YELLOW IPÊ GROUPED REDD PROJECT

Document Prepared by Ecológica Assessoria

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1. Project Details

1.1 Summary Description of the Project

In Brazil, 58.39% of its entire 851,029,591.4 ha territory (IBGE, 2019[1]) is covered by forests, representing almost 497 million hectares of forest area (FAO, 2020[2]) and putting it in second place for nations with most forest area worldwide. Brazil has also been at times the country with the highest levels of deforestation in the world, having lost almost 15 million hectares of its forest area from 2010 to 2020 (FAO, 2020[3]). The expansion of the agriculture frontier due to cattle ranching, soy farming, timber collection, infrastructure and colonization by subsistence agriculturalists has contributed to this historically high deforestation rate, which is concentrated in the northern portion of the country, where the Amazon Rainforest lies.

The Yellow Ipê Grouped REDD Project is located in the municipalities of Novo Aripuanã and Borba, south of Amazonas state, in the Northern region of Brazil. The region is surrounded by many rivers, its borders having direct contact with three of them: Rio Sucunduri, Rio Camaiú and Rio Camaiuxazinho. The Trans-Amazonian Highway BR-230 is located south of the municipality and, along its route, cattle raising can be found, which is one of the many drivers to deforestation in the region (WWF-Brasil, 2017[4]).

The primary objective of the Yellow Ipê Grouped REDD Project is to avoid unplanned deforestation (AUD) of a region within the municipalities of Novo Aripuanã and Borba. The first Project activity instance has 86,091.66 ha project area, which is within two private properties in Novo Aripuanã, consisting of 100% Amazon rainforest and owned by Getulio Matias da Silva (hereafter, Grupo Leão or "the farm"). The contract signing between Grupo Leão and Ecológica Assessoria, on 12-February-2020, was the first action in terms of initiating the present REDD project and has thus designated this date as its project start date. The project's crediting period start is 01-March-2020. However, other REDD project

[1] IBGE – Instituto Brasileiro de Geografia e Estatística. Brasil. 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] WWF-Brasil. Perfil socioeconômico e ambiental do sul do estado do Amazonas: Subsídios para Análise da Paisagem. 2017. Available at: <https://d3nehc6yl9qzo4.cloudfront.net/downloads/perfil_sul_amazonas.pdf>.

instances could be inserted into this grouped project activity in the future, as long as they comply with the eligibility criteria defined in sections below.

Besides the ecological and carbon benefits of the project, a proportion of the carbon credits generated will be dedicated to improving social and environmental conditions for the local community around the project area, specifically contributing to environmental education and other social activities. The contribution to sustainability is being monitored applying the SOCIALCARBON® Standard, which is based in six key indicators: Biodiversity; Natural; Financial; Human; Social and Carbon Resources.

This REDD project is expected to avoid a predicted 27,228.38 ha of deforestation, equating to around 16,205,376 tCO2e in emissions reductions over the 30-year project lifetime (01-March-2020 to 28-February-2050).

1.2 Sectoral Scope and Project Type

14. Agriculture, Forestry, Land Use

Reducing Emissions from Deforestation and Degradation (REDD) through Avoided Unplanned Deforestation.

This is a grouped project.

1.3 Project Eligibility

The project is eligible under the scopes of the VCS Program Version 4.0:

- 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-permanence risk will be analysed 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

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 Yellow Ipê REDD is a grouped project, all instances implemented after validation shall meet the elements mentioned in Sections 3.5.15 and 3.5.16 of VCS Standard v4.0. 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	Yellow Ipê Grouped Project	Instance 1 – Grupo Leão Project Activity
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 – Grupo Leão Project Activity 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	The Grupo Leão project activity complies with this criterion because it was the instance that originated the baseline scenario and the development of the Yellow Ipê Grouped Project. Also, this instance is in the same reference region

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

	according to STEP 2 of VCS VT001 v 3.0 tool. 1) Instances may or may not include Sustainable Forest Management Plan. 2) In case the project activity does not involve Sustainable Forest Management Plan: - The instance should have financial, technical and scale consistent with the described in the VCS PD, facing similar investments, technological and/or other barriers as the initial instance. As the VCS AFOLU project generates no financial or economic benefits other than VCS related income, the simple cost analysis (Option I) shall be applied. - A new AFOLU non-permanence risk analysis shall be provided. 3) In case the project activity includes a Sustainable Forest Management Plan: - A new additionality analysis shall be provided. In this case, the investment comparison analysis (Option II) or the benchmark analysis (Option III) of the Tool VCS VT001 v 3.0 shall be used. - In addition, a new AFOLU non-permanence risk analysis shall be provided.	

New Project Activity Instances shall occur within one of the designated geographic areas specified in the project description.	Projects must be located within the Reference Region described in Section 3.4 of the VCS PD.	The area referring to instance 1 - Grupo Leão project activity is within the project's reference region as described in section 3.4 of the VCS PD.
Instances shall must comply with at least one complete set of eligibility criteria for the inclusion of new project activity instances. Partial compliance with multiple sets of eligibility criteria is insufficient.	All instances must comply with the complete set of eligibility criteria for the inclusion of new project activities instances.	The Grupo Leão project activity - Instance 1 - complies with all eligibility criteria for the inclusion of new project activity.
Instances must be included in the monitoring report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/verification body.	The Project activity instances must be included in the Monitoring Report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/verification body.	Grupo Leão properties comply with this criterion, as it is included in this Joint PD as the first project activity instance.
New Project Activity Instances must be validated at the time of verification against the applicable set of eligibility criteria	The addition of new Project activity instances shall be made in the monitoring report for the Grouped Project, being validated at the time of verification.	Grupo Leão project activity complies with this criterion, as it is included in this Joint PD as the first project activity instance.

New Project Activity Instances must have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance (i.e., the date upon which the project activity instance began reducing or removing GHG emissions).	All Project activity instances must provide evidence of Project ownership (land title and related documents) and Project start date (agreements, protection or management plan, or others in accordance with the applicable VCS Standard definitions).	The Grupo Leão Project activity instance is in accordance with this criterion. The evidence of Project ownership and Project start date were provided, as described in sections 1.7 and 1.8 of the VCS PD.
New Project Activity Instances must have a start date that is the same as or later than the grouped project start date	The start date of the activity of each instance shall be the same as or after the start date of the grouped project, as established in Section 1.8 of the VCS PD.	This instance 1 – Grupo Leão project activity has the same start date of the grouped Project, as described in section 1.8 of the VCS PD.
Instances shall be eligible for crediting from the start date of the instance through the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period.	Instances shall be eligible for crediting from the start date of the instance activity until the end of the grouped project crediting period, i.e., the instance shall not generate credits after the end date of the Grouped Project. Where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period.	This instance 1 – Grupo Leão project activity has the same start and end date of the grouped Project, as described in section 1.8 of the VCS PD

1.5 Project Proponent

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1.6 Other Entities Involved in the Project

Organization name	Sustainable Carbon Projetos Ambientais LTDA.
Role in the project	Carbon credits trader and Registry Manager
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Organization name	Grupo Leão
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1.7 Ownership

The grouped project covers a region in the municipalities of Novo Aripuanã and Borba, in the States of Amazonas, Brazil. The initial area is located within two private properties named "Fazenda Grupo Leão – Gleba 2" and "Fazenda Grupo Leão – Gleba 4", which are located in the municipality of Novo Aripuanã, in the State of Amazonas, South-eastern Amazon.

The two properties composing the first instance of the Yellow Ipê Grouped REDD Project are owned by Getulio Matias da Silva, that is, Grupo Leão. The legal documents proving the land title and ownership of each property will be made available to the auditors during the validation process.

1.8 Project Start Date

According to the rules established by the "VCS Standard V4.0" document, "The project start date of an AFOLU project is the date on which activities that led to the generation of GHG emission reductions or removals are implemented (eg, preparing land for seeding, planting, changing agricultural or forestry practices, rewetting, restoring hydrological functions, or implementing management or protection plans).

Therefore, the project start date is 12-February-2020, and it was defined taking into consideration the date of the contract named “Private Partnership Instrument for the Development of the Project to Generate Verified Emission Reductions” signed between Grupo Leão and Ecológica Assessoria. This action was the first step to demonstrate the intention and commitment to the conservation of the project area.

The project itself, as well as the application of the social and environmental standard (SOCIALCARBON), are the first steps for conservation activities within the area, once it is based on the monitoring of deforestation and creation of SOCIALCARBON indicators that the owner's actions are guided, which will be enhanced with the sale of credits, and constantly evolving according to the success of the project. In line with the Project Design Document, a Conservation Plan was prepared to formalize the actions already taken after the contract signature and those that will be developed throughout the project's progress.

In addition, the land regularization was a fundamental process to ensure the land title and the exact limits of each property, namely the georeferencing. The georeferencing of the Gleba 2 property was carried out in 2018 and updated in the land title in October/2018. The georeferencing of the Gleba 4 property was updated in the respective land title in June/2019. This land regularization procedure was an essential step that enabled the project owner to analyze some alternatives within the properties, amongst them conservation activities, which culminated in the contract for the development of the present REDD project together with the SOCIALCARBON Indicators, guided by the conservation plan.

Therefore, the contract signed between Grupo Leão and Ecológica Assessoria was the project start date since it could be applied as a framework for a protection plan, an activity which was mentioned in the paragraph above that led to the generation of GHG emission reductions or removals.

As provided in Clause 3, the contract binds the landowner to pay for the activities determined in this PDD, for the implementation and/or maintenance of the project activities to reduce deforestation and degradation, surveillance, fire prevention, illegal logging, prevention of invasions, in addition to social and environmental activities.

As provided in Clause 5.2, Items ii and v., of this same document:

It is the contractor's obligation to “Keep all documents regularized” and “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 socio-environmental activities, the reduction of greenhouse gases and the maintenance of its legal obligations."

1.9 Project Crediting Period

The project has a crediting period of 30 years, starting from 01-March-2020 until 28-February-2050.

This version of the VCS PD covers the first baseline period of the Yellow Ipê Grouped REDD Project, from 01-March-2020 to 28-February-2030.

According to VCS requirements, the baseline must be reassessed every 10 years for ongoing unplanned deforestation[5] because projections for deforestation are difficult to predict over the long term.

1st baseline period: 01/03/2020 to 28/02/2030;

2nd baseline period: 01/03/2030 to 29/02/2040;

3rd baseline period: 01/03/2040 to 28/02/2050.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

	Year	Estimated GHG emission reductions or removals (tCO_2e)
First baseline period	2020	23,877
	2021	33,215
	2022	50,701
	2023	59,104
	2024	83,950
	2025	83,080
	2026	114,703
	2027	150,699

[5] According to applied methodology VM0007 - REDD+ Methodology Framework (REDD-MF), available at: <https://verra.org/wp-content/uploads/2017/10/VM0007v1.5.pdf>

	2028	165,718
	2029	187,518
Second baseline period	2030	216,554
	2031	218,014
	2032	272,853
	2033	291,009
	2034	330,990
	2035	389,293
	2036	430,644
	2037	503,178
	2038	603,426
	2039	716,438
Third baseline period	2040	823,288
	2041	904,595
	2042	989,819
	2043	1,052,363
	2044	1,086,217
	2045	1,204,982
	2046	1,248,154
	2047	1,259,672
	2048	1,279,188
	2049	1,215,474
	2050	216,659
	Total estimated ERs 2nd and 3rd baseline periods	**16,205,376**
	Total number of crediting years	**30**
	Average annual ERs	**540,179**

1.11 Description of the Project Activity

The principal objective of the present grouped REDD project is the conservation of a region within the municipalities of Novo Aripuanã and Borba, in the south of Amazonas state. This will be achieved through avoidance of unplanned deforestation. The first instance of this Grouped Project presents a 86,091.66 ha of forest area within the Grupo Leão properties (Glebas 2 e 4). In the future, new instances may be added to the project, expanding the conservation of the forest.

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

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

The ex-ante estimate for the predicted avoided deforestation within the first instance project area over the 30-year project lifetime would be 25,860.81 ha. The avoided emissions are expected to 13,281,249 tCO_2e across the project crediting period (01-March-2020 to 28-February-2050), including buffer (RF), leakage (DLF) and project efficiency (EI) reductions.

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 region[8].

Therefore, besides forest conservation, the present project aims to improve and quantify its social and environmental benefits through application of the SOCIALCARBON® Methodology. This methodology is an innovative concept developed by the Ecológica Institute to measure the contribution of carbon projects to sustainability. The SOCIALCARBON® Methodology is based on six main resources: Biodiversity; Natural; Financial; Human; Social and Carbon Resources and aims to deliver high-integrity benefits in each.

The area's conservation plan involves increasing satellite monitoring, overflight and/or in person, with monitoring posts in the area, as well as socio-environmental education and community insertion in the project activity through the generation of jobs, such as monitoring agents, as the main way to mitigate illegal actions in the area. This plan will be based on the monitoring parameters, in addition to being verified in every SocialCarbon Report. The SocialCarbon methodology drives continuous improvement in the local community through prospects (at least one per resource, totalling 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 Ponit 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.

1.12 Project Location

[8] 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.

The Yellow Ipê Grouped REDD Project is situated in the municipalities of Novo Aripuanã and Borba, in Amazonas state in the north of Brazil, a region known as Southern Amazon. Belonging to the South-Amazonian Mesoregion and Microregion of Madeira, Novo Ariapuanã and Borba's population, according to the Brazilian Institute of Geography and Statistics (IBGE) in 2019, had about 67,794 inhabitants. Their territorial areas sum up to around 85,415 km^2, which makes them among the largest municipalities in Brazil in the territorial area.[9]

The area of the first project activity instance comprehensively belongs to Grupo Leão, and is split into two properties (Portuguese: Fazendas): Gleba 2 and Gleba 4 (Figure below). In accordance with VCS requirements, stipulated in Approved VCS Methodology VM0015, version 1.1, they are areas which include only "forest"[10] for a minimum of ten years prior to the project start date'. To define the project area, areas within the two properties that were defined as forest for ten years prior to the project start date were identified and utilized to compose the project area. In addition, some non-forest areas were also excluded, such as vegetation classified as non-forest (Pioneer Formations with river influence) and water bodies. Therefore, the total size of the areas that were considered as "non-forest" within the project area at the project start date was 4,709.58 ha. This was excluded from the initial area of 90,801.24 ha, resulting in 86,091.66 ha, which was then defined as project area.

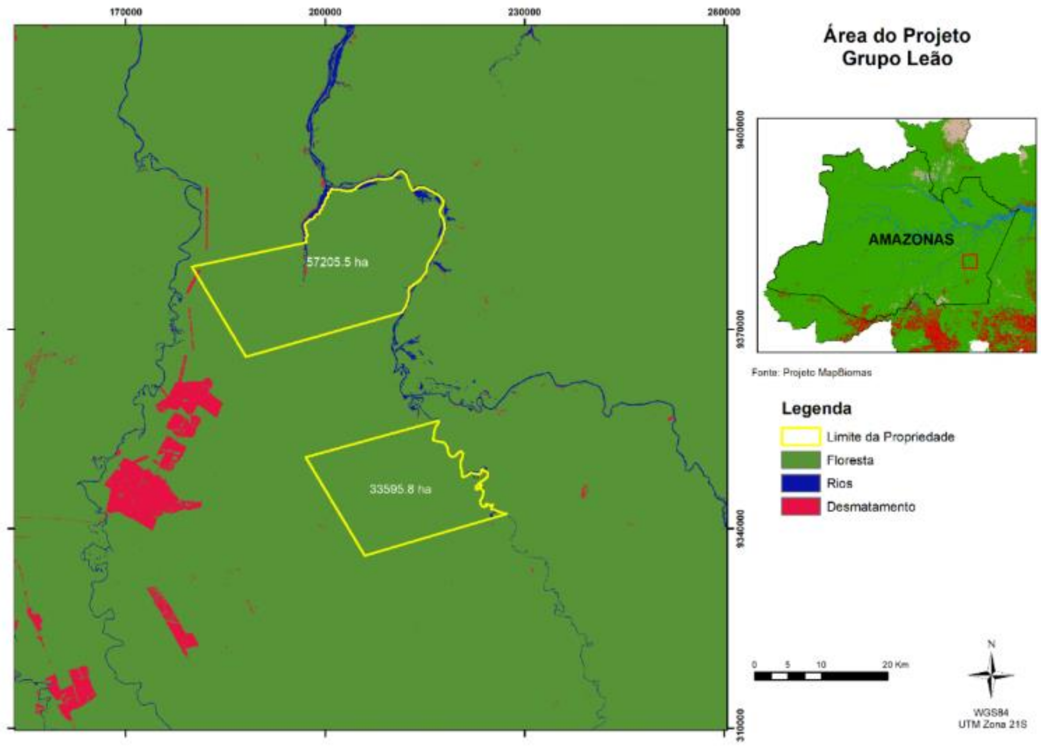
Table and figure below show the location of the project area (detailed coordinates are described in Appendix I):

Gleba	Centroid location coordinates
Gleba 4	5°37'25.60"S ; 59°41'47.49"W
Gleba 2	5°54'46.08"S ; 59°36'9.77"W

[9] Brazilian Institute of Geography and Statistics (IBGE) < https://www.ibge.gov.br/cidades-e-estados/am/novo-aripuana.html>

[10] The applied definition of forest is from the FAO: "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

Figure 1. Location of Grupo Leão properties in the state of Amazonas



[11]

There is a difference between the values of the project area in the property documentation and the database used for the mapping due to the projection used. For the mapping, planimetric WGS 1984 UTM Zone 21S projection was used to calculate the flat area. For the georeferencing of SIGEF, the GCS SIRGAS 2000 projection was used, which considers the curvature of the Earth (geodetic). The blueprint and the descriptive memorial with the coordinates of both Gleba 2 and 4 are presented in Appendix III and IV.

The table below shows the difference in the results:

Table 2. Project area measures.

	SIGEF (GCS SIRGAS2000)	Calculated (GCS SIRGAS2000)	Difference	Calculated (WGS 1984 UTM Zone 21S)	Difference
Gleba 02	33,554.49	33,552.60	1.89	33,595.76	41.27
Gleba 04	57,124.60	57,122.86	1.74	57,205.48	80.88
Property	90,679.09	90,675.46	3.63	90,801.24	122.15

[11] The sources for the elaboration of this map can be found through the link: <http://mapbiomas.org/>

PA		85,972.54		86,091.66	
Area removed from PA		4,702.92		4,709.58	

1.13 Conditions Prior to Project Initiation

The present project activity has not been implemented to generate GHG emissions for the purpose of their subsequent reduction, removal, or destruction. On the other hand, the project aims to combine REDD and socioenvironmental activities, which will promote forest conservation combined with alternative income generation from sustainable practices, associated with a greater surveillance against deforestation agents.

