2019 and July 2020 was of 234,290 ha. This area represents half of the total areas managed for wood in the entire Amazon biome in the same period. In Mato Grosso, most of the logging is done legally (62%), with valid

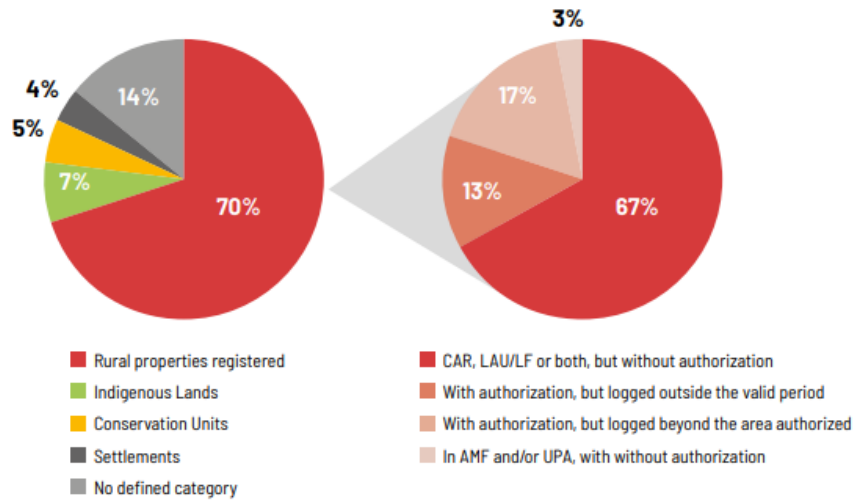
¹⁹⁹ Annual inflation (IPCA), cumulative value per year. Available at: <<https://www.inflation.eu/pt/taxas-de-inflacao/brasil/inflacao-historica/ipc-inflacao-brasil.aspx>>.

²⁰⁰ "The Rotten Apples of Brazil's Agribusiness" Available at <<https://www.researchgate.net/publication/343017296> The rotten apples of Brazil's agribusiness> Last visited on 14/01/2022.

²⁰¹ Available at <<http://www.sema.mt.gov.br/transparencia/index.php/sistemas/simgeo>> Last visited on 14/01/2022

authorizations and within the authorized area. However, 38% of the harvested wood is illegal, which represents 88,386 ha, and 70% is located on rural lands registered by the State environmental agency²⁰².

Figure 69. Categories of illegal logging in Mato Grosso in 2020.



The area illegally harvested in 2020 increased by 10% when compared to 2019. Colniza, municipality located in the Reference Region, was the 3rd most illegally deforested city in the state, with 7,879 ha, representing 8.9% of the total deforestation²⁰³. During August 2020 and June 2021, three of the municipalities in the reference region accounted for more illegal than legal deforestation²⁰⁴

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 continuation of the legally conducted forest management project, and resources from the sales of carbon credits would be a very important component for continuing the sustainable forest management operation.

Although there are Sustainable Forest Management Plans and logging authorizations in Cotriguaçu and in the reference region, as it is observed in the SEMA-MT database, these activities do not involve any additional measures to prevent deforestation and forest.

Therefore, no similar activity to the Project was found as part of the common practice analysis. Therefore, the proposed VCS AFOLU project is not the baseline scenario and, hence, it is additional.

²⁰² Available at <https://amazon.org.br/wp-content/uploads/2021/10/Simex_MT_Agosto2019-Julho2020.pdf> Last visited on 14/01/2022

²⁰³ Available at <https://www.icv.org.br/website/wp-content/uploads/2021/11/tf-15-mapeamento-ilegalidade-exploracao-madeira-mt-2020-icv-eng.pdf> Last visited on 14/01/2022

²⁰⁴ Available at <<https://www.icv.org.br/website/wp-content/uploads/2021/11/caracteristicas-do-desmatamento-na-amazonia-2021-v2.pdf>> Last visited on 14/01/2022

3.6 Methodology Deviations

This project activity does not apply any methodology deviations.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

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

Where,

Cab_{icl}	Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class icl ; $\text{tCO}_2\text{e ha}^{-1}$
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 CO_2e

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

Where,

Cbb_{icl}	Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class icl ; $\text{tCO}_2\text{e ha}^{-1}$
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 CO_2e

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

$$\Delta C_{BSLPA_t} = \Delta Cab_{BSLPA_{icl,t}} + \Delta Cbb_{BSLPA_{icl,t}}$$

Where,

ΔC_{BSLPA_t}	Total baseline carbon stock changes in the project area at year t ; tCO_2e
$\Delta Cab_{BSLPA_{icl,t}}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t ; tCO_2e

$\Delta C_{bbBSLPA_{icl,t}}$ Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO₂e

$$\Delta C_{abBSLPA_{icl,t}} = ABSLPA_{icl,t} * \Delta C_{ab_{icl}}$$

Where,

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

$ABSLPA_{icl,t}$ Area of initial forest class icl deforested at time t within the project area in the baseline case; ha

$\Delta C_{ab_{icl}}$ Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class icl; tCO₂e ha⁻¹

$$\Delta C_{bbBSLPA_{icl,t}} = ABSLPA_{icl,t} * \Delta C_{bb_{icl}}$$

Where,

$\Delta C_{bbBSLPA_{icl,t}}$ Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t; tCO₂e

$ABSLPA_{icl,t}$ Area of initial forest class icl deforested at time t within the project area in the baseline case; ha

$\Delta C_{bb_{icl}}$ Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category icl; tCO₂e ha⁻¹

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

As previously described, the Open Submontane Rainforest is the main forest type present within the project area, with around 67% of the total forest cover. Thus, to consider a conservative approach in terms of carbon stocks, the forest class was not stratified, i.e., the “Forest” class includes just one strata.

Project carbon stocks were calculated based on the biomass values from the study from FAO, 2020²⁰⁵. The methodology and eligibility of the study, according to the requirements of the methodology is summarized below:

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

²⁰⁵ FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020, Report, Rome, 2020. Available at: <https://www.fao.org/3/ca9976en/ca9976en.pdf>

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

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

The data are less than 10 years old;	The data used for estimating volume stocks were obtained from Brazil's National Forest Inventory collected until and available by December 2018.
The data are derived from multiple measurement plots;	Field data for the FAO report was collected during the National Forest Inventory. Sampling was made according to the Field Manual of the NFI ²⁰⁶ , described below: The IFN standard national grid consists of equidistant points within 20 km, called the 20 km x 20 km standard national grid. The consolidation of the grid may be necessary for special applications, aiming at representativeness of different phytophysionomies and in state and municipal inventories, among other possibilities. These crowding can be 10 km x 10 km (grid 10), 5 km x 5 km (grid 5) or more.

²⁰⁶ Available at < https://snif.florestal.gov.br/images/pdf/publicacoes/publicacoes_ifn/manual_de_campo/Manual_de_Campo_IFN_Versao_7_4_1.pdf>

	<p>The size of the subunit is related to the characteristics of existing forests in Brazilian biomes. Thus, in the Atlantic Forest, Cerrado, Caatinga, Pantanal and Pampas Biomes, the subunits will have an area of 1,000 m² (20 m x 50 m), and in the Amazon Biome, 2,000 m² (20 m x 100 m). Each of these subunits will be subdivided into subplots of 10 m x 10 m.</p> <p>The number of clusters for each forest type is listed in FAO's Brazil Report (for the Amazon Biome)</p>
<p>All species above a minimum diameter are included in the inventories;</p>	<p>Data collection starts with the tree stratum, following the numerical order of the subplots, where all individuals with DBH \geq 10 cm will be identified and measured. All trees included within the subunit area, including standing dead trees, regardless of the subplot they are in, must have their diameter at breast height (DBH), measured and recorded, be identified by a field name and have the measured and/or estimated heights, obeying the respective inclusion limits.</p>
<p>The minimum diameter for trees included is 30 cm or less at breast height (DBH);</p>	<p>In the four subunits of each conglomerate, all tree individuals with DBH \geq 10 cm (Diameter at breast height \geq 10 cm) and all bamboo individuals are measured and identified. In the last subplot of 10 m x 10 m (subplot 10), individuals with DBH between 5 and 10 cm ($5 \text{ cm} \leq \text{DBH} < 10 \text{ cm}$) are also measured.</p> <p>In this same subplot (10), a 5 m x 5 m subplot is demarcated, where natural regeneration is evaluated. In this case, individuals with height less than or equal to 1.3 m and DBH $<$ 5 cm are measured and identified.</p> <p>At the extremes of the subunits (subplots 1, 2, 9 and 10), four quadrants measuring 0.4</p>

	m x 0.6 m are also demarcated, where the coverage of herbaceous plants is evaluated, and the dominant species is indicated.
Data are sampled from good coverage of the classes over which they will be extrapolated.	For each vegetation type on each biome were statistically estimated biomass and then converted to the equivalent carbon quantity (0.49). For the vegetation types with low number of samples and consequently sample insufficiency was used instead the total samples for all biomes of this specific type.

As previously described in section 3.3, according to the analysis, two main vegetation classes occur within the project area boundaries: Open Submontane Tropical Rainforest (67%) and Dense Submontane Tropical Rainforest (33%). However, in the Reference Region, the predominant forest class is Dense Submontane Tropical Rainforest (70%), while the Open Submontane Tropical Rainforest has a lower presence (26%). Therefore, in order to conservatively define the carbon stocks for this project activity, the forest class with the lowest carbon stocks, i.e. Open Submontane Tropical Rainforest, was considered.

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 32. Biomass to CO₂ conversion factors²⁰⁷

Conversion Factors***	
Biomass to Carbon	0.5
C to CO ₂	3.6667

²⁰⁷ IPCC, 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>

Table 33. Biomass values used for the “forest” classes within the reference region, project area and leakage belt

Forest class	% of the PA	PROJECT AREA								
		Aboveground*			Belowground**			TOTAL		
		Biomass (Mg ha ⁻¹)	Biomass to Carbon (tC/ha)	C _{bi,cl} (tCO ₂ /ha)	Biomass (Mg ha ⁻¹)	Biomass to Carbon (tC/ha)	C _{bb,cl} (tCO ₂ /ha)	Total biomass (Mg ha ⁻¹)	Biomass to Carbon (tC/ha)	C _{tot,cl} (tCO ₂ /ha)
Dense Submontane Tropical Rainforest	33%	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Open Submontane Tropical Rainforest	67%	225.46	112.73	413.34	54.11	27.06	99.20	279.57	139.79	512.4

Average carbon stocks of post-deforestation classes

The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomass, which is detailed below:

Land Use	Area (%)
Pasturelands	89.87%
Secondary forests	10.04%
Agriculture	0.08%
Rivers, lakes and reservatories	0.01%
Urban area	0.00%

Therefore, most of the post-deforestation land uses within the reference region is composed by pasturelands.

In order to estimate the post-deforestation carbon stocks, the average carbon stocks of pasturelands, agriculture and other land uses were taken from the National GHG Emissions Communication of Brazil to the UNFCCC (2019)²⁰⁸.

For secondary forests, a regional study was conducted. Most secondary forests in the Brazilian Amazon are young. In 2017, 65% of secondary forests was ≤10 years old. On average, 35% of annual land abandonment to secondary forests was re-cleared within 5 years, and 57% within 10 years²⁰⁹. The half-life of secondary forests is 8 years, on average, which is also the same value found by other study that

²⁰⁸ Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-unfccc/arquivos/3tcn_volume_3.pdf>

²⁰⁹ Sâmia Nunes *et al* 2020 *Environ. Res. Lett.* **15** 034057. Available at: <<https://iopscience.iop.org/article/10.1088/1748-9326/ab76db>>

concludes that more than 50% of the secondary forests in the Amazon biome have less than 8 years old²¹⁰.

According to a study conducted in the Amazon Forest that analyzed the carbon stocks of a secondary forest with 14 years old, the average carbon stock in above ground biomass is around 19 tC/ha²¹¹. Below ground biomass was estimated through the root-to-shoot ratio from the applied methodology. Therefore, the average value for secondary forests is around 22,8 tC/ha.

Therefore, the weighted average carbon stocks was calculated through the data below.

Land Use	Area (%)	Carbon stocks (tC/ha)
Pasturelands	89.87%	7.57
Secondary forests	10.04%	22.8
Agriculture	0.08%	21
Rivers, lakes and reservatory	0.01%	0
Urban area	0.00%	0
Weighted average of post-deforestation carbon stocks		9.11

Table 34. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Post deforestation class <i>fcl</i>	
Name	Non forest
ID _{fcl}	1
Average carbon stock per hectare ±90% CI	
C _{totfcl}	
tCO _{2e} /ha	
33.40	

Uncertainty assessment

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

²¹⁰ Silva Junior, C.H.L., Heinrich, V.H.A., Freire, A.T.G. *et al.* Benchmark maps of 33 years of secondary forest age for Brazil. *Sci Data* **7**, 269 (2020). Available at: <<https://doi.org/10.1038/s41597-020-00600-4>>

²¹¹ Pereira, Izaura Cristina Nunes. *Estoque de biomassa e carbono florestal em unidades de paisagem na Amazônia: uma análise a partir da abordagem metodológica.* Universidade Federal do Pará, Belém, 2013. Available at: <<https://ppgdstu.propesp.ufpa.br/ARQUIVOS/teses/TESES/2013/IZAURA%20CRISTINA%20NUNES%20PEREIRA.pdf>>

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.

The uncertainty of the FAO study was used, corrected to a 90% confidence interval, as per the methodology.

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

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

Initial forest class <i>icl</i>						
Boundaries	Average carbon stock 90% CI					
	Name	Forest - Open Submontane Tropical Rainforest				
	ID _{icl}	1				
	Cab _{icl}		Cbb _{icl}		Ctot _{icl}	
	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI
	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/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 36. Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt after discounts for uncertainties

Initial forest class <i>icl</i>							
Boundaries		Average carbon stock 90% CI					
		Name	Forest - Open Submontane 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
		tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha
Initial forest class	Project Area	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55
Initial forest class	Leakage Belt	413.34	413.34	99.20	99.20	512.55	512.55
Final forest class		413.34	413.34	99.20	99.20	512.55	512.55

Carbon stock change factors

In the baseline scenario the Project considers the change in carbon stock from forest cover replacing for a type of vegetation that can be grazing areas, small scale agricultural plantations or plantations (temporary or permanent). The AFOLU Requirements requires that the decay of carbon stock in soil carbon, below-ground biomass, dead wood and harvested wood products in the baseline case is considered. To calculate this decay of carbon stock, the VM0015 version 1.1 apply a default linear function to account for the decay of carbon stock in initial forest classes (icl) and increase in carbon stock in post-deforestation classes. Table 36 and Table 37, below, summarize how carbon stock change factor was calculated.

Table 37 – Carbon Stock Change Factors for Initial Forest Class icl (Method 1, Reference Region) (Table 20a of Methodology VM0015).

Year after deforestation		$\Delta C_{ab_{icl,t}}$	$\Delta C_{bb_{icl,t}}$	$\Delta C_{dw_{icl,t}}$	$\Delta C_{tot_{cl,t}}$
0	t*	413.3	9.9	0.0	423.3
1	t*+1	0.0	9.9	0.0	9.9
2	t*+2	0.0	9.9	0.0	9.9
3	t*+3	0.0	9.9	0.0	9.9
4	t*+4	0.0	9.9	0.0	9.9
5	t*+5	0.0	9.9	0.0	9.9
6	t*+6	0.0	9.9	0.0	9.9
7	t*+7	0.0	9.9	0.0	9.9
8	t*+8	0.0	9.9	0.0	9.9
9	t*+9	0.0	9.9	0.0	9.9

Table 38 - Carbon Stock Change Factors for final Classes fcl or zones Z (Method 1, Reference Region) (Table 20a of Methodology VM0015).

Year after deforestation		$\Delta C_{tot_{icl,t}}$
0	t*	0.0
1	t*+1	3.3
2	t*+2	3.3
3	t*+3	3.3
4	t*+4	3.3
5	t*+5	3.3

6	t*+6	3.3
7	t*+7	3.3
8	t*+8	3.3
9	t*+9	3.3

Table 39. Carbon stock change factors for initial forest classes icl (Method 1, Project Area) (Table 20b of Methodology VM0015).

Year after deforestation		$\Delta C_{bicl,t}$	$\Delta C_{bbicl,t}$	$\Delta C_{dwicl,t}$	$\Delta C_{totcl,t}$
0	t*	413.3	9.9	0.0	423.3
1	t*+1	0.0	9.9	0.0	9.9
2	t*+2	0.0	9.9	0.0	9.9
3	t*+3	0.0	9.9	0.0	9.9
4	t*+4	0.0	9.9	0.0	9.9
5	t*+5	0.0	9.9	0.0	9.9
6	t*+6	0.0	9.9	0.0	9.9
7	t*+7	0.0	9.9	0.0	9.9
8	t*+8	0.0	9.9	0.0	9.9
9	t*+9	0.0	9.9	0.0	9.9

Table 40. Carbon stock change factors for final classes fcl or zones z (Method 1, Project Area) (Table 20b of Methodology VM0015).

Year after deforestation		$\Delta C_{totfcl,t}$
0	t*	0
1	t*+1	3.3
2	t*+2	3.3

3	t*+3	3.3
4	t*+4	3.3
5	t*+5	3.3
6	t*+6	3.3
7	t*+7	3.3
8	t*+8	3.3
9	t*+9	3.3

Table 41 - Carbon Stock Change Factors for Initial Forest Classes icl (Method 1, Leakage Belt) (Table 20c of Methodology VM0015).

Year after deforestation		$\Delta C_{bicl,t}$	$\Delta C_{bbicl,t}$	$\Delta C_{dwicl,t}$	$\Delta C_{toticl,t}$
0	t*	413.3	9.9	0.0	423.3
1	t*+1	0.0	9.9	0.0	9.9
2	t*+2	0.0	9.9	0.0	9.9
3	t*+3	0.0	9.9	0.0	9.9
4	t*+4	0.0	9.9	0.0	9.9
5	t*+5	0.0	9.9	0.0	9.9
6	t*+6	0.0	9.9	0.0	9.9
7	t*+7	0.0	9.9	0.0	9.9
8	t*+8	0.0	9.9	0.0	9.9
9	t*+9	0.0	9.9	0.0	9.9

Table 42 - Carbon Stock Change Factors for Final Classes fcl or Zones Z (Method 1, Leakage Belt) (Table 20c of Methodology VM0015).

Year after deforestation		$\Delta C_{totfcl,t}$
0	t^*	0.0
1	t^*+1	3.3
2	t^*+2	3.3
3	t^*+3	3.3
4	t^*+4	3.3
5	t^*+5	3.3
6	t^*+6	3.3
7	t^*+7	3.3
8	t^*+8	3.3
9	t^*+9	3.3

Calculation of baseline carbon stock changes

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

Table 43 - Baseline Carbon Stock Change in the Reference Region (Table 21a of Methodology VM0015)

Carbon stock changes per initial forest class <i>icl</i>		Total carbon stock change of initial forest class in the reference region		Carbon stock changes per post-deforestation zone <i>z</i>		Total carbon stock change of post-deforestation zones in the reference region		Total net carbon stock change of the reference region	
ID _{icl} >	1	$\Delta\text{CBSLLK}_{icl,t}$	$\Delta\text{CBSLLK}_{icl}$	ID _z >	1	$\Delta\text{CBSLLK}_{z,t}$	ΔCBSLLK_z	ΔCBSLLK_t	ΔCBSLLK
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative	annual	cumulative
Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e
2021	2,013,904.5	2,013,904.5	2,013,904.5	2021	0.0	0.0	0.0	2,013,904.5	2,013,904.5
2022	2,152,212.7	2,152,212.7	4,166,117.2	2022	15,894.0	15,894.0	15,894.0	2,136,318.7	2,136,318.7
2023	2,292,656.3	2,292,656.3	6,458,773.4	2023	32,506.9	32,506.9	48,400.9	2,260,149.3	4,396,468.1
2024	2,435,235.2	2,435,235.2	8,894,008.6	2024	49,839.0	49,839.0	98,239.8	2,385,396.2	6,781,864.3
2025	2,579,949.4	2,579,949.4	11,473,958.0	2025	67,890.0	67,890.0	166,129.8	2,512,059.4	9,293,923.7
2026	2,726,799.0	2,726,799.0	14,200,757.0	2026	86,660.1	86,660.1	252,789.9	2,640,138.9	11,934,062.6
2027	2,875,783.9	2,875,783.9	17,076,540.8	2027	106,149.2	106,149.2	358,939.1	2,769,634.7	14,703,697.3
2028	3,026,904.1	3,026,904.1	20,103,444.9	2028	126,357.3	126,357.3	485,296.4	2,900,546.8	17,604,244.1
2029	3,180,159.6	3,180,159.6	23,283,604.5	2029	147,284.5	147,284.5	632,580.9	3,032,875.1	20,637,119.2
2030	3,335,550.5	3,335,550.5	26,619,155.0	2030	168,930.7	168,930.7	801,511.5	3,166,619.8	23,803,739.0
2031	3,445,875.8	3,445,875.8	30,065,030.8	2031	175,401.9	175,401.9	976,913.4	3,270,473.9	27,074,212.9
2032	3,556,201.1	3,556,201.1	33,621,231.9	2032	181,873.2	181,873.2	1,158,786.6	3,374,327.9	30,448,540.8
2033	3,666,526.4	3,666,526.4	37,287,758.3	2033	188,344.4	188,344.4	1,347,131.0	3,478,182.0	33,926,722.8
2034	3,776,851.7	3,776,851.7	41,064,610.1	2034	194,815.7	194,815.7	1,541,946.7	3,582,036.0	37,508,758.9
2035	3,887,177.1	3,887,177.1	44,951,787.1	2035	201,287.0	201,287.0	1,743,233.7	3,685,890.1	41,194,649.0
2036	3,997,502.4	3,997,502.4	48,949,289.5	2036	207,758.2	207,758.2	1,950,992.0	3,789,744.1	44,984,393.1
2037	4,107,827.7	4,107,827.7	53,057,117.2	2037	214,229.5	214,229.5	2,165,221.4	3,893,598.2	48,877,991.3
2038	4,218,153.0	4,218,153.0	57,275,270.2	2038	220,700.8	220,700.8	2,385,922.2	3,997,452.2	52,875,443.5
2039	4,328,478.3	4,328,478.3	61,603,748.5	2039	227,172.0	227,172.0	2,613,094.2	4,101,306.3	56,976,749.8
2040	4,438,803.6	4,438,803.6	66,042,552.2	2040	233,643.3	233,643.3	2,846,737.5	4,205,160.3	61,181,910.2
2041	4,549,129.0	4,549,129.0	70,591,681.1	2041	240,114.6	240,114.6	3,086,852.1	4,309,014.4	65,490,924.6
2042	4,659,454.3	4,659,454.3	75,251,135.4	2042	246,585.8	246,585.8	3,333,437.9	4,412,868.5	69,903,793.0

2043	4,769,779.6	4,769,779.6	80,020,915.0	2043	253,057.1	253,057.1	3,586,495.0	4,516,722.5	74,420,515.5
2044	4,880,104.9	4,880,104.9	84,901,019.9	2044	259,528.3	259,528.3	3,846,023.3	4,620,576.6	79,041,092.1
2045	4,990,430.2	4,990,430.2	89,891,450.1	2045	265,999.6	265,999.6	4,112,022.9	4,724,430.6	83,765,522.7
2046	5,100,755.5	5,100,755.5	94,992,205.6	2046	272,470.9	272,470.9	4,384,493.8	4,828,284.7	88,593,807.4
2047	5,211,080.8	5,211,080.8	100,203,286.4	2047	278,942.1	278,942.1	4,663,435.9	4,932,138.7	93,525,946.1
2048	5,321,406.2	5,321,406.2	105,524,692.6	2048	285,413.4	285,413.4	4,948,849.3	5,035,992.8	98,561,938.8
2049	5,431,731.5	5,431,731.5	110,956,424.1	2049	291,884.7	291,884.7	5,240,734.0	5,139,846.8	103,701,785.7
2050	5,542,056.8	5,542,056.8	116,498,480.9	2050	298,355.9	298,355.9	5,539,089.9	5,243,700.9	108,945,486.5

Table 44 - Baseline Carbon Stock Change in the Project Area (Table 21b of Methodology VM0015)

Carbon stock changes per initial forest class <i>icl</i>		Total carbon stock change of initial forest class in the Project Area		Carbon stock changes per post-deforestation zone <i>z</i>		Total carbon stock change of post-deforestation zones in the Project Area		Total net carbon stock change of the Project Area	
ID _{icl} >	1	$\Delta\text{CBSLLK}_{icl,t}$	$\Delta\text{CBSLLK}_{icl}$	ID _z >	1	$\Delta\text{CBSLLK}_{z,t}$	ΔCBSLLK_z	ΔCBSLLK_t	ΔCBSLLK
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative	annual	cumulative
Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e
2021	53,331.2	53,331.2	53,331.2	2021	0.0	0.0	0.0	53,331.2	53,331.2
2022	42,729.8	42,729.8	96,061.0	2022	420.9	420.9	420.9	42,308.9	42,308.9
2023	77,986.3	77,986.3	174,047.3	2023	748.3	748.3	1,169.2	77,238.1	119,546.9
2024	100,078.7	100,078.7	274,126.0	2024	1,346.2	1,346.2	2,515.4	98,732.5	218,279.4
2025	106,986.5	106,986.5	381,112.5	2025	2,104.5	2,104.5	4,619.8	104,882.0	323,161.4
2026	89,030.8	89,030.8	470,143.3	2026	2,899.5	2,899.5	7,519.3	86,131.3	409,292.8
2027	109,116.0	109,116.0	579,259.3	2027	3,534.2	3,534.2	11,053.5	105,581.8	514,874.6
2028	176,610.0	176,610.0	755,869.4	2028	4,312.5	4,312.5	15,366.0	172,297.5	687,172.1
2029	209,654.4	209,654.4	965,523.7	2029	5,605.3	5,605.3	20,971.3	204,049.1	891,221.2
2030	130,795.1	130,795.1	1,096,318.8	2030	7,128.5	7,128.5	28,099.8	123,666.6	1,014,887.8
2031	163,859.2	163,859.2	1,260,178.0	2031	7,572.8	7,572.8	35,672.6	156,286.4	1,171,174.2
2032	147,153.5	147,153.5	1,407,331.5	2032	8,361.1	8,361.1	44,033.7	138,792.4	1,309,966.6

2033	257,870.0	257,870.0	1,665,201.6	2033	8,728.6	8,728.6	52,762.3	249,141.4	1,559,108.1
2034	189,099.6	189,099.6	1,854,301.2	2034	9,800.9	9,800.9	62,563.2	179,298.8	1,738,406.8
2035	175,251.0	175,251.0	2,029,552.1	2035	10,268.5	10,268.5	72,831.7	164,982.4	1,903,389.3
2036	209,773.4	209,773.4	2,239,325.5	2036	10,776.3	10,776.3	83,607.9	198,997.1	2,102,386.4
2037	291,625.3	291,625.3	2,530,950.8	2037	11,400.9	11,400.9	95,008.9	280,224.4	2,382,610.8
2038	173,197.5	173,197.5	2,704,148.3	2038	12,142.5	12,142.5	107,151.4	161,055.0	2,543,665.7
2039	180,776.5	180,776.5	2,884,924.8	2039	11,701.6	11,701.6	118,852.9	169,075.0	2,712,740.7
2040	298,450.4	298,450.4	3,183,375.3	2040	11,988.8	11,988.8	130,841.8	286,461.6	2,999,202.2
2041	165,006.7	165,006.7	3,348,381.9	2041	12,947.6	12,947.6	143,789.4	152,059.1	3,151,261.4
2042	245,102.7	245,102.7	3,593,484.6	2042	12,981.0	12,981.0	156,770.3	232,121.7	3,383,383.1
2043	263,977.6	263,977.6	3,857,462.2	2043	12,780.5	12,780.5	169,550.8	251,197.1	3,634,580.1
2044	199,072.8	199,072.8	4,056,534.9	2044	13,301.6	13,301.6	182,852.5	185,771.1	3,820,351.2
2045	253,597.7	253,597.7	4,310,132.6	2045	13,418.6	13,418.6	196,271.0	240,179.2	4,060,530.4
2046	229,891.6	229,891.6	4,540,024.3	2046	13,702.5	13,702.5	209,973.5	216,189.1	4,276,719.5
2047	274,420.3	274,420.3	4,814,444.6	2047	13,161.3	13,161.3	223,134.9	261,258.9	4,537,978.5
2048	226,353.4	226,353.4	5,040,798.0	2048	13,936.3	13,936.3	237,071.2	212,417.1	4,750,395.6
2049	248,852.5	248,852.5	5,289,650.5	2049	14,243.6	14,243.6	251,314.9	234,608.9	4,985,004.5
2050	221,290.8	221,290.8	5,510,941.3	2050	13,799.4	13,799.4	265,114.2	207,491.4	5,192,495.9

Table 45. Baseline carbon stock change in the leakage belt area (Table 21c of Methodology VM0015).

Carbon stock changes per initial forest class <i>icl</i>		Total carbon stock change of initial forest class in the leakage belt area		Carbon stock changes per post-deforestation zone <i>z</i>		Total carbon stock change of post-deforestation zones in leakage belt area		Total net carbon stock change of the leakage belt area	
ID _{icl} >	1	$\Delta\text{CBSLLK}_{icl,t}$	$\Delta\text{CBSLLK}_{icl}$	ID _z >	1	$\Delta\text{CBSLLK}_{z,t}$	ΔCBSLLK_z	ΔCBSLLK_t	ΔCBSLLK
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative	annual	cumulative
Project Year <i>t</i>	tCO _{2-e}	tCO _{2-e}	tCO _{2-e}	Project Year <i>t</i>	tCO _{2-e}	tCO _{2-e}	tCO _{2-e}	tCO _{2-e}	tCO _{2-e}
2021	232,795.0	232,795.0	232,795.0	2021	0.0	0.0	0.0	232,795.0	232,795.0
2022	417,714.9	417,714.9	650,509.8	2022	1,837.2	1,837.2	1,837.2	415,877.6	415,877.6
2023	401,134.8	401,134.8	1,051,644.6	2023	5,090.8	5,090.8	6,928.1	396,044.0	811,921.6
2024	389,018.9	389,018.9	1,440,663.5	2024	8,137.3	8,137.3	15,065.4	380,881.6	1,192,803.2
2025	456,827.1	456,827.1	1,897,490.6	2025	11,016.8	11,016.8	26,082.2	445,810.3	1,638,613.5
2026	544,647.6	544,647.6	2,442,138.2	2026	14,363.9	14,363.9	40,446.1	530,283.7	2,168,897.2
2027	497,156.1	497,156.1	2,939,294.4	2027	18,325.7	18,325.7	58,771.7	478,830.5	2,647,727.7
2028	536,314.6	536,314.6	3,475,609.0	2028	21,819.8	21,819.8	80,591.5	514,494.9	3,162,222.5
2029	505,462.7	505,462.7	3,981,071.7	2029	25,541.0	25,541.0	106,132.5	479,921.7	3,642,144.2
2030	626,003.5	626,003.5	4,607,075.2	2030	28,931.6	28,931.6	135,064.1	597,071.9	4,239,216.1
2031	516,808.1	516,808.1	5,123,883.3	2031	31,356.7	31,356.7	166,420.9	485,451.4	4,724,667.5
2032	621,198.8	621,198.8	5,745,082.1	2032	31,446.9	31,446.9	197,867.8	589,751.9	5,314,419.4
2033	551,720.8	551,720.8	6,296,802.9	2033	32,566.0	32,566.0	230,433.8	519,154.8	5,833,574.2
2034	582,615.7	582,615.7	6,879,418.6	2034	33,277.5	33,277.5	263,711.2	549,338.2	6,382,912.4
2035	539,148.5	539,148.5	7,418,567.1	2035	33,748.5	33,748.5	297,459.7	505,400.0	6,888,312.4
2036	480,529.8	480,529.8	7,899,096.9	2036	33,250.8	33,250.8	330,710.5	447,279.0	7,335,591.4
2037	573,489.1	573,489.1	8,472,586.0	2037	32,769.7	32,769.7	363,480.2	540,719.3	7,876,310.8
2038	572,328.4	572,328.4	9,044,914.4	2038	32,806.5	32,806.5	396,286.7	539,521.9	8,415,832.7
2039	556,882.6	556,882.6	9,601,797.0	2039	33,163.9	33,163.9	429,450.6	523,718.7	8,939,551.4
2040	600,680.5	600,680.5	10,202,477.4	2040	32,519.2	32,519.2	461,969.9	568,161.2	9,507,712.6

2041	668,171.2	668,171.2	10,870,648.6	2041	33,153.9	33,153.9	495,123.7	635,017.3	10,142,729.9
2042	468,949.6	468,949.6	11,339,598.2	2042	33,484.6	33,484.6	528,608.3	435,465.0	10,578,194.9
2043	449,168.6	449,168.6	11,788,766.8	2043	32,809.8	32,809.8	561,418.2	416,358.8	10,994,553.7
2044	463,427.3	463,427.3	12,252,194.1	2044	31,767.6	31,767.6	593,185.8	431,659.7	11,426,213.4
2045	441,050.6	441,050.6	12,693,244.7	2045	31,216.4	31,216.4	624,402.2	409,834.1	11,836,047.5
2046	522,380.0	522,380.0	13,215,624.7	2046	30,952.5	30,952.5	655,354.8	491,427.5	12,327,475.0
2047	510,727.0	510,727.0	13,726,351.7	2047	30,591.8	30,591.8	685,946.5	480,135.2	12,807,610.2
2048	441,292.0	441,292.0	14,167,643.7	2048	30,157.5	30,157.5	716,104.1	411,134.4	13,218,744.6
2049	454,452.8	454,452.8	14,622,096.5	2049	29,315.7	29,315.7	745,419.8	425,137.1	13,643,881.7
2050	369,558.7	369,558.7	14,991,655.2	2050	28,236.8	28,236.8	773,656.5	341,321.9	13,985,203.7

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 checked for significance, as established in methodology VM0015, version 1.1 (page 28). It was therefore concluded that they are not significant (they account for less than 5% of the total GHG benefits generated) and were therefore excluded from the emissions calculation. The calculations made are presented below.

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

Where,

- EBBtot_{icl,t} Total GHG emission from biomass burning in forest class icl at year t; tCO₂e/ha
- EBBN₂O_{icl,t} N₂O emission from biomass burning in forest class icl at year t; tCO₂e/ha
- EBBCH₄_{icl,t} CH₄ emission from biomass burning in forest class icl at year t; tCO₂e/ha

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

Where,

- EBBCO_{2icl,t} Per hectare CO₂ emission from biomass burning in slash and burn in forest class icl at year t; tCO₂e/ha
- NCR Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
- ER_{N2O} Emission ratio for N₂O (IPCC default value = 0.007)
- GWP_{N2O} Global Warming Potential for N₂O (IPCC default value)²¹²

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

Where,

- EBBCO_{2icl,t} Per hectare CO₂ emission from biomass burning in slash and burn in forest class icl at year t; tCO₂e/ha

²¹² 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).

ER _{CH4}	Emission ratio for CH ₄ (IPCC default value = 0.012)
GWP _{CH4}	Global Warming Potential for CH ₄ (IPCC default value) ²¹³

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

Where,

EBBCO _{2icl,t}	Per hectare CO ₂ emission from biomass burning in the forest class icl at year t; tCO ₂ e/ha
F _{burnt_{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 ₂ e/ha
P _{burnt_{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 F_{burnt} analysis was carried out on the municipality of Cotriguaçu, as it is where the Project Area is fully inserted in. The proportion of forest burned during the historical reference period was obtained from data available on MapBiomias²¹⁴. All fire scar mapping in Brazil was based on mosaics of images from Landsat satellites with resolution of 30 meters. The mapping period was from 1985 to 2020 covering the entire Brazilian territory. The work was organized by biomes and regions, with sample collection in burned and unburned areas to train the algorithm by regions, in addition to the use of reference maps, such as burned areas from the MODIS product (MCD64A1²¹⁵) of 500 m spatial resolution and INPE²¹⁶ hotspot data. The figure below illustrates the main steps and platforms used by MapBiomias to classify fire scars. Based on the available data, it was possible to calculate the proportion of burned areas in the municipality of Cotriguaçu. The data available for this municipality were from 2010 to 2019, as can be seen in the following table. The F_{burnt} estimated was 52.81%.

²¹³ 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 CH₄ = 28).

²¹⁴ Mapbiomas - Available at: <https://plataforma.brasil.mapbiomas.org/>

²¹⁵ MODIS- available: <https://lpdaac.usgs.gov/products/mcd64a1v006/>

²¹⁶ INPE – Agência Nacional de Pesquisas Espaciais. Available in: <https://queimadas.dgi.inpe.br/>

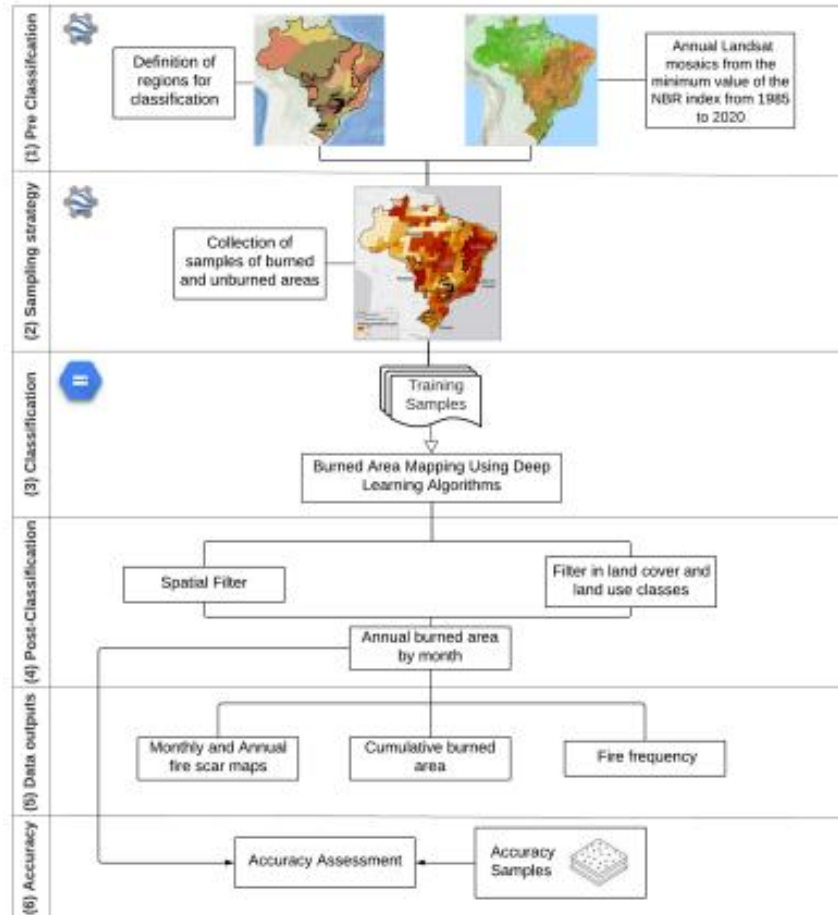


Figure 70. Method for classification burned areas in Brazil in MapBiomass Fire Collection 1.0²¹⁷

Class	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total burned area	1,065.00	1,027.00	835.00	885.00	2,453.00	4,613.00	2,897.00	3,478.00	649.00	3,064.00
Forest	756,006.24	754,065.82	749,834.36	745,826.96	739,448.93	732,955.40	729,568.34	723,633.61	720,140.92	718,164.78
Non forest	1,799.00	2,668.00	4,482.00	3,719.00	4,845.00	5,517.00	4,087.00	4,754.00	2,102.00	3,885.00
% burned deforested area	59.20%	38.49%	18.63%	23.80%	50.63%	83.61%	70.88%	73.16%	30.88%	78.87%

The Pburnt estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m³/ha was

²¹⁷ Algorithm Theoretical Basis Document (ATBD). Mapbiomas Fire, Collection 1.0, version 1. Available at: https://mapbiomas-br-site.s3.amazonaws.com/ATBD_MapBiomass_Fogo_Cole%C3%A7%C3%A3o_1.pdf

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., P_{burnt} 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-CO₂ emissions from forest fire at year t in the project area at the baseline scenario ($EBBBSLPA_t$), as well as their significance, 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 ₂ e/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 ₂ e/ha

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

Table 46. Parameters used to calculate non-CO₂ emissions from forest fires

Initial Forest Class		Parameters								
		$F_{burnt_{icl}}$	C_{ab}	$P_{burnt_{ab,icl}}$	$CE_{ab,icl}$	$ECO2_{-ab}$	$EBBCO2_{-tot}$	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
IDcl	Name	%	tCO ₂ e/ha	%	%	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha	tCO ₂ e/ha
1	Forest	52.81%	413.34	78%	50%	85.13	85.13	0.68	10.40	11.08

Table 47. Baseline non-CO2 emissions from forest fires in the project area (Table 24 of Methodology VM0015).

Project Year t	Emissions of non-CO2 gasses from ex-ante forest fires		Total ex-ante non-CO2 emissions from forest fires in the project area		Significance
	ID _{cl} =	1	annual	cummulative	
	ABSLPA _{icl,t}	EBBBSL _{tot,cl,t}	EBBBSLPA _t	EBBBSLPA	
	ha	tCO ₂ e ha ⁻¹	tCO ₂ e	tCO ₂ e	
2021	66,5	11,1	737,2	737,2	1,38%
2022	51,8	11,1	573,4	1.310,6	1,36%
2023	94,5	11,1	1.047,3	2.358,0	1,36%
2024	119,9	11,1	1.328,2	3.686,1	1,35%
2025	125,7	11,1	1.392,5	5.078,7	1,33%
2026	100,3	11,1	1.111,7	6.190,4	1,29%
2027	123,1	11,1	1.363,3	7.553,7	1,29%
2028	204,4	11,1	2.264,3	9.818,0	1,31%
2029	240,8	11,1	2.668,1	12.486,1	1,31%
2030	136,8	11,1	1.515,4	14.001,5	1,23%
2031	176,4	11,1	1.954,2	15.955,7	1,25%
2032	152,6	11,1	1.690,9	17.646,7	1,22%
2033	289,4	11,1	3.206,4	20.853,0	1,29%
2034	199,6	11,1	2.211,7	23.064,7	1,23%
2035	180,6	11,1	2.001,0	25.065,8	1,21%
2036	221,8	11,1	2.457,4	27.523,2	1,23%
2037	321,6	11,1	3.563,3	31.086,5	1,27%
2038	171,1	11,1	1.895,7	32.982,2	1,18%
2039	182,2	11,1	2.018,6	35.000,8	1,19%
2040	328,0	11,1	3.633,5	38.634,3	1,27%
2041	157,9	11,1	1.749,5	40.383,7	1,15%
2042	257,7	11,1	2.855,3	43.239,0	1,23%
2043	282,0	11,1	3.124,4	46.363,5	1,24%
2044	199,1	11,1	2.205,8	48.569,3	1,19%
2045	266,7	11,1	2.954,8	51.524,1	1,23%
2046	236,1	11,1	2.615,4	54.139,5	1,21%
2047	293,7	11,1	3.253,2	57.392,7	1,25%
2048	230,8	11,1	2.556,9	59.949,6	1,20%
2049	257,7	11,1	2.855,3	62.804,9	1,22%
2050	225,0	11,1	2.492,5	65.297,4	1,20%

4.2 Project Emissions

The present REDD project includes logging activities within the project area. These carbon stock changes are estimated ex ante and shall be measured ex post.

Sustainable Forest Management Plan activities mainly includes implementation of infrastructure, such as opening of main and secondary roads, skidding trails²¹⁸, and timber yards in each annual production unit – APU (Unidade de Produção Anual, in portuguese) within the project area, estimated to be around 1,18% of each APU. According to the current sustainable forest management plan, the authorized forest management area is 3,051.8384 ha, and the average annual logging area is 392.90 ha.

Table below presents an ex ante estimated carbon stock decrease due to planned deforestation in the project area. The location of annual planned deforestation areas was proportionally divided among the forest classes existing within the project area. The ex ante estimated carbon stock decrease due to planned deforestation in the project area was calculated using the following equation:

$$\Delta CPDdPA_t = \sum_{icl=1}^{icl} (APDPA_{icl,t} \times \Delta Ct_{ot_{icl}})$$

Where,

$\Delta CPDdPA_t$	Total decrease in carbon stock due to planned deforestation at year t in the project area; tCO _{2e}
$APDPA_{icl,t}$	Areas of planned deforestation in forest class icl at year t in the project area; ha
$\Delta Ct_{ot_{icl}}$	Average carbon stock change of all accounted carbon pools in forest class icl at time t; tCO _{2e} /ha

²¹⁸ According to Holmes et al. (2002) less than 10% of skidding trails from reduced impact logging (RIL) forest management systems caused soil degradation and consequently clearings in the forest, while 100% of trails in conventional management areas are affected.

Table 48. Ex ante estimated actual carbon stock decrease due to planned deforestation in the project area (Table 25a of Methodology VM0015).

Project year t	Areas of planned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned deforestation	
	Forest		annual	cumulative
	$APDPA_{icl,t}$	$C_{tot_{icl,t}}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}
2021	4.64	512.55	2376.25	2,376.25
2022	4.64	512.55	2376.25	4,752.51
2023	4.64	512.55	2376.25	7,128.76
2024	4.64	512.55	2376.25	9,505.01
2025	4.64	512.55	2376.25	11,881.26
2026	4.64	512.55	2376.25	14,257.52
2027	4.64	512.55	2376.25	16,633.77
2028	4.64	512.55	2376.25	19,010.02
2029	4.64	512.55	2376.25	21,386.27
2030	4.64	512.55	2376.25	23,762.53
2031	4.64	512.55	2376.25	26,138.78
2032	4.64	512.55	2376.25	28,515.03
2033	4.64	512.55	2376.25	30,891.28
2034	4.64	512.55	2376.25	33,267.54
2035	4.64	512.55	2376.25	35,643.79
2036	4.64	512.55	2376.25	38,020.04
2037	4.64	512.55	2376.25	40,396.29
2038	4.64	512.55	2376.25	42,772.55
2039	4.64	512.55	2376.25	45,148.80
2040	4.64	512.55	2376.25	47,525.05
2041	4.64	512.55	2376.25	49,901.31
2042	4.64	512.55	2376.25	52,277.56
2043	4.64	512.55	2376.25	54,653.81
2044	4.64	512.55	2376.25	57,030.06
2045	4.64	512.55	2376.25	59,406.32
2046	4.64	512.55	2376.25	61,782.57
2047	4.64	512.55	2376.25	64,158.82
2048	4.64	512.55	2376.25	66,535.07
2049	4.64	512.55	2376.25	68,911.33
2050	4.64	512.55	2376.25	71,287.58

Planned logging operations are carried out following a Reduced Impact Logging (RIL) system combined with other improved forest management techniques, including: planning of management activities, selection of best locations for infrastructure construction, directional felling, utilization of advanced technologies, tracking record of wood logs, reforestation activities, among others; which are essential practices to minimize the damage caused to the forest.