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

<u>Climate</u>

The project region is classified as Tropical rainforest climate type – category Af – in the Köppen climate classification[12]. This means that it has no dry season, and the average annual rainfall is high, averaging 2,289mm $year^{-1}$ in the project area. The relative humidity average in the region is 85%[13].

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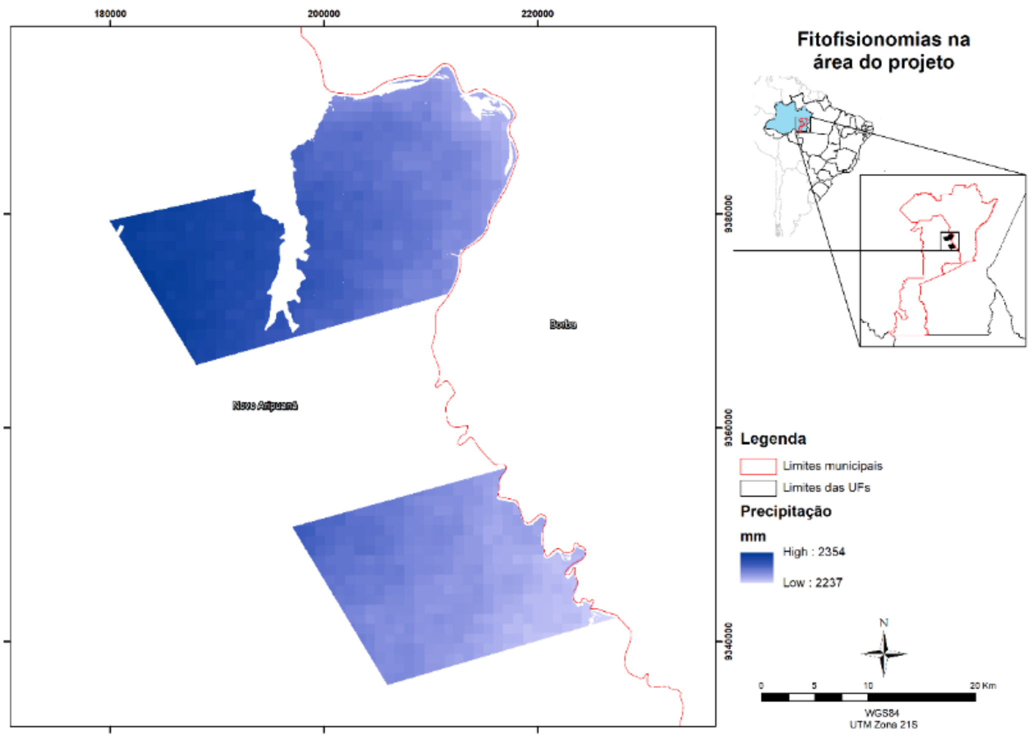
[12] KÖPPEN, W.; GEIGER, R. Klimate der Erde. Gotha: Verlag Justus Perthes. 1928. Available at: <https://www.britannica.com/science/Koppen-climate-classification> Access on 29/12/2020.

[13] TANAKA, A. EVALUATION OF SPECIES GROWTH RINGS FORESTRY IN THE MUNICIPALITY OF NOVO ARIPUANÃ – AM Federal University of Amazonas – UFAM. 2005

Figure 2. Variation of annual precipitation in the Reference Region of the Yellow Ipê Grouped REDD Project



[14]

These conditions combined make excellent conditions for biomass to thrive, leading to the high levels of biomass described below. The Af climate type is defined as follows:

1) The driest month having average rainfall >60mm;

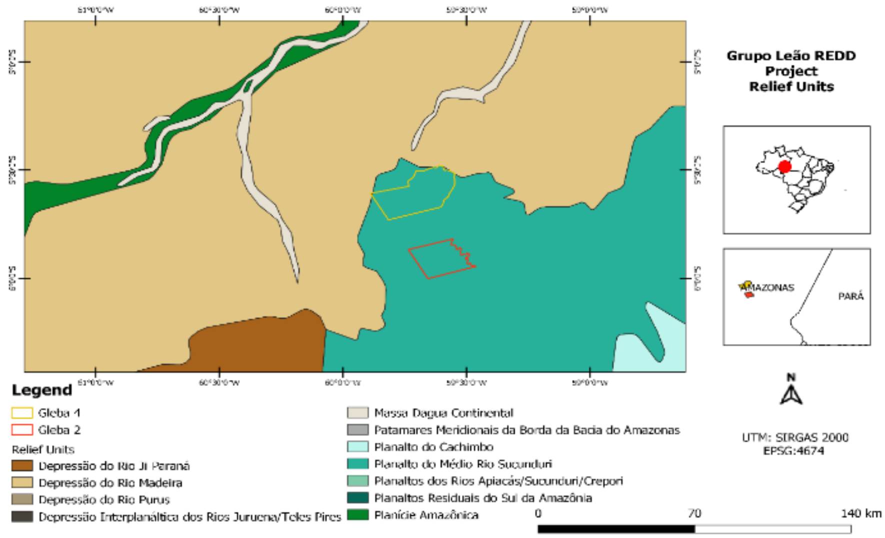
2) The project area displays very little monthly and annual variation in temperature, ranging between 25°C and 29°C as a monthly average, with an annual average of 27°C.

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

Relief and topography within the project area are from the middle plateau of the Sucunduri River, according to the figure 3 below. Plateaus are planed surfaces, characterized by the erosion factor and material deposition. The relief can assume different shapes, as escarpment, saw or plateau.

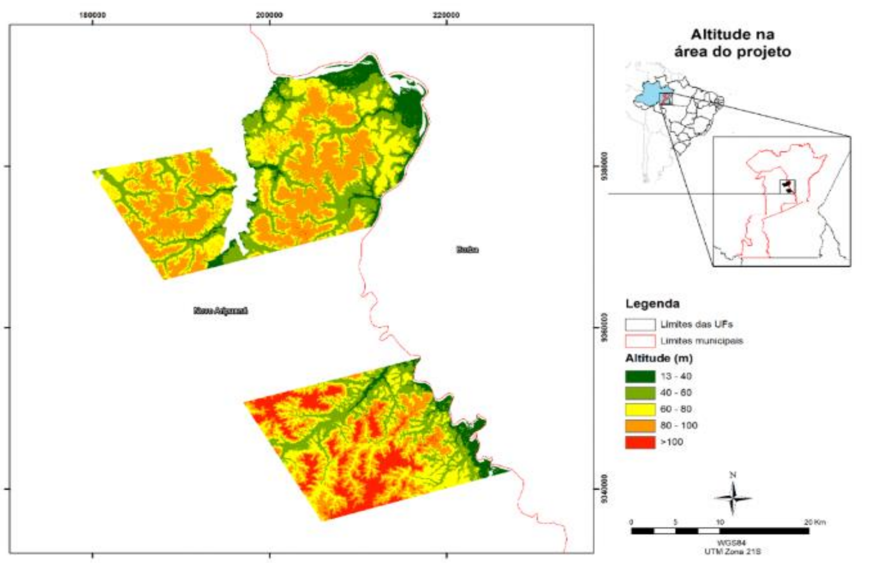
[14] The sources for the elaboration of this map can be found through the link: <https://www.worldclim.org/data/worldclim21.html>

Figure 3. Relief units in the project area.



[15]

Figure 4. Altitude variation on the Yellow Ipê Grouped REDD Project Area



[16]

The municipalities of Novo Aripuanã and Borba consist of Detrito-Lateric Cover geology type. The Detrito-Lateritic Cover is attributed to the post-Cretaceous sedimentary origin, with basal conglomeratic occurrences, covered by layers or levels of sandstones, claystones, make up deep weathering mantles with oxisols red.

[15] The sources for the elaboration of this map can be found through the link: <https://dados.gov.br/dataset/cren_geomorfologia_5000> Relevo do Brasil 1:5.000.000

[16] The sources for the elaboration of this map can be found through the link:<https://earthexplorer.usgs.gov/>

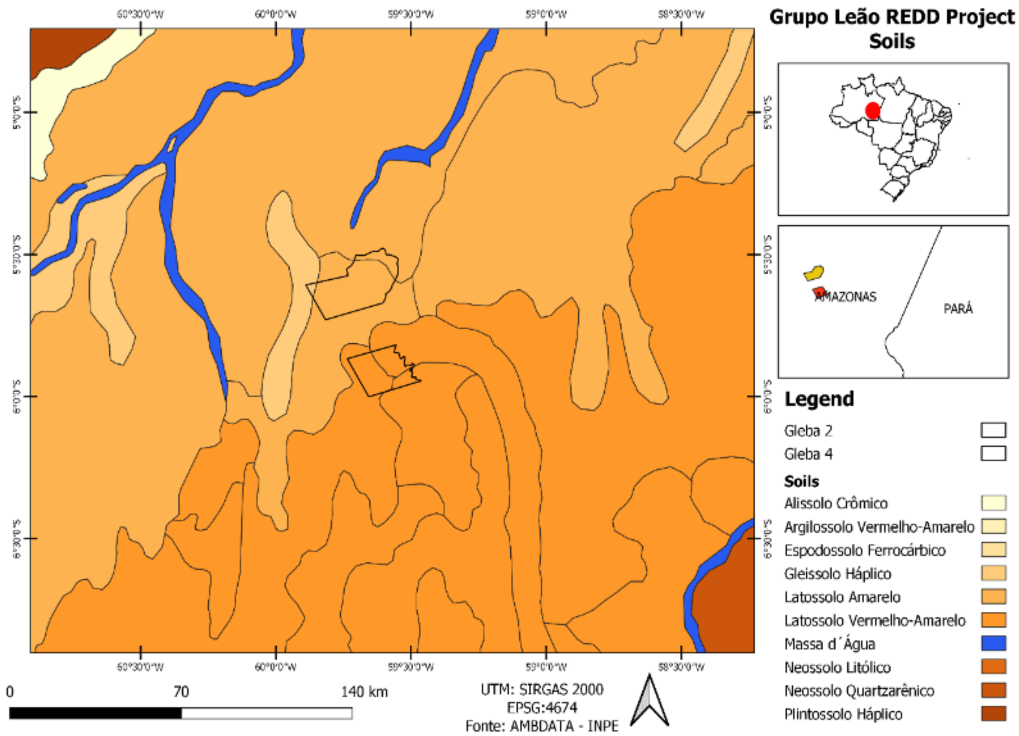
Regarding soil content, the soils within the Project Area are described as Oxisols. Oxisols are mineral soils deep and very weathered, whose diagnostic feature is the presence of a B horizon latosol, i.e., a subsurface horizon, at least 50 cm thick, which presents a high degree of weathering, and are practically devoid of primary or secondary minerals less resistant to weathering, in addition to having a low nutrient reserve.[17]

Erosive processes acting for thousands of years on the Southern Amazon Plateau have eroded the main river channels flowing from south to north direction, such as the Aripuanã and Roosevelt Rivers. This process has also produced rapids and waterfalls, such as the Sumaúma Waterfall, on the edge of the aforementioned Plateau. In addition, all the regional rivers run to the Madeira River in the north, being that the largest plains are located at the end of the Guariba River.

The predominant soil types within the project area are clayey latosols, yellow latosols and red-yellow latosols, from the oxisols group within the aluminum-iron complex, together with medium-high acidity clays. These soils are poor in phosphorus and potassium, with low to medium levels of calcium and magnesium. In addition, these soils have medium to high clay content, with sections with low to moderate sand and silt contents. Furthermore, there is a high concentration of organic matter on the surface soil layers resulting from the thick organic layer under the forest litter. Clay and sandy-clayey soils, notably red-yellow podzolic, are also found in the landscape's slopes, which predominate in less than 10% of the total project area, concentrated in its southern portion.

[17] According to the Territorial plan for sustainable rural development – Madeira Territory, 2010. Available at: <http://sit.mda.gov.br/download/ptdrs/ptdrs_qua_territorio119.pdf>

Figure 5. Soil types in the project area[18]



Lithosoils are constituted by mineral material, in advanced weathering stages, very evolved as result of energetic transformations in the constitutive material[19]. In opposition from peatlands, categorized as histosols in USA[20] and Brazil[21], they vary from strongly to well drained, although some types have pale colors, moderate drainage or even imperfectly drained, which is indicative of formation in current or past conditions with a certain degree of gleization.

These soils are typical of the equatorial and tropical regions, also occurring in subtropical zones, distributed, mainly, by wide and old surfaces of erosion, old river plains or terraces, usually in flat relief and smooth wavy, although they can occur in more rugged areas, including in mountainous

[18] Soil type data from IBGE EMBRAPA. Available in: <http://www.dpi.inpe.br/Ambdata/mapa_solos.php>

[19] Sistema Brasileiro de Classificação de Solos / Humberto Gonçalves dos Santos ... [et al.]. – 5. ed., rev. e ampl. – Brasília, DF : Embrapa, 2018.

[20] Definition available in <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/peatland>

[21] Histosols are also categorized as organosols. Data available in < http://www.agencia.cnptia.embrapa.br/gestor/solos_tropicais/arvore/CONTAG01_13_2212200611541.html>

relief. They are originated from the most diverse species of rocks and sediments under climatic conditions and the most diverse types of vegetation[22].

In the Amazon, they are used mainly for grazing, since they are categorized as low fertility soils (Dystrophic Lithosoils)[23].

In addition, dystrophic lithosols with quartz gravel are found at the end of steep slopes and close to streams and hills to the south of the properties. Gley hydromorphic soils from grey to dark colors are also found in some floodplains and flooded riverbanks at the end of their course, such as the Guariba, Paxiuba, Paxiubinha, Samaúma and Suçuarana Rivers[24].

Furthermore, according to RADAMBRASIL (1978)[25], there are some small areas of anthropogenic soils, known as “indigenous black soil” (Portuguese: terra preta de índio), generally distributed across the riverbanks. These soils are characterized by having high concentration of nitrogen and phosphorus[26].

Therefore, as presented above, the project area does not include forested wetlands growing on peat, in accordance with the conditions of applicability of the methodology VM0015, version 1.1[27]

Socio-economic conditions

Industrial activity in the Novo Aripuanã and Borba micro-region is concentrated in timber production, açaí berries and Brazilian nuts. During the 2008-2018 period, in the municipalities of Novo Aripuanã and Borba, in which the reference region is located, 32% of the total value of production from these three products was represented by logged timber, while around 27% was

[22] Sistema Brasileiro de Classificação de Solos / Humberto Gonçalves dos Santos ... [et al.]. – 5. ed., rev. e ampl. – Brasília, DF : Embrapa, 2018.

[23] Data available at: <https://www.agencia.cnptia.embrapa.br/gestor/solos_tropicais/arvore/CONT000gn230xho02wx5ok0liq1mqxhk6vk7.html > Access on 29/12/2020

[24] LUZ, Horacio de Figueredo. **Laudo de avaliação da capacidade de uso do solo:** Imóvel Fazenda Boa Fé. Manaus: Ibiraú Florestal, 2014. 26 p.

[25] RADAMBRASIL. Levantamento de Recursos Naturais: Geologia, Geomorfologia, Solos, Vegetação, Uso Potencial da Terra. Rio de Janeiro, 1978. Available at <https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=224035>

[26] CARRERO, G.C. Dinâmica do Desmatamento e Consolidação de Propriedades Rurais na Fronteira de Expansão Agropecuária no Sudeste do Amazonas. Master thesis, Instituto Nacional de Pesquisas da Amazônia. 68p. 2009. Available at <https://repositorio.inpa.gov.br/handle/1/11835> Access on 29/12/2020.

[27] Available at: < https://verra.org/wp-content/uploads/2018/03/VM0015-Methodology-for-Avoided-Unplanned-Deforestation-v1.1.pdf>

represented by açaí berries and 18% by Brazilian nuts[28]. In addition, other activities occur such as, copaiba oil extraction (around 11%) and hevea berries (3%), as depicted in the Table below.

Table 3. Annual average values of production in municipalities of Reference Region (2008 - 2018) (R$)[29]

	Timber Logs	Açaí Berries	Hevea	Charcoal	Copaíba	Brazil Nuts Barries	TOTAL
Novo Aripuanã	R$ 2,830,181.82	R$ 1,369,875.00	R$ 390,636.36	R$ 20,727.27	R$ 1,266,727.27	R$ 1,630,000.00	R$ 7,508,147.72
Borba	R$ 687,090.91	R$ 1,630,000.00	R$ 20,727.27	R$ 544,454.55	R$ 10,777.78	R$ 390,636.36	R$ 3,283,686.87
Total production (R$)	R$ 3,517,272.73	R$ 2,999,875	R$ 411,363.63	R$ 565,181.82	R$ 1,277,505.05	R$ 2,020,636.36	R$ 10,791,835.04
Percentage total value of production	32.59%	27.79%	3.81%	5.23%	11.83%	18.73%	100%

The socio-economic and climate conditions described are integrated into the Yellow Ipê Grouped REDD Project's goals, as the application of SOCIALCARBON® Standard and the planned collaboration with a government environmental body[30] aims to deliver appropriate, integrated, and quantifiable ecological and socio-economic benefits to the population of the project area.

As a condition for defining the Reference Region, the types of properties around the project area were also verified. In addition to public areas, protected areas or not, there are also private property, as shown in the map below[31]. This complies with the applicability conditions set out in the methodology, that states 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.