In the project scenario, emissions due to planned logging activities results from timber harvesting and also from damages to vegetation during the directional tree felling, which generate forest residues (branches, remains of logs and other damaged trees during the tree felling).

According to Feldpausch et al (2005), the mean Coarse woody debris returned to the soil as necromass following logging and damage in: (1) tree felling gap formation (trees killed by tree-fall), (2) residual canopy from the felled tree, (3) road, (4) deck construction (whole trees plowed to the ground) and (5) skid maneuvering during logging, is about 6.9 Mg C/ha.

According to section 4.3 from this same study, this represents 2.4 times the carbon taken off site in logs. However, the MR already takes into account as planned deforestation the roads and decks constructions, which represent around 16% of the total damage. Therefore, the LDF is $2.4 * (1-0,159) = 2.0174$.

Thus, GHG emissions from logging activities include the volume of harvested timber plus the logging damage factor, as follows.

$$\Delta CLd_{icl} = (HI_{icl,t} + LDF) \times D_m \times CF \times 44 / 12$$

Where,

$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class <i>icl</i> at time <i>t</i> ; tCO ₂ e/ha
$HI_{icl,t}$	Harvesting intensity of timber in forest class <i>icl</i> at year <i>t</i> in the project area due to planned logging activities (i.e., sustainable forest management plan); m ³ /ha
LDF	Logging damage factor; m ³ /m ³
D_m	Mean wood density; g/cm ³
CF	Default value of carbon fraction in biomass; tC t-1 d.m.
44/12	Ratio of molecular weight of CO ₂ to carbon; dimensionless

As previously detailed, Harvested Wood Products were not considered in baseline and project scenarios. Thus, $C_{wp} = 0$.

Therefore, the *ex ante* estimated carbon stock decrease due to planned logging activities in the project area was considered as “0” as instructed in section 7.1.1 item f of the VM0015 methodology v1.1. Tables 25.b and 25.c can only be filled out *ex post* and do not need to be filled out *ex ante*.

Table 49. Ex ante estimated actual carbon stock decrease due to planned logging activities in the project area (Table 25b of Methodology VM0015).

Project year <i>t</i>	Areas of planned logging activities x Carbon stock change (decrease) in the project area	Total carbon stock decrease due to planned logging activities	
	Forest	annual	cumulative

	APLPA _{icl,t}	ΔCL _{dicl,t}	ΔCPL _{dPA_t}	ΔCPL _{dPA}
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}
2021	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00
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

Fossil fuel emissions from sustainable forest management activities are likely to be less than 5% of the total GHG emissions reductions benefits generated by the present project. Considering that emissions from deforestation and forest degradation would be much higher than those associated with timber harvesting, the emissions from fossil fuel during transport and machinery use can be considered *de minimis*. In addition, according to VCS AFOLU Requirements, fossil fuel emissions from transport and machinery use in REDD project activities can be considered *de minimis*.

No production of fuel wood or charcoal is expected to occur within the project area under the project scenario. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out. According to the applied methodology, if the project activity generates a significant decrease in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

Thus, Table below presents an *ex ante* estimated carbon stock decrease due to planned activities in the project area.

Table 50. Total ex ante carbon stock decrease due to planned activities in the project area (Table 25d of Methodology VM0015).

Project year t	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuel-wood and charcoal activities		Total carbon stock decrease due to planned activities	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCPDdPA_t	ΔCPDdPA	ΔCPLdPA_t	ΔCPLdPA	ΔCPFdPA_t	ΔCPFdPA	ΔCPAdPA_t	ΔCPAdPA
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
2021	2376.25	2376.25	0.00	0.00	0.00	0.00	2,376.25	2,376.25
2022	2376.25	4752.51	0.00	0.00	0.00	0.00	2,376.25	4,752.51
2023	2376.25	7128.76	0.00	0.00	0.00	0.00	2,376.25	7,128.76
2024	2376.25	9505.01	0.00	0.00	0.00	0.00	2,376.25	9,505.01
2025	2376.25	11881.26	0.00	0.00	0.00	0.00	2,376.25	11,881.26
2026	2376.25	14257.52	0.00	0.00	0.00	0.00	2,376.25	14,257.52
2027	2376.25	16633.77	0.00	0.00	0.00	0.00	2,376.25	16,633.77
2028	2376.25	19010.02	0.00	0.00	0.00	0.00	2,376.25	19,010.02
2029	2376.25	21386.27	0.00	0.00	0.00	0.00	2,376.25	21,386.27
2030	2376.25	23762.53	0.00	0.00	0.00	0.00	2,376.25	23,762.53
2031	2376.25	26138.78	0.00	0.00	0.00	0.00	2,376.25	26,138.78
2032	2376.25	28515.03	0.00	0.00	0.00	0.00	2,376.25	28,515.03
2033	2376.25	30891.28	0.00	0.00	0.00	0.00	2,376.25	30,891.28
2034	2376.25	33267.54	0.00	0.00	0.00	0.00	2,376.25	33,267.54
2035	2376.25	35643.79	0.00	0.00	0.00	0.00	2,376.25	35,643.79
2036	2376.25	38020.04	0.00	0.00	0.00	0.00	2,376.25	38,020.04
2037	2376.25	40396.29	0.00	0.00	0.00	0.00	2,376.25	40,396.29
2038	2376.25	42772.55	0.00	0.00	0.00	0.00	2,376.25	42,772.55
2039	2376.25	45148.80	0.00	0.00	0.00	0.00	2,376.25	45,148.80
2040	2376.25	47525.05	0.00	0.00	0.00	0.00	2,376.25	47,525.05
2041	2376.25	49901.31	0.00	0.00	0.00	0.00	2,376.25	49,901.31
2042	2376.25	52277.56	0.00	0.00	0.00	0.00	2,376.25	52,277.56
2043	2376.25	54653.81	0.00	0.00	0.00	0.00	2,376.25	54,653.81
2044	2376.25	57030.06	0.00	0.00	0.00	0.00	2,376.25	57,030.06
2045	2376.25	59406.32	0.00	0.00	0.00	0.00	2,376.25	59,406.32
2046	2376.25	61782.57	0.00	0.00	0.00	0.00	2,376.25	61,782.57
2047	2376.25	64158.82	0.00	0.00	0.00	0.00	2,376.25	64,158.82

2048	2376.25	66535.07	0.00	0.00	0.00	0.00	2,376.25	66,535.07
2049	2376.25	68911.33	0.00	0.00	0.00	0.00	2,376.25	68,911.33
2050	2376.25	71287.58	0.00	0.00	0.00	0.00	2,376.25	71,287.58

According to methodology VM0015, Tables 26.b and 26.c are exclusively filled out ex post, as recommended. This means that their ex ante values are initially set to 0. This approach reflects the unpredictable nature of carbon stock increases, especially in areas prone to events such as forest fires and other catastrophes. In such circumstances, forest regeneration may result in significant variations in carbon stock, which need to be monitored and quantified post-event. Therefore, the decision to zero out these tables in the initial phase of the assessment process is a precautionary measure that enables an accurate evaluation of the actual impacts of forest regeneration on carbon stock.

Table 51. Ex ante estimated carbon stock increase following planned logging activities in the project area (Table 26b of Methodology VM0015).

Project year t	Areas of planned logging activities x Carbon stock change (increase up to maximum long-term average)		Total carbon stock increase due to planned logging activities	
	Forest		annual	cumulative
	$APLPA_{icl,t}$	$\Delta CLI_{icl,t}$	$\Delta CPLiPA_t$	$\Delta CPLiPA$
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}
2021	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00
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

No significant unavoidable unplanned deforestation is expected in the project scenario, due to the present conservation measures and sustainable forest management practices adopted by Juruena River Project. 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 <i>ex ante</i> 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	<i>Ex ante</i> 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 <i>ex ante</i> 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 <i>ex ante</i> 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 90%. This percentage is based on the project's initial non-permanence risk (10%), as this parameter takes into account the possibility of losses in carbon stocks over time, whether due to climate change, social pressures, or changes in local governance.

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 52. Ex ante estimated net carbon stock change in the project area under the project scenario (Table 27 of Methodology VM0015).

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
	ΔCPAdPA_t	ΔCPAdPA	ΔCPAiPA_t	ΔCPAiPA	ΔCUDdPA_t	ΔCUDdPA	ΔCPSPA_t	ΔCPSPA
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
2021	2,376.25	2,376.25	0.00	0.00	5,333.12	5,333.12	7,709.37	7,709.37
2022	2,376.25	4,752.51	0.00	0.00	4,230.89	9,564.01	6,607.14	14,316.51
2023	2,376.25	7,128.76	0.00	0.00	7,723.81	17,287.81	10,100.06	24,416.57
2024	2,376.25	9,505.01	0.00	0.00	9,873.25	27,161.06	12,249.50	36,666.07
2025	2,376.25	11,881.26	0.00	0.00	9,439.38	36,600.44	11,815.63	48,481.71
2026	2,376.25	14,257.52	0.00	0.00	7,751.82	44,352.26	10,128.07	58,609.78
2027	2,376.25	16,633.77	0.00	0.00	9,502.37	53,854.63	11,878.62	70,488.40
2028	2,376.25	19,010.02	0.00	0.00	13,783.80	67,638.43	16,160.05	86,648.45
2029	2,376.25	21,386.27	0.00	0.00	16,323.93	83,962.36	18,700.18	105,348.63
2030	2,376.25	23,762.53	0.00	0.00	9,893.32	93,855.68	12,269.58	117,618.21
2031	2,376.25	26,138.78	0.00	0.00	10,940.05	104,795.73	13,316.30	130,934.51
2032	2,376.25	28,515.03	0.00	0.00	9,715.47	114,511.20	12,091.72	143,026.23
2033	2,376.25	30,891.28	0.00	0.00	17,439.90	131,951.10	19,816.15	162,842.39
2034	2,376.25	33,267.54	0.00	0.00	10,757.93	142,709.03	13,134.18	175,976.57
2035	2,376.25	35,643.79	0.00	0.00	9,898.95	152,607.98	12,275.20	188,251.77
2036	2,376.25	38,020.04	0.00	0.00	11,939.83	164,547.80	14,316.08	202,567.85
2037	2,376.25	40,396.29	0.00	0.00	14,011.22	178,559.02	16,387.47	218,955.32
2038	2,376.25	42,772.55	0.00	0.00	8,052.75	186,611.77	10,429.00	229,384.32
2039	2,376.25	45,148.80	0.00	0.00	8,453.75	195,065.52	10,830.00	240,214.32
2040	2,376.25	47,525.05	0.00	0.00	11,458.46	206,523.98	13,834.72	254,049.03
2041	2,376.25	49,901.31	0.00	0.00	6,082.36	212,606.34	8,458.62	262,507.65
2042	2,376.25	52,277.56	0.00	0.00	9,284.87	221,891.21	11,661.12	274,168.77
2043	2,376.25	54,653.81	0.00	0.00	7,535.91	229,427.12	9,912.16	284,080.94
2044	2,376.25	57,030.06	0.00	0.00	5,573.13	235,000.26	7,949.39	292,030.32
2045	2,376.25	59,406.32	0.00	0.00	7,205.37	242,205.63	9,581.63	301,611.95
2046	2,376.25	61,782.57	0.00	0.00	4,323.78	246,529.42	6,700.04	308,311.98
2047	2,376.25	64,158.82	0.00	0.00	5,225.18	251,754.59	7,601.43	315,913.42
2048	2,376.25	66,535.07	0.00	0.00	4,248.34	256,002.94	6,624.59	322,538.01

2049	2,376.25	68,911.33	0.00	0.00	2,346.09	258,349.03	4,722.34	327,260.35
2050	2,376.25	71,287.58	0.00	0.00	2,074.91	260,423.94	4,451.17	331,711.52

As was done for the baseline scenario, non-CO₂ emissions from biomass burning were assessed for their significance. To do this, the emissions from the reference scenario were multiplied by the factor (1 - EI), as follows, and the significance was assessed in relation to the total GHG benefits generated.

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

Where,

EBBPSPA _t	Total <i>ex ante</i> actual non-CO ₂ emissions from forest fire due to unavoided unplanned deforestation at at year t in the project area; tCO ₂ e/ha
EBBBSPA _t	Total non-CO ₂ emissions from forest fire at year t in the project area; tCO ₂ e
EI	<i>Ex ante</i> estimated Effectiveness Index; %
t	1, 2, 3 ... t, a year of the proposed project crediting period; dimensionless

It was conservatively assumed that all unplanned deforestation in the project area would involve fire and that all above-ground biomass would be burned. It is worth mentioning that the effect of fire on CO₂ emissions is accounted for in the estimation of carbon stock changes in the ΔCUDdPAt parameter; therefore, CO₂ emissions from forest fires should be ignored to avoid double counting.

Table 53. Total ex ante estimated actual emissions of non-CO₂ gases due to forest fires in the project area (Table 28 of Methodology VM0015).

Project year <i>t</i>	Total ex ante estimated actual non-CO ₂ emissions from forest fires in the Project area		Significance
	EBBPSPA _{<i>t</i>}	EBBPSPA	
	annual	cumulative	
	tCO _{2e}	tCO _{2e}	
2021	73.7	73.7	0.14%
2022	57.3	131.1	0.14%
2023	104.7	235.8	0.14%
2024	132.8	368.6	0.13%
2025	125.3	493.9	0.12%
2026	100.1	594.0	0.12%
2027	122.7	716.7	0.12%
2028	181.1	897.8	0.11%
2029	213.4	1,111.3	0.10%
2030	121.2	1,232.5	0.10%
2031	136.8	1,369.3	0.09%
2032	118.4	1,487.7	0.09%
2033	224.4	1,712.1	0.09%
2034	132.7	1,844.8	0.07%
2035	120.1	1,964.9	0.07%
2036	147.4	2,112.3	0.07%
2037	178.2	2,290.5	0.06%
2038	94.8	2,385.3	0.06%
2039	100.9	2,486.2	0.06%
2040	145.3	2,631.6	0.05%
2041	70.0	2,701.5	0.05%
2042	114.2	2,815.7	0.05%
2043	93.7	2,909.5	0.04%
2044	66.2	2,975.7	0.04%
2045	88.6	3,064.3	0.04%
2046	52.3	3,116.6	0.02%
2047	65.1	3,181.7	0.02%
2048	51.1	3,232.8	0.02%
2049	28.6	3,261.4	0.01%
2050	24.9	3,286.3	0.01%

Total ex ante estimations for the project area

The expected *ex ante* net carbon stock changes and non-CO₂ emissions in the Project area is summarized in the table below. The column "Total ex ante estimated actual non-CO₂ emissions from forest fires in the project area" is also affected by Verra's recommendation. According to the VM0015 methodology, emissions from fires used to clear forests in the baseline can always be omitted. When emissions from fires is not considered in baseline, the values for these tables must be zero *ex ante* and only filled out *ex post*. The *ex post* assessment accounts for unpredictable changes in non-CO₂ emissions resulting from forest fires and other catastrophic events. Consequently, setting this column to zero during the initial assessment phase aligns with the methodology's requirement to provide a more accurate post-event evaluation of non-CO₂ emissions.

Table 54. Total ex ante estimated actual net carbon stock changes and emissions of non-CO₂ gases in the project area (Table 29 of Methodology VM0015).

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 net 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
	ΔCPA_dPA_t	ΔCPA_dPA	ΔCPA_iPA_t	ΔCPA_iPA	ΔCUD_dPA_t	ΔCUD_dPA	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
2021	2,376.3	2,376.3	0.0	0.0	5,333.1	5,333.1	7,709.4	7,709.4	0.0	0.0
2022	2,376.3	4,752.5	0.0	0.0	4,230.9	9,564.0	6,607.1	14,316.5	0.0	0.0
2023	2,376.3	7,128.8	0.0	0.0	7,723.8	17,287.8	10,100.1	24,416.6	0.0	0.0
2024	2,376.3	9,505.0	0.0	0.0	9,873.2	27,161.1	12,249.5	36,666.1	0.0	0.0
2025	2,376.3	11,881.3	0.0	0.0	9,439.4	36,600.4	11,815.6	48,481.7	0.0	0.0
2026	2,376.3	14,257.5	0.0	0.0	7,751.8	44,352.3	10,128.1	58,609.8	0.0	0.0
2027	2,376.3	16,633.8	0.0	0.0	9,502.4	53,854.6	11,878.6	70,488.4	0.0	0.0
2028	2,376.3	19,010.0	0.0	0.0	13,783.8	67,638.4	16,160.1	86,648.5	0.0	0.0
2029	2,376.3	21,386.3	0.0	0.0	16,323.9	83,962.4	18,700.2	105,348.6	0.0	0.0
2030	2,376.3	23,762.5	0.0	0.0	9,893.3	93,855.7	12,269.6	117,618.2	0.0	0.0
2031	2,376.3	26,138.8	0.0	0.0	10,940.1	104,795.7	13,316.3	130,934.5	0.0	0.0
2032	2,376.3	28,515.0	0.0	0.0	9,715.5	114,511.2	12,091.7	143,026.2	0.0	0.0
2033	2,376.3	30,891.3	0.0	0.0	17,439.9	131,951.1	19,816.2	162,842.4	0.0	0.0
2034	2,376.3	33,267.5	0.0	0.0	10,757.9	142,709.0	13,134.2	175,976.6	0.0	0.0
2035	2,376.3	35,643.8	0.0	0.0	9,898.9	152,608.0	12,275.2	188,251.8	0.0	0.0

2036	2,376.3	38,020.0	0.0	0.0	11,939.8	164,547.8	14,316.1	202,567.8	0.0	0.0
2037	2,376.3	40,396.3	0.0	0.0	14,011.2	178,559.0	16,387.5	218,955.3	0.0	0.0
2038	2,376.3	42,772.5	0.0	0.0	8,052.7	186,611.8	10,429.0	229,384.3	0.0	0.0
2039	2,376.3	45,148.8	0.0	0.0	8,453.7	195,065.5	10,830.0	240,214.3	0.0	0.0
2040	2,376.3	47,525.1	0.0	0.0	11,458.5	206,524.0	13,834.7	254,049.0	0.0	0.0
2041	2,376.3	49,901.3	0.0	0.0	6,082.4	212,606.3	8,458.6	262,507.6	0.0	0.0
2042	2,376.3	52,277.6	0.0	0.0	9,284.9	221,891.2	11,661.1	274,168.8	0.0	0.0
2043	2,376.3	54,653.8	0.0	0.0	7,535.9	229,427.1	9,912.2	284,080.9	0.0	0.0
2044	2,376.3	57,030.1	0.0	0.0	5,573.1	235,000.3	7,949.4	292,030.3	0.0	0.0
2045	2,376.3	59,406.3	0.0	0.0	7,205.4	242,205.6	9,581.6	301,611.9	0.0	0.0
2046	2,376.3	61,782.6	0.0	0.0	4,323.8	246,529.4	6,700.0	308,312.0	0.0	0.0
2047	2,376.3	64,158.8	0.0	0.0	5,225.2	251,754.6	7,601.4	315,913.4	0.0	0.0
2048	2,376.3	66,535.1	0.0	0.0	4,248.3	256,002.9	6,624.6	322,538.0	0.0	0.0
2049	2,376.3	68,911.3	0.0	0.0	2,346.1	258,349.0	4,722.3	327,260.4	0.0	0.0
2050	2,376.3	71,287.6	0.0	0.0	2,074.9	260,423.9	4,451.2	331,711.5	0.0	0.0

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 (CH₄) and nitrous oxide (N₂O) emissions from livestock intensification (involving a change in the animal diet and/or animal numbers).

$$\Delta\text{CLPMLKt} = \Delta\text{CBSLLKt} - \Delta\text{CPSLKt}$$

Where,

$\Delta\text{CLPMLKt}$ Carbon stock decrease due to leakage prevention measures at year t; tCO_{2e}

$\Delta\text{CBSLLKt}$ 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.

Table 55. Ex ante estimated net carbon stock change in leakage management areas (Table 30 of Methodology VM0015)

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	cumulative	annual	cumulative	annual	cumulative
	ΔCBSLLK_t	ΔCBSLLK	ΔCPSLK_t	ΔCPSLK	ΔCLPMLK_t	ΔCLPMLK
	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
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

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 10²¹⁹:

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

²¹⁹ Available at <https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf>

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
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According to the Local Stakeholder Consultation and the context and history of the region, it was considered that families located in the Leakage Management Area carry out cattle raising activities, with an average of 15 cattle heads per family.

As previously presented, in the region of Mato Grosso it is traditional to raise cattle for beef. Data from the last available Agricultural Census²²⁰ were considered to obtain the numbers of agricultural establishments in the municipality of Cotriguaçu. In addition, data of cattle herd in Cotriguaçu from the last 10 years was analyzed in order to obtain an annual growth rate of the number of animals, to be used in the projection for the project scenario. Forage areas were not accounted as it is not a common practice in the region.