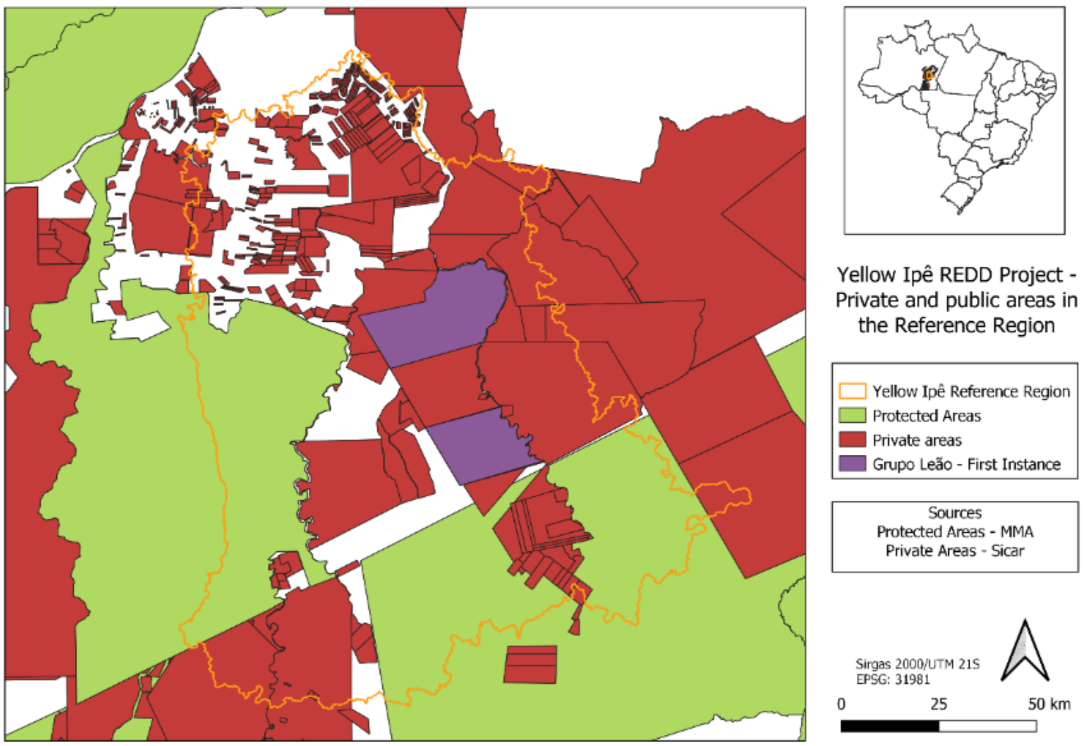
[28] Pesquisa de Extração Vegetal e Silvicultura - Instituto Brasileiro de Geografia e Estatística (IBGE). Available at <https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/16/12705?tipo=grafico> Access on 29/12/2020

[29] Pesquisa de Extração Vegetal e Silvicultura - Instituto Brasileiro de Geografia e Estatística (IBGE). Available at <https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/16/12705?tipo=grafico> Access on 29/12/2020.

[30] Currently under negotiation

[31] Private properties database source:< https://www.car.gov.br/publico/imoveis/index>. Data from Novo Aripuanã and Borba – AM. Downloaded in 30/07/2021.

Figure 6. Other properties in the Reference Region

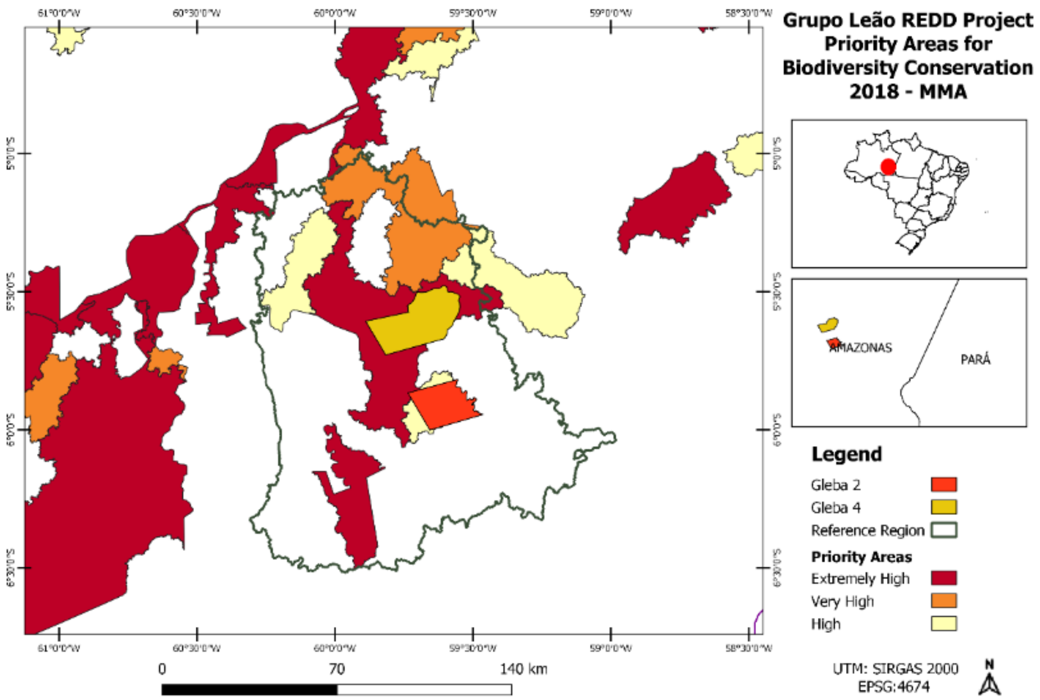


<u>Biodiversity</u>

The Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included the project region in its 2018 survey of Brazil's 900 priority areas for conservation[32]. The Project Area is classed within the ministry's "extremely high" and "high" classes, as demonstrated in the Figure 6 below. The report classified the priority actions in the area as "inspection and control of illegal activities" and "regularization of degrading activity".

[32] MMA (2018): <http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias> Access on 29/12/2020.

Figure 7. Priority areas for biodiversity conservation according to the Environmental Ministry. [33]



The Southern Amazon Mosaic is located in a well-preserved region within the Legal Amazon, noting its high biological importance. However, this is also one of the least scientifically known regions of Brazil and therefore considered a priority area for wildlife inventories[34].

In the regional context, the Southern Amazon Mosaic is within areas of high richness of birds, mammals and amphibian species, according to Figure 7 below. Although scientific research is scarce in the region, it is very likely that the existing biodiversity assessments underestimate the reality. A recent example was a new primate species found in the region, named *Zogue-zogue* fire tail (*Callicebus miltoni*), that only occurs between the rivers Aripuanã and Roosevelt[35].

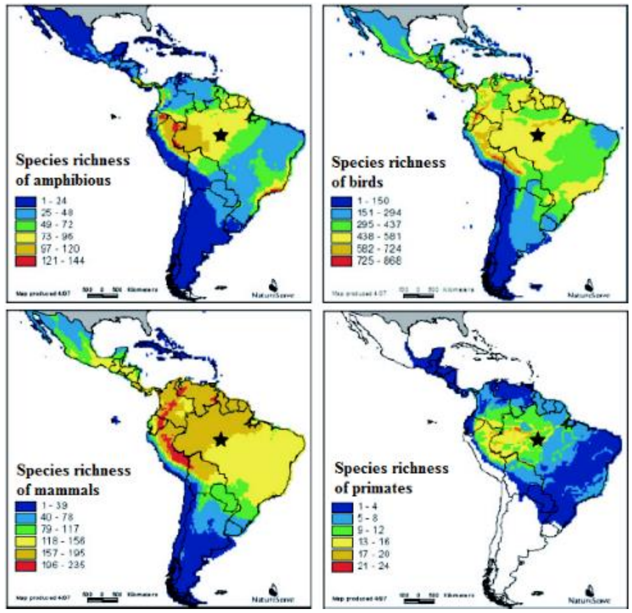
[33] The source for the elaboration of this map can be found through the link:<http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias> 2ª Atualização das Áreas Prioritárias para Conservação da Biodiversidade 2018 MMA

[34] WWF (Brasil). **Mosaico da Amazônia Meridional:** Vencendo limites geográficos e integrando gestão. Brasília-DF: WWF, 2014. 136 p. Available at:

<http://d3nehc6yl9qzo4.cloudfront.net/downloads/mam_livro_vencendo_limites_geograficos_final.pdf>. Access on 29/12/2020

[35] O ESTADO DE SÃO PAULO. Sustentabilidade. Nova espécie de primata é descoberta na Amazônia. March 11th, 2015. Available at: <http://sustentabilidade.estadao.com.br/noticias/geral,nova-especie-de-primata-e-descoberta-na-amazonia,1648925>. Last visit on: July 09th, 2020.

Figure 8. Space richness of amphibians, birds, mammals, and primates within the project region.



In addition, it is estimated that there are at least 13 threatened species of fauna, ten of these being mammals. Among those of great conservation interest are the Golden-White Tassel-ear Marmoset (Mico chrysoleucus), the Giant Armadillo (Priodontes maximus), the Brazilian Tapir (Tapirus terrestris), the Red Brocket (Mazama americana), and the Azara's Agouti (Dasyprocta azarae). Furthermore, there are several other species expected to be at some grade of risk, such as the Golden Parakeet (Guaruba guarouba) and the Hyacinth Macaw (Anodorhynchus hyacinthinus), both within the vulnerable category, according to the International Union for Conservation of Nature - IUCN. In addition, the present project contributes to the preservation of species that require large areas, such as the Jaguar (*Panthera onca*)[36]. Table 4 below shows the fauna species within the following IUCN categories: vulnerable and endangered. It can be observed that the present project helps to preserve at least 2% of the Brazilian threatened species, most of them being mammals.

[36] IUCN 2014. The IUCN Red List of Threatened Species. Version 2014. Available at: <http://www.iucnredlist.org>. Last visit on: July 09th, 2020.

Table 4. Species listed by IUCN as vulnerable or endangered categories in Brazil and project region[37].

Fauna	Threatened species in Brazil	Threatened species in the project region	% of Brazil
Mammals	181	10	6%
Non-primates	149	8	5%
Primates	32	2	6%
Birds	219	2	1%
Reptiles	30	1	3%
Amphibians	257	0	0%
Fish	54	0	0%
TOTAL	**741**	**13**	**2%**

Regarding flora biodiversity, the presence of the Amazon and Cerrado (Savannah) biomes makes the region a complex environment with a great diversity of species and vegetation types. Three forest inventories have been carried out in protected areas within the region, revealing a great flora biodiversity[38]:

- Sucunduri State Park: a forest inventory was conducted over 5 ha, covering four different vegetation types, resulting in the impressive number of 2,840 trees (DBH>10cm) of 69 families, 218 genders and 365 species;
- Aripuanã Sustainable Development Reserve (where around 18% of the project area is located): a forest inventory was conducted over 3ha, covering two different vegetation types, resulting in 1,419 trees of 39 families and 556 species;
- Guariba Extractive Reserve (encompassing 5% of the project area): two forest inventories were conducted (2ha each), covering four different vegetation types, measuring trees with DBH>10cm.
    - Dense tropical rainforest: 527 trees of 38 families and 177 species;
    - Open tropical rainforest: 505 trees of 41 families and 145 species
    - Savannah: 49 trees of 100 genera and 117 species;
    - Floodplain forest: 495 trees of 34 families and 129 species.

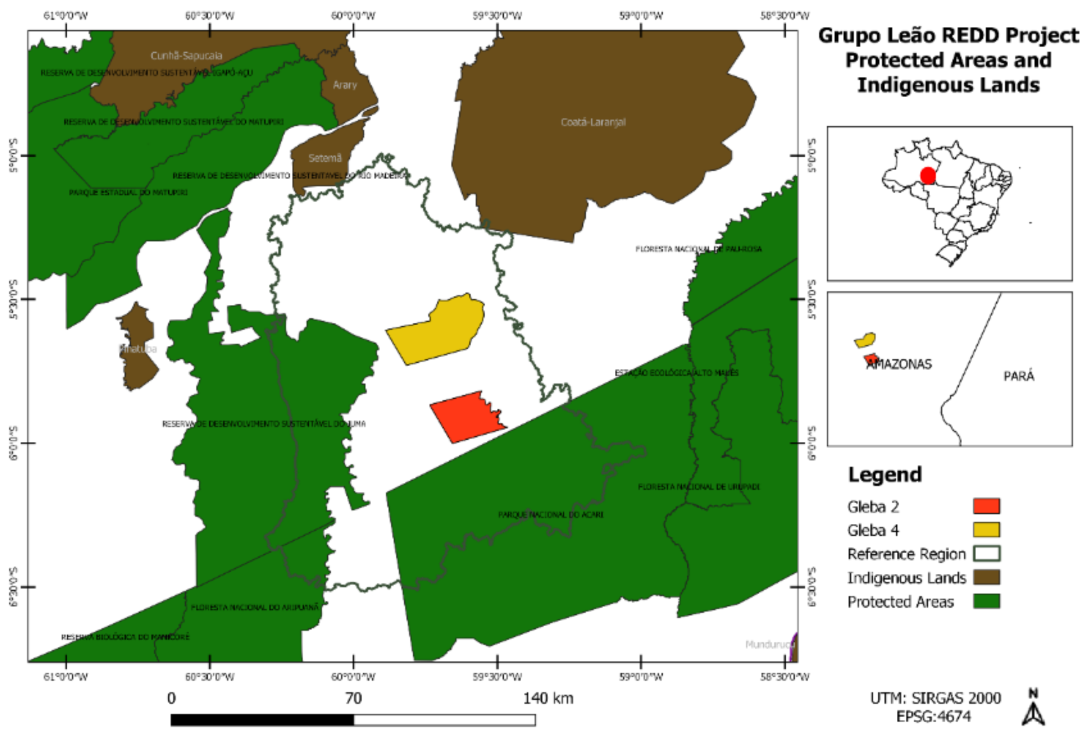
[37] Government of the State of Amazonas. Plano de gestão do mosaico de unidades de conservação do Apuí. Manaus: WWF - Brasil, 2010. 246 p.

[38] Government of the State of Amazonas. Plano de gestão do mosaico de unidades de conservação do Apuí. Manaus: WWF - Brasil, 2010. 246 p.

Therefore, the current situation indicates that the rainforests of the Southern Amazon are critically endangered, as well as their great biological diversity and presence in several environment types, in addition to the presence of endemic species of extreme importance to the conservation of Amazon biodiversity. Amazonas state has one of the largest priority areas in Brazil, with most of the extremely high priority areas of the country[39].

The figure below demonstrates the project area proximity with protected areas and indigenous lands.

Figure 9. Protected areas and indigenous lands[40].



Vegetation Cover

[39] WWF, MMA, 2015.. Áreas Prioritárias para Uso Sustentável e Repartição dois Benefícios da Biodiversidade da Amazônia.

[40] All sources utilized for the elaboration of this map are available through these links: Unidades de Conservação Federais – SHP (SIRGAS2000) - <https://www.icmbio.gov.br/portal/geoprocessamentos/51-menu-servicos/4004-downloads-mapa-tematico-e-dados-geoestatisticos-das-uc-s> ; Unidades de Conservação Estaduais - SHP fornecido para outro projeto pela Agência Verde. Anexado nas pastas. ;Terras indígenas <http://www.funai.gov.br/index.php/2013-11-06-16-22-33>

The vegetation in the present project was mapped based on SIVAM Amazônia information sources[41]. Three vegetation types were found to be present in the project instance area: Dense Alluvial Tropical Rainforest, Dense Submontane Tropical Rainforest, and Dense Lowland Tropical Rainforest.

The Dense Alluvial Tropical Rainforest is a type of vegetation that relates to environments located on the margins of some watercourses, on the outskirts of swamps, as well as in wetlands, and even in temporarily flooded areas. It is also known under the designations of riparian forest, gallery forest and riverside forest.

It is a vegetation that practically no longer exists, according to field observations, as its geographical location correlates with environments where occupation and agricultural use are very intensive.[42]

The Dense Submontane Tropical Rainforest is a type of vegetation characterized by phanerophytes, precisely by the sub-forms of macro and mesophanerophyte life, in addition to abundant woody and epiphytic lianas, which differentiate it from other classes of formations. However, the main ecological characteristic resides in the ombrophilic environments. Thus, the ombrothermal characteristic of the Dense Ombrophilous Forest is tied to tropical climatic factors of high temperatures (averages of 25º) and high precipitation, well distributed during the year (from 0 to 60 dry days), which determines a bioecological situation practically without biologically dry periods. In addition, dystrophic and, exceptionally, eutrophic oxisols dominate in the environments of these forests, originating from various types of rocks.

The dissection of the mountainous relief and the plateaus with moderately deep soils is occupied by a forest formation that presents phanerophytes with approximately uniform height. The sub-forest is made up of seedlings of natural regeneration, few nanofanerophytes and camphites, in addition to the presence of small palms and herbaceous lianas in greater quantity. Its main characteristics are the high trees, some exceeding 50m.[43]

The Dense Lowland Tropical Rainforest is a formation that generally occupies the coastal plains, covered by Pliopleistocene boards of the Barreiras Group. It occurs from the Amazon, extending

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[41]Sistema de vigilância da Amazônia: SIVAM

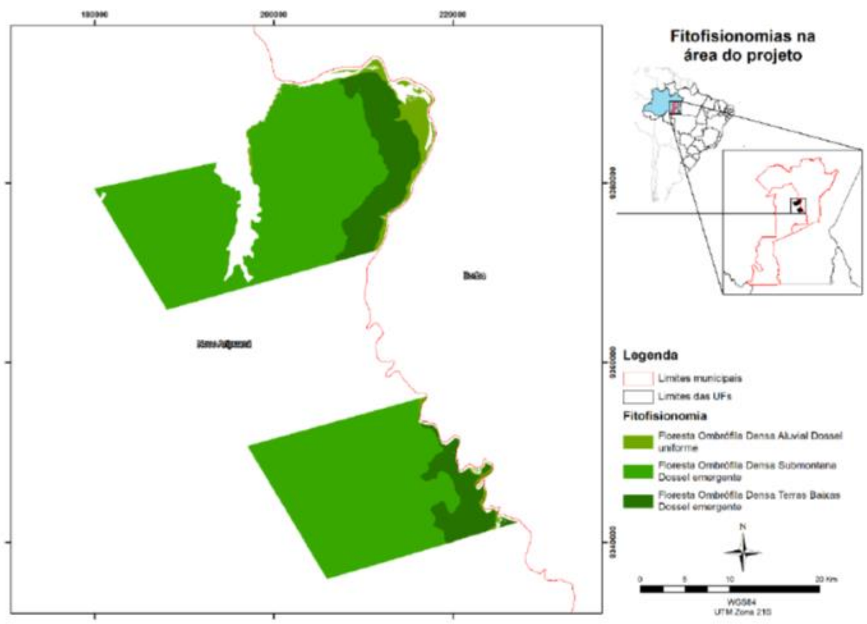
[42] Alluvial Dense Ombrophilous Forest – Embrapa. Available at: <http://www.agencia.cnptia.embrapa.br/gestor/territorio_mata_sul_pernambucana/arvore/CONT000gt7eon7l02wx7ha087apz2tjys6j3.html#:~:text=A%20floresta%20ombr%C3%B3fila%20densa%20aluvial,mesmo%20em%20%C3%A1reas%20alagadas%20temporariamente> Last visited: 05/07/2020.

[43] Dense Ombrophilous Forest. Available at: <https://ambientes.ambientebrasil.com.br/natural/regioes_fitoecologicas/regioes_fitoecologicas_-_floresta_ombrofila_densa.html> Last visited: 05/07/2020

throughout the Northeast Region to the vicinity of the São João River, in the State of Rio de Janeiro.