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

²²⁰ Available at <
https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/pecuaria.html?localidade=13&tema=75652>

Table 56. Ex ante estimation of leakage emissions above the baseline from grazing animals in leakage management areas. (Table 32 of Methodology VM0015)

Project year	annual	annual	annual	annual	annual	annual	annual	annual	annual	cumulative
	Afforage	Pforage	Population	ECH4fermt	ECH4mant	EdirN2Omant	EindN2Omant	EN2Omant	EgLkt	EgLkt
	ha	kgd.m.yr	Nr Heads	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
2021	0.0	0.0	189.0	296.4	5.3	0.6	0.1	0.7	302.3	302.3
2022	0.0	0.0	198.0	310.5	5.5	0.6	0.1	0.7	316.7	619.0
2023	0.0	0.0	207.0	324.6	5.8	0.6	0.1	0.7	331.1	950.1
2024	0.0	0.0	217.0	340.3	6.1	0.7	0.1	0.7	347.1	1,297.2
2025	0.0	0.0	227.0	355.9	6.4	0.7	0.1	0.8	363.1	1,660.2
2026	0.0	0.0	238.0	373.2	6.7	0.7	0.1	0.8	380.7	2,040.9
2027	0.0	0.0	249.0	390.4	7.0	0.7	0.1	0.9	398.3	2,439.2
2028	0.0	0.0	261.0	409.2	7.3	0.8	0.1	0.9	417.5	2,856.6
2029	0.0	0.0	273.0	428.1	7.6	0.8	0.1	0.9	436.6	3,293.3
2030	0.0	0.0	286.0	448.4	8.0	0.9	0.1	1.0	457.4	3,750.7
2031	0.0	0.0	299.0	468.8	8.4	0.9	0.1	1.0	478.2	4,228.9
2032	0.0	0.0	313.0	490.8	8.8	0.9	0.1	1.1	500.6	4,729.6
2033	0.0	0.0	328.0	514.3	9.2	1.0	0.1	1.1	524.6	5,254.2
2034	0.0	0.0	343.0	537.8	9.6	1.0	0.2	1.2	548.6	5,802.8
2035	0.0	0.0	359.0	562.9	10.1	1.1	0.2	1.2	574.2	6,377.0
2036	0.0	0.0	376.0	589.6	10.5	1.1	0.2	1.3	601.4	6,978.4
2037	0.0	0.0	393.0	616.2	11.0	1.2	0.2	1.4	628.6	7,607.0
2038	0.0	0.0	411.0	644.4	11.5	1.2	0.2	1.4	657.4	8,264.3
2039	0.0	0.0	430.0	674.2	12.0	1.3	0.2	1.5	687.8	8,952.1
2040	0.0	0.0	450.0	705.6	12.6	1.3	0.2	1.6	719.8	9,671.9
2041	0.0	0.0	471.0	738.5	13.2	1.4	0.2	1.6	753.3	10,425.2
2042	0.0	0.0	493.0	773.0	13.8	1.5	0.2	1.7	788.5	11,213.7
2043	0.0	0.0	516.0	809.1	14.4	1.5	0.2	1.8	825.3	12,039.0
2044	0.0	0.0	540.0	846.7	15.1	1.6	0.2	1.9	863.7	12,902.7
2045	0.0	0.0	565.0	885.9	15.8	1.7	0.3	1.9	903.7	13,806.4
2046	0.0	0.0	591.0	926.7	16.5	1.8	0.3	2.0	945.3	14,751.7
2047	0.0	0.0	618.0	969.0	17.3	1.9	0.3	2.1	988.5	15,740.2
2048	0.0	0.0	646.0	1,012.9	18.1	1.9	0.3	2.2	1,033.2	16,773.4
2049	0.0	0.0	676.0	1,060.0	18.9	2.0	0.3	2.3	1,081.2	17,854.6
2050	0.0	0.0	707.0	1,108.6	19.8	2.1	0.3	2.4	1,130.8	18,985.4

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 57. Ex ante estimated total emissions above the baseline from leakage prevention activities (Table 33 of Methodology VM0015)

Project Year t	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
	ΔCLPMLK_t	ΔCLPMLK	EgLK_t	EgLK	ELPMLK_t	ELPMLK
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
2021	0,0	0,0	302.3	302.3	302.3	302.3
2022	0,0	0,0	316.7	619.0	316.7	619.0
2023	0,0	0,0	331.1	950.1	331.1	950.1
2024	0,0	0,0	347.1	1,297.2	347.1	1,297.2
2025	0,0	0,0	363.1	1,660.2	363.1	1,660.2
2026	0,0	0,0	380.7	2,040.9	380.7	2,040.9
2027	0,0	0,0	398.3	2,439.2	398.3	2,439.2
2028	0,0	0,0	417.5	2,856.6	417.5	2,856.6
2029	0,0	0,0	436.6	3,293.3	436.6	3,293.3
2030	0,0	0,0	457.4	3,750.7	457.4	3,750.7
2031	0,0	0,0	478.2	4,228.9	478.2	4,228.9
2032	0,0	0,0	500.6	4,729.6	500.6	4,729.6
2033	0,0	0,0	524.6	5,254.2	524.6	5,254.2
2034	0,0	0,0	548.6	5,802.8	548.6	5,802.8
2035	0,0	0,0	574.2	6,377.0	574.2	6,377.0
2036	0,0	0,0	601.4	6,978.4	601.4	6,978.4
2037	0,0	0,0	628.6	7,607.0	628.6	7,607.0
2038	0,0	0,0	657.4	8,264.3	657.4	8,264.3
2039	0,0	0,0	687.8	8,952.1	687.8	8,952.1
2040	0,0	0,0	719.8	9,671.9	719.8	9,671.9
2041	0,0	0,0	753.3	10,425.2	753.3	10,425.2
2042	0,0	0,0	788.5	11,213.7	788.5	11,213.7
2043	0,0	0,0	825.3	12,039.0	825.3	12,039.0
2044	0,0	0,0	863.7	12,902.7	863.7	12,902.7
2045	0,0	0,0	903.7	13,806.4	903.7	13,806.4

2046	0,0	0,0	945.3	14,751.7	945.3	14,751.7
2047	0,0	0,0	988.5	15,740.2	988.5	15,740.2
2048	0,0	0,0	1,033.2	16,773.4	1,033.2	16,773.4
2049	0,0	0,0	1,081.2	17,854.6	1,081.2	17,854.6
2050	0,0	0,0	1,130.8	18,985.4	1,130.8	18,985.4

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

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted ex-ante would indicate displacement of deforestation activities due to the project.

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

$$\Delta CADLk_t = \Delta CBSLP_{At} * DLF$$

Where,

$\Delta CADLk_t$ Total decrease in carbon stocks due to displaced deforestation at year t; tCO_{2e}

DLF Displacement leakage factor; %

DLF was adopted as 15% as per the applied methodology. Projects may apply the optional default activity-shifting leakage deduction of 15 percent to the gross GHG emission reductions and/or removals.

However, to reduce the risk of activity displacement leakage, baseline deforestation agents 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.

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 DLF²²¹ used to estimate the decrease in carbon stocks, as follows.

$$EADLK_t = EBBBSPA_t * DLF$$

Where,

EADLK_t Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_{2e}

EBBBSPA_t Total non-CO₂ 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.

²²¹ 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.

Table 58. Ex ante estimated leakage due to activity displacement (Table 34 of Methodology VM0015)

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
	ΔCADLK_t	ΔCADLK	EADLK_t	EADLK
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
2021	7,999.7	7,999.7	0.0	0.0
2022	6,346.3	14,346.0	0.0	0.0
2023	11,585.7	25,931.7	0.0	0.0
2024	14,809.9	40,741.6	0.0	0.0
2025	15,732.3	56,473.9	0.0	0.0
2026	12,919.7	69,393.6	0.0	0.0
2027	15,837.3	85,230.9	0.0	0.0
2028	25,844.6	111,075.5	0.0	0.0
2029	30,607.4	141,682.9	0.0	0.0
2030	18,550.0	160,232.8	0.0	0.0
2031	23,443.0	183,675.8	0.0	0.0
2032	20,818.9	204,494.7	0.0	0.0
2033	37,371.2	241,865.9	0.0	0.0
2034	26,894.8	268,760.7	0.0	0.0
2035	24,747.4	293,508.1	0.0	0.0
2036	29,849.6	323,357.6	0.0	0.0
2037	42,033.7	365,391.3	0.0	0.0
2038	24,158.2	389,549.5	0.0	0.0
2039	25,361.2	414,910.8	0.0	0.0
2040	42,969.2	457,880.0	0.0	0.0
2041	22,808.9	480,688.9	0.0	0.0
2042	34,818.3	515,507.1	0.0	0.0
2043	37,679.6	553,186.7	0.0	0.0
2044	27,865.7	581,052.4	0.0	0.0
2045	36,026.9	617,079.2	0.0	0.0
2046	32,428.4	649,507.6	0.0	0.0
2047	39,188.8	688,696.5	0.0	0.0
2048	31,862.6	720,559.0	0.0	0.0
2049	35,191.3	755,750.4	0.0	0.0
2050	31,123.7	786,874.1	0.0	0.0

Ex ante estimation of total leakage

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

$$\Delta\text{CLK}_t = \Delta\text{CADLK}_t + \Delta\text{CLPMLK}_t$$

Where,

ΔCLK_t Total decrease in carbon stocks within the leakage belt at year t; tCO_{2e}

$\Delta CADLK_t$ Total decrease in carbon stocks due to displaced deforestation at year t; tCO_{2e}

$\Delta CLPMLK_t$ 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 ($\Delta CLPMLK_t$) 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 59. Ex ante estimated total leakage (Table 35 of Methodology VM0015)

Project Year t	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
	E_{gLK_t}	E_{gLK}	E_{ADLK_t}	E_{ADLK}	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
2021	302	302	0	0	8,000	8,000	0	0	8,000	8,000	302	302
2022	317	619	0	0	6,346	14,346	0	0	6,346	14,346	317	619
2023	331	950	0	0	11,586	25,932	0	0	11,586	25,932	331	950
2024	347	1,297	0	0	14,810	40,742	0	0	14,810	40,742	347	1,297
2025	363	1,660	0	0	15,732	56,474	0	0	15,732	56,474	363	1,660
2026	381	2,041	0	0	12,920	69,394	0	0	12,920	69,394	381	2,041
2027	398	2,439	0	0	15,837	85,231	0	0	15,837	85,231	398	2,439
2028	417	2,857	0	0	25,845	111,076	0	0	25,845	111,076	417	2,857
2029	437	3,293	0	0	30,607	141,683	0	0	30,607	141,683	437	3,293
2030	457	3,751	0	0	18,550	160,233	0	0	18,550	160,233	457	3,751
2031	478	4,229	0	0	23,443	183,676	0	0	23,443	183,676	478	4,229
2032	501	4,730	0	0	20,819	204,495	0	0	20,819	204,495	501	4,730
2033	525	5,254	0	0	37,371	241,866	0	0	37,371	241,866	525	5,254
2034	549	5,803	0	0	26,895	268,761	0	0	26,895	268,761	549	5,803
2035	574	6,377	0	0	24,747	293,508	0	0	24,747	293,508	574	6,377
2036	601	6,978	0	0	29,850	323,358	0	0	29,850	323,358	601	6,978
2037	629	7,607	0	0	42,034	365,391	0	0	42,034	365,391	629	7,607
2038	657	8,264	0	0	24,158	389,550	0	0	24,158	389,550	657	8,264
2039	688	8,952	0	0	25,361	414,911	0	0	25,361	414,911	688	8,952
2040	720	9,672	0	0	42,969	457,880	0	0	42,969	457,880	720	9,672
2041	753	10,425	0	0	22,809	480,689	0	0	22,809	480,689	753	10,425
2042	789	11,214	0	0	34,818	515,507	0	0	34,818	515,507	789	11,214
2043	825	12,039	0	0	37,680	553,187	0	0	37,680	553,187	825	12,039
2044	864	12,903	0	0	27,866	581,052	0	0	27,866	581,052	864	12,903
2045	904	13,806	0	0	36,027	617,079	0	0	36,027	617,079	904	13,806
2046	945	14,752	0	0	32,428	649,508	0	0	32,428	649,508	945	14,752
2047	988	15,740	0	0	39,189	688,696	0	0	39,189	688,696	988	15,740
2048	1,033	16,773	0	0	31,863	720,559	0	0	31,863	720,559	1,033	16,773
2049	1,081	17,855	0	0	35,191	755,750	0	0	35,191	755,750	1,081	17,855
2050	1,131	18,985	0	0	31,124	786,874	0	0	31,124	786,874	1,131	18,985

4.4 Estimated Net GHG Emission Reductions and Removals

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

$$\Delta REDD_t = (\Delta CBSLP_{At} + EBBBSLP_{At}) - (\Delta CPSP_{At} + EBBPSP_{At}) - (\Delta CLK_t + ELK_t)$$

Where:

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

$\Delta CBSLP_{At}$ Sum of baseline carbon stock changes in the project area at year t; tCO₂e

$EBBBSLP_{At}$ Sum of baseline emissions from biomass burning in the project area at year t; tCO₂e

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

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

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

ΔCLK_t Sum of ex ante estimated leakage net carbon stock changes at year t; tCO₂e

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

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

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

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

$$VCU_t = \Delta REDD_t - VBCT_t$$

$$VBCT_t = (\Delta CBSLP_{At} - \Delta CPSP_{At}) * R_{Ft}$$

Where:

VCU_t Number of Verified Carbon Units that can be traded at time t; t CO₂e

ΔREDD_t	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO ₂ e
VBCT	Number of Buffer Credits deposited in the VCS Buffer at time t; t CO ₂ e
$\Delta\text{CBSLPAT}$	Sum of baseline carbon stock changes in the project area at year t; tCO ₂ e
ΔCSPAT	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO ₂ e ha ⁻¹
F _t	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 ... T, a year of the proposed project crediting period; dimensionless.

The R_{Ft} was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value was 10%.

The detailed and summarized estimates of GHG Emissions Reduction are shown in tables below:

Table 60. Ex ante estimated net anthropogenic GHG emission reductions (ΔREDD_t) and Verified Carbon Units (VCU_t) (Table 36 of Methodology VM0015)

Project Year t	Baseline carbon stock changes		Baseline GHG emissions		Ex ante project carbon stock changes		Ex ante project GHG emissions		Ex ante leakage carbon stock changes		Ex ante leakage GHG emissions		Ex ante net anthropogenic GHG emission reductions		Ex ante VCUs tradable		Ex ante buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCBSLPA_t	ΔCBSLPA	$\Delta\text{EBBBSLPA}_t$	$\Delta\text{EBBBSLPA}$	ΔCPSPA_t	ΔCPSPA	EBBPSPA_t	EBBPSPA	ΔCLK_t	ΔCLK	ELK_t	ELK	ΔREDD_t	ΔREDD	VCU_t	VCU	VCB_t	VCB
	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e	tCO ₂ e
2021	53,331	53,331	0	0	7,709	7,709	0	0	8,000	8,000	302	302	37,320	37,320	32,758	32,758	4,562	4,562
2022	42,309	95,640	0	0	6,607	14,317	0	0	6,346	14,346	317	619	29,039	66,359	25,469	58,226	3,570	8,132
2023	77,238	172,878	0	0	10,100	24,417	0	0	11,586	25,932	331	950	55,221	121,580	48,507	106,734	6,714	14,846
2024	98,732	271,611	0	0	12,250	36,666	0	0	14,810	40,742	347	1,297	71,326	192,906	62,678	169,411	8,648	23,494
2025	104,882	376,493	0	0	11,816	48,482	0	0	15,732	56,474	363	1,660	76,971	269,877	67,664	237,076	9,307	32,801
2026	86,131	462,624	0	0	10,128	58,610	0	0	12,920	69,394	381	2,041	62,703	332,580	55,103	292,178	7,600	40,401
2027	105,582	568,206	0	0	11,879	70,488	0	0	15,837	85,231	398	2,439	77,468	410,047	68,097	360,276	9,370	49,772
2028	172,298	740,503	0	0	16,160	86,648	0	0	25,845	111,076	417	2,857	129,875	539,923	114,262	474,537	15,614	65,385
2029	204,049	944,552	0	0	18,700	105,349	0	0	30,607	141,683	437	3,293	154,305	694,228	135,770	610,307	18,535	83,920
2030	123,667	1,068,219	0	0	12,270	117,618	0	0	18,550	160,233	457	3,751	92,390	786,617	81,250	691,557	11,140	95,060
2031	156,286	1,224,505	0	0	13,316	130,935	0	0	23,443	183,676	478	4,229	119,049	905,666	104,752	796,309	14,297	109,357
2032	138,792	1,363,298	0	0	12,092	143,026	0	0	20,819	204,495	501	4,730	105,381	1,011,047	92,711	889,020	12,670	122,027
2033	249,141	1,612,439	0	0	19,816	162,842	0	0	37,371	241,866	525	5,254	191,429	1,202,477	168,497	1,057,517	22,933	144,960
2034	179,299	1,791,738	0	0	13,134	175,977	0	0	26,895	268,761	549	5,803	138,721	1,341,198	122,105	1,179,622	16,616	161,576
2035	164,982	1,956,720	0	0	12,275	188,252	0	0	24,747	293,508	574	6,377	127,386	1,468,584	112,115	1,291,737	15,271	176,847
2036	198,997	2,155,718	0	0	14,316	202,568	0	0	29,850	323,358	601	6,978	154,230	1,622,814	135,762	1,427,499	18,468	195,315
2037	280,224	2,435,942	0	0	16,387	218,955	0	0	42,034	365,391	629	7,607	221,175	1,843,988	194,791	1,622,290	26,384	221,699
2038	161,055	2,596,997	0	0	10,429	229,384	0	0	24,158	389,550	657	8,264	125,810	1,969,799	110,748	1,733,037	15,063	236,761
2039	169,075	2,766,072	0	0	10,830	240,214	0	0	25,361	414,911	688	8,952	132,196	2,101,995	116,371	1,849,409	15,824	252,586
2040	286,462	3,052,533	0	0	13,835	254,049	0	0	42,969	457,880	720	9,672	228,938	2,330,933	201,675	2,051,084	27,263	279,848

2041	152,059	3,204,593	0	0	8,459	262,508	0	0	22,809	480,689	753	10,425	120,038	2,450,971	105,678	2,156,762	14,360	294,208
2042	232,122	3,436,714	0	0	11,661	274,169	0	0	34,818	515,507	789	11,214	184,854	2,635,825	162,808	2,319,570	22,046	316,255
2043	251,197	3,687,911	0	0	9,912	284,081	0	0	37,680	553,187	825	12,039	202,780	2,838,605	178,652	2,498,222	24,128	340,383
2044	185,771	3,873,682	0	0	7,949	292,030	0	0	27,866	581,052	864	12,903	149,092	2,987,697	131,310	2,629,532	17,782	358,165
2045	240,179	4,113,862	0	0	9,582	301,612	0	0	36,027	617,079	904	13,806	193,667	3,181,364	170,607	2,800,139	23,060	381,225
2046	216,189	4,330,051	0	0	6,700	308,312	0	0	32,428	649,508	945	14,752	176,115	3,357,479	155,167	2,955,306	20,949	402,174
2047	261,259	4,591,310	0	0	7,601	315,913	0	0	39,189	688,696	988	15,740	213,480	3,570,960	188,114	3,143,420	25,366	427,540
2048	212,417	4,803,727	0	0	6,625	322,538	0	0	31,863	720,559	1,033	16,773	172,897	3,743,856	152,317	3,295,737	20,579	448,119
2049	234,609	5,038,336	0	0	4,722	327,260	0	0	35,191	755,750	1,081	17,855	193,614	3,937,470	170,625	3,466,363	22,989	471,108
2050	207,491	5,245,827	0	0	4,451	331,712	0	0	31,124	786,874	1,131	18,985	170,786	4,108,256	150,482	3,616,845	20,304	491,412

Table 61. Summary of net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	<i>Ex ante</i> buffer credits (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2021	53,331	7,709	8,302	4,562	37,320
2022	42,309	6,607	6,663	3,570	29,039
2023	77,238	10,100	11,917	6,714	55,221
2024	98,732	12,250	15,157	8,648	71,326
2025	104,882	11,816	16,095	9,307	76,971
2026	86,131	10,128	13,300	7,600	62,703
2027	105,582	11,879	16,236	9,370	77,468
2028	172,298	16,160	26,262	15,614	129,875
2029	204,049	18,700	31,044	18,535	154,305
2030	123,667	12,270	19,007	11,140	92,390
2031	156,286	13,316	23,921	14,297	119,049
2032	138,792	12,092	21,319	12,670	105,381
2033	249,141	19,816	37,896	22,933	191,429
2034	179,299	13,134	27,443	16,616	138,721
2035	164,982	12,275	25,322	15,271	127,386
2036	198,997	14,316	30,451	18,468	154,230
2037	280,224	16,387	42,662	26,384	221,175
2038	161,055	10,429	24,816	15,063	125,810
2039	169,075	10,830	26,049	15,824	132,196
2040	286,462	13,835	43,689	27,263	228,938
2041	152,059	8,459	23,562	14,360	120,038
2042	232,122	11,661	35,607	22,046	184,854
2043	251,197	9,912	38,505	24,128	202,780
2044	185,771	7,949	28,729	17,782	149,092
2045	240,179	9,582	36,931	23,060	193,667
2046	216,189	6,700	33,374	20,949	176,115
2047	261,259	7,601	40,177	25,366	213,480
2048	212,417	6,625	32,896	20,579	172,897
2049	234,609	4,722	36,273	22,989	193,614
2050	207,491	4,451	32,255	20,304	170,786
Total	5,245,827	331,712	805,860	491,412	4,108,256

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	<p>Values from the literature, e.g. IPCC 2003. Good practice guidance for land use, land-use change and forestry. Kanagawa: IGES, 2003.</p> <p>Available at: http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf.html.</p>
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 ₂ e/ha
Description	Average carbon stock per hectare in anthropic areas in equilibrium of post-deforestation class fcl in tCO ₂ e/ha
Source of data	<p>The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomass.</p> <p>Average carbon stocks of pastureland, agriculture and other land uses – National GHG Emissions Communication of Brazil to the</p>

	<p>UNFCCC (2019) - Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf</p> <p>Secondary Forest average carbon stocks - Pereira, Izaura Cristina Nunes. <i>Estoque de biomassa e carbono florestal em unidades de paisagem na Amazônia: uma análise a partir da abordagem metodológica</i>. Universidade Federal do Pará, , Belém, 2013. Available at: https://ppgdstu.propesp.ufpa.br/ARQUIVOS/teses/TESES/2013/IZAURA%20CRISTINA%20NUNES%20PEREIRA.pdf</p> <p>Belowground biomass – Root to shoot ratio available at VM0015.</p> <p>A weighted average of the post-deforestation carbon stocks was done, considering the % of area for each land use.</p>
Value applied	33.40
Justification of choice of data or description of measurement methods and procedures applied	<p>Most of post-deforestation land uses within the reference region is composed by pasturelands. In order to estimate the post-deforestation carbon stocks, the average carbon stocks of pasturelands, agriculture and other land uses were taken from the National GHG Emissions Communication of Brazil to the UNFCCC (2019)²²².</p> <p>For secondary forests, a regional study was conducted. Most secondary forests in the Brazilian Amazon are young. In 2017, 65% of secondary forests was ≤10 years old. On average, 35% of annual land abandonment to secondary forests was re-cleared within 5 years, and 57% within 10 years²²³. The half-life of secondary forests is 8 years, on average, which is also the same value found by other study that concludes that more than 50% of the secondary forests in the Amazon biome have less than 8 years old²²⁴.</p> <p>According to the referenced study, conducted in the State of Pará, that analyzed the carbon stocks of a secondary forest with 14 years old, the average carbon stock in above ground biomass is around 19 tC/ha. Below ground biomass was estimated through the root-to-shoot ratio from the applied methodology. Therefore, the average value for secondary forests is around 22,8 tC/ha.</p>

²²² Available at: <https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/3tcn_volume_3.pdf>

²²³ Sâmia Nunes *et al* 2020 *Environ. Res. Lett.* **15** 034057. Available at: <<https://iopscience.iop.org/article/10.1088/1748-9326/ab76db>>

²²⁴ Silva Junior, C.H.L., Heinrich, V.H.A., Freire, A.T.G. *et al.* Benchmark maps of 33 years of secondary forest age for Brazil. *Sci Data* **7**, 269 (2020). Available at: <<https://doi.org/10.1038/s41597-020-00600-4>>

	The applied value was obtained with the weighted average of the carbon stock and land use.
Purpose of Data	This parameter is used to calculate the baseline emissions from deforestation occurred in the baseline scenario. Provides an average of the post-deforestation carbon stock per hectare within the reference region.
Comments	If new and more accurate biomass stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	DLF was adopted as 15% as a conservative factor, based on previous REDD projects developed by Ecologica Assessoria Ltda, where no leakage due to displaced deforestation occurred during all the verified monitoring periods. 95% of agents are involved in the LMA: garimpo in João Inn, settlement in Nova União, and indigenous people in the Indigenous Land.
Value applied	15%
Justification of choice of data or description of measurement methods and procedures applied	DLF was adopted as the default activity-shifting leakage deduction as per VCS Standard.
Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an <i>ex ante</i> estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	<p><i>Ex post</i> monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease.</p> <p>This parameter will be updated at each renewal of fixed baseline period.</p>

Data / Parameter	Dm
Data unit	g/cm ³
Description	Mean wood density
Source of data	NOGUEIRA, E. M. Densidade de Madeira e Alometria de Árvores em Florestas do 'Arco do Desmatamento': Implicações para Biomassa e Emissão de Carbono a partir de Mudanças de Uso da Terra na Amazônia Brasileira (Wood Density and Tree Allometry in 'Arc of Deforestation' Forests: Implications for Biomass and Carbon Emissions from Land Use Change in the Brazilian Amazon). 2008. 151 pages. Doctor Thesis - Tropical Rainforest Science Course, INPA, Manaus, 2008.
Value applied:	0.588
Justification of choice of data or description of measurement methods and procedures applied	The mean wood density presented in Nogueira (2008) was obtained from the Brazilian Amazon, where the project region is located. The value is for the Open Submontane Tropical Rainforest (Table 3 of the referred study), vegetation type that is logged through SFMP.
Purpose of Data	This parameter is used to calculate baseline, project and leakage emissions through the conversion from m ³ to tons for estimating above-ground biomass from local forest inventories, specifically for the main forest type within the project area – Open Submontane Tropical Rainforest – composing 67% of the project area.
Comments	Furthermore, it is also used to calculate project emissions from logging activities occurred in the project scenario due to sustainable forest management. Carbon stock decrease due to planned logging activities were calculated through multiplying the harvested volume by the mean wood density. Carbon stock increase due to natural regeneration after periodical harvest cycle can be calculated through multiplying the mean annual increment by the mean wood density.

Data / Parameter	ΔCBSLLK_t
Data unit	tCO ₂ e

Description	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data	<ul style="list-style-type: none"> - 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	<p>Leakage prevention activities generating a decrease in carbon stocks should be estimated <i>ex ante</i> and accounted.</p> <p>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.</p>
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 <i>ex ante</i> estimation of the decrease in carbon stocks due to the activities implemented.
Comments	<p><i>Ex post</i> monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions.</p> <p>This parameter will be updated at each renewal of fixed baseline period.</p>

Data / Parameter	Fburnt _{icl}
Data unit	%
Description	Proportion of forest area burned during the historical reference period in the forest class.
Source of data	<p>Measured or estimated from literature.</p> <p><i>Fburnt data source:</i></p> <ul style="list-style-type: none"> - Fire spots and deforestation (fire scars): MapBiomas data from Cotriguaçu – MT, from 2009 to 2020, burnt area for the Forest Formation + Savanna Formation vegetation class <http://t.ly/mmnc>
Value applied	52.81
Justification of choice of data or description of measurement methods and procedures applied	The analysis was carried out with the complete collection of MapBiomas Fogo with the mapping of fire scars in Brazil from 1985 to 2020, with Annual and Monthly data for the whole period including: (i) data in the year and accumulated in a period; (ii)

	<p>frequency of occurrence of a burn scar; (iii) classification of land cover and use intended for burning. The municipality where most of the project area is located, Cotriguaçu, was evaluated for the Forest Formation + Savanna Formation vegetation classes, between 2009 and 2020.</p> <p>Fire associated with newly deforested areas can occur both in areas classified as native vegetation and in areas of anthropogenic use depending on the time of year in which the coverage and use data were classified and the time when the fire occurred. More information on the MapBiomass fire methodology can be found in <https://mapbiomas.org/metodo-mapbiomas-fogo></p>
Purpose of data	<p>This parameter is the average percentage of the area within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming, and is used to calculate baseline and project non-CO₂ emissions from forest fire at year t in the project area (parameter EBBBSLPAt).</p>
Comments	<p>Monitoring is done only once at project start.</p>

Data / Parameter	Pburnt _{p,icl}
Data unit	%
Description	Average proportion of mass burnt in the carbon pool in the forest class
Source of data	<p>Measured or estimated from literature.</p> <p><i>Pburnt data source:</i></p> <p>Anderson LO, Aragão LE, Gloor M, et al. Disentangling the contribution of multiple land covers to fire-mediated carbon emissions in Amazonia during the 2010 drought. Global Biogeochem Cycles. 2015; 29 (10):1739-1753. Doi: 10.1002/2014GB005008. Available at <https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014GB005008>. Last visited on September 2021.</p>
Value applied	78
Justification of choice of data or description of measurement methods and procedures applied	<p>Pburnt was estimated using the average biomass per hectare that has commercial value and could be removed prior to clear cutting and burning. Based on literature, an average value of 61.6 m³/ha was obtained, which would correspond to approximately 11% of the total biomass in 1 ha. In this way, the remaining is burned to clear the area, therefore, its new value is 88.6%.</p>

	<p>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.</p> <p>The most conservative value between these two estimates were used, i.e., Pburnt was estimated as 78%.</p> <p>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.</p>
Purpose of data	<p>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-CO₂ emissions from forest fire at year t in the project area (parameter EBBBSLPAt).</p>
Comments	<p>Monitoring is done only once at project start.</p>

Data / Parameter	EI
Data unit	%
Description	<i>Ex ante</i> estimated effectiveness index
Source of data	Estimate from project proponent based on the Non-Permanence Risk Assessment
Value applied	90% (initially in the first years of the project)
Justification of choice of data or description of measurement methods and procedures applied	<p>The estimated value is based on the project's initial non-permanence risk (10%), as this parameter takes into account the possibility of losses in carbon stocks over time, whether due to climate change, social pressures, or changes in local governance. Thus, with each verification event, scheduled to occur every 3 years, the project's effectiveness increases by 1%. It is understood that with the implementation of activities and the overall maturity of the project, it is expected that the project will become increasingly effective in preventing deforestation throughout its crediting period</p>
Purpose of Data	<p>This parameter is used to calculate project emissions in the baseline scenario. Provides an <i>ex ante</i> estimation of the carbon</p>

	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	<p><i>Ex post</i> monitoring of the project area will be done to determine deforestation rate and the project emissions.</p> <p>This parameter will be updated at each renewal of fixed baseline period.</p>

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	<p>Average value for the above-ground biomass was taken from the following study:</p> <p>FAO, Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020 – Brazil Report, Rome, 2020.</p>																			
Description of measurement methods and procedures to be applied	<p>The following sources will be monitored:</p> <ul style="list-style-type: none"> - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories 																			
Frequency of monitoring/recording	At each monitoring report.																			
Value applied	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th colspan="4">Above-ground biomass</th> </tr> <tr> <th colspan="4">ab_{icl} (Mg/ha)</th> </tr> <tr> <th>Vegetation</th> <th>Reference Region</th> <th>Project Area</th> <th>Leakage Belt</th> </tr> </thead> <tbody> <tr> <td>Forest</td> <td>225.46</td> <td>225.46</td> <td>225.46</td> </tr> </tbody> </table>				Above-ground biomass				ab _{icl} (Mg/ha)				Vegetation	Reference Region	Project Area	Leakage Belt	Forest	225.46	225.46	225.46
Above-ground biomass																				
ab _{icl} (Mg/ha)																				
Vegetation	Reference Region	Project Area	Leakage Belt																	
Forest	225.46	225.46	225.46																	
Monitoring equipment	No monitoring equipment is used to determine this parameter.																			

QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements
Purpose of data	This parameter is used to calculate baseline emissions, project emissions and leakage emissions in both baseline and project scenarios.
Calculation method	Following a literature search the above-ground biomass values of these studies were used as they were determined to accurately represent the values of vegetation within the project reference region.
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.

Data / Parameter	bb_{icl}																
Data unit	Mg/ha																
Description	Average biomass stock per hectare in the below-ground biomass pool of initial forest class icl in Mg/ha.																
Source of data	Average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.																
Description of measurement methods and procedures to be applied	The following sources will be monitored: <ul style="list-style-type: none"> - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories 																
Frequency of monitoring/recording	At each monitoring report.																
Value applied	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th colspan="4">Below-ground biomass</th> </tr> <tr> <th colspan="4">bb_{icl} (Mg/ha)</th> </tr> <tr> <th>Vegetation</th> <th>Reference Region</th> <th>Project Area</th> <th>Leakage Belt</th> </tr> </thead> <tbody> <tr> <td>Forest</td> <td>54.11</td> <td>54.11</td> <td>54.11</td> </tr> </tbody> </table>	Below-ground biomass				bb_{icl} (Mg/ha)				Vegetation	Reference Region	Project Area	Leakage Belt	Forest	54.11	54.11	54.11
Below-ground biomass																	
bb_{icl} (Mg/ha)																	
Vegetation	Reference Region	Project Area	Leakage Belt														
Forest	54.11	54.11	54.11														
Monitoring equipment	No monitoring equipment is used to determine this parameter.																

QA/QC procedures to be applied	Data shall be in accordance to VM0015 v1.1 requirements
Purpose of data	This parameter is used to calculate baseline, project and leakage emissions in the baseline and project scenarios.
Calculation method	Calculation according to the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.20 for values below 125 tons/ha.
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.

Data / Parameter	ACPA _t
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.
Source of data	<ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - INMET²²⁵ - INPE²²⁶
Frequency of monitoring/recording	At each time a catastrophic event occurs.
Value applied	0
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: <ul style="list-style-type: none"> - INMET - INPE - Field data from the management team

²²⁵ INMET. Instituto Nacional de Meteorologia. Available at: <<https://portal.inmet.gov.br/>>. Last visited on 06/08/2021.

²²⁶ INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <<http://www.inpe.br/>>. Last visited on 06/08/2021.

Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an <i>ex post</i> estimation of the area affected by catastrophic events within the project area.
Calculation method	Remote sensing and GIS
Comments	Decreases in carbon stocks and increases in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

Data / Parameter	$ABSLLK_t$
Data unit	Ha
Description	Annual area of deforestation within the leakage belt at year t.
Source of data	Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	534,52
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 <i>ex post</i> 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	ABSLPA _t
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	8,44
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 <i>ex ante</i> and <i>ex post</i> 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	APDPA _{icl,t}
Data unit	Hectare
Description	Areas of planned deforestation in forest class icl at year t in the project area
Source of data	<ul style="list-style-type: none"> - Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.

Description of measurement methods and procedures applied	The planned deforestation activities in the project area that result in carbon stock decrease will be subject to monitoring. The forest management team records such information according to procedures established in its sustainable forest management plan.
Frequency of monitoring/recording	Annually
Value applied:	7.60
Monitoring equipment	<ul style="list-style-type: none"> - Remote sensing and GIS - Forest Management team, based on the Sustainable Forest Management Plan
QA/QC procedures applied	<ul style="list-style-type: none"> - Best practices in remote sensing. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the <i>ex post</i> value of the decrease in carbon stocks due to planned deforestation in the project area.
Calculation method	Emissions from deforestation at each forest class are quantified by multiplying the detected area of forest loss by the average forest carbon stock per unit area. For an <i>ex ante</i> estimation, it was considered that 1.18% of each annual production unit will be deforested for the implementation of SFMP infrastructure.
Comments	Planned deforestation mainly includes implementation of the forest management infrastructure, such as opening of main and secondary roads, skidding trails, and timber yards in each annual production unit within the project area.
Data / Parameter	APLPAicl,t
Data unit	Hectare
Description	Areas of planned logging activities in forest class icl at year t in the project area

Source of data	<ul style="list-style-type: none"> - Annual operational plan; - Annual post-harvesting report; - Remote sensing and GIS.
Description of measurement methods and procedures applied	<p>The planned logging activities in the project area that resulted in carbon stock increase or decrease shall be subjected to monitoring, when significant.</p>
Frequency of monitoring/recording	<p>Annually</p>
Value applied:	<p>0</p> <p>Planned logging areas expected to occur during the crediting period will be accounted only ex-post</p>
Monitoring equipment	<ul style="list-style-type: none"> - Remote sensing and GIS - Forest Management team, based on the Sustainable Forest Management Plan
QA/QC procedures applied	<ul style="list-style-type: none"> - Best practices in remote sensing. - Internal procedures required by the SFMP and forest certification.
Purpose of data	<p>This parameter will be used to calculate project emissions in the project scenario. Provides the <i>ex post</i> value of the increase or decrease in carbon stocks due to planned logging activities in the project area.</p>
Calculation method	<p>Carbon stock decrease from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the harvested timber volume intensity, and then by the mean wood density.</p> <p>Carbon stock increase from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the mean annual increment due to natural regeneration of managed forests, and then by the mean wood density.</p>
Comments	<p>According to the current sustainable forest management plan, the authorized forest management area is 3,051.8384 ha, and the average annual logging area is 392.90 ha. Considering that logging activities will occur in the Dense Submontane Tropical Rainforest and Open Submontane Tropical Rainforest vegetation types.</p>

	The SFMP provides guidance to the management team in order to harvest forest products/by-products in a consistent manner with the conservation of the local ecosystem.
Data / Parameter	AUDPA _{icl,t}
Data unit	Hectare/year
Description	Areas of unplanned deforestation in forest class <i>icl</i> at year <i>t</i> in the project area
Source of data	<ul style="list-style-type: none"> - Remote sensing and GIS. - Field reports
Description of measurement methods and procedures applied	The unplanned deforestation within the project area that result in carbon stock decrease will be subject to monitoring.
Frequency of monitoring/recording	Annually
Value applied:	0.84
Monitoring equipment	<ul style="list-style-type: none"> - Remote sensing and GIS - Field reports
QA/QC procedures 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 decrease in carbon stocks due to unplanned deforestation in the project area.
Calculation method	Emissions from deforestation at each forest class are quantified by multiplying the detected area of forest loss by the average forest carbon stock per unit area. For an ex ante estimation, it was considered that around 5.47% of the projected deforestation (ABSLP _{at}) would occur within the project area, according to the Effectiveness Index parameter.
Comments	N/A

Data / Parameter	$\Delta\text{CPFdPat}$
Data unit	Hectare
Description	Areas of planned fuel-wood collection and charcoal production activities in forest class icl at year t in the project area
Source of data	- Authorization for the Use of Forest Raw Material document (Autorização de Utilização de Matéria-Prima Florestal-AUMPF, Portuguese)
Description of measurement methods and procedures applied	<p>No production of fuel wood or charcoal is expected to occur within the project area during the crediting period.</p> <p>The methods must follow the legislation:</p> <ul style="list-style-type: none"> • State Legislation nº 698, 13/07/2021 • Federal Legislation nº 06, 07/04/2009
Frequency of monitoring/recording	Annually
Value applied:	0
Monitoring equipment	- Remote sensing and GIS - Planned interventions proposed by the project proponent
QA/QC procedures applied	Best practices in remote sensing. Internal audit of the AOP.
Purpose of data	This parameter was used to calculate project emissions in the project scenario. Provides the ex post value of the increase or decrease in carbon stocks due to planned fuel-wood collection and charcoal production activities in the project area.
Calculation method	Emissions at each forest class are quantified by multiplying the detected area subject to fuel wood collection or charcoal production by the harvested volume intensity, and then by the mean wood density.
Comments	N/A
Data / Parameter	ΔCADLK_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	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 <i>ex post</i> value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	ΔCPAdPA_t
Data unit	tCO _{2e}
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	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.

and procedures to be applied	
Frequency of monitoring/recording	Annually
Value applied	2,376
Monitoring equipment	Remote sensing and GIS SFMP reports, including the post-harvesting annual report.
QA/QC procedures to be applied	<ul style="list-style-type: none"> - Best practices in remote sensing. - Internal procedures required by the SFMP and forest certification
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	ΔCPSLK_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	<ul style="list-style-type: none"> - 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 <i>ex post</i> 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	ΔCUDdPA_t
Data unit	tCO ₂ e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Source of data	<ul style="list-style-type: none"> - 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	430,53
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 <i>ex post</i> 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 <i>ex post</i> 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	0
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 <i>ex post</i> 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	EBBtot _{icl,t}
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Data unit	tCO ₂ e/ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Source of data	Calculated according to methodology VM0015 v1.1.
Description of measurement methods and procedures to be applied	This parameter was calculated according to requirements and default values established by the VM0015 v1.1 methodology. In order to estimate non-CO ₂ emissions from forest fires, the average percentage of the area which contemplates the three municipalities within the RR that was cleared by burning for other land uses involving deforestation, such as cattle raising and farming (Fburnt), and the average of biomass that has commercial value, and could be removed prior to clear cutting and burning (Pburnt,p) were estimated, either for the baseline and project case. These average percentage values are assumed to remain the same in the future, according to the applied methodology
Frequency of monitoring/recording	Annually
Value applied	11.08
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 N ₂ O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	EgLK _t
Data unit	tCO ₂ e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	<ul style="list-style-type: none"> - 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	287,90
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 <i>ex post</i> value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: <i>Ex ante</i> estimation of CH ₄ and N ₂ O emissions from grazing animals.
Comments	The community living within the leakage management area practices grazing activities. Therefore, this shall be monitored during the crediting period. GWP for CH ₄ and N ₂ O were obtained according to the most recent version of the VCS Standard.

Data / Parameter	H _{licl,t}
Data unit	m ³ /ha
Description	Harvesting intensity of timber in forest class icl at year t in the project area due to planned logging activities (i.e., sustainable forest management plan).
Source of data	Sustainable forest management activity reports, such as the annual operational plan and the annual post-harvesting report.
Description of measurement methods and procedures to be applied	Forest inventory and measurements of wood logs by the forest management team. Harvesting intensity followed procedures described in the Sustainable Forest Management Plan and Annual Operating Plan-AOP (POA, in Portuguese)
Frequency of monitoring/recording	Annually
Value applied	27.76

Monitoring equipment	The same equipment applied in the forest inventory. Each harvested timber log is measured by the forest management team and stored in a collector, which is linked to the SFMP and AOP data control.
QA/QC procedures to be applied	Control procedures applied to forest inventory. SFMP and AOP internal audit. Logging authorization from the Brazilian Environmental Agency ²²⁷ .
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides the ex post value of the harvested timber volume due to planned logging activities in the project area.
Calculation method	This parameter was calculated through the annual timber inventory and movement, which is carried out before harvesting and contains the timber volume from each Annual Productive Unit (APU). After harvesting operations, each harvested timber log is measured (diameter and height) by employees and stored in a collector, which automatically calculate the timber volume through the following equation: Wood volume with bark (V) $V (m^3) = \pi \cdot d^2 \cdot h \cdot f$ Where, d = Diameter h = Height f = factor - 0.7395 Wood volume without bark (V) $V (m^3) = \pi \cdot d^2 \cdot h \cdot f \cdot 0,90$ Where d = Diameter h = Height f = factor - 0.7395 0.90 = correction factor to determine volume without bark according to legislation Carbon stock decrease from planned logging activities at each forest class are quantified by multiplying the detected area subject to logging by the harvested timber volume intensity (added to logging damage factor), and then by the mean wood density.

²²⁷ The responsible environmental agency in this case is the Environmental Agency of the State of Mato Grosso

Comments	N/A
Data / Parameter	RF _t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	<ul style="list-style-type: none"> - VCS Non-Permanence Risk Report – Juruena River REDD Project; - Remote sensing data and GIS; - SFMP data; - Literature data.
Description of measurement methods and procedures to be applied	All sources of data from the VCS Non-Permanence Risk Report will be used to measure the various risk factors.
Frequency of monitoring/recording	Annually
Value applied	10
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing and GIS. The VCS Non-Permanence Risk Report will be verified together with the monitoring report at each verification event.
Purpose of data	This parameter represents the non-permanence risk rating of the project, which was used to determine the number of buffer credits that shall be deposited into the AFOLU pooled buffer account.
Calculation method	This parameter was calculated using the last available version of the AFOLU Non-Permanence Risk Tool. All the risk factors described in the VCS Non-Permanence Risk Report will be assessed.
Comments	N/A

5.3 Monitoring Plan

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

Organizational structure

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

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

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

- **Revision of the baseline**

The current baseline is valid for 6 years, i.e. through November 11th, 2026. The baseline will be reassessed every 6 years, and it will be validated at the same time as the subsequent verification.

Technical description of the monitoring task

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

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

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

Data to be collected

Data will be collected to comply with the parameters used in VM0015 version 1.1, listed in Appendix 5, or the most recent.

Overview of data collection procedures

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

Quality control and quality assurance procedures

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

Data archiving

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by the project owner. A digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the first monitoring period will also be kept, 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

Ecológica Assessoria 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 project 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.

Uezu Planejamento Ambiental 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 project proponent is responsible for the implementation of the project activity. The monitoring of the sustainable management plan is carried out by the municipal and state secretariats.

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

Updating Forest Carbon Stocks Estimates

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

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

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

It will also be kept 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. 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)²²⁸ and LANDSAT satellite images (or other available source accepted by the methodology), which will be subject to digital processing to perform the interpretation and classification of the land cover classes studied.

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

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

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

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

Procedures for handling internal auditing and non-conformities

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

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 Juruena River REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This is the responsibility of the Project Developer.

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.

²²⁸ Available at: <<http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>> Last visited on 10/03/2021.

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 *ic*; 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 land owner is responsible for the implementation of monitoring bases, if necessary, to guarantee the standing forest and carbon stock.

Satellite images and remote sensing monitoring

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

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

Security procedures

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

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

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

- **Monitoring of carbon stock changes and non-CO2 emissions from fires**

In addition to the mentioned above, the project 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 the responsibility of the project owner, who must include the related impacts in the carbon project reports and update the related parameters, including the buffer report. Where an event occurs that is likely to qualify as a loss event, the project proponent shall notify Verra within 30 days of discovering the likely loss event.

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

- **Monitoring of Leakage**

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

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

leakage emissions in the project scenario will be done by monitoring the following sources of leakage:

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

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

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

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

- **Organizational structure, responsibilities and competencies**

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

For all aspects of project monitoring, the project proponent will ensure that data collection, processing, analysis, management and archiving are conducted in accordance with the monitoring plan.

Table 62. Type of Monitoring and Party Responsible for Monitoring

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Project Proponent, together with external experts	Every 6 years
Monitoring Deforestation and Project Emissions	Project Proponent, together with external experts	Prior to each verification
Monitoring of non-CO ₂ emissions from forest fires	Project Proponent, together with external experts	Prior to each verification
Monitoring Leakage emissions	Project Proponent, together with external experts	Prior to each verification
Monitoring of Natural Disturbance and catastrophic events	Project proponent	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Project proponent	Data must be less than 10 years old, as per the methodology. Thus, the applied study must be updated when this period is achieved.

5.3.1 Implementation Status of the Project Activity

Starting from November 12, 2020, the Juruena River REDD+ Project implemented actions focused on the expansion of community activities and continuous monitoring of deforestation, such as the field surveillance of the area to ensure detection and immediate response to any deforestation events or illegal activities. Monitoring was also carried out through data from the Brazilian Amazon Forest Monitoring Program by Satellites (PRODES) by analysing and identifying changes in forest cover.

A crucial aspect of the conservation of the Juruena River area is the work of engaging with local stakeholders, especially the communities living near the project area. Since before the project began, the landowner already had a good relationship with the local communities: the proponent carried out several actions to support the surrounding communities, for example, donating bags of cement for the construction of a sports court in the Apiaká Indigenous Land in August 2020, among other donations in the past years.

After the beginning of the project, efforts were made to strengthen ongoing dialogue with these communities, aiming to raise awareness about the project's importance and the benefits of keeping the forest standing (described in section 2.2). These interactions were essential for the local population to understand the existence and objectives of the Juruena River REDD+ Project, including the potential for generating carbon credits and the economic and environmental benefits that can result from forest

conservation. Although it is not possible to prove that these conversations directly prevented deforestation, they certainly contributed to a better understanding of the project and the consequences of deforestation activities within the project area.