The Figure below shows that all vegetation cover types within the project instance area, leakage belt and reference region fall within the classes Dense Alluvial Tropical Rainforest, Dense Submontane Tropical Rainforest, Dense Lowland Tropical Rainforest, Open Alluvial Tropical Rainforest, Open Submontane Tropical Rainforest, and Pioneer formations with fluvial influence.

Figure 10. Vegetation cover of the project area



1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law Nº 12.651, 25/05/2012[45]), all rural estates located in forest zones should have:

I - Permanent preservation area: 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, protect the soil and ensure the well-being of human populations

II - Legal Reserve (LR): an area located within a rural property or possession, except for the permanent preservation, necessary for the sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and shelter, and protection

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

of native flora and fauna. In the Brazilian Legal Amazon[46], eighty percent (80%) of a rural property should be preserved as LR.

One of the main ways to combat deforestation in Brazil are the command and control mechanisms, such as effective monitoring, requiring compliance with environmental legislation along with a greater state presence. However, this does not seem effective in most regions of the country, because the failure of the government to fulfil these responsibilities in comparison with other social goals and economic interests has put Brazil among the world's largest deforesters[47].

In spite of the legal provisions intended to preserve at least 80% of the Amazon Forest coverage, 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 complete disregard of the mandatory provisions of the Forest Code. In addition to that, to cover vast distances of areas with low demographic density makes tracking of illegal activities and land surveillance very difficult for the authorities[48].

Therefore, all calculations were made assuming that the reference region has a general non-compliance with the Brazilian Forest Code. Thus, the baseline scenario considers the potential of unplanned deforestation in the project area to surpass the limits stipulated by the Law.

In addition, a small area of the reference region overlaps with the indigenous territories Coatá-Laranjal and Setemã, which are approximately 30 km from the northernmost area of the project (Gleba 4).

Thus, composing the legislative scope of this document, it is worth mentioning decree No. 10,088, of November 5, 2019, 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, values spiritual and the land they occupy or use.

[46] 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 km^2, distributed through the entirety or a proportion of 9 Brazilian states.

[47] Food And Agriculture Organization Of The United Nations (FAO) (2011), “State of the World's Forests 2011.” FAO Forestry Paper. Rome, Italy.

[48] 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.

Annex LXXII to the decree provides for ILO Convention No. 169 on Indigenous and Tribal Peoples, 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;

According to PART II - Lands, Article 13, item 2, "The use of the term" lands "in Articles 15 and 16 should include the concept of territories, which covers the entire habitat of the regions that the people concerned occupy or use.

According to Article 14, item 1: "The people concerned should be given the property and possession rights over the lands they traditionally occupy. In addition, in appropriate cases, measures should be taken to safeguard the right of interested people to use land that is not exclusively occupied by them, but which they have traditionally had access to for their traditional and subsistence activities. In this regard, special attention should be paid to the situation of nomadic peoples and itinerant farmers".

It is also worth mentioning decree No. 6,040, of February 7, 2007, 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 peoples.

1.15 Participation under Other GHG Programs

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

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

1.15.2 Projects Rejected by Other GHG Programs

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

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

1.16.2 Other Forms of Environmental Credit

The project activity has not created any other form of environmental credit. This project has not been registered in any other credited activity.

The project does not intend to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under this VCS project.

1.17 Additional Information to the Project

Leakage Management

The leakage management plan and maps of the leakage management area are located in section Baseline Scenario, of the present VCS PD.

Commercially Sensitive Information

None of the information exposed to the Validation and Verification Body was withheld from the public version of the report.

Sustainable Development

The primary objective of the Yellow Ipê Grouped REDD Project is to avoid the unplanned deforestation (AUD) of the project area, consisting of 100% Amazon rainforest at the project start date.

These measures contribute to several nationally stated sustainable development priorities, such as the following objectives and targets from the Brazilian Government related to the UN Sustainable Development Goals (SDG)[49]:

- SDG 1: No poverty.

Part of the funds from the sale of carbon credits will go to the education and sustainable development of the riverside communities present inside and outside the project area. Thus, the project collaborates with targets such as:

[49] UN's Sustainable Development Goals and targets available at: <https://sdgs.un.org/goals> Last visited on 04/01/2021.

- 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 4: Quality education.

The project aims to invest in education for the communities affected by the project, such as basic education, professional training, environmental education, among others. The targets determined by the UN that will act as a guideline for monitoring actions are:

- 4.3 “By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university”;
- 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”;
- 4.7 “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 8: Decent work and economic growth.

The project may offer professional training and job creation, as well as other alternative sources of income, aiming to minimize illegal extraction in the region. 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”;
- 8.4 “Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead”;

- 8.8 “Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment”;
- 8.9 “By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products”.
    - SDG 12: Ensure sustainable production and consumption patterns.

The project is based on encouraging sustainable development and maintaining the standing forest, optimizing access to non-timber forest products and the consumption of local inputs. In case of wood extraction, the Sustainable Forest Management Plan will be required, in encouraging the emission of certifications of good practices. One of the main objectives is to reduce illegal deforestation and profit from this activity, offering alternatives for income and extraction. The Yellow Ipê Grouped REDD Project has the following target and guideline:

- 12.2 “By 2030, achieve the sustainable management and efficient use of natural resources”
    - 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. The targets and guidelines for this objective are:

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

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

- 15.1 “By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements";
- 15.2 “By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally”;

- 15.5 "Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species";
- 15.9 "By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts";
- 15.a "Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems";
- 15.c "Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities".

Reducing deforestation and promoting sustainable development in the Amazon is also a key component to Brazil's Nationally Determined Contribution (NDC) under the Paris Agreement. According to the Brazilian Government Ministry for the Environment (in Portuguese, *Ministério do Meio Ambiente*), the implementation of REDD+ activities are an important component to meet the Country's contribution under the United Nations Framework Convention on Climate Change while preserving natural forest resources[50].

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

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

In summary, the project plans to expand the extraction of NTFPs and other alternative income for the community, encouraging handicrafts and local traditions. In addition, the project activities will enable the creation of jobs to monitor the area, prioritizing the hiring of local residents for monitoring of the area, with professional training. Income from the sale of credits will make it

[50] Brazil's Nationally Determined Contribution towards achieving the objective of the United Nations Framework Convention on Climate Change can be accessed in full at: <http://www4.unfccc.int/submissions/INDC/Published%20Documents/Brazil/1/BRAZIL%20iNDC%20english%20FINAL.pdf>. Last visited on December 10th, 2019.

possible to invest in the educational and professional training of children and adults in the Community.

In addition, beyond the project's ecological and carbon benefits, the implementation of REDD and SOCIALCARBON mechanisms promotes benefit sharing: 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.

SOCIALCARBON methodology 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.

SOCIALCARBON is based on the monitoring of indicators of six aspects of the project's sustainability: carbon, social, biodiversity, financial, natural and human. The result is a hexagon that shows the evolution of the project's contributions over time.

Further Information

Not applicable.

2 Safeguards

2.1 No Net Harm

Yellow Ipê Grouped REDD Project has conducted a social and environmental impact assessment within the Project Area. In addition, through the SOCIALCARBON certification it will be possible to quantify the main potential environmental and socio-economic risks.

8 families were identified, totalling 23 people. The families live in very precarious conditions, with no antenna for communication via telephone or radio, nor electricity. The region is quite isolated; transportation to the nearest location, Vila Arara, in Novo Aripuanã, takes approximately 2 days with the means of transport they currently have.

There is no school, despite having the structure built, and the church has not been completed.

In total, 2 women, 8 men and 13 children were counted via the applied questionnaire. The predominant age group is between 19 and 30 years, in addition to children between 0 and 18 years. Between 30 and 50 years old there are 3 people, and 2 over 50.

Most of the community members don't have schooling or have incomplete basic education. There is no source of income, and subsistence agriculture is the only activity.

The table below provides details on the identified potential risks:

Table 5. Main social, economic and environmental impacts of the Yellow Ipê Grouped REDD Project.

Activity	Aspect	Impact	Effect		Comments/ Observation
			Beneficial	Adverse	
REDD: Carbon credit project	Conservation of Amazon Rainforest	Greenhouse Gas Emissions Reductions	X		Monitored by the Carbon resource: • Project performance Monitored by the Natural resource: • Project efficiency in agents that fight deforestation/ degradation
REDD: Carbon credit project	Conservation of Amazon Rainforest	Monitoring and supervision to avoid deforestation of forest within the project area.	X		Monitored by the Biodiversity resource: • Biodiversity conservation Monitored by the Natural resource: • Monitoring Methods
REDD: Carbon credit project	Conservation of Amazon Rainforest	Conflict management with communities in the project area, due to banning of timber product extraction.		X	Monitored by the Carbon resource: • Stakeholder consultation

REDD: Carbon credit project	Empowerment	Increased independence of the communities in the project area.	X		Monitored by the Social resource: • Local traditional people assistance • Additional social programs • Women's inclusion Monitored by the Human resource: • Community education and training Monitored by the Financial resource: • Employment creation • Alternative income sources Monitored by the Biodiversity resource: • Non timber forest products (NTFPs)
REDD: Carbon credit project	Application of the Social Carbon methodology	Encouragement and investment in research on social, economic and environmental aspects in the project region.	X		Monitored by the Social resource: • Local traditional people assistance Monitored by the Human resource: • Community education and

					formation programs • Research incentive Monitored by the Financial resource: • Carbon credit benefits Monitored by the Carbon resource: • Project performance

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, Sustainable Carbon has identified another risk that could affect the project activity, which are described by the SOCIALCARBON indicators. This risk is described on Table below:

Table 6. Significant risks to the project

Activity	Aspect	Risk	SOCIALCARBON Indicators that will monitor the identified potential risks
REDD carbon project	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.	Monitored by the Carbon resource: • Buffer reduction

This risk 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.

2.2 Local Stakeholder Consultation

The main stakeholders considered in this project are:

- The local community living inside and around the project instance area;
- The Municipalities of Novo Aripuanã and Borba;
- Sustainable Development Agency (ADS);
- Amazon Association of Municipalities (AAM);
- Sustainable Amazonas Foundation (FAS);
- Chico Mendes Institute for Biodiversity Conservation (ICMBio);
- (Centro Nacional de Pesquisa e Conservação da Biodiversidade Amazônica – CEPAM);
- Amazonas Conservation and Sustainable Development Institute (IDESAM);
- Amazon Sustainable Agricultural and Forestry Development Institute (IDAM);
- Amazonas Environmental Protection Institute (IPAAM);
- National Institute of Colonization and Agrarian Reform (INCRA);
- State Secretariat for the Environment (SEMA);
- Amazonas State University (UEA);
- WWF – Brazil;
- Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA).

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. In the city of Novo Aripuanã, the incidence of covid-19 is 3,249 cases per 100 thousand inhabitants[51], and to contain new cases and avoid agglomerations, stakeholder consultation will be carried out remotely during this validation. Thus, the Stakeholder consultation will be divided in two steps: an online meeting and a local consultation with the community within and near the project instance area, where the leakage management area was defined.

To stakeholders located in urban areas, mostly government agencies, an explanatory e-mail and letter were sent, briefly presenting the project. Moreover, they were also invited to attend two remote conferences. The invitation letter and e-mail are shown below.

The riverside community will be consulted individually and on site by a consultant, presenting the project in simple and accessible language, appropriate to the colloquial discourse used by this

[51] According to the COVID-19 Amazonas Panel of the Health Surveillance Foundation (FVS/AM) available at: http://saude.am.gov.br/painel/corona/. Last visited on October 30th, 2020.

community. During the consultation, comments, suggestions, and criticisms made by these parties will be collected.

The first online local stakeholders' consultation was held on 07-December-2020, at 4pm (Brasília time zone, 2pm local time) on a Virtual Conference Platform.

As there were few responses to the first meeting, and as a new opportunity for greater stakeholder participation, a new online consultation was organized, taking place on January 18, 2021.

These presentations detailed a summary of the proposed activities of the project implementation and monitoring. The auditor from VVB, who will conduct the validation of this project, is also going to be invited to this meeting.

The presential consultation with stakeholders (riverside community) too place in April 13th, 2021, where the presence of housing is located (*Vila Nova Amazônia).* The meeting had a simplified presentation about the project, exposing the risks and benefits resulting from the project activities for the riverside population.

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

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

Furthermore, 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.

Figure 11. Invitation letter sent to the stakeholders.

Ecológica Assessoria Ltda.

Ecológica

06 de novembro de 2020.

CONVITE ÀS PARTES INTERESSADAS

Assunto: Apresentação da Ecológica Assessoria Ltda. – Projeto REDD Agrupado Ipê Amarelo (Yellow Ipê Grouped REDD Project)

Prezado (a),

Viemos por meio desta informar V. Sa. sobre o desenvolvimento de um projeto de reduções de emissões de gases de efeito estufa provenientes do desmatamento e degradação florestal (REDD) da floresta amazônica. O projeto Yellow Ipê Grouped REDD Project, localizado em Novo Aripuanã e Borba, municípios ao sul do estado do Amazonas, tem como principal objetivo evitar o desmatamento não planejado (AUD) de uma área de 86.097,67 ha. O projeto está em consonância com as diretrizes e critérios de desenvolvimento sustentável do país.

Com esta iniciativa, a Ecológica Assessoria Ltda. visa reduzir de forma voluntária os impactos ambientais provocados pelo desmatamento da Floresta Amazônica, além de gerar benefícios socioambientais para região do projeto através da metodologia do Carbono Social, impactando positivamente o ecossistema local.

O Projeto encontra-se em fase de validação, para posteriormente ser apresentado ao VCS (Verified Carbon Standard)/Verra, atendendo aos procedimentos estabelecidos pelo Standard para a geração de créditos de carbono através da redução de emissões voluntárias.

Assim, a Ecológica Assessoria Ltda. está em contato com as partes interessadas para a divulgação deste projeto e convida-o a participar de uma videoconferência no dia 7 de dezembro de 2020, às 16:00 horas (horário de Brasília). A conferência será realizada online, o link para acesso será enviado por email em breve.

A partir da data aqui proposta, estará aberto o período para solicitações de informações e envio de comentários sobre o relatório técnico do Projeto Yellow Ipê Grouped REDD Project. O prazo para comentários é de 40 dias a partir da realização da Apresentação do Projeto (17 de janeiro de 2021). Para mais informações e solicitações, favor entrar em contato através de mh@ecologica.earth.

Atenciosamente,

Merlin Stefano

Stefano Merlin

Ecológica Assessoria Ltda.

Ecológica Assessoria Ltda.
Rua Dr. Bacelar, 368 - Conjunto 23 - Vila Clementino, São Paulo, Brasil
(11) 2649-0036

2.3 Environmental Impact

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

The Amazon Biome, the location of a hugely diverse fauna and flora, spreads over almost 50% of the Brazilian territory[52]. However, the uncontrolled deforestation is breaking up the forest in this habitat and, without necessary care, entire regions with local fauna and ancient habitats of unique species are at risk of complete destruction[53]. To 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 loss[54].

The conservation of the Amazon Rainforests is vitally important to humankind and the global environment, as well as the local environment, as these forests provide a wide range of critical ecosystem services. Some of them are detailed in the Table below:

Table 7. Main environmental impacts generated by Yellow Ipê Grouped REDD Project Activity.

Environmental Factor	Environmental Impact	Classification
Soil	Improvement of soil conditions and minimization of soil loss. Preservation of the nutrient cycles (e.g., phosphorous and nitrogen)	Positive
Air	Preservation of air quality	Positive
Climate	GHG emission reduction	Positive
Water/ hydric resources	Preservation of ground water quality	Positive
Water/ hydric resources	Water cycle renewal	Positive
Fauna	Biodiversity preservation	Positive
Flora	Biodiversity preservation	Positive

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

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

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

Therefore, the Yellow Ipê Grouped REDD Project will bring a net positive environmental impact, also benefiting the local communities. Furthermore, the Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included the Project area and part of the Reference Region in its 2018 survey of Brazil's 900 priority areas for conservation[55]. The project area *is* classified within the ministry's "extremely high" and high" categories. The report classified the priority actions in the area as "inspection and control of illegal activities" and "regularization of degrading activity".

Thus, the conservation of this private land located inside the Grupo Leão properties and other instances in the Yellow Ipê Grouped REDD Project is in accordance with the Brazilian Government proposal for conservation, helping to reach this goal, and encouraging the creation of new conservation projects and areas.

2.4 Public Comments

No negative input or comment was received during the public comment period.

2.5 AFOLU-Specific Safeguards

<u>**Local Stakeholder Identification and Background**</u>

According to VCS Standard version 4.0, 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 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 Amazonas 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.

According to the local social diagnosis, there are riverside communities directly affected by the project. 8 families live within the project area.

It is important to note that environmental and social activities carried out by the project will try to benefit all families present in this area. These activities will be monitored by SOCIALCARBON indicators at each verification event, which will analyse the extent of alternative income

[55] MMA (2018): http://areasprioritarias.mma.gov.br/2-atualizacao-das-areas-prioritarias

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 territories and resources, including collective and/or conflicting rights, held by local stakeholders.

The property is in the name of a single owner. During the social diagnosis, 8 families were counted in the surroundings, with access to the property. These families are traditional communities, called Ribeirinhos, and carry out subsistence planting. Despite this, they have no land ownership 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, 2007[56], 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 territorial, social rights, environmental, economic and cultural. It also advocates the respect and appreciation of the identity of traditional people and communities, as well as their forms of organization and their different institutions[57].

The Policy is structured around four strategic axes:

1) Access to Traditional Territories and Natural Resources

2) Infrastructure

3) Social Inclusion and

4) Promotion and Sustainable Production.

As previously described in section 1.17, these are 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

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

society, it includes, among others, their forms of expression and their ways of creating, making and living (art. 216, i and ii)[58].

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, a consultation was carried out together with a socio-environmental diagnostic study, already 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 stakeholder characteristics under the baseline scenario, including changes to ecosystem services identified as important to local stakeholders;

The risks and impacts of the project were analysed during its development, as detailed in Table 6, concluding that it will bring positive impacts to the region. Project planning is geared towards forest conservation and sustainable community development, using approved methodologies for monitoring these advances. Communities will be directly impacted since they will have actions aimed exclusively at them, which may be:

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

- Expansion of alternative sources of income as a way to empower and create community independence, in addition to preventing illegal deforestation of the property and RR;

- Directing resources to expand education, health, professionalization, and environmental education actions;

- Maintenance of traditions and way of life of the communities, involving the locals in the development of the project.

More information is detailed in section "Risks to Local Stakeholders" below.

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

Figure below shows the defined Leakage Management Area, with the location of the communities that reside within the project area and reference region.

Figure 12. Location of the Leakage Management Area of Yellow Ipê Grouped Redd Project

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

The communities have free access to the project area. There is a school and a church, but the buildings are abandoned or unfinished. Locations are detailed below:

Table 8. Location of the main properties in the community Vila Nova Amazônia

	EAST	NORTH
Mr Carlos' house – community representant	199990	9391558
Mr Raimundo – Community member	199974	9391626
Church	199947	9391506
School	199937	9391442

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. In case new project activity instances are added to the Grouped Project, a new assessment must be made for each of them.

Table 9. Risks to local stakeholders

Aspect	Impact	Effect		Comments/ Observation
		Beneficial	Adverse	Grupo Leão Instance
Land use	Reduced access to land and traditional areas due to the project activity		X	The baseline scenario activity of the project area will be maintained, i.e, no activity will be conducted in the project area. The communities will not have reduced access to the property, as long as no unplanned deforestation occurs. One of the objectives of the project is to benefit the local community with resources from the carbon credit sales, providing life quality and sustainable development, and communities are guaranteed access to customary land. Monitored by the Biodiversity resource: • Non-timber forest products (NTFPs) Monitored by the Social resource: • Local traditional people assistance
Resources	Withdrawal of natural, economic and cultural resources (water, food, alternative income,		X	The project's objective is to guarantee financial resources to expand the socio-environmental benefits for the communities within and around the Project Area. No resource will be denied from customary use of the communities. Monitored by the Biodiversity resource: • Non-timber forest products (NTFPs)

	cultural events, etc.) from families			Monitored by the Financial resource: • Alternative income sources Monitored by the Social resource: • Additional Social Programs
Land use	Displacement of families due to project activity		X	Families will not be removed from the area currently used. Grupo Leão maintains a friendly relationship with the families, and one of the objectives of the carbon project is to expand social and environmental benefits. Grupo Leão recognizes the permanence and land use of the families in the project area, and any changes will be previously communicated. Monitored by the Carbon resource: • Stakeholder Consultation
Food Security	Withdrawal of land used for food production or income generation		X	The communities 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 affected and the removal of these lands is not planned. Monitored by the Biodiversity resource: • Non-timber forest products (NTFPs) Monitored by the Financial resource: • Alternative income sources
Climate change adaptation	Adaptations and impacts related to the climate crisis	X		The main objective of the project is forest conservation, 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. Monitored by the Financial resource: • Carbon Credit Benefits Monitored by the Social resource: • Additional Social Programs Monitored by the Carbon resource: • Project performance

In addition, a consultation with official agencies was carried out to verify any process that violates human rights. The proponent or any entity related to the project does not have administrative (Public Prosecutor's Office, Public Prosecutor's Office, Unions, among others) or judicial procedures that involve, directly or indirectly, sexual moral harassment, racism, work in conditions similar to that of slave, forced or childish.

The team responsible for the development of the project, mapping and socio-environmental diagnosis has previous experience and technical knowledge to conduct the project. *Ecológica Assessoria* is responsible for the Project development; *Ecológica* Institute experience in forest projects dates back to 1998 with ten projects and contracts. In addition, the *Ecológica Assessoria* team has successfully validated and verified more than 50 voluntary emission reduction projects, over twelve years.

For the present Joint PD, mapping of deforestation and future projections was developed by *Uezu Planejamento Ambiental S/S LTDA*, that has worked with Ecológica and Sustainable Carbon's team in over 4 validated REDD projects.

For the socioenvironmental diagnosis and georeferencing activities, *Amazon Topografia e Logística de Selva Ltda*. was hired, and the company it is legally authorized to conduct identification, registration, socioeconomic survey, logistical support, metering, and georeferenced topographic demarcation.

<u>Respect for Local Stakeholder Resources</u>

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 formally hire the local community, offering technical training (as well as training for worker health and safety), in addition to providing education for children and women, through partnerships with educational institutions. Also, the project proponent seeks ways to generate other sources of income for this population

, both by hiring work and encouraging studies, and by valuing the artisanal work done by the communities.

Aside that, the company plans to facilitate the communities' access to health and education by building a community centre that will feature educational activities and health campaigns. Moreover, it is planned to finance the improvement of boats, speeding up the community's transportation, as well as providing more comfort and efficiency.

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. If the project implements any reforestation project with non-native species over native species in the future, the possible risks and adverse effects of exotic species will be justified and explained to communities.

In addition, the project was planned to reduce damage to the ecosystem on which stakeholders depend. Thus, the project will not introduce any invasive species or allow invasive species to be planted, since the objective is to preserve the existing native vegetation. In case there is management of any non-native species, the use of such species will be evaluated and justified, minimizing risks and impacts and prioritizing the benefit of the ecosystem. If it is necessary to use fertilizers, chemical pesticides, biological control agents or the like, it must be evaluated and justified, punctuating the possible adverse effects.

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 an average of at least one local stakeholders consultations per year (to be held on site after the end of the pandemic), which will be monitored by SOCIALCARBON certification. 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, three consultations were held, two online and one on site. Details on agenda and results are presented below:

Online consultations

Two online consultations were held, as described above. The first, on December 07th, and the second, on January 18th, 2021, with 14 participants.

Both meetings took place via videoconference on Google Meets, with the presence of Ecológica and audit teams.

Meeting schedule:

- Introduction: Presentation of the project proponent and general context of the project area's region;
- Technical information: Emission reduction estimates, standard, chosen methodology, project area and biome;
- Carbon Project: Information on the Yellow Ipê Grouped Project and on how a carbon project works and credits are generated;
- Socio-environmental benefits: Presentation of the SOCIALCARBON standard and possible social benefits for the surrounding communities;
- Feedback round: Any doubts, comments and concerns were registered and answered.

<u>On site consultation</u>

In addition to the presentation of the project, this consultation carried out a survey for a socio-environmental diagnosis of communities inside and outside the project area. The diagnosis schedule is presented below:

1. Presentation of the project

Present the project to the community members present on the day of the visit. The presentation must contain:

- A summary of the project, including information on the proposed forest conservation project, measures to be taken, objectives, size, duration and implementation plan;
- Summary of the economic, social and environmental impacts of the project;
- Contact details for more information;
- Records of doubts, suggestions and complaints, as well as the name of those who made them.

2. Social-environmental diagnosis

A questionnaire to collect information about the communities was elaborated, containing questions regarding:

- Name
- Education
- Time of residence
- Number of family members, sex and age
- Information on sewerage, water treatment, and solid residues destination
- Information on diseases and pests
- Access to Healthcare (hospital, health center, homecare traditional medicines)

- Access to electricity
- Access to communication (telephone, cellphone, radio and television)
- Associations, cooperatives and syndicates in the region
- Agricultural production
- Livestock
- Fire management for crops and cattle
- Timber and non-timber (nuts, copaîba, seeds, açaí, etc) forest products extraction
- Production for subsistence or sale
- Fishing and hunting
- Pension payments and income
- Government payment programs
- Land tenure (Purchase, deed, registry office, title or unknown)
- Land conflicts
- Conflicts and concerns with Grupo Leão
- Cultural and religious parties and rituals
- Places of cultural value (cemetery, churches)

Name and signature of the respondents were collected and are available to VVB.

The geographical coordinates of the places visited, and the houses identified were also collected.

Figure below presents the folder that was given to the community during the consultation:

Figure 13. PIN distributed to the local community

Furthermore, a permanent communication channel with local stakeholders was created in order to receive any comments or suggestions regarding the present REDD project. All comments received will be responded, and grievances will be resolved in a suitable timeframe whenever possible, taking into account culturally appropriate conflict resolution methods.

For those who have access to communication and that the LSC was done remotely, the communication channel is the e-mail mh@ecologica.earth, and telephone +55 11 2649-0036/mobile: +55 11 98882-2550 (Whatsapp).

For the 8 families that live close to the property, as they are in a very remote location, the contact was provided to them during the LSC and social diagnosis, which was done in person. On the folder distributed in the meeting was the phone number and physical and virtual address for the communication channel. In addition, with carbon credit resources, it is intended to improve the communication channels and presence in the area, in order to make communication more effective.

The minutes and attendance list of online presentations will be attached to this PD, in addition to the socio-environmental diagnosis carried out in person.

3 Application of Methodology

3.1 Title and Reference of Methodology

This project utilizes the approved VCS Methodology VM0015: Methodology for Avoided Unplanned Deforestation, version 1.1, published on 03-December-2012.

Furthermore, the following tools were used:

- VT0001 - Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, v3.0, published on 01-February-2012;
- AFOLU Non-Permanence Risk Tool v4.0, published on 19-September-2019.

3.2 Applicability of Methodology

Table 10. Methodology applicability conditions

Applicability Conditions	Yellow Ipê Grouped Project Justification of Applicability	Instance 1 – Grupo Leão Project Activity Justification of Applicability
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.	All instances may have baseline activity that includes 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.	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 v4.0. The primary land uses in the baseline scenario consists of two activities: illegal logging for timber collection, clearing of the area and subsequent cattle ranching, as mentioned on section 3.2 of the PD. Therefore, the present criteria are fulfilled.
b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the	Within the categories of Table 1 and Figure 2 of the methodology, the present grouped project falls within category A, “Avoided Deforestation without Logging” or B, “Avoided	The first project instance contains alluvial dense rainforest, submontane dense ombrophilous forest, lowland dense ombrophilous forest and degradation is not included in either the

methodology (table 1 and figure 2).	Deforestation with Logging in the Project Case".	baseline or project scenario. This instance does not have logging activity or a Sustainable Forest Management Plan.
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".	All instances that compose the Yellow Ipe Grouped project could include different types of forest, such as, but not limited to, old growth forest, degraded forest, among others since meeting the definition of "forest".	The REDD project instance area is 100% made up of alluvial dense rainforest, submontane dense ombrophilous forest, and lowland dense ombrophilous forest, as described in the section Conditions Prior to Project Initiation of the present VCS PD. No deforested, degraded or areas otherwise modified by humans were included in the project area at Project Start Date.
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	For all instances of this grouped project is a requirement that the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	The project instance area consisted of 100% tropical rainforest in 2010 – 10 years prior to project start date – all of which conformed to the Brazilian definition of forest[59]. This was ascertained using satellite images, as described in the

[59] 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

		section Project Location of the present VCS PD.
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.	As a criteria for this item, none of the instances of this grouped project will be aloud to maintain regions grows on peat. Apart of the exception above the project area can include forested wetlands (such as bottomland forests, flood plain forests, mangrove forests)	As described in the section 1.13 of the present VCS PD, all soil types are oxisoils, thus, mineral. Therefore, none of the project region grows on peat, satisfying this applicability criterion.

3.3 Project Boundary

The Grouped REDD project boundaries are defined by the limits of the reference region. The first project instance area is composed of two properties as described in the section Project Location

minimum height of 5 meters (m) at maturity in situ." Available at: <http://www.fao.org/docrep/006/ad665e/ad665e06.htm>.

(Gleba 2 and Gleba 4). Given that the coordinates represented by these properties are extensive, the area contour coordinates of the properties composing the Yellow Ipê Grouped REDD Project are presented in Appendix I.

The sum of the two properties comprising the project instance area – defined in accordance with the methodology's rules governing the latter – as well as the size of the reference region and leakage belt, are displayed in the Table below.

Table 11. Forested areas within the Project Instance Area and Leakage Belt.

Name	Area (ha)
Project Area	86,091.66
Leakage Belt	62,894.07
Reference Region	1,440,404.91

The applied Methodology considers the six carbon pools 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 12. Carbon pools included or excluded within the boundary of the proposed AUD project activity.

Carbon pools	Included / Excluded	Justification / Explanation of choice
Above-ground	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. This exclusion is conservative.
Harvested wood products	Included	Stock change in this pool is considered significant in the case a project instance implements sustainable forest management. The first instance of this grouped project does not conduct a SFMP, thus this carbon stock is considered insignificant.
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, 4.0.

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.

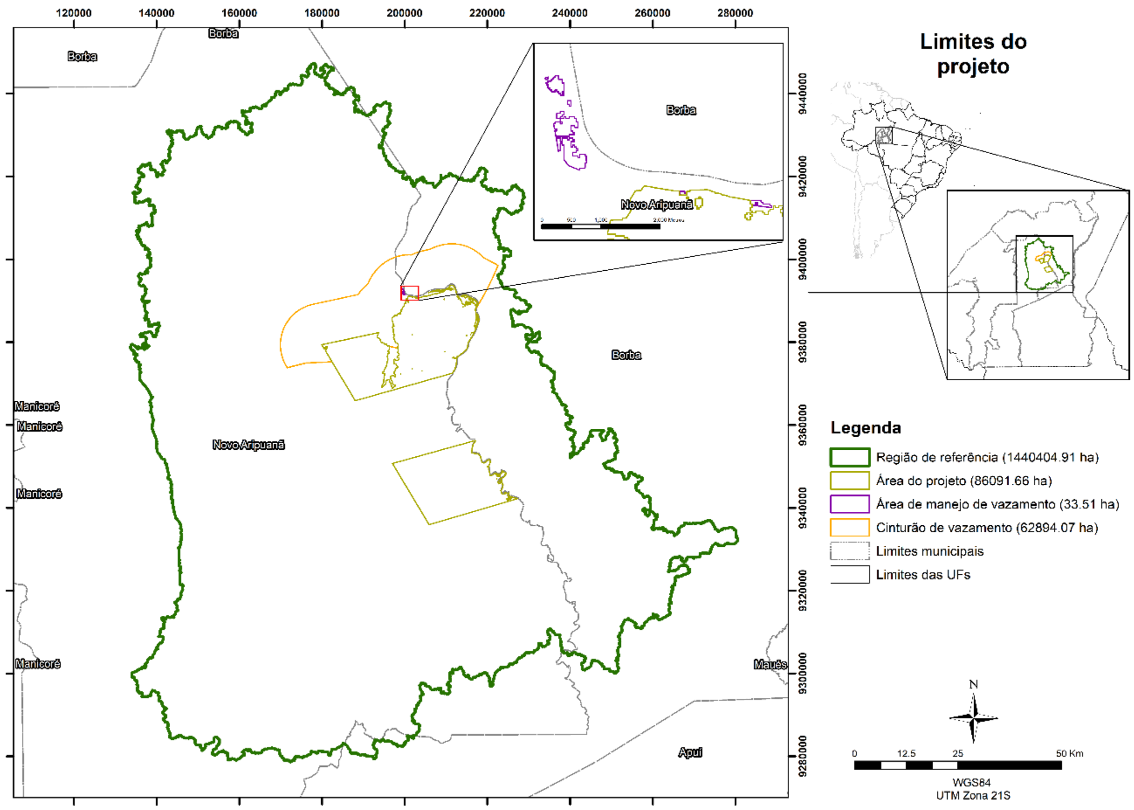
Table 13. Sources and GHG included or excluded within the boundary of the proposed AUD project activity

Source		Gas	Included?	Justification/Explanation
Baseline	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_2O	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_2O	Excluded	Excluded for simplification. This is conservative.
		Other	Excluded	No other GHG gases were considered in this project activity.
Project	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 project scenario, according to the methodology.

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

The map of the project boundary including the locations of project area, reference region and leakage belt is shown at the Figure below.

Figure 14. Project boundaries[60]



3.4 Baseline Scenario

The baseline scenario described in this section is valid for the Yellow Ipê Grouped Project and its instances, present and future.

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 (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.

[60] The sources for the elaboration of this map can be found through the link: <ftp://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/informacoes_tecnicas/>

Definition of the property boundaries

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.

The RR was defined in accordance with two criteria:

- The methodology recommendation that projects over 100,000 ha in size should have RRs 5 to 7 times bigger than the project area. As the areas of this project totalled 86,096.66 ha, that is, a value close to 100,000 ha, an approximation was made, and a buffer 10 times larger than the project areas was decided (since these are less than 100,000 ha).
- 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 in order for it to more accurately represent the land use dynamics. Specifically, this was based on the waterways (watersheds) and infrastructure (roads), which are the main means of human and product transportation in the region.

As detailed above, the project area is located in the south of the State of Amazonas, in municipalities that are in the list of regions with increasing land conflict, expansion of livestock and history of increase of deforestation rate.

Taking this into account, in order to define the limits of the Reference Region, a socioeconomic analysis of the region was carried out and the existence of governmental forest preservation programs or even REDD projects was surveyed, since these municipalities are within the limits of the “Amazonian Arc of Deforestation” and livestock expansion. For the socioeconomic analysis it was necessary to analyze the region where the project area is located, considering hydrographic basins, types of vegetation and existing land structure.

The 4th order hydrographic basins were initially defined within an area of more than 10 million hectares around the project area, from the drainage network produced by the digital model of elevation of the Shuttle Radar Topography Mission (SRTM). For each of these basins the average values of elevation, slope and precipitation and the percentages of the different vegetation types were determined. From the definition of this area, the criteria related to the type of vegetation, elevation, slope and precipitation were tested to verify the similarity in relation to the project area and the rest of the reference region.

Thus, based on the project area definition, the Reference Region was delimited encompassing the leakage belt. The criterion of the minimum area was adopted as mentioned in the applied methodology. A concentric buffer was developed around the Project Area with a size 7 times greater than the project area. After this first delimitation, adjustments were made based on:

- Agents and drivers of deforestation expected to cause deforestation within the project area in absence of the proposed REDD project activity (i.e., cattle ranching and agriculture) caused deforestation in the reference region during the historical reference period;
- History of deforestation and economic growth of the region, expansion of the agricultural frontier, limits of the arc of deforestation, land conflicts, land structure in the region (presence of conservation units, indigenous lands and agrarian reform settlements);
- Existing infrastructure with the presence of navigable rivers, roads and highways and their respective production outflow routes;
- Socioeconomic characteristics of the municipalities involved, such as Gross Domestic Products (GDP), concentration of
- in urban or rural areas and main economic products;
- The legal status of the land and the land tenure system found within the project area, i.e. private land, is also found in the reference region;
- Current and projected land use within the project area are found in the reference region;
- The project area is governed by the same policies, legislation and regulations that apply in the reference region;
- Elevation, Slope, Climate and Forest Classes characteristics in the Project Region: at least 90% of the project area have landscape configurations and ecological conditions that exist in at least 90% of the rest of the reference region.

Considering all criteria above, the reference region has an area of 1,440,404.91 ha. Maps below show some of the criteria that were taken into account in order to adjust the Yellow Ipê Grouped REDD Project's Reference Region.

Vegetation cover

Three vegetation types were found to be present in the project instance area: Dense Alluvial Tropical Rainforest, Dense Submontane Tropical Rainforest, and Dense Lowland Tropical Rainforest. In the reference region, these phytophysiognomies occupy 89.1%, however, excluding areas of water bodies and pasturelands, this value reaches 90.7% (figures below). Other vegetation types present within the reference region are Open Alluvial Tropical Rainforest, Open Submontane Tropical Rainforest, and Pioneer formations with fluvial influence.