During this monitoring period, the project proponent expanded community activities by:

- Hiring people from the Nova União district to be part of the property's security and control team, thus generating jobs and helping to economically develop the region (12/November/2020);
- Paying the internet bills of the Apiaká Indigenous Land (24/May/2021);

Also, since 2020, the landowner has annually lent heavy machinery for road repairs in the surrounding area and donated cows for the Christmas dinner of the Apiaká Indigenous Land. However, there are no evidence of these activities, as prior to the REDD+ project, the proponent did not have the habit of recording all the social actions carried out. Therefore, one of the REDD+ Project activity that is planned to be implemented in the coming years is the improvement of monitoring and recording of implemented activities, in order to evaluate the indicators and the achievement of the project's objectives. As a result, evidence of the cow donation and road repairs activities began to be recorded in 2022, so there will be evidence of those activities in the next monitoring period. In addition, the REDD+ Project aims to improve the actions that were already carried out by the proponent, making them more frequent and structured and improving the tracking of what is implemented.

To increase effectiveness in combating unauthorized deforestation, from 2020 onwards, property surveillance was intensified with physical presence in the field, enabling quicker and more accurate actions. The continuous presence of people in the area discourages illegal activities, as it demonstrates that the region is being actively monitored and watched. The activity is carried out by hired, unarmed employees who adopt a "surprise effect" strategy. In other words, there are no fixed times or frequencies for patrolling, so that trespassers cannot identify a pattern in the surveillance actions. The duties of the surveillance team include inspecting project areas, monitoring signs of illegal activity and identifying violations. They are trained to deal with these situations without directly confronting trespassers, following a security protocol. If they observe illegal activity, the surveillance team is instructed to immediately report the incident to the landowner, who will then contact the responsible authorities so that the necessary legal measures can be taken. In the future, to improve monitoring of activities, the team will also be trained to document occurrences and provide detailed information on patrols.

These measures ensured that, during the monitoring period, the project achieved 99% reduction in unauthorized deforestation, as the unauthorized deforestation in the Project Area expected in the baseline of the project's first year was 126 ha and only 0.84 ha (0,66%) were actually deforested, significantly contributing to the conservation of carbon stocks in the region and ensuring the environmental integrity of the project area. The positive outcome reflects the Juruena River REDD+ Project's commitment to climate change mitigation and forest protection, providing a solid foundation for the continuity of activities and the generation of high-quality carbon credits.

The activities described in section 1.11, although some have not yet been implemented during the first monitoring period, such as the environmental education activities, play a crucial role in the future strategy

of the REDD+ Project. With the generation of carbon credits and the influx of new financial resources it will be possible to intensify actions such as surveillance, forest management through Sustainable Forest Management Plans and social activities that benefit the local community, besides monitoring and evaluating the activities carried out, aimed at promoting the sustainable use of natural resources and optimizing deforestation control strategies. These complementary activities will be essential to reinforce forest conservation, create sustainable economic alternatives for local communities, and improve the monitoring of risk areas. Also, the updating and completion of technical studies in future years will allow continuous adjustments to the project's actions, ensuring that measures are adapted according to the needs and challenges identified in the field. These future efforts are expected to further enhance the project's effectiveness in preventing unplanned deforestation, ensuring the longevity and positive impact of conservation actions in the region.

The main activities of the Juruena River REDD+ Project are described in the table below.

Activity	Description	Implementation	Impact on GHG Emissions	How Implementation Was Monitored	Monitoring Period
Stakeholder consultation	Meetings with stakeholders to inform about the REDD+ Project	Started in 2020	Allows the project to be adjusted to maximize stakeholder acceptance, generating impacts on GHG emissions reduction	Monitored through records of consultations and meeting minutes	Continuously monitored
Improvement of property surveillance	Development of actions to improve property surveillance to mitigate and prevent unplanned deforestation in the Project Area, as well as the consequent reduction of greenhouse gas emissions, through physical presence in the field	Started in 2020	Direct impact on GHG emissions reduction by preventing unplanned deforestation	Contracts and receipts for the provision of surveillance services	Continuously monitored
Strengthening the forest management	Support the increasing complexity and costs associated with sustainable forest operations, bureaucracies and price fluctuations of certified timber	Planned to start in 2026	Helps in forest conservation by making forest management more competitive than illegal logging	Documentations from the forest management	Activity not yet started, planned to begin after verification, using resources from carbon credits revenue and continue throughout the project duration
Expansion of community activities	Promotion of social and environmental education activities with the communities surrounding the Project Area to develop the region, raise environmental awareness and maintain a good relationship with the local population	Started in 2020	Maximize stakeholder acceptance, generating impacts on GHG emissions reduction	Service provision contracts and receipts, payment receipts, actions implementation reports	Continuously monitored

Activity	Description	Implementation	Impact on GHG Emissions	How Implementation Was Monitored	Monitoring Period
Implementation, monitoring, and evaluation of activities carried out	Monitor the status and execution of each activity, as well as their results, through the strategies defined in the monitoring plan, allowing continuous evaluation of what will be carried out, enabling the incorporation of learning and improvements	Planned to start in 2025	Continuous evaluation allows adjustments that improve the efficiency of GHG emissions reduction.	Annual reviews and continuous monitoring.	Activity not yet started, planned to begin after verification, using resources from carbon credits revenue and continue throughout the project duration
Updating and complementing technical studies	Conducting technical studies required for the development of Project activities throughout its duration and subsequent verification, such as: review of baseline study, natural and socioeconomic studies, among other actions as needed	Planned to start in 2024	Provides updated foundations for strategies that reduce GHG emissions.	Reports on the progress of studies and recommendations for adjustments	Planned to continue throughout the project duration

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 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.			
Value applied:	Above-ground biomass			
	ab_{icl} (Mg/ha)			
	Vegetation	Reference Region	Project Area	Leakage Belt

	Forest	225.46	225.46	225.46
Comments	The values will be reassessed every 10 years or when data is more than 10 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.																			
Value applied:	<table border="1"> <thead> <tr> <th colspan="4">Below-ground biomass</th> </tr> <tr> <th colspan="4">bb_{icl} (Mg/ha)</th> </tr> <tr> <th>Vegetation</th> <th>Reference Region</th> <th>Project Area</th> <th>Leakage Belt</th> </tr> </thead> <tbody> <tr> <td>Forest</td> <td>54.11</td> <td>54.11</td> <td>54.11</td> </tr> </tbody> </table>				Below-ground biomass				bb _{icl} (Mg/ha)				Vegetation	Reference Region	Project Area	Leakage Belt	Forest	54.11	54.11	54.11
Below-ground biomass																				
bb _{icl} (Mg/ha)																				
Vegetation	Reference Region	Project Area	Leakage Belt																	
Forest	54.11	54.11	54.11																	
Comments	The values will be reassessed every 6 years or when data is more than 6 years old, whichever occurs first.																			

Data / Parameter	ACPA _t			
Data unit	Ha			
Description	Annual area within the Project Area affected by catastrophic events at year t.			
Value applied:	0			
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.								
Value applied:	<table border="1"> <thead> <tr> <th rowspan="2">Year</th> <th>ABSLLK_t (ha)</th> </tr> <tr> <th>Forest</th> </tr> </thead> <tbody> <tr> <td>12/11/2020 – 11/11/2021</td> <td>534,52</td> </tr> <tr> <td>Total</td> <td>534.52</td> </tr> </tbody> </table>	Year	ABSLLK _t (ha)	Forest	12/11/2020 – 11/11/2021	534,52	Total	534.52	
Year	ABSLLK _t (ha)								
	Forest								
12/11/2020 – 11/11/2021	534,52								
Total	534.52								
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	ABSLPA _t						
Data unit	Ha						
Description	Annual area of deforestation in the project area at year t						
Value applied:	<table border="1"> <thead> <tr> <th rowspan="2">Year</th> <th>ABSLPA_t (ha)</th> </tr> <tr> <th>Forest</th> </tr> </thead> <tbody> <tr> <td>12/11/2020 – 11/11/2021</td> <td>8.44</td> </tr> </tbody> </table>	Year	ABSLPA _t (ha)	Forest	12/11/2020 – 11/11/2021	8.44	
Year	ABSLPA _t (ha)						
	Forest						
12/11/2020 – 11/11/2021	8.44						
Comments	N/A						

Data / Parameter	APDPA _{icl,t}		
Data unit	Hectare		
Description	Areas of planned deforestation in forest class <i>icl</i> at year <i>t</i> in the project area		
Value applied:	Year	APDPA _{icl,t} (ha)	
		Forest	
	12/11/2020 – 11/11/2021	7.60	
Comments	N/A		

Data / Parameter	APLPA _{icl,t}		
Data unit	Hectare		
Description	Areas of planned logging activities in forest class <i>icl</i> at year <i>t</i> in the project area		
Value applied:	Year	APLPA _{icl,t} (ha)	
		Forest	
	12/11/2020 – 11/11/2021	455.385	
Comments	Only one Forest Exploration Authorization (AUTEX-PMFS), with a total area of 910.77 ha, was in the course of the MR period. Considering the period of up to 2 years for logging, the effective annual logging area is 455.39 ha.		

Data / Parameter	AUDPA _{icl,t}		
Data unit	Hectare		

Description	Areas of unplanned deforestation in forest class icl at year t in the project area
Value applied	0.84
Comments	N/A

Data / Parameter	ΔCPFdPA_t
Data unit	Hectare
Description	Areas of planned fuel-wood collection and charcoal production activities in forest class icl at year t in the project area
Value applied:	0
Comments	No production of fuel wood or charcoal occurred during the monitoring period.

Data / Parameter	ΔCADLK_t
Data unit	tCO _{2e}
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Value applied:	0
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	ΔCPAdPA_t
Data unit	tCO _{2e}
Description	Total decrease in carbon stock due to all planned activities at year t in the project area

Value applied:	Year	ΔCPAdPA_t (tCO _{2e})
	12/11/2020 - 11/11/2021	24,449.84
Comments	N/A	

Data / Parameter	ΔCPSLK_t	
Data unit	tCO _{2e}	
Description	Total annual carbon stock change in leakage management areas in the project case at year t	
Value applied:	Year	ΔCPSLK_t (tCO _{2e})
	12/11/2020 - 11/11/2020	0.00
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	ΔCUDdPA_t	
Data unit	tCO _{2e}	
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area	
Value applied:	Year	ΔCUDdPA_t (tCO _{2e})
	12/11/2020 - 11/11/2021	430,53
Comments	N/A	

Data / Parameter	EADLK _t								
Data unit	tCO _{2e}								
Description	Total <i>ex post</i> increase in GHG emissions due to displaced forest fires at year t.								
Value applied:	<table border="1"> <thead> <tr> <th>Year</th> <th>EADLK_t (tCO_{2e})</th> </tr> </thead> <tbody> <tr> <td>12/11/2020</td> <td>0.00</td> </tr> <tr> <td>-</td> <td></td> </tr> <tr> <td>11/11/2021</td> <td></td> </tr> </tbody> </table>	Year	EADLK _t (tCO _{2e})	12/11/2020	0.00	-		11/11/2021	
Year	EADLK _t (tCO _{2e})								
12/11/2020	0.00								
-									
11/11/2021									
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	EBBtot _{icl,t}
Data unit	tCO _{2e} /ha
Description	Total GHG emission from biomass burning in forest class icl at year t
Value applied:	11.08
Comments	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

Data / Parameter	EgLK _t					
Data unit	tCO _{2e}					
Description	Emissions from grazing animals in leakage management areas at year <i>t</i> .					
Value applied:	<table border="1"> <thead> <tr> <th>Year</th> <th>EgLK_t (tCO_{2e})</th> </tr> </thead> <tbody> <tr> <td>12/11/2020 – 11/11/2021</td> <td>287.90</td> </tr> </tbody> </table>	Year	EgLK _t (tCO _{2e})	12/11/2020 – 11/11/2021	287.90	
Year	EgLK _t (tCO _{2e})					
12/11/2020 – 11/11/2021	287.90					
Comments	There were no project activities in the leakage management area that resulted in GHG emissions during the monitoring period. However, the community living within the leakage management area practices grazing activities, which were considered as EgLK _t .					

Data / Parameter	H _{icl,t}	
Data unit	m ³ /ha	
Description	Harvesting intensity of timber in forest class <i>icl</i> at year <i>t</i> in the project area due to planned logging activities (i.e., sustainable forest management plan).	
Value applied:	27.76 (Average harvesting intensity)	
Comments	N/A	

Data / Parameter	RF _t	
Data unit	%	
Description	Risk factor used to calculate VCS buffer credits	
Value applied:	10	
Comments	N/A	

6.2 Baseline Emissions

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

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

Where,

Cab_{icl}	Average carbon stock per hectare in the above-ground biomass carbon pool of initial forest class icl ; $\text{tCO}_2\text{e ha}^{-1}$
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 CO_2e

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

Where,

Cbb_{icl}	Average carbon stock per hectare in the below-ground biomass carbon pool of initial forest class icl ; $\text{tCO}_2\text{e ha}^{-1}$
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 CO_2e

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

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

Where,

$\Delta CBSLPA_t$	Total baseline carbon stock changes in the project area at year t ; tCO_2e
$\Delta CabBSLPA_{icl,t}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t ; tCO_2e
$\Delta CbbBSLPA_{icl,t}$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t ; tCO_2e

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

Where,

$\Delta CabBSLPA_{icl,t}$	Total baseline carbon stock change for the above-ground biomass pool in the project area for initial forest class at year t ; tCO _{2e}
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCab_{icl}	Average carbon stock change factor per hectare in the above-ground biomass carbon pool of initial forest class icl ; tCO _{2e} ha ⁻¹

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

Where,

$\Delta CbbBSLPA_{icl,t}$	Total baseline carbon stock change for the below-ground biomass pool in the project area for initial forest class at year t ; tCO _{2e}
$ABSLPA_{icl,t}$	Area of initial forest class icl deforested at time t within the project area in the baseline case; ha
ΔCbb_{icl}	Average carbon stock change factor per hectare in the below-ground biomass carbon pool of category icl ; tCO _{2e} ha ⁻¹

Project carbon stocks were calculated as presented in section 4.1.

Average carbon stocks of post-deforestation classes

The average classification of post-deforestation land-uses within the reference region during the historical reference period was conducted through MapBiomass, as detailed in section 4.1.

Land Use	Area (%)	Carbon stocks (tC/ha)
Pasturelands	89.87%	7.57
Secondary forests	10.04%	22.8
Agriculture	0.08%	21
Rivers, lakes and reservatory	0.01%	0
Urban area	0.00%	0
Weighted average of post-deforestation carbon stocks		9.11

Table 63. Long-term (20 years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Non-forest vegetation	Carbon*** * (tC/ha)	Ctot _{fcl} (tCO ₂ /ha)
Anthropic areas in equilibrium (post-deforestation class)	9.11	33.40

Calculation of baseline carbon stock changes

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

Table 64. Ex post carbon stock change in the project area (Table 21b of VM0015 methodology)

Carbon stock changes per initial forest class icl		Total carbon stock change of initial forest class in the project area			Carbon stock changes per post-deforestation zone z		Total carbon stock change of post-deforestation zones in the project area		
ID $_{icl}$ >		1	Δ CBSLPA $_{icl,t}$	Δ CBSLPA $_{icl}$	ID $_{iz}$ >		1	Δ CBSLPA $_{z,t}$	Δ CBSLPA $_{z}$
Name>		Forest	annual	cumulative	Name>		Zone 1	annual	cumulative
Project Year t		tCO $_2$ -e	tCO $_2$ -e	tCO $_2$ -e	Project Year t		tCO $_2$ -e	tCO $_2$ -e	tCO $_2$ -e
Initial	Final				Initial	Final			
12-Nov-2020	11-Nov-2021	3,572.31	3,572.31	3,572.31	12-Nov-2020	11-Nov-2021	0	0	0.00

Total net carbon stock change of the project area	
Δ CBSLPA $_t$	Δ CBSLPA
annual	cumulative
tCO $_2$ -e	tCO $_2$ -e
3,572.31	3,572.31

Table 65. Ex post carbon stock change in the leakage belt. (Table 21c of VM0015 Methodology)

Carbon stock changes per initial forest class <i>icl</i>		Total carbon stock change of initial forest class in the leakage belt area		Carbon stock changes per post-deforestation zone <i>z</i>		Total carbon stock change of post-deforestation zones in leakage belt area			
ID _{icl} >	1	$\Delta\text{CBSLLK}_{icl,t}$	$\Delta\text{CBSLLK}_{icl}$	ID _{iz} >	1	$\Delta\text{CBSLLK}_{z,t}$	ΔCBSLLK_z		
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative		
Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	Project Year <i>t</i>	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e		
Initial				Final				Initial	Final
12-Nov-2020	11-Nov-2021	226,240.94	226,240.94	226,240.94	12-Nov-2020	11-Nov-2021	0	0.00	0.00

Total net carbon stock change of the leakage belt area		Total baseline net carbon stock change of the leakage belt area		Total ex-post Leakage	
ΔCBSLLK_t	ΔCBSLLK	ΔCBSLLK_t	ΔCBSLLK	ΔCBSLLK_t	ΔCBSLLK
annual	cumulative	annual	cumulative	annual	cumulative
tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e	tCO ₂ -e
226,240.94	226,240.94	232,794.97	232,794.97	0,00	0,00

6.3 Project Emissions

As detailed in section 5.4 above, the areas within the Juruena River REDD Project have sustainable forest management plan implemented. This type of economic activity enables the harvesting of an economically feasible volume of forest products, however allowing the regeneration of the natural stock in accordance with the growth and recovery rates of the biome.

As previously described, almost all deforestation occurred within the project area resulted from planned deforestation activities. During the current monitoring period, one APU was harvested, according to Table below.

Annual Productive Unit (APU)	m ³	ha	m ³ /ha
APU Tico Tico	12,639.66	455.39	27.76

The *ex post* carbon stock decrease due to planned deforestation in the project area was calculated using the following equation:

$$\Delta CPDdPA_t = \sum_{icl=1}^{icl} (APDPA_{icl,t} \times \Delta Ctot_{icl})$$

Where,

$\Delta CPDdPA_t$	Total decrease in carbon stock due to planned deforestation at year t in the project area; tCO ₂ e
$APDPA_{icl,t}$	Areas of planned deforestation in forest class icl at year t in the project area; ha
$\Delta Ctot_{icl}$	Average carbon stock change of all accounted carbon pools in forest class icl at time t ; tCO ₂ e/ha

In addition, some unplanned deforestation occurred in the southern border of the project area, corresponding to a total of 0.84119 ha during the monitoring period. The *ex post* carbon stock decrease due to unplanned deforestation in the project area was calculated using the following equation:

$$\Delta CUDdPA_t = \sum_{icl=1}^{icl} (AUDPA_{icl,t} \times \Delta Ctot_{icl})$$

Where,

$\Delta CPUdPA_t$	Total <i>ex post</i> actual carbon stock change due to unavoidable unplanned deforestation at year t in the project area; tCO ₂ e
$AUDPA_{icl,t}$	Areas of unplanned deforestation in forest class icl at year t in the project area; ha
$\Delta Ctot_{icl}$	Average carbon stock change of all accounted carbon pools in forest class icl at time t ; tCO ₂ e/ha

Therefore, the total carbon stock decreases due to planned and unplanned deforestation in the project area could be calculated, as depicted in Table below.

Table 66. Ex post carbon stock decrease due to planned and unplanned deforestation in the project area (Table 25a of VM0015 Methodology)

Project year t	Areas of planned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned deforestation		Areas of unplanned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to unplanned deforestation		Total carbon stock decrease due to planned and unplanned deforestation	
	IDcl = 1 Forest		annual	cumulative	IDcl = 1 Forest		annual	cumulative	annual	cumulative
	$APDPA_{icl,t}$	$C_{tot_{icl,t}}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$AUDPA_{icl,t}$	$C_{tot_{icl,t}}$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	tCO _{2e}	tCO _{2e}
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}		
12/11/2020 - 11/11/2021	7.6	512.55	3,893.05	3,893.05	0.84	512.55	430.54	430.54	4,323.59	4,323.59

In the project scenario, emissions due to planned logging activities results from timber harvesting and also from damages to vegetation during the directional tree felling, which generate forest residues (branches, remains of logs and other damaged trees during the tree felling).

According to Feldpausch et al (2005), the mean Coarse woody debris returned to the soil as necromass following logging and damage in: (1) tree felling gap formation (trees killed by tree-fall), (2) residual canopy from the felled tree, (3) road, (4) deck construction (whole trees plowed to the ground) and (5) skid maneuvering during logging, is about 6.9 Mg C/ha. According to section 4.3 (pg 212) from this same study, this represents 2.4 times the carbon taken off site in logs. However, the MR already takes into account as planned deforestation the roads and decks constructions, which represent around 16% of the total damage. Therefore, the LDF is $2.4 * (1-0,159) = 2.0174$.

Thus, GHG emissions from logging activities include the volume of harvested timber plus the logging damage factor, as follows.

$$\Delta CLD_{icl,t} = (HI_{icl,t} + LDF) \times D_m \times CF \times 44 / 12$$

Where,

$\Delta CLD_{icl,t}$	Average carbon stock decrease due to logging activities in forest class <i>icl</i> at time <i>t</i> ; tCO ₂ e/ha
$HI_{icl,t}$	Harvesting intensity of timber in forest class <i>icl</i> at year <i>t</i> in the project area due to planned logging activities (i.e., sustainable forest management plan); m ³ /ha
LDF	Logging damage factor; m ³ /ha
D_m	Mean wood density; g/cm ³
CF	Default value of carbon fraction in biomass; tC t-1 d.m.
44/12	Ratio of molecular weight of CO ₂ to carbon; dimensionless

Harvested wood products was not accounted for in baseline and project scenarios. Thus, $C_{wp} = 0$

Therefore, the *ex post* carbon stock decrease due to planned logging activities in the project area was calculated using the following equation:

$$\Delta CPLdPA_t = \sum_{icl=1}^{icl} (APLPA_{icl,t} \times \Delta CLD_{icl,t}) - \left(\sum_{icl=1}^{icl} \backslash PLPA_{icl,t} \right) \times \Delta C_{wpt}$$

Where,

$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities at year <i>t</i> in the project area; tCO ₂ e
$APLPA_{icl,t}$	Areas of planned logging activities in forest class <i>icl</i> at year <i>t</i> in the project area; ha

$\Delta CL_{icl,t}$	Average carbon stock decrease due to logging activities in forest class <i>icl</i> at time <i>t</i> ; tCO _{2e} /ha
ΔCwp_t	Average carbon stock per hectare in the harvested wood products carbon pool at time <i>t</i> ; tCO _{2e} /ha

Thus, Table below presents the *ex post* carbon stock decrease due to planned logging activities in the project area.

Table 67. Ex post actual carbon stock decrease due to planned logging activities in the project area (Table 25b of VM0015 Methodology)

Project year <i>t</i>	Areas of planned logging activities x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned logging activities	
	IDcl = 1 Forest		annual	cumulative
	APLPA _{icl,t}	$\Delta CL_{icl,t}$	$\Delta CPLdPA_t$	$\Delta CPLdPA$
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	455.39	45.14	20,556.79	20,556.79

Fossil fuel emissions from sustainable forest management activities are likely to be less than 5% of the total GHG emissions reductions benefits generated by the present project. Considering that emissions from deforestation and forest degradation would be much higher than those associated with timber harvesting, the emissions from fossil fuel during transport and machinery use can be considered *de minimis*. In addition, according to VCS AFOLU Requirements, fossil fuel emissions from transport and machinery use in REDD project activities can be considered *de minimis*.