Figure 15. Vegetation cover of the reference region[61].

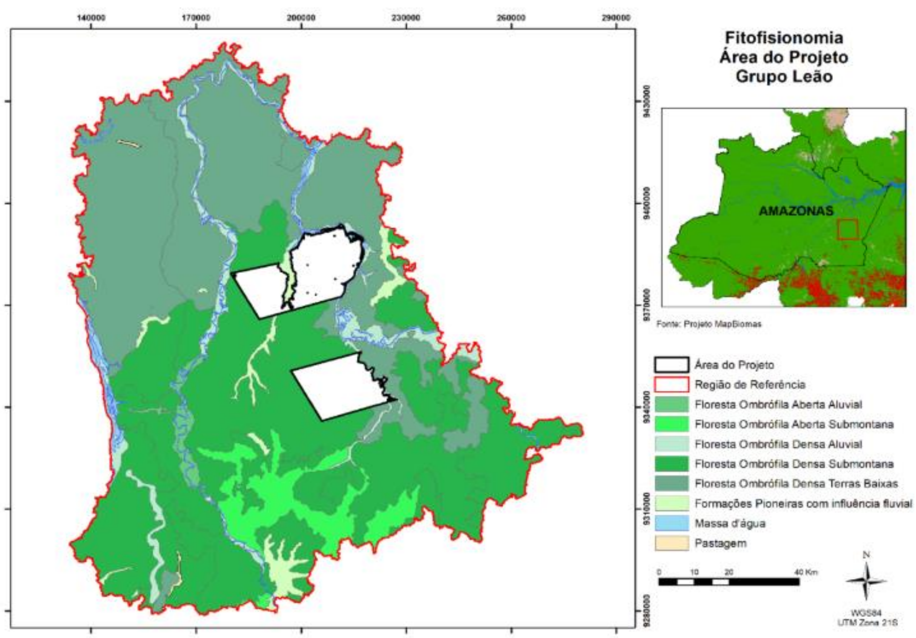
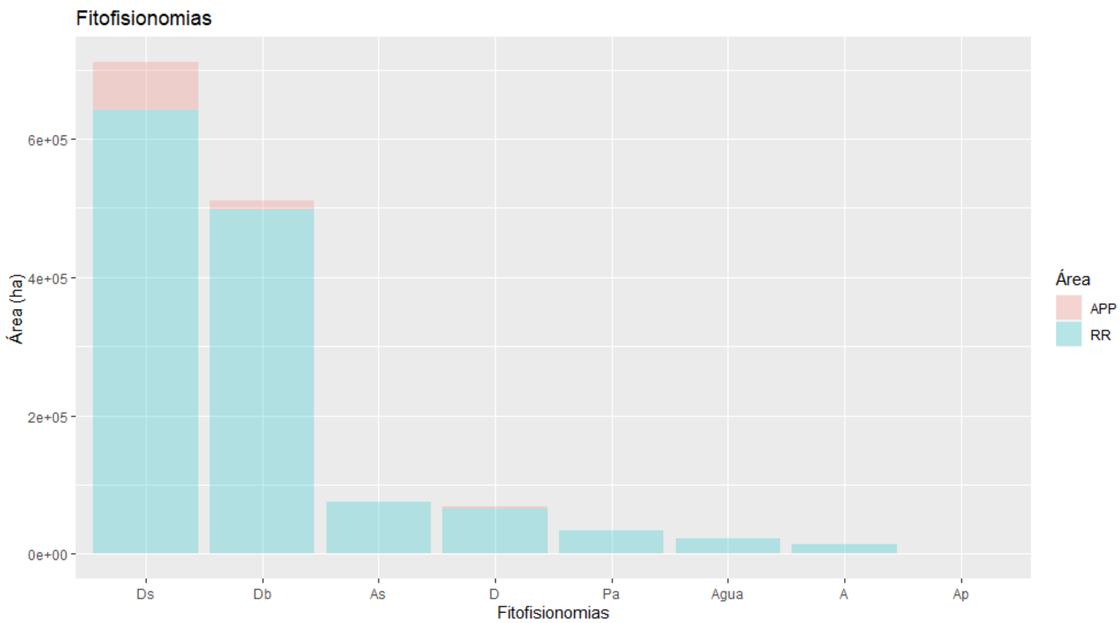


Figure 16. Vegetation types in the Reference Region of the Yellow Ipê Grouped REDD Project

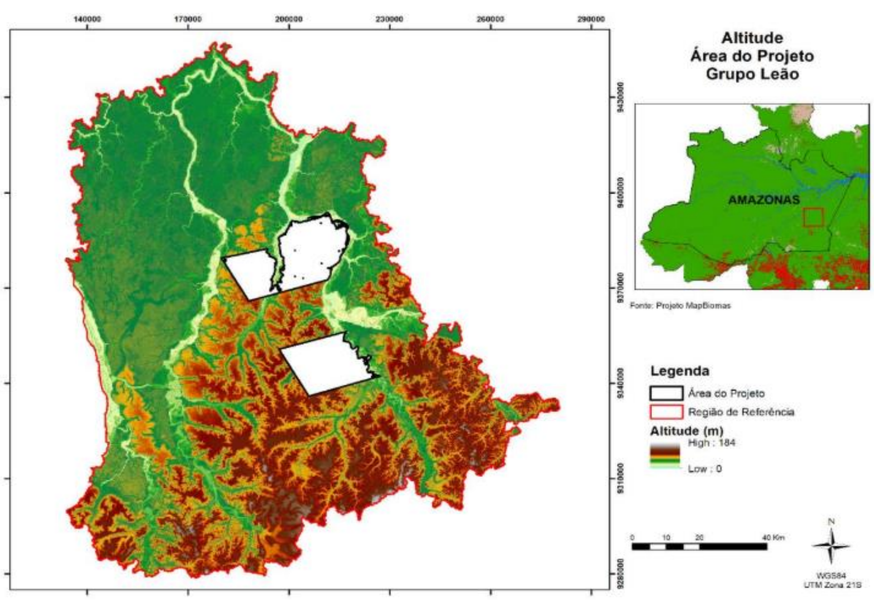
[61] The sources for the elaboration of this map can be found through the link: <http://www.dpi.inpe.br/Ambdata/mapa_sipam.php>



Altitude

The altitude in the project area ranges from 13 to 138 m, as presented in map on section 1.13 and these values are within 99% of the variation in the reference region.

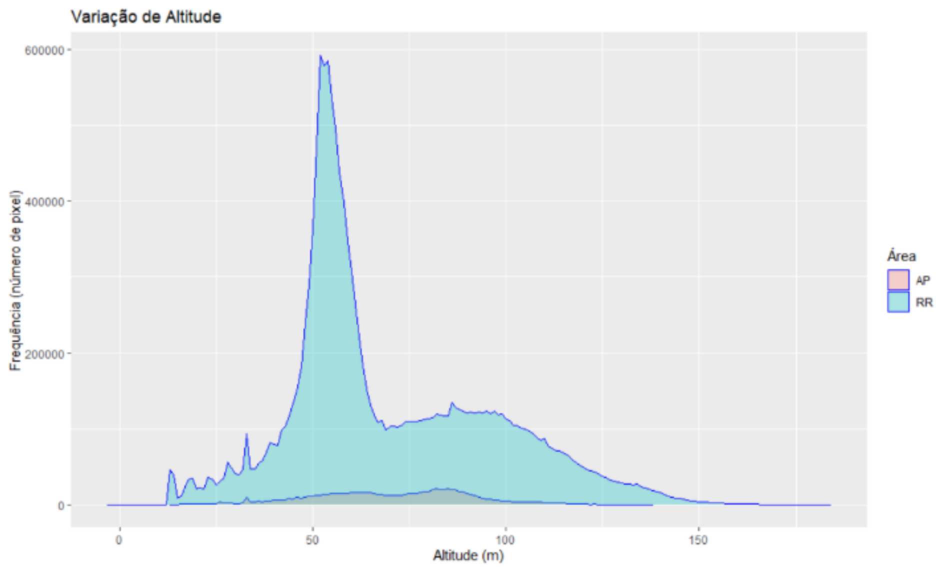
Figure 17. Altitude variation in the reference region of Yellow Ipê Grouped REDD Project.



[62]

62 The sources for the elaboration of this map can be found through the link:<https://earthexplorer.usgs.gov/>

Figure 18. Altitude distribution (m), in number of pixels, in the Reference Region (RR) and in the Project Area (PA)[63].



Slope

The average slope in the project area is 4.26 while in the remaining 90.5% of the reference region it is 3.97. Therefore, the average value of the project area is within the range of ± 10% of the average in this region, which is between 3.57 and 4.37.

63 The sources for the elaboration of this figure can be found through the link: <https://www.worldclim.org/data/worldclim21.html>

Figure 19. Slope variation in the Reference Region

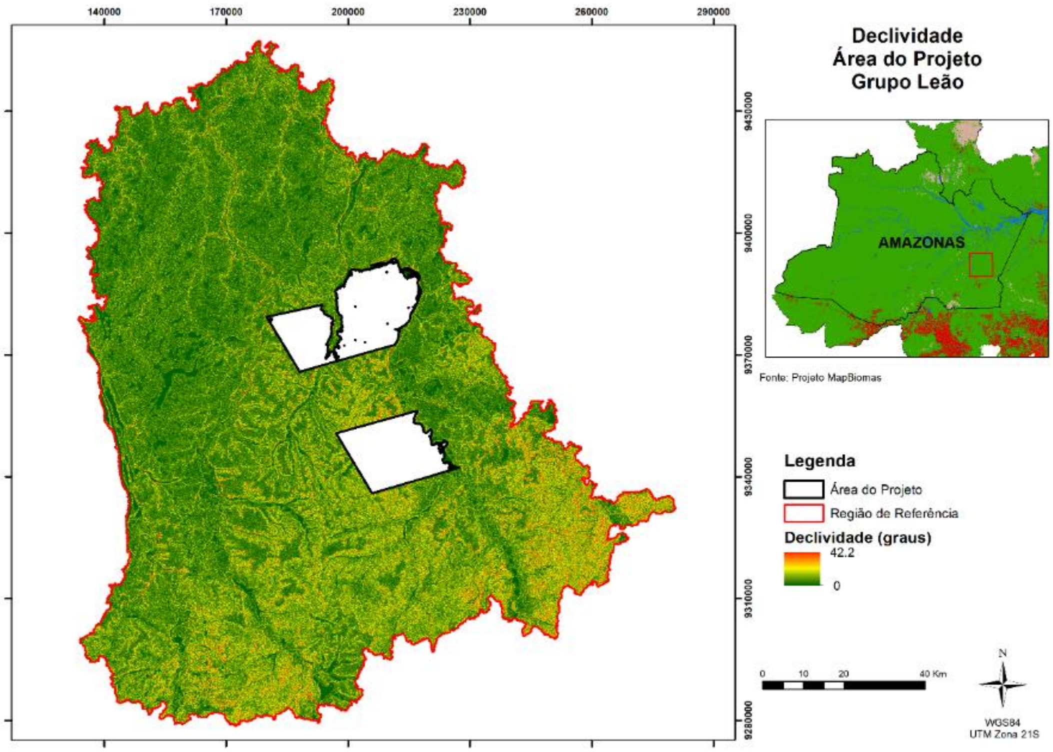
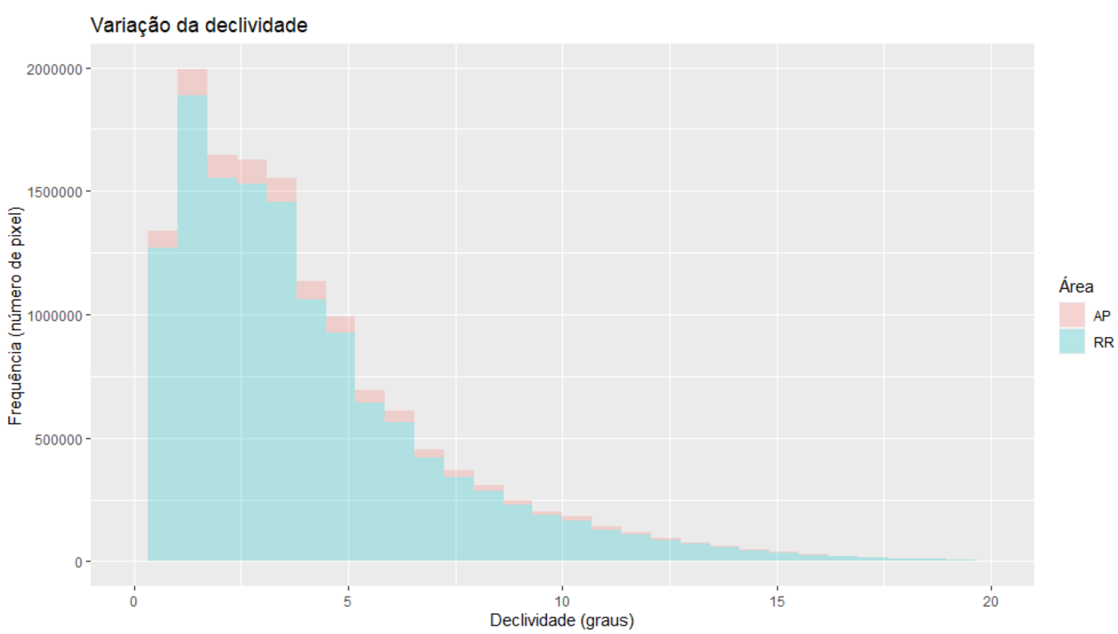


Figure 20.. Variation of slope on the Reference Region and Project Area



Rainfall

The average annual rainfall is high, averaging 2,289.71 mm year−1 in the project area, while in the rest of the reference region it is 2,309.46 mm, thus, the amount of rain in the project area is within the range of ± 10% of 100% of the average of the rest of the reference region, which varies between 2,078.5 and 2,540.41 mm.

Figure 21. Rainfall variation on Reference Region

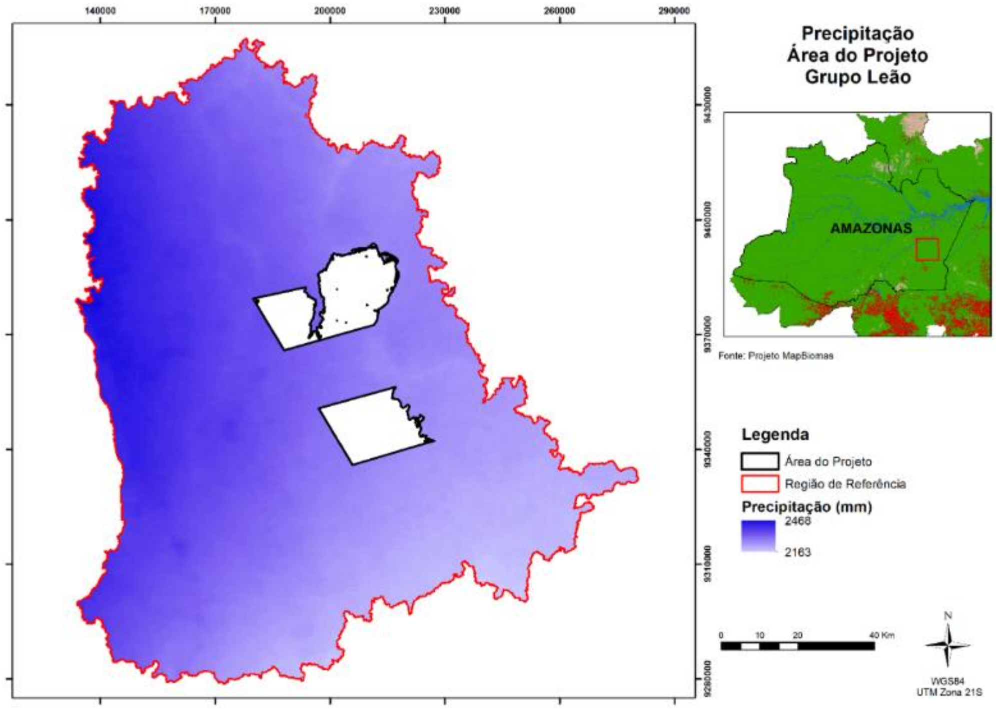
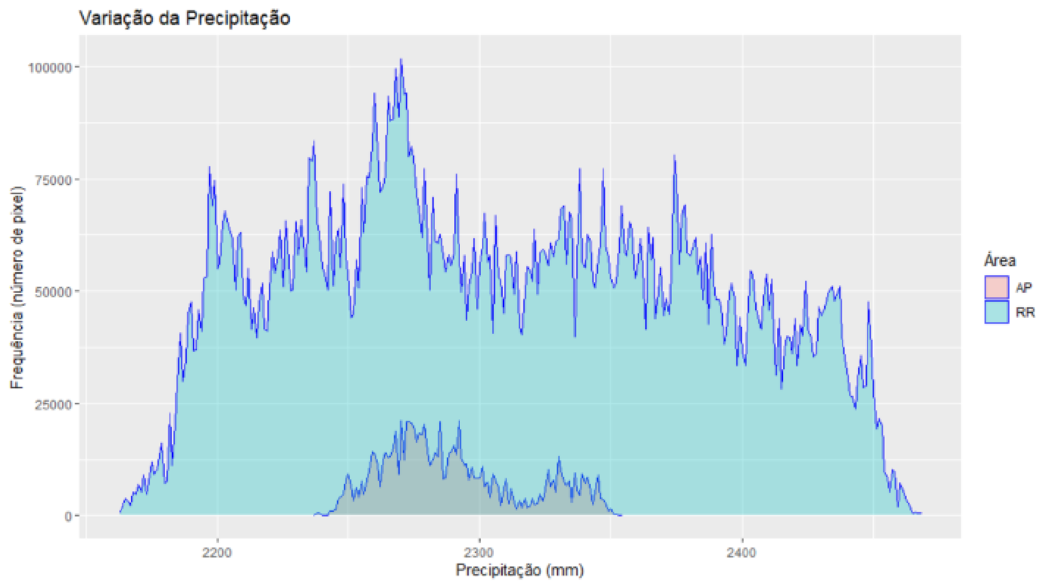


Figure 22. Distribution of annual precipitation (mm), in number of pixels, in the Reference Region (RR) and in the Project Area (PA) [64].



Leakage Belt

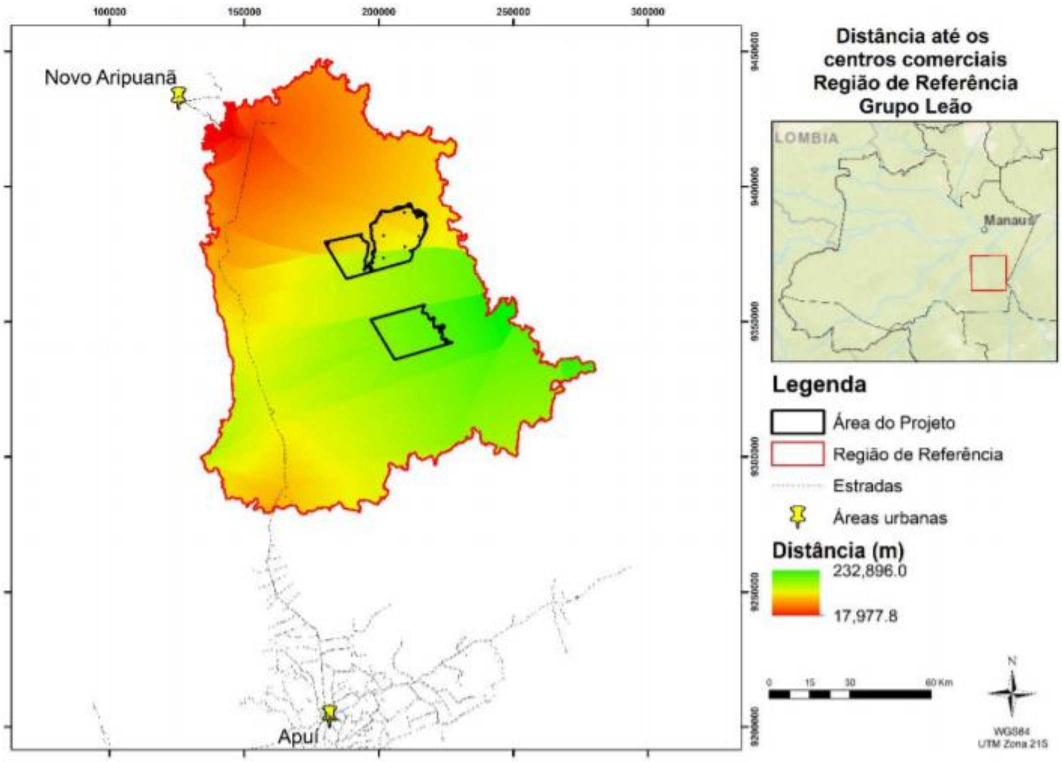
To determine the leakage belt area, the opportunity cost methodology was carried out. Therefore, the economic viability of livestock production was spatialized in the Reference Region of the project, which consists of the difference between the sale price of the cattle (per ton) and the average cost of production (per ton) plus the cost of transportation to take the product to the nearest consumer center.

The 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 travelled to the nearest commercial center (Apuí or Novo Aripuanã).

Figure 22 represents the total distance in the reference region.

[64] The sources for the elaboration of this figure can be found through the link: <https://www.worldclim.org/data/worldclim21.html>

Figure 23. Surface distances (m) to the nearest commercial centers (Apuí and Novo Aripuanã) in the Reference Region (RR) [65].



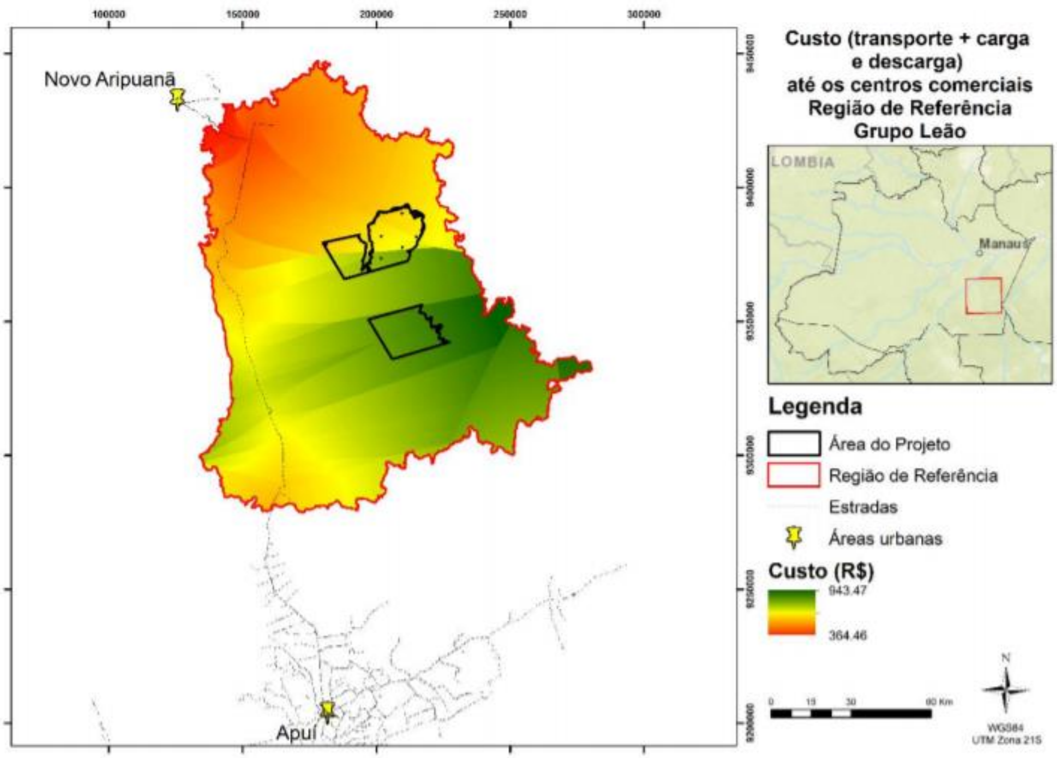
For monetary costs, the freight table for road transportation of cargo capacity was considered[66]. In Apuí, each animal weighs an average of 13 arrobas[67], so it was considered 1 three-axle truck carrying an average of 72 cattle heads at the price of R$ 2.6941 / km + R$ 316.03 of loading and unloading. Figure 25 illustrates the freight values that would be paid at each point in the reference region.

[65] The sources for the elaboration of this map can be found through the link: <>ftp://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/informacoes_tecnicas/>

[66] Freight table available in Resolution nº 5,890, of May 26th, 2020. Available in < https://www.legisweb.com.br/legislacao/?id=396001> Last access in 03/11/2020

[67] A Cadeia Produtiva da Carne Bovina no Amazonas./Gabriel Cardoso Carrero; Gabriela Albuja; Pedro Frizo; Evando Konrad Hoffmann; Cristiano Alves; Caroline de Souza Bezerra. IDESAM, 2015. Available in: <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>

Figure 24. Surface costs (R$) for road transportation to the nearest commercial centers (Apuí and Novo Aripuanã) in the Reference Region (RR) [68].



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$ 906.00[69]. As reported in interviews in Apuí, the average price of the arroba varies between R$ 80 and R$ 92[70] 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:

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[68] The sources for the elaboration of this map can be found through the link: <http://www.dpi.inpe.br/Ambdata/mapa_sipam.php>

[69]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-produtiva-corte-amazonas.pdf>

[70] A Cadeia Produtiva da Carne Bovina no Amazonas./Gabriel Cardoso Carrero; Gabriela Albuja; Pedro Frizo; Evando Konrad Hoffmann; Cristiano Alves; Caroline de Souza Bezerra. IDESAM, 2015. Available in: <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>

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

Where:

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

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

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

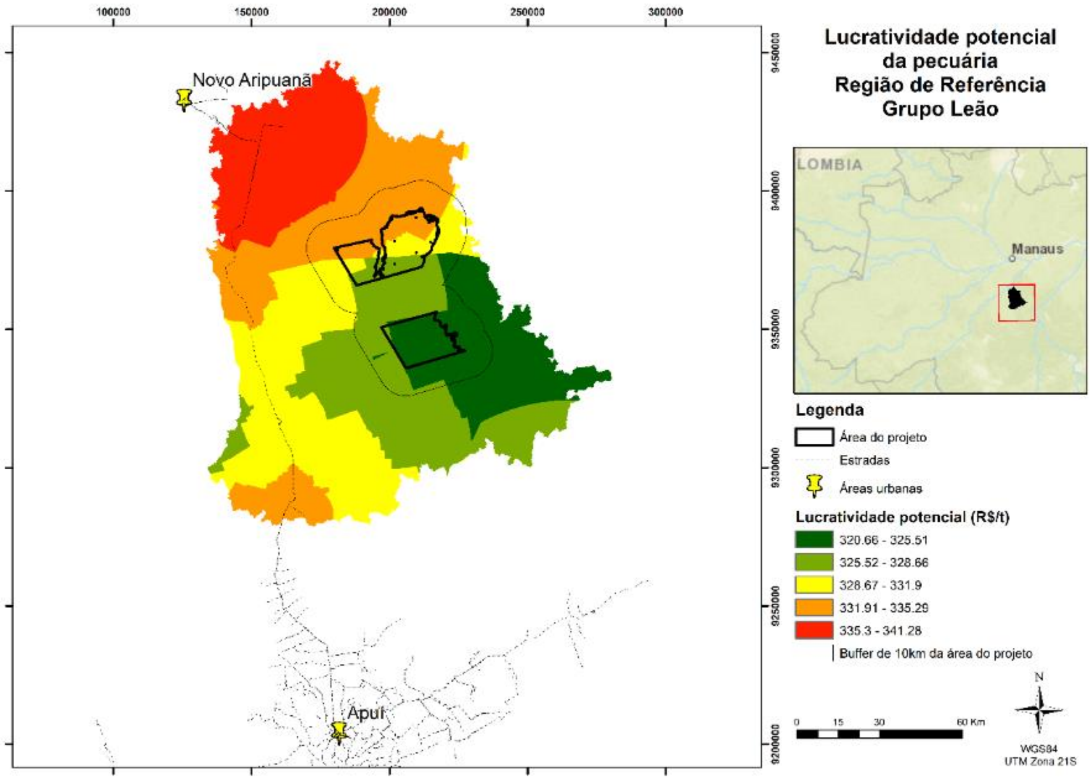
TCv: Average transport cost per kilometer for one ton of product Px on land, river or road of type v; $/t/km

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

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

The location of these areas is illustrated in figure 24 below.

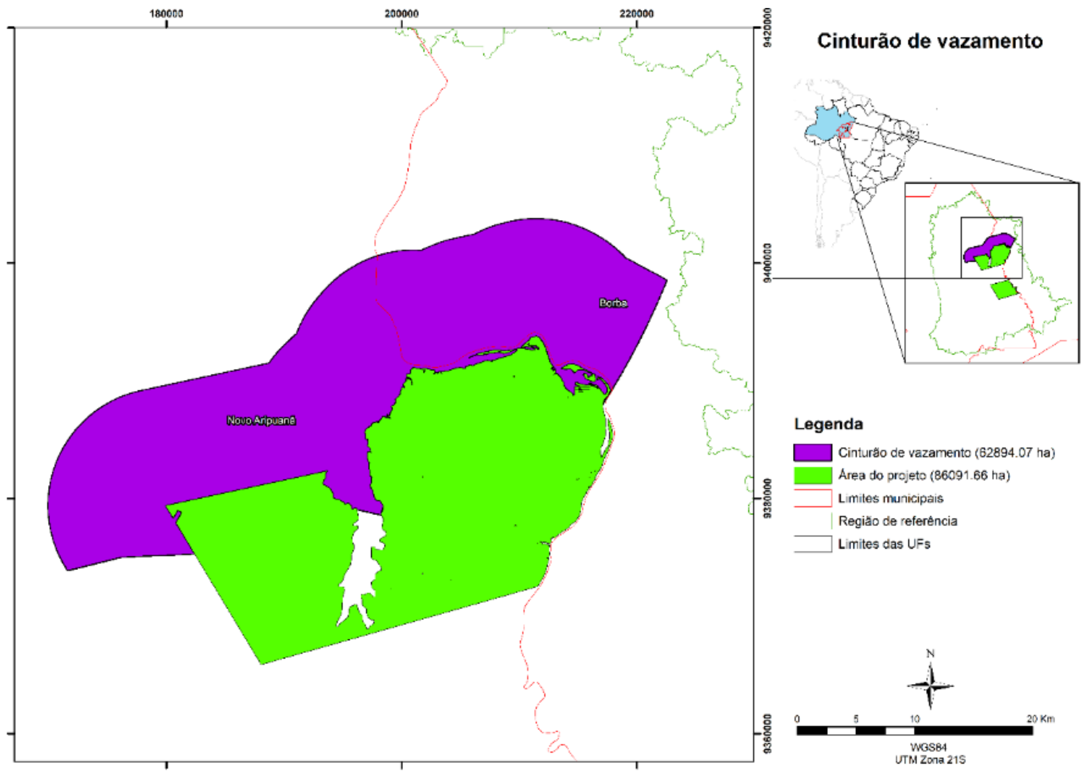
Figure 25. Potential profitability areas for cattle ranching within the Reference Region (RR)[71].



Within this analysis, it was considered that areas with a higher profitability value would be more attractive for the activity. Thus, a classification by natural breaks based on the profitability values was made, highlighting the values starting from the 4th class. In addition, it was considered that areas adjacent to the project area viable according to the opportunity cost analysis within a 10 km radius would be where deforestation could occur directly due to the project's actions. In more distant areas, the increase in deforestation as it is already occurring is probably associated with the proximity to rivers and roads. Thus, from an overlap of these two information, we define the area of the leakage belt, with an area of 62,894.07 ha. Figure below illustrates its location.

[71] The sources for the elaboration of this map can be found through these references and links: CARRERO, G. C.; ALBUJA, G.; FRIZO, P.; HOFFMANN, E. K.; ALVES, C.; BEZERRA, C. S. A Cadeia Produtiva da Carne Bovina no Amazonas. Manaus: IDESAM, 2015; CARRERO, G.; ALBUJA, G; CENAMO. M. C.; BETTARELLO, M; VICENTE, A. 2014. Viabilidade econômica da pecuária semi-intensiva no sul do Amazonas: uma oportunidade para reduzir o avanço do desmatamento. Idesam, Manaus-AM. <http://www.idesam.org.br/ viabilidade-economica-da-pecuaria-semi-intensiva-no-sul-do-amazonas> ; Ministério da Infraestrutura/Agência Nacional de Transportes Terrestres/Diretoria Colegiada. RESOLUÇÃO Nº 5.890, DE 26 DE MAIO DE 2020 – Altera o Anexo II da Resolução nº 5.867, de 14 de janeiro de 2020. Diário Oficial da União, p. 160-161, 27 de maio de 2020. <http://www.in.gov.br/en/web/dou/-/resolucao-n-5.890-de-26-de-maio-de-2020-258705401>

Figure 26. Leakage belt location



Leakage Management Area

The leakage management area (LMA) is designed 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, agro-forestry, reforestation, education, or other activities.

The Yellow Ipê Grouped REDD Project's leakage management area is located in the border of the north property of Grupo Leão, the first instance activity. This leakage management area may change with the addition of new instances. The LMA covers the community Vila Nova Amazon and has an area of 33.51 ha.

Therefore, the area was chosen due to the presence of the closest community, as education, employment, alternative income and mobility activities are planned to be carried out during the project's lifetime.

Figure 27. Leakage Management Area

Leakage Management Plan

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

As detailed in section 1.17, in summary, the project plans to expand the extraction of NTFPs and other alternative income for the community, encouraging handicrafts and local traditions. Moreover, the project activities will enable the creation of jobs to monitor the area, prioritizing the hiring of local residents for monitoring of the area, with professional training. Income from the sale of credits will make it possible to invest in the educational and professional training of children and adults in the Community.

Beyond the project's ecological and carbon benefits, the implementation of REDD and SOCIALCARBON mechanisms promotes benefit sharing.

SOCIALCARBON methodology 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.

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 (2010-2019), 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 first baseline period comprised analysis of images from 2010 - 2019. 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 2010 to 2018 produced by MapBiomas were used, made available in raster format on the program's website (http: //mapbioma .org /) and supervised classifications using Google Earth Engine for the year 2019. This classifier was chosen because it is the same used in MapBiomas, allowing a closer approximation of the method.

In order to compose the entire reference region, one Landsat scene per year (orbit / point: 230/64) from the reference period was required (Table 14). The final mapping resolution was of 30 m pixel.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[72] promoted by the Climate Observatory. The MapBiomas creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

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

[72] SEEG website. Available at: http://seeg.eco.br/en/ Last visited on 18/06/2020

For the supervised classification of the year 2019, this same algorithm was used, but without the use of metrics, filters and neighbourhood rules applied in the MapBiomas methodology. In order to obtain an adequate image for the direct classification of samples, images from the USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance were collected within the reference region with a limit of 1% cloud cover and an average of these images was generated. 50 polygons for each class of use (forest, water and deforestation) were generated and the Random Forest automatic classifier via Google Earth Engine was applied.

Table 14. Data used for historical LU/LC change analysis

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(km^2)	Year	Path	Row
Satellite	Landsat TM	30	0.45-2.35	34,225	2009 - 2018	230	64

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

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

Stratification was not carried out in either class, and therefore the categories “forest” and “non-forest” have homogenous carbon stocks. Satellite images were used to generate the land-use and land-cover map in 2019 shown in the figure below.

Figure 28. Land use and land cover map comparing 2010 and 2019.

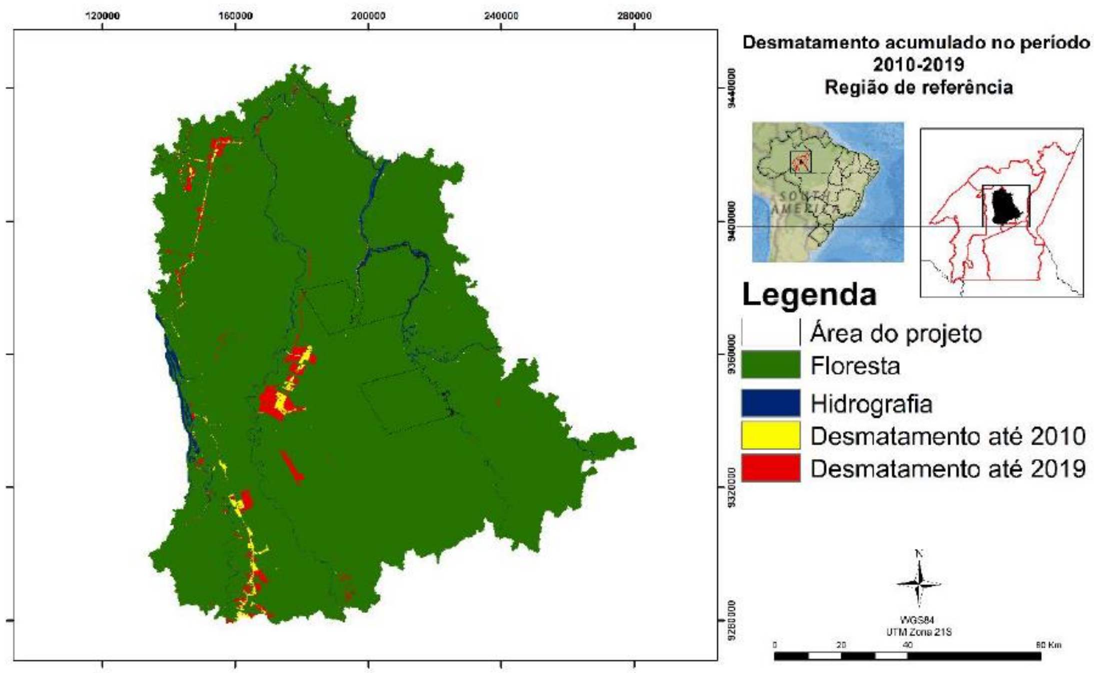


Table 15. List of land use and land cover change categories

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	Dense Alluvial Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM). Predominantly Dense Alluvial Tropical Rainforest.
2	Dense Submontane Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM). Predominantly Dense Submontane Tropical Rainforest.