No production of fuel wood or charcoal occurred within the project area during the monitoring period.

Thus, Table below presents the total *ex post* carbon stock decrease due to planned activities in the project area.

**Table 68. Total ex post carbon stock decrease due to planned activities in the project area
(Table 25d of VM0015 Methodology)**

Project year t	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuel-wood and charcoal activities		Total carbon stock decrease due to planned activities	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCPDdPA_t	ΔCPDdPA_A	ΔCPLdP_t	ΔCPLdP_A	ΔCPFdPA_t	ΔCPFdPA_A	ΔCPAdP_t	ΔCPAdP_A
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	3,893.05	3,893.05	20,556.79	20,556.79	0.00	0.00	24,449.84	24,449.84

Neither planned protection of secondary/degraded forests without harvest nor production of fuel-wood and charcoal are expected to occur within the project area under the project scenario. Thus, carbon stock increase due to growth without harvest or due to planned fuel-wood and charcoal activities were not monitored. However, if any of these activities is implemented in the future, a measurement of the carbon stock changes will be carried out.

According to the applied methodology, if the project activity generates a significant change in carbon stocks due to these activities, the carbon stock change shall be measured *ex post*. However, if the decrease is not significant, it shall not be accounted, and *ex post* monitoring is not required.

The calculation of the *ex post* net carbon stock change in the project area under the project scenario (ΔCPSPA_t) is described as follows.

$$\Delta\text{CPSPA}_t = \Delta\text{CPAdPA}_t + \Delta\text{CUDdPA}_t - \Delta\text{CPAiPA}_t$$

Where,

- ΔCPSPA_t Sum of ex post actual carbon stock changes in the project area at year t; tCO_{2e}
- ΔCPAdPA_t Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_{2e}
- ΔCUDdPA_t Total ex post actual carbon stock change due to unavoidable unplanned deforestation at year t in the project area; tCO_{2e}
- ΔCPAiPA_t Total increase in carbon stock due to all planned activities at year t in the project area; tCO_{2e}

Ex post carbon stock change in the project area under the project scenario is shown below.

Table 69. Total ex post estimated actual net changes in carbon stocks and emissions of GHG gases in the project area (Table 29 of VM0015 Methodology)

Project year t		Total ex post carbon stock decrease due to planned activities		Total ex post carbon stock increase due to planned activities		Total ex post carbon stock decrease due to unavoided unplanned deforestation		Total ex post carbon stock change		Total ex post estimated actual non-CO ₂ emissions from forest fires in the project area	
		annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
		ΔCPA_{dPA_t}	ΔCPA_{dPA}	$\Delta CPA_{iP_{A_t}}$	ΔCPA_{iPA}	$\Delta CUD_{dP_{A_t}}$	ΔCUD_{dPA}	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSP_{A_t}$	$EBBPSPA$
Initial	Final	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12-Nov-2020	11-Nov-2021	24.449,84	24.449,84	422,18	422,18	430,53	430,53	24.458,20	24.458,20	0,00	0,00

6.4 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 post 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.

In order to calculate the net carbon stock changes that the planned leakage prevention measures are expected to occasion during the monitoring period, the projected carbon stocks shall be estimated in the leakage management area under the baseline case and project scenario.

$$\Delta CLPMLK_t = \Delta CPSLK_t - \Delta CBSLLK_t$$

Where,

$\Delta CLPMLK_t$	Carbon stock decrease due to leakage prevention measures at year t ; tCO _{2e}
$\Delta CBSLLK_t$	Annual carbon stock changes in leakage management areas in the baseline case at year t ; tCO _{2e}
$\Delta CPSLK_t$	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 carried out by Juruena River REDD Project in the baseline case, no decrease in carbon stocks due to activities implemented in the leakage management area were identified, thus $\Delta CBSLLK = 0$. However, during the current monitoring period, there were carbon stock changes within the leakage management area due to deforestation of regenerated forests. Therefore, the *ex post* carbon stock change in leakage management areas in the project case ($\Delta CPSLK_t$) was calculated as follows. The annual values are detailed in the Table below.

$$\Delta CPSLK_t = APSLK_{fcl,t} * \Delta Ct_{ot,icl}$$

Where,

$\Delta CPSLK_t$	Annual carbon stock change in leakage management areas in the project case; tCO _{2e}
$APSLK_{fcl,t}$	Annual area of class fcl with decreasing carbon stock in leakage management areas in the project case at year t ; ha
$\Delta Ct_{ot,icl}$	Average carbon stock change of all accounted carbon pools in forest class icl at time t ; tCO _{2e} /ha

Table 70. Ex post carbon stock change in leakage management areas in the project case (Table 30b of VM0015 Methodology).

Project year	Carbon stock changes in leakage management area in the project case			
	ID _{fcl}	1	annual	cumulative
	APSLK _{fcl,t}	C _{tot} _{fcl,t}	ΔCPSLK _t	ΔCPSLK
	ha	tCO _{2e} /ha	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	0.00	8.67	0.00	0.00

The Table below shows that the net sum of carbon stock changes within the leakage management area during the current monitoring period is less than zero, i.e., leakage prevention measures are causing carbon stock decrease and therefore, are included as leakage emissions.

Table 71. Ex post estimated net carbon stock change in leakage management areas (Table 30c of VM0015 Methodology).

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	cumulative	annual	cumulative	annual	cumulative
	ΔCBSLLK_t	ΔCBSLLK	ΔCPSLK_t	ΔCPSLK	ΔCLPMLK_t	ΔCLPMLK
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	0.00	0.00	0.00	0.00	0.00	0.00

Furthermore, leakage prevention measures carried out by the present project during the current monitoring period did not include agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. However, it was considered that families in the LMA develop cattle ranching activities, according to information from the owners and which will be confirmed during field observation.

Therefore, emissions from grazing animals in leakage management areas (EgLK_t), which calculation is detailed below, are presented in the following table.

$$\text{EgLK}_t = \text{ECH}_4\text{ferm}_t + \text{ECH}_4\text{man}_t + \text{EN}_2\text{Oman}_t$$

Where,

EgLK_t	Emissions from grazing animals in leakage management areas at year t; tCO _{2e} /year
$\text{ECH}_4\text{ferm}_t$	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 ₂ O 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

Table 72. Ex post estimation of leakage emissions above the baseline from grazing animals in leakage management areas (Table 32 of VM0015 Methodology).

Project year	annual	annual	annual	annual	annual	annual	annual	annual	annual	cumulati ve
	Afforage	Pforage	Populati on	ECH4fer mt	ECH4ma nt	EdirN20m ant	EindN20m ant	EN20ma nt	EgLkt	EgLKt
	ha	kgd.m. yr	Nr Heads	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	0.00	0.00	180	282.24	5.04	0.54	0.08	0.62	287.9 0	287.90

Therefore, the total ex post estimated carbon stock changes and increases in GHG emissions due to leakage prevention measures during this monitoring period is calculated as follows.

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

ELPMLK_t Annual total increase in GHG emissions due to leakage prevention measures at year t; tCO_{2e}

Table 73. Ex post estimated total emissions above the baseline from leakage prevention activities (Table 33 of VM0015 Methodology).

Project year	Carbon stock decrease due to leakage prevention measures		Total ex post GHG emissions from increased grazing activities		Total ex post increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCLPMLK_t	ΔCLPMLK	EgLK_t	EgLK	ELPMLK_t	ELPMLK
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12/11/2020 to 11/11/2021	0.00	0.00	287.90	287.90	287.90	287.90

Ex post estimation of total leakage

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

$$\Delta\text{CLK}_t = \Delta\text{CLPMLK}_t + \Delta\text{CADLK}_t$$

Where:

- ΔCLK_t Total decrease in carbon stocks within the leakage belt at year t; tCO_{2e}
- ΔCLPMLK_t Carbon stock decrease due to leakage prevention measures at year t; tCO_{2e}
- ΔCADLK_t Total decrease in carbon stocks due to displaced deforestation at year t; tCO_{2e}

$$\text{ELK}_t = \text{EgLK}_t + \text{EADLK}_t$$

Where:

- ELK_t Sum of ex post leakage emissions at year t; tCO_{2e}
- EgLK_t Emissions from grazing animals in leakage management areas at year t; tCO_{2e}
- EADLK_t Total ex post increase in GHG emissions due to displaced forest fires at year t; tCO_{2e}

The results of all ex post estimations of leakage are summarized in the table below.

Table 74. Ex post estimated total leakage (Table 35 of VM0015 Methodology).

Project year	Total ex post GHG emissions from increased grazing activities		Total ex post increase in GHG emissions due to displaced forest fires		Total ex post 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	EADL _{K_t}	EADLK	ΔCADL _{K_t}	ΔCADLK	ΔCLPML _{K_t}	ΔCLPMLK	ΔCLK _t	ΔCLK	ELK _t	ELK
	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12/11/2020 – 11/11/2021	287.90	287.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	287.90	287.90

6.5 Net GHG Emission Reductions and Removals

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

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

Where:

$\Delta REDD_t$ *Ex post* net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t ; tCO₂e

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

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

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

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

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

ΔCLK_t Sum of *ex post* estimated leakage net carbon stock changes at year t ; tCO₂e

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

ELK_t Sum of *ex post* estimated leakage emissions at year t ; tCO₂e

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

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

$$VCU_t = \Delta REDD_t - VBC_t$$

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

Where:

VCU_t Number of Verified Carbon Units that can be traded at time t ; tCO₂e

Note: If $VCU_t < 0$ no credits (VCUs) will be awarded to the proponents of the AUD project activity.

$\Delta REDD_t$	<i>Ex post</i> estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t ; tCO _{2e}
VBC_t	Number of Buffer Credits deposited in the VCS Buffer at time t ; tCO _{2e}
$\Delta CBSLPA_t$	Sum of baseline carbon stock changes in the project area at year t ; tCO _{2e}
$\Delta CPSPA_t$	Sum of <i>ex post</i> carbon stock changes in the project area at year t ; tCO _{2e} ha ⁻¹
RF_t	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 ... T , a year of the proposed project crediting period; dimensionless.

The RF_t was estimated using the most recent version of the *VCS-approved AFOLU Non-Permanence Risk Tool* and the resulting value of RF_t for the present REDD project during the current monitoring period was 10%.

The specific summary of GHG reductions and removals in the Juruena River REDD project during the current monitoring period is included in Table below. The latter table includes estimates of GHG emissions reduction ($REDD_t$), calculations of buffer and leakage, and the resulting calculation of tradable Verified Carbon Units (VCU_t).

Table 75. Ex post estimated net anthropogenic GHG emissions reductions and VCUs (Table 36 of VM0015 Methodology)

Project year		Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex post project carbon stock changes		Ex post project GHG emissions from biomass burning		Ex post leakage carbon stock changes		Ex post leakage GHG emissions		Total carbon stock decrease due to forest fires		Total carbon stock decrease due to catastrophic events		Ex post net anthropogenic GHG emission reductions		Ex post VCUs tradable		Ex post buffer credits	
		annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
		ΔCBSLP_{At}	ΔCBSLP_A	EBBBSL_{PA_t}	EBBBSL_{PA}	ΔCPSPA_t	ΔCPSPA	EBBPS_{PA_t}	EBBPS_{PA}	ΔCLK_t	ΔCLK	ELK_t	ELK	ΔCUFd_{PA_t}	ΔCUFd_{PA}	ΔCUCdP_{At}	ΔCUCdPA_t	ΔREDD_t	ΔREDD	VCU_t	VCU	VBC_t	VBC
Initial	Final	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}	tCO _{2e}	tCO _{2e}	tCO _{2e}	tCO _{2e}
12-Nov-2020	11-Nov-2021	53,331,21	53,331,21	0,00	0,00	24,458,20	24,458,20	0,00	0,00	0,00	0,00	287,90	287,90	0,00	0,00	0,00	0,00	28,585,11	28,585,11	25,726,60	25,726,60	2,858,51	2,858,51

In addition, the net GHG emission reductions and removals in the Juruena River REDD Project are summarized in the Table below.

**Table 76. Net GHG emissions reductions and removals in the Juruena River REDD Project
(Summary of net GHG Emission Reductions and Removals)**

Vintage period		Baseline emissions (tCO ₂ e)	Project emissions (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Buffer pool allocation (tCO ₂ e)	Reductions VCU (tCO ₂ e)	Removals VCU (tCO ₂ e)	Total VCU issuance (tCO ₂ e)
Initial	Final							
12-Nov-2020	31-Dec-2020	7,305.65	3,350.44	39.44	391.58	3,524.19	0.00	3,524.19
01-Jan-2021	11-Nov-2021	46,025.57	21,107.76	248.46	2,466.93	22,202.41	0.00	22,202.41
Total		53,331	24,458	287	2,858	25,726	0.00	25,726

APPENDIX I: PROJECT AREA CONTOUR COORDINATES

Project Area Contour Coordinates																	
UTM 21S, Datum WGS84																	
Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
1	350738.59	8934986.5	36	351476.77	8934191.71	71	350940.26	8932031.58	106	341899.28	8934713.9	141	351638.06	8943622.28	176	351670.14	8941030.47
2	350736.03	8934683.36	37	351476.68	8934189.57	72	350939.26	8932029.64	107	353926.18	8944339.68	142	351636.59	8943620.66	177	351670.95	8941028.52
3	350733.46	8934379.24	38	351476.77	8934058.84	73	350938.43	8932027.62	108	353952.6	8943858.9	143	351635.27	8943618.93	178	351671.93	8941026.65
4	350733.46	8934378.93	39	351326.75	8933805.45	74	350937.78	8932025.54	109	353951.7	8943858.86	144	351634.11	8943617.08	179	351672.36	8941025.9
5	350733.57	8934376.75	40	351177.51	8933553.35	75	350937.32	8932023.41	110	353951.49	8943858.84	145	351633.11	8943615.15	180	351681.11	8939427.42
6	350733.86	8934374.59	41	351095.28	8933519.49	76	350937.04	8932021.24	111	353554.56	8943819.25	146	351632.28	8943613.13	181	351573.07	8939346.43
7	350734.34	8934372.46	42	351093.72	8933518.79	77	350936.96	8932019.06	112	353157.64	8943779.65	147	351631.64	8943611.04	182	351571.92	8939345.51
8	350735	8934370.39	43	351092.21	8933517.98	78	350936.97	8932018.7	113	352886.73	8943752.62	148	351631.17	8943608.91	183	351570.74	8939344.44
9	350735.85	8934368.38	44	351090.38	8933516.8	79	347613.93	8931974.15	114	352760.71	8943740.05	149	351630.9	8943606.75	184	351570.3	8939344.02
10	350736.86	8934366.45	45	351088.66	8933515.46	80	339869.6	8931868.86	115	352415.56	8943705.61	150	351630.81	8943604.57	185	351568.42	8939342
11	350738.04	8934364.61	46	351087.05	8933513.98	81	339895.77	8931982.32	116	352395.49	8943703.61	151	351630.83	8943603.68	186	351567.41	8939340.71
12	350739.37	8934362.89	47	351085.59	8933512.37	82	340092.11	8932112.94	117	351961.84	8943660.33	152	351632.67	8943557.26	187	351566.5	8939339.36
13	350740.85	8934361.29	48	351084.52	8933511	83	340337.59	8931946.57	118	351950.61	8943663.81	153	351634.02	8943523.3	188	351483.24	8939207.57
14	350742.47	8934359.82	49	351083.56	8933509.56	84	340424.8	8932067.83	119	351949.05	8943664.23	154	351634.23	8943518.14	189	351482.68	8939206.63
15	350744.2	8934358.5	50	350940.68	8933279.37	85	340547.06	8932074.63	120	351947.47	8943664.56	155	351636.89	8943451	190	351481.82	8939204.99
16	350746.05	8934357.33	51	350940.23	8933278.6	86	340559.47	8932230.23	121	351945.31	8943664.83	156	351642.21	8943316.91	191	351481.08	8939203.29
17	350747.98	8934356.33	52	350939.23	8933276.67	87	340687.06	8932193	122	351943.13	8943664.92	157	351649.79	8943126.19	192	351432.46	8939078.35
18	350750	8934355.51	53	350938.4	8933274.65	88	340769.13	8932335.73	123	351940.95	8943664.82	158	351662.67	8942801.81	193	351432.24	8939077.74
19	350752.08	8934354.86	54	350937.75	8933272.57	89	340676.65	8932574.17	124	351938.79	8943664.52	159	351664.82	8942406.74	194	351431.64	8939075.84
20	350754.22	8934354.4	55	350937.29	8933270.43	90	340876.13	8933225.36	125	351936.66	8943664.04	160	351666.98	8942011.23	195	351431.19	8939073.9
21	350756.38	8934354.12	56	350937.01	8933268.27	91	340952.77	8933203.88	126	351934.59	8943663.38	161	351668.34	8941762.12	196	351410.33	8938962.8
22	350758.56	8934354.03	57	350936.93	8933266.09	92	341115	8933400.85	127	351932.57	8943662.54	162	351669.14	8941615.73	197	351410.3	8938962.65
23	350759.39	8934354.05	58	350937.03	8933263.91	93	341121.98	8933559.47	128	351930.64	8943661.52	163	351671.48	8941187.13	198	351382.97	8938812.36
24	351154.48	8934368.8	59	350937.32	8933261.75	94	341249.44	8933595.11	129	351928.81	8943660.34	164	351670.7	8941185.89	199	351345.15	8938698.89
25	351531.69	8934382.88	60	350937.8	8933259.63	95	341322.59	8933496.72	130	351927.08	8943659.01	165	351669.7	8941183.95	200	351284.24	8938659.89
26	351529.25	8934298.28	61	350938.47	8933257.55	96	341493.48	8933771.68	131	351925.8	8943657.85	166	351668.87	8941181.94	201	351282.12	8938658.85
27	351529.21	8934296.89	62	350939.31	8933255.54	97	341521.73	8933989.36	132	351924.6	8943656.61	167	351668.23	8941179.85	202	351280.48	8938657.98
28	351528.19	8934261.62	63	350940.33	8933253.61	98	341479.86	8934082.7	133	351653.32	8943629.54	168	351667.76	8941177.72	203	351278.64	8938656.8
29	351482.31	8934205.39	64	350941.5	8933251.77	99	341483.35	8934222.14	134	351651.37	8943629.27	169	351667.49	8941175.56	204	351276.92	8938655.46
30	351481.07	8934203.75	65	350942.84	8933250.05	100	341592.3	8934390.58	135	351649.24	8943628.79	170	351667.4	8941173.33	205	351275.31	8938653.98
31	351479.98	8934202	66	350943.04	8933249.81	101	341809.56	8934330.21	136	351647.16	8943628.13	171	351668.45	8941039.75	206	351273.85	8938652.37
32	351478.98	8934200.06	67	351215.5	8932935.84	102	341872.36	8934375.53	137	351645.15	8943627.28	172	351668.56	8941037.62	207	351272.53	8938650.63
33	351478.15	8934198.05	68	351238.22	8932660.61	103	341854.01	8934495.55	138	351643.22	8943626.27	173	351668.85	8941035.5	208	351271.36	8938648.79
34	351477.5	8934195.96	69	351121.79	8932303.54	104	341706.64	8934546.35	139	351641.39	8943625.09	174	351669	8941034.66	209	351270.36	8938646.85
35	351477.04	8934193.83	70	350941.16	8932033.05	105	341769.44	8934607.36	140	351639.66	8943623.76	175	351669.48	8941032.54	210	351269.54	8938644.83