3	Dense Lowland Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM). Predominantly Dense Lowland Tropical Rainforest.
4	Open Alluvial Tropical Rainforest	decreasing	RR	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM). Predominantly Open Alluvial Tropical Rainforest.
5	Open Submontane Tropical Rainforest	decreasing	RR	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM). Predominantly Open Submontane Tropical Rainforest.
6	Pioneer formations with fluvial influence	decreasing	RR, LK	no	no	no	According to official classification of the types of vegetation of Brazil (SIVAM).
7	No forest	increasing	RR, PA, LK	no	no	no	Mosaic of anthropic areas: pasture, annual, perennial crops and roads according to the satellite image classification
8	Hydrography	constant	RR, PA, LK	no	no	no	Presence of rivers and water bodies in the satellite image classification and information from the National Water Agency - ANA

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

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

Table 16 shows that deforestation could occur in the baseline and project scenarios within both the PA and LK areas and shows the quantities of deforestation observed within the historical reference period associated with each identifier. The deforestation present within the PA and LK are shown in the LU/LC-change map. This Table displays deforestation across the whole reference period.

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

Table 16. Land use change matrix in the reference region between 2010 and 2019

		Initial LU/LC class						
	IDcl	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	No forest
Final Class	Dense Alluvial Tropical Rainforest	I1/F1	0	0	0	0	0	0
	Dense Submontane Tropical Rainforest	0	I2/F2	0	0	0	0	0
	Dense Lowland Tropical Rainforest	0	0	I3/F3	0	0	0	0
	Open Alluvial Tropical Rainforest	0	0	0	I4/F4	0	0	0
	Open Submontane Tropical Rainforest	0	0	0	0	I5/F5	0	0
	Pioneer formations with fluvial influence	0	0	0	0	0	I6/F6	0
	No forest	I1/F7	I2/F7	I3/F7	I4/F7	I5/F7	I6/F7	I7/F7

BASELINE SCENARIO

PA	Initial LU/LC class			
IDcl	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Non Forest in the PA
Final Class: Dense Alluvial Tropical Rainforest	2,745.36	0.00	0.00	0.00
Final Class: Dense Submontane Tropical Rainforest	0.00	46,772.73	0.00	0.00
Final Class: Dense Lowland Tropical Rainforest	0.00	0.00	11,004.67	0.00
Final Class: Non Forest in the PA	392.29	23,533.84	1,642.77	0.00

LB	Initial LU/LC class				
IDcl	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Pioneer formations with fluvial influence	Non Forest in the LK
Final Class: Dense Alluvial Tropical Rainforest	1,693.00	0.00	0.00	0.00	0.00
Final Class: Dense Submontane Tropical Rainforest	0.00	7,462.85	0.00	0.00	0.00
Final Class: Dense Lowland Tropical Rainforest	0.00	0.00	23,144.13	0.00	0.00
Final Class: Pioneer formations with fluvial influence	0.00	0.00	0.00	947.49	0.00
Final Class: Non Forest in the LK	4,201.91	10,766.65	10,408.15	898.72	669.10

PROJECT SCENARIO

PA	Initial LU/LC class			
IDcl	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Non Forest in the PA
Final Class: Dense Alluvial Tropical Rainforest	3,121.74	0.00	0.00	0.00
Final Class: Dense Submontane Tropical Rainforest	0.00	69,352.25	0.00	0.00
Final Class: Dense Lowland Tropical Rainforest	0.00	0.00	12,580.83	0.00
Final Class: Non Forest in the PA	15.91	954.33	66.62	0.00

LB	Initial LU/LC class				
IDcl	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Pioneer formations with fluvial influence	Non Forest in the LK
Final Class: Dense Alluvial Tropical Rainforest	1,693.00	0.00	0.00	0.00	0.00
Final Class: Dense Submontane Tropical Rainforest	0.00	7,462.85	0.00	0.00	0.00
Final Class: Dense Lowland Tropical Rainforest	0.00	0.00	23,144.13	0.00	0.00
Final Class: Pioneer formations with fluvial influence	0.00	0.00	0.00	947.49	0.00

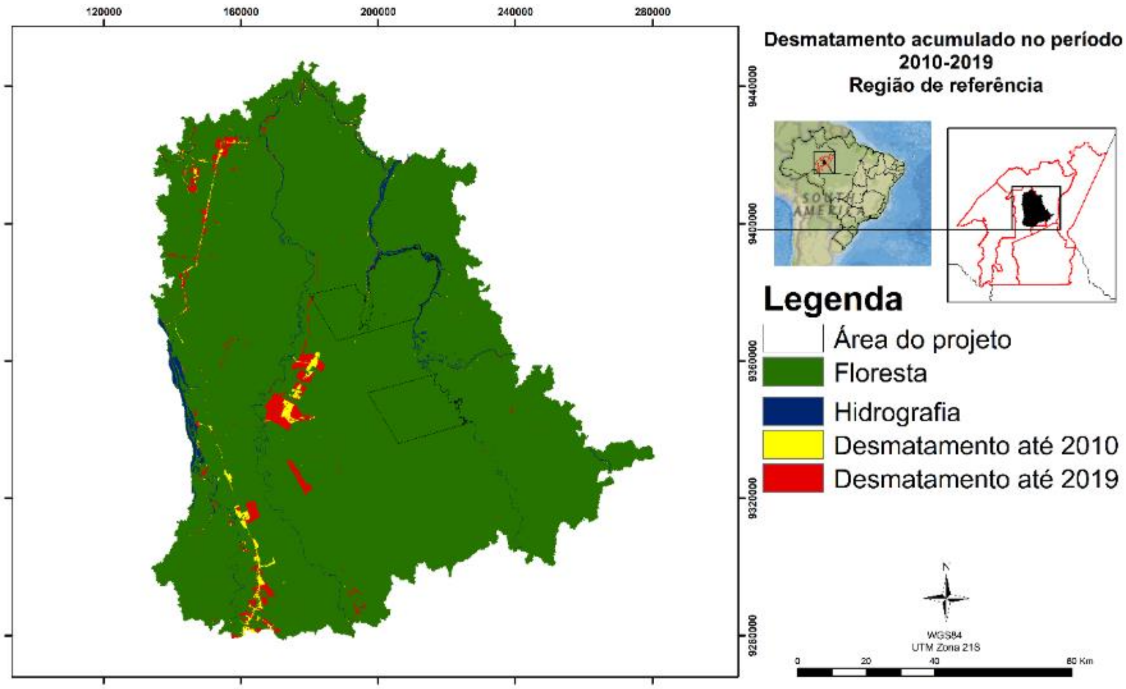
		Non Forest in the LK	4,201.91	10,766.65	10,408.15	898.72	669.10

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 17. 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	Dense Alluvial Tropical Rainforest	constant	RR, PA, LK	no	no	no	Dense Alluvial Tropical Rainforest	constant	RR, PA, LK	no	no	no
I1/F7	Dense Alluvial Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	Non-Forest	constant	RR, PA, LK	no	no	no
I2/F2	Dense Submontane Tropical Rainforest	constant	RR, PA, LK	no	no	no	Dense Submontane Tropical Rainforest	constant	RR, PA, LK	no	no	no
I2/F7	Dense Submontane Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	Non Forest	constant	RR, PA, LK	no	no	no
I3/F3	Dense Lowland Tropical Rainforest	constant	RR, PA, LK	no	no	no	Dense Lowland Tropical Rainforest	constant	RR, PA, LK	no	no	no
I3/F7	Dense Lowland Tropical Rainforest	decreasing	RR, PA, LK	no	no	no	Non Forest	constant	RR, PA, LK	no	no	no
I4/F4	Open Alluvial Tropical Rainforest	constant	RR	no	no	no	Open Alluvial Tropical Rainforest	constant	RR	no	no	no
I4/F7	Open Alluvial Tropical Rainforest	decreasing	RR	no	no	no	Non Forest	constant	RR	no	no	no
I5/F5	Open Submontane Tropical Rainforest	constant	RR	no	no	no	Open Submontane Tropical Rainforest	constant	RR	no	no	no
I5/F7	Open Submontane Tropical Rainforest	decreasing	RR	no	no	no	Non Forest	constant	RR	no	no	no
I6/F6	Pioneer formations with fluvial influence	constant	RR, LK	no	no	no	Pioneer formations with fluvial influence	constant	RR, LK	no	no	no
I6/F7	Pioneer formations with fluvial influence	decreasing	RR, LK	no	no	no	Non Forest	constant	RR, LK	no	no	no
I7/F7	Non Forest	constant	RR, LK	no	no	no	Non Forest	constant	RR, LK	no	no	no

Figure 29.Cumulative deforestation between 2010-2019 in reference region



Analysis of historical land-use and land-cover change

According to the GIS analysis, between 2010 and 2019, there was a deforestation of 29,482.11 ha within the reference region, with an average oscillation of approximately 2,948.21 ha/year. There was a significant increase in deforestation rate during that period (R2 = 0.58, p = 0.0065). In the leakage area, there was a deforestation of 620.77 ha, and an average of 62.08 ha/year. These information are presented in figures and tables below:

Figure 30. Deforestation dynamics, between the years 2010 and 2019, in the region of reference (RR) and project area. Source: MapBiomas and IPE data

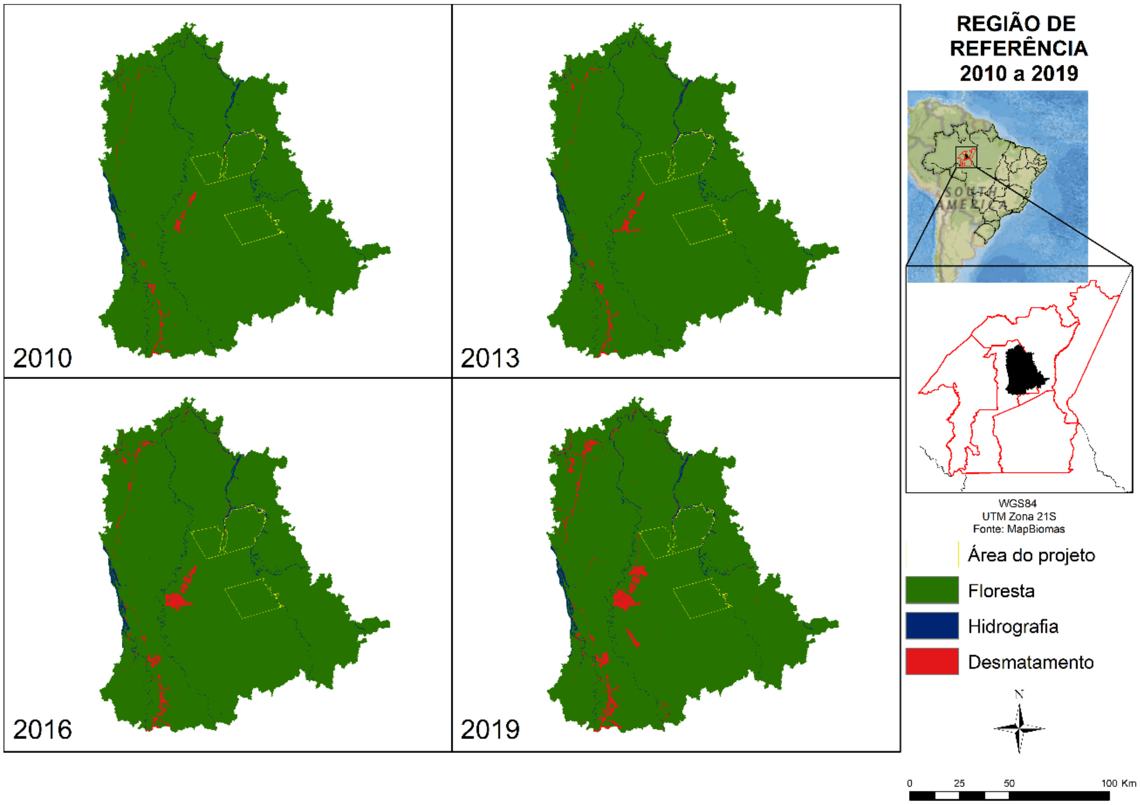


Figure 31. Variation in the deforestation rate in the reference region between the years 2010 and 2019. Source: MapBiomas

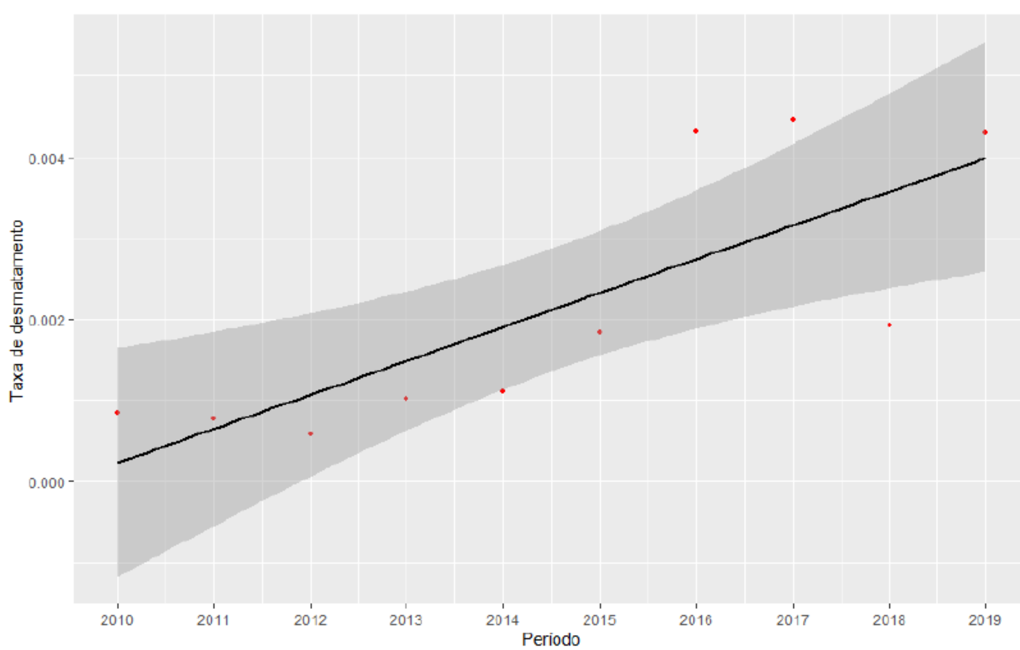


Figure 32. Deforestation dynamics between the years 2010 and 2019 in the leakage belt. Source: MapBiomas and IPE data

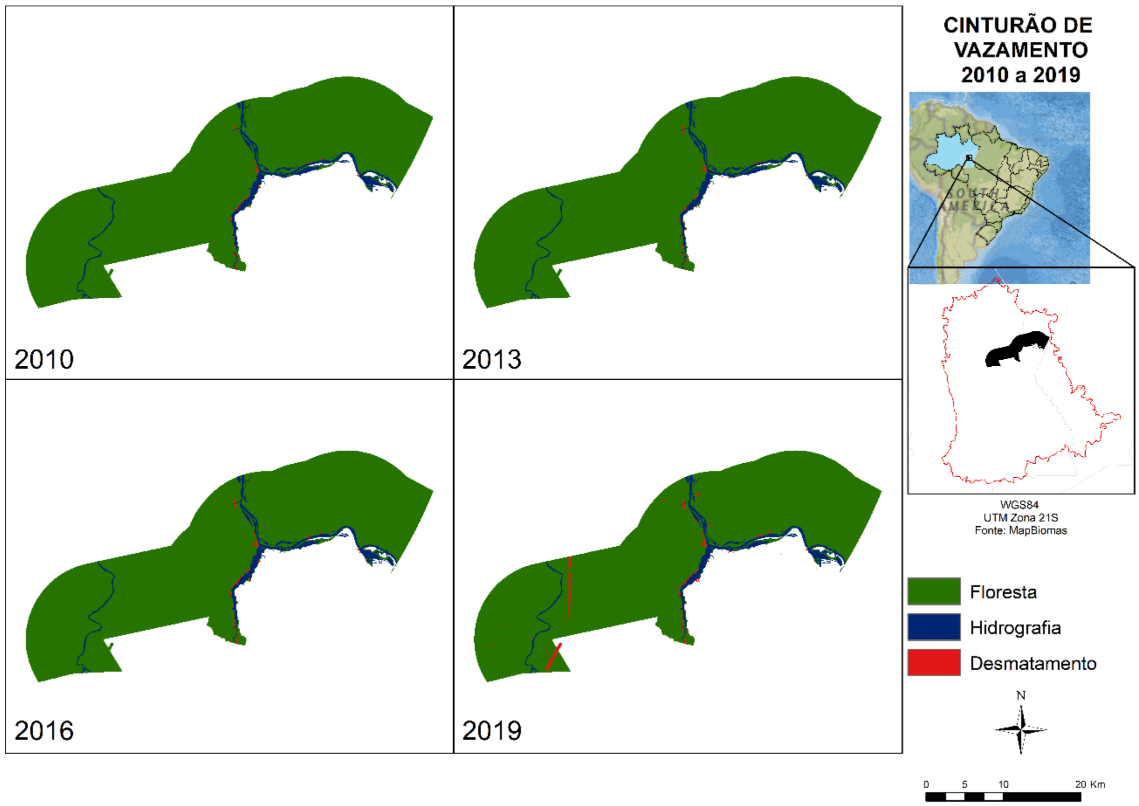