Project Area Contour Coordinates

UTM 21S, Datum WGS84

Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
211	351268.89	8938642.75	253	346708.93	8938398.5	295	347459.23	8941828.2	337	321953.84	8995615.02	379	319548.69	8998300.37	421	317661.8	8998590.7
212	351268.43	8938640.62	254	346716.84	8938485.53	296	347604.87	8942040.75	338	321408.17	8995850.76	380	319549.1	8998302.31	422	317660.98	8998588.68
213	351268.15	8938638.46	255	346726.62	8938562.19	297	347672.39	8942188.55	339	321649.7	8996403.7	381	319549.38	8998304.47	423	317660.18	8998585.98
214	351268.06	8938636.28	256	346783.59	8938551.71	298	347664.32	8942334.26	340	321649.9	8996404.16	382	319549.46	8998306.65	424	317567.69	8998194.59
215	351268.17	8938634.1	257	346826.13	8938511.64	299	347645.09	8942463.55	341	321650.53	8996405.72	383	319549.36	8998308.83	425	317475.2	8997803.2
216	351268.46	8938631.94	258	346876.76	8938508.78	300	347642.69	8942666.39	342	321651.17	8996407.8	384	319549.06	8998310.99	426	317382.72	8997411.81
217	351268.94	8938629.81	259	346887.77	8938574.87	301	347746.68	8942913.83	343	321651.64	8996409.93	385	319548.58	8998313.12	427	317290.24	8997020.41
218	351269.6	8938627.73	260	346828.32	8938662.14	302	347799.14	8943109.51	344	321651.91	8996412.1	386	319547.92	8998315.19	428	317289.93	8997018.89
219	351270.45	8938625.72	261	346840.16	8938788.8	303	347858.09	8943161.21	345	321652	8996414.28	387	319547.07	8998317.2	429	317289.65	8997016.73
220	351271.46	8938623.79	262	346886.96	8938781.5	304	348052.81	8943295.78	346	321651.89	8996416.46	388	319546.06	8998319.13	430	317289.57	8997014.55
221	351272.64	8938621.96	263	347021.59	8938828.04	305	348157.72	8943453.02	347	321651.6	8996418.62	389	319544.88	8998320.97	431	317289.67	8997012.37
222	351273.97	8938620.23	264	347174.67	8938805.77	306	348175.2	8943528.15	348	321651.11	8996420.74	390	319543.54	8998322.69	432	317289.97	8997010.21
223	351275.45	8938618.63	265	347273.88	8938831.8	307	348091.28	8943678.4	349	321650.45	8996422.82	391	319542.06	8998324.29	433	317289.45	8997008.08
224	351277.07	8938617.16	266	347226.89	8938911.83	308	347996.41	8943862.95	350	321649.61	8996424.83	392	319540.45	8998325.76	434	317291.11	8997006.01
225	351277.5	8938616.81	267	347304.92	8939062.82	309	347856.53	8944032.42	351	321648.59	8996426.76	393	319538.71	8998327.08	435	317291.96	8997004
226	351281.84	8938613.36	268	347357.53	8939136.85	310	347650.2	8944102.31	352	321647.41	8996428.6	394	319536.87	8998328.24	436	317292.97	8997002.07
227	351371.82	8938541.82	269	347404.74	8939288.83	311	347605.85	8944255.34	353	321646.08	8996430.32	395	319534.93	8998329.24	437	317294.15	8997000.23
228	351372.14	8938541.57	270	347452.6	8939442.4	312	350177.53	8944283.18	354	321644.59	8996431.92	396	319532.91	8998330.07	438	317295.49	8996998.51
229	351461.46	8938472.86	271	347445.9	8939572.92	313	316048.22	9000818.25	355	321642.98	8996433.39	397	319530.82	8998330.71	439	317296.97	8996996.91
230	351462.84	8938471.87	272	347443.84	8939749.96	314	316686.49	9000760.15	356	321641.24	8996434.71	398	319528.69	8998331.18	440	317298.59	8996995.44
231	351464.29	8938470.98	273	347534.85	8939865.03	315	318577.33	9000405.3	357	321639.4	8996435.87	399	319528.35	8998331.23	441	317300.32	8996994.12
232	351465.78	8938470.19	274	347569.02	8939955.13	316	320182.9	9000237.68	358	321637.45	8996436.85	400	319040.95	8998407.98	442	317302.17	8996992.96
233	351467.32	8938469.5	275	347653.53	8940152.57	317	321239.05	9000126.79	359	321636.67	8996437.2	401	319040.61	8998408.03	443	317304.11	8996991.96
234	351473.26	8938467.1	276	347760.5	8940456.37	318	322402.12	8999543.57	360	321635.45	8996437.71	402	318552.87	8998484.82	444	317306.12	8996991.13
235	351474.19	8938466.75	277	347770.34	8940624.9	319	322284.39	8999462.68	361	321530.86	8996481.65	403	318540.68	8998486.74	445	317308.21	8996990.49
236	351474.74	8938466.55	278	347667.63	8940719.39	320	322273.13	8999021.95	362	321171.81	8996632.43	404	318540.22	8998486.81	446	317310.34	8996990.02
237	351487.54	8938462.29	279	347585.45	8940745.6	321	322238.3	8998855.9	363	320409.42	8996952.58	405	318114.08	8998545.91	447	317312.55	8996989.75
238	351511.68	8938454.24	280	347414.1	8940873.14	322	322031.34	8998596.74	364	320396.45	8996958.03	406	317687.94	8998605	448	317332.69	8996988.12
239	351513.5	8938453.71	281	347328.42	8940916.82	323	321835.67	8998440.54	365	320309	8996994.75	407	317686.17	8998605.18	449	317758.15	8996953.7
240	351515.34	8938453.32	282	347192.03	8941018.15	324	321749.06	8997987.48	366	320062.24	8997098.37	408	317684.39	8998605.23	450	318183.61	8996919.29
241	351515.69	8938453.36	283	347127.34	8941095.02	325	321745.13	8997936.44	367	319814.7	8997202.31	409	317682.21	8998605.13	451	318609.07	8996884.87
242	351516.49	8938453.12	284	347150.57	8941195.64	326	321913.18	8997806.15	368	319813.47	8997202.79	410	317680.05	8998604.84	452	319028.17	8996850.96
243	351518.49	8938452.9	285	347390.72	8941279.82	327	321820.61	8997681.54	369	319812.96	8997202.96	411	317677.93	8998604.35	453	318550.82	8995461.11
244	351520.49	8938452.83	286	347414.1	8941129.96	328	321976.7	8997488.91	370	319716.96	8997235.11	412	317675.85	8998603.69	454	320643.16	8994268.57
245	351520.7	8938452.83	287	347595.94	8941074.06	329	322017.72	8997307.67	371	319635.41	8997262.41	413	317673.84	8998602.84	455	320376.7	8993767.97
246	351632.19	8938454.18	288	347651.89	8941121.23	330	322127.83	8997023.24	372	319553.86	8997289.72	414	317671.91	8998601.83	456	320172.17	8993342.34
247	351676.27	8938435.53	289	347711.22	8941275.28	331	322128.44	8996740.5	373	319425.39	8997332.74	415	317670.07	8998600.65	457	320143.17	8993163.52
248	351675.6	8938375.65	290	347811.65	8941323.31	332	322037.36	8996464.82	374	319240.04	8997394.79	416	317668.35	8998599.31	458	319999.36	8992938.02
249	351675.47	8938363.03	291	347802.73	8941418.5	333	321980.22	8996372.61	375	319279.35	8997510.1	417	317666.75	8998597.83	459	319923.47	8992856.51
250	351675.39	8938361.11	292	347611.6	8941538.13	334	321849.62	8996260.97	376	319282.76	8997520.1	418	317665.28	8998596.22	460	319883.72	8992618.32
251	351675.4	8938360.96	293	347534.67	8941616.75	335	321822.23	8996061.32	377	319446.4	8998000.09	419	317663.96	8998594.48	461	319781.6	8992617.63
252	351675.38	8938360.73	294	347468.23	8941688.38	336	321875.11	8995781.89	378	319548.13	8998298.47	420	317662.8	8998592.64	462	319785.96	8992479.79

Project Area Contour Coordinates

UTM 21S, Datum WGS84

Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
463	319688.44	8992383.9	505	313119.87	8987385.55	547	312661.17	8989412.91	589	309137.18	8988383.05	631	307026.02	8982045.01	673	310356.8	8984016.13
464	319471.55	8992002.2	506	313102.54	8987399.88	548	312659.34	8989411.73	590	309136.18	8988381.12	632	307026.31	8982042.85	674	310639.49	8984324.55
465	319346.48	8991807.64	507	313094.56	8987406.49	549	312657.61	8989410.39	591	309135.35	8988379.1	633	307026.79	8982040.72	675	310736.69	8984430.59
466	319280.01	8991520.24	508	312566.68	8987843.11	550	312657.12	8989409.96	592	309134.71	8988377.01	634	307027.46	8982038.64	676	310743.5	8984438.02
467	319197.92	8991057.68	509	312970.79	8988270.03	551	312080.25	8988894.42	593	309134.25	8988374.88	635	307028.31	8982036.63	677	311049.02	8984771.32
468	319224.54	8990506	510	313378.28	8988700.49	552	312043.66	8988925.29	594	309133.97	8988372.72	636	307029.32	8982034.7	678	311049.83	8984772.23
469	319126.91	8990300.71	511	313433.52	8988758.85	553	312043.52	8988925.41	595	309133.89	8988370.54	637	307030.5	8982032.87	679	311190.67	8984925.85
470	318843.28	8990111.74	512	313434.59	8988760.06	554	312027.25	8988939.15	596	309133.99	8988368.36	638	307031.84	8982031.14	680	311535.22	8985301.72
471	318659.77	8989958.55	513	313435.91	8988761.8	555	311479.1	8989401.65	597	309134.29	8988366.2	639	307033.08	8982029.78	681	311550.61	8985318.51
472	318392.71	8989714.68	514	313437.08	8988763.64	556	311469.19	8989410.01	598	309134.77	8988364.07	640	307034.42	8982028.51	682	311688.45	8985468.88
473	318244.4	8989573.85	515	313438.08	8988765.58	557	311047.3	8989766	599	309135.44	8988361.99	641	307037.31	8982025.98	683	311770.55	8985558.44
474	318076.64	8989534.27	516	313438.9	8988767.6	558	311047.15	8989766.12	600	309136.28	8988359.98	642	307044.89	8982019.33	684	311812.51	8985604.21
475	317754.41	8989547.74	517	313439.55	8988769.68	559	311045.41	8989767.43	601	309137.3	8988358.05	643	307050.94	8981540.19	685	311829.56	8985622.8
476	317455.72	8989565.01	518	313440.01	8988771.82	560	311043.57	8989768.6	602	309138.48	8988356.22	644	307847.84	8981314.76	686	312046.48	8985859.43
477	317145.93	8989556.85	519	313440.28	8988773.98	561	311041.63	8989769.6	603	309139.81	8988354.5	645	307848.35	8981314.32	687	312077.05	8985892.78
478	316759.68	8989440.44	520	313440.37	8988776.16	562	311039.61	8989770.42	604	309141.75	8988352.45	646	307850.09	8981313	688	312273.88	8986107.48
479	316524.84	8989233.91	521	313440.26	8988778.34	563	311037.01	8989771.2	605	311168.86	8986444.88	647	307851.93	8981311.84	689	312331.52	8986170.36
480	316436.67	8989020.27	522	313439.97	8988780.5	564	310787.26	8989831.15	606	311042.3	8986310.85	648	307853.87	8981310.84	690	312384.8	8986228.47
481	316514.24	8988567.54	523	313439.49	8988782.63	565	310785.65	8989831.48	607	311026.35	8986293.95	649	307855.89	8981310.02	691	315625.95	8983432.02
482	316584.37	8988309.94	524	313438.82	8988784.7	566	310783.49	8989831.75	608	310736.26	8985986.73	650	307857.97	8981309.37	692	315557.07	8983394.72
483	316656.82	8987974.25	525	313437.98	8988786.71	567	310781.31	8989831.84	609	310195.01	8985413.51	651	307860.1	8981308.91	693	315466.69	8983299.27
484	316642.34	8987893.6	526	313436.96	8988788.64	568	310779.13	8989831.73	610	309700.48	8984889.77	652	307862.27	8981308.64	694	315195.23	8983320.5
485	316657.65	8987575.36	527	313435.78	8988790.48	569	310776.97	8989831.44	611	309247.99	8984410.61	653	307864.45	8981308.55	695	314941.5	8983400.37
486	316559.39	8987312.85	528	313434.44	8988792.2	570	310774.84	8989830.95	612	309239.53	8984401.65	654	307866.63	8981308.66	696	314706.59	8983412.29
487	316526.97	8986808.67	529	313432.96	8988793.8	571	310772.77	8989830.29	613	308942.71	8984087.31	655	307868.79	8981308.95	697	314662.2	8983336.81
488	316430.76	8986588.24	530	313431.35	8988795.27	572	310770.75	8989829.44	614	308935.83	8984080.03	656	307870.91	8981309.44	698	314685.73	8983268.18
489	316395.7	8986281.64	531	313430.16	8988796.2	573	310768.82	8989828.43	615	308024.92	8983115.34	657	307872.99	8981310.1	699	314777.78	8983190.99
490	316329.51	8986065.03	532	313429.36	8988796.79	574	310766.99	8989827.25	616	308005.02	8983094.26	658	307875	8981310.95	700	314810.08	8983045.72
491	316240.64	8986007.74	533	312689.74	8989410.55	575	310765.27	8989825.91	617	307846.34	8982926.2	659	307876.93	8981311.96	701	314744.56	8982888.78
492	316203.33	8985954.66	534	312688.01	8989411.87	576	310764.86	8989825.55	618	307781.44	8982857.47	660	307878.77	8981313.14	702	314680.58	8982760.64
493	316180.86	8985660.87	535	312686.17	8989413.03	577	309570.44	8988768.18	619	307743.53	8982817.32	661	307880.49	8981314.48	703	314603.37	8982629.81
494	316179.52	8985371.24	536	312684.23	8989414.02	578	309562.16	8988760.85	620	307734.08	8982807.3	662	307882.76	8981316.66	704	314517.8	8982539.71
495	316165.75	8984865.94	537	312682.21	8989414.85	579	309236.19	8988472.29	621	307032.73	8982064.47	663	307923.03	8981360.61	705	314488.71	8982494.63
496	315705.24	8985246.92	538	312680.13	8989415.49	580	309173.95	8988417.19	622	307031.68	8982063.28	664	307929.79	8981367.99	706	314323.64	8982371.15
497	315465.82	8985444.98	539	312678	8989415.96	581	309145.09	8988391.64	623	307030.36	8982061.55	665	308091.11	8981544.02	707	314246.27	8982275.59
498	315405.48	8985494.9	540	312675.84	8989416.23	582	309143.28	8988390.19	624	307029.2	8982059.7	666	308359.66	8981837.07	708	314191.27	8982180.17
499	315396.06	8985502.69	541	312673.66	8989416.32	583	309142.72	8988389.73	625	307028.2	8982057.76	667	308422.91	8981906.08	709	314108.78	8982114.17
500	313685.42	8986917.76	542	312671.48	8989416.21	584	309141.12	8988388.25	626	307027.38	8982055.74	668	308454.15	8981940.17	710	314054.58	8982042.95
501	313418.35	8987138.67	543	312669.32	8989415.92	585	309140.62	8988387.7	627	307026.73	8982053.66	669	309142.63	8982691.41	711	314014.35	8981831.53
502	313333.88	8987208.53	544	312667.19	8989415.43	586	309140.62	8988387.69	628	307026.27	8982051.53	670	309623.9	8983216.52	712	313857.52	8981754.26
503	313319.01	8987220.83	545	312665.11	8989414.77	587	309139.66	8988386.64	629	307026	8982049.36	671	309956.87	8983579.81	713	313667.75	8981674.7
504	313136.09	8987372.13	546	312663.1	8989413.92	588	309138.34	8988384.9	630	307025.91	8982047.18	672	309963.64	8983587.19	714	313489.34	8981647.78

Project Area Contour Coordinates

UTM 21S, Datum WGS84

Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y	Point	X	Y
715	313282.65	8981632.73	757	312415.82	8975536.19	799	297345.87	8978099.91	841	315558.47	8999544.89						
716	313197.81	8981554.08	758	312314.83	8975365.16	800	297343.79	8978100.55	842	315558.48	8999544.89						
717	313105.52	8981408.33	759	312253.73	8975103.17	801	297341.66	8978101.01	843	315558.48	8999544.9						
718	312980.94	8981232.93	760	312061.49	8974949.82	802	297339.49	8978101.29									
719	313021.76	8981114.7	761	311885.74	8974871.93	803	297337.32	8978101.37									
720	312885.31	8981040.38	762	311905.16	8974652.82	804	297336.41	8978101.35									
721	312794.93	8980980.94	763	311806.26	8974507.28	805	297281.87	8978099.09									
722	312638.01	8981007.37	764	311750.25	8974323.02	806	297265.12	8978098.39									
723	312504.12	8980790.31	765	311812.14	8974160.68	807	296936.62	8978084.76									
724	312478.53	8980856.58	766	311764.4	8973932.65	808	296918.47	8978084.01									
725	312350.5	8980838.39	767	311766.98	8973740.74	809	296767.37	8978077.74									
726	312343.37	8980717.7	768	311573.77	8973667.48	810	296704.76	8978075.14									
727	312379.13	8980608.94	769	311421.04	8973527.91	811	296513.15	8978067.19									
728	312515.83	8980479.55	770	311149.51	8973349.25	812	296502.41	8978066.74									
729	312734.92	8980284.22	771	311053.61	8973200.33	813	296378.88	8978061.62									
730	312839.13	8980226.61	772	309669.04	8973181.34	814	296126.36	8978051.13									
731	312742.31	8980014.13	773	298876.26	8973095.93	815	295598.67	8978029.21									
732	312730.38	8979758.81	774	298796.69	8976434.72	816	295597.77	8978029.19									
733	312721.43	8979528.73	775	297373.6	8976426.18	817	295596.04	8978029.08									
734	312871.13	8979281.9	776	297373.6	8976426.25	818	295580.96	8978028.49									
735	312915.7	8979115.78	777	297372.59	8976614.49	819	295579.45	8978028.43									
736	313019.48	8978956.27	778	297372.48	8976616.67	820	295569.52	8978028.01									
737	312970.93	8978768.98	779	297372.19	8976618.83	821	294999.08	8978004.32									
738	312836.37	8978657.11	780	297372.08	8976619.37	822	294984.54	8978003.71									
739	312770.11	8978482.49	781	297369.69	8976631.07	823	293964.4	8977961.32									
740	312875.59	8978359.07	782	297365.44	8977282.74	824	293954.43	8977960.91									
741	312920.4	8978177.04	783	297365.32	8977285.08	825	293170.27	8977928.3									
742	313002.09	8978016.36	784	297363.83	8977299.85	826	292547.31	8977901.76									
743	312913.73	8977859.22	785	297362.45	8978076.45	827	292537.45	8977901.34									
744	313087.87	8977738.86	786	297362.34	8978078.68	828	292411.05	8977895.95									
745	313194.04	8977500.99	787	297362.04	8978080.84	829	292400.67	8977895.47									
746	313236.3	8977237.44	788	297361.56	8978082.96	830	292304.19	8981380.32									
747	313186.19	8977050.61	789	297360.89	8978085.04	831	298698.53	8980980.15									
748	313067.44	8976971.71	790	297360.05	8978087.05	832	300454.98	8985057.31									
749	312996.65	8976829.51	791	297359.03	8978088.98	833	300454.98	8985057.32									
750	313020.91	8976681.02	792	297357.85	8978090.81	834	299466.23	8985348.47									
751	312983.09	8976480.17	793	297356.51	8978092.54	835	299749.19	8992239.55									
752	312853.35	8976365.82	794	297355.03	8978094.14	836	303496.99	8992261.74									
753	312808.92	8976227.74	795	297353.42	8978095.6	837	308983.5	8992274.75									
754	312677.14	8976000.78	796	297351.68	8978096.92	838	308983.51	8992274.75									
755	312657.64	8975800.48	797	297349.83	8978098.08	839	308983.51	8992274.76									
756	312576.19	8975631.65	798	297347.89	8978099.08	840	308764.44	8999548.86									

APPENDIX II: 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 MapBiomass (version 5.0, which was the last available version), available in raster format, which can be downloaded from the <http://mapbiomas.org/> website. MapBiomass is a multi-institutional initiative of the Greenhouse Gas Emissions Estimation System (SEEG - <http://seeg.eco.br/en/>) promoted by the Climate Observatory. MapBiomass co-creation involves NGO's, universities and technology companies.

Table 77. Source of the remotely sense data used for historical reference period

Vector	Sensor	Resolution		Coverage (Km ²)	Acquisition date 2007 to 2020	Scene	
		Spatial (m)	Spectral (µm)			Path/ Latitude	Row/ Longitude
Satellite	Landsat TM	30	0.45 - 2.35	34.225	2007 a 2020	229	67
Satellite	Landsat TM	30	0.45 - 2.35	34.225	2007 a 2020	229	66
Satellite	Landsat TM	30	0.45 - 2.35	34.225	2007 a 2020	228	67

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

The MapBiomass 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 table below:

Figure 71. Number of Landsat images for mapping the Amazon. Source: MapBiomass

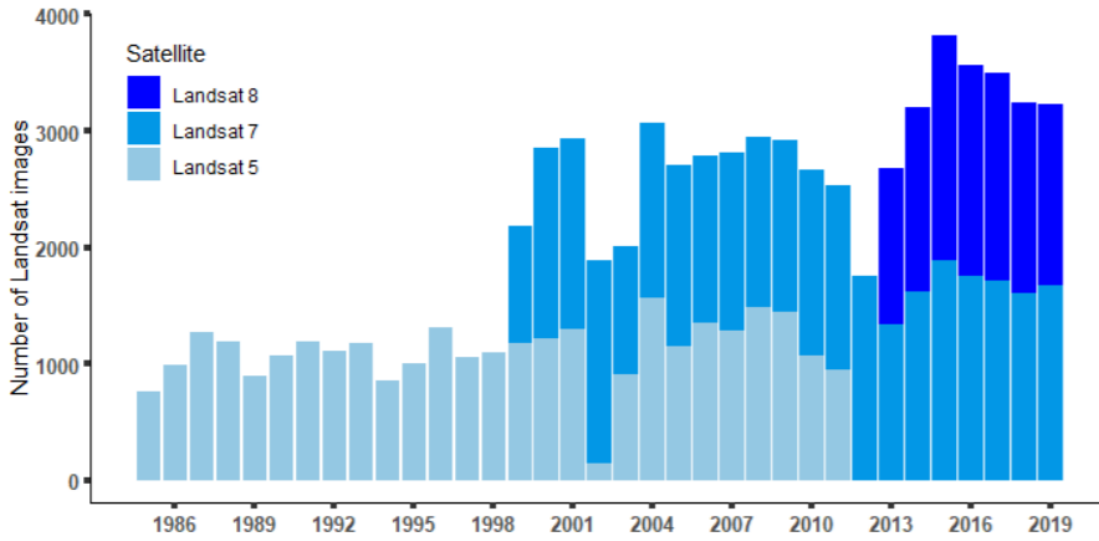


Figure 72. List, description and reference of bands, fractions and indexes available in the feature space

	band or index name	formula	Reducer					Reference	
			median	median_dry	median_wet	amplitude	std Dev		min
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	$(2.5 * (nir - red)/(nir + 2.4 * red + 1))$							
	cal	$(swir2 / swir1)$							
	ndwi	$(nir - swir1)/(nir + swir1)$							
	gcv	$(nir / green - 1)$							
	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	<code>('median_green').entropy(ee.Kernel.square({radius: 5}))</code>							
	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		$100 - (gv + npv + soil + cloud)$							
gvs		$gv / (gv + npv + soil + cloud)$							
MEM index	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 MapBiomass were accessible via Google Earth Engine, and most of them are composed by the Collection 1 Tier 1 from USGS. This is the highest quality Level-1 products suitable for pixel-level time series analysis. These images are radiometrically calibrated and orthorectified using ground control points (GCPs) and digital elevation model (DEM) data to correct for relief displacement.

Data classification and post-processing

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

- a) Forested areas that remains as forested areas (Conservation);
- b) Forest that are converted to non-forested areas (Deforestation); or
- c) Non-forested areas that remains as non-forested areas.

The image classification methodology for each year involves all Landsat images available for each period (Landsat 5 [L5], Landsat 7 [L7] and Landsat 8 [L8]) or other sensor available) with a cloud cover less than or equal to 50%, and in accordance with its 30m resolution, the minimum mapping unit was defined at 30x30m (0.09ha), therefore falling easily to the methodology requirement that the MMU cannot be larger than 1ha. Thus, a representative mosaic of each year could be generated, selecting cloud free pixels from the available images. Metrics should be extracted for each pixel that describes its behavior during the year and could contain up to 105 layers of information. The mapping should be done with an artificial intelligence classifier, such as the Random 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 MapBiomass 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 MapBiomass 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 neighbour 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 in the 34 years of time span. All pixels that changed more than eight times and are connected to less than 6 pixels were replaced by the MODE value of that given pixel position in the stack of years.

Classification accuracy assessment

The MapBiomass 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 MapBiomass methodology, a confusion matrix was generated calculating the percentages of user and producer correctness, as well as omission and commission errors.

A total of 240 random points was drawn on the reference region (80 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 78. Summary of confusion matrices from the evaluation of MapBiomass from 2007 to 2020

Year	Producer Accuracy				User Accuracy			
	Forest	Hydrography	Country Formation	Deforestation	Forest	Hydrography	Country Formation	Deforestation
2007	86.52%	94.74%	81.48%	94.59%	96.25%	90.00%	82.50%	87.50%
2008	88.89%	96.25%	82.19%	82.56%	90.00%	96.25%	75.00%	88.75%
2009	91.25%	100.00%	79.52%	84.62%	91.25%	98.75%	82.50%	82.50%
2010	94.81%	94.81%	80.23%	88.75%	91.25%	91.25%	86.25%	88.75%
2011	94.94%	93.75%	82.50%	91.36%	93.75%	93.75%	82.50%	92.50%
2012	92.94%	97.30%	79.31%	91.89%	98.75%	90.00%	86.25%	85.00%
2013	94.81%	95.00%	79.52%	91.25%	91.25%	95.00%	82.50%	91.25%
2014	96.20%	100.00%	79.55%	87.65%	95.00%	90.00%	87.50%	88.75%
2015	97.47%	100.00%	80.00%	86.25%	96.25%	95.00%	85.00%	86.25%
2016	97.40%	100.00%	87.80%	90.36%	93.75%	97.50%	90.00%	93.75%
2017	93.98%	97.40%	88.31%	90.36%	97.50%	93.75%	85.00%	93.75%
2018	86.52%	94.74%	81.48%	94.59%	96.25%	90.00%	82.50%	87.50%
2019	97.26%	90.24%	79.76%	90.12%	88.75%	92.50%	83.75%	91.25%
2020	96.20%	100.00%		94.12%	95.00%	95.00%		100.00%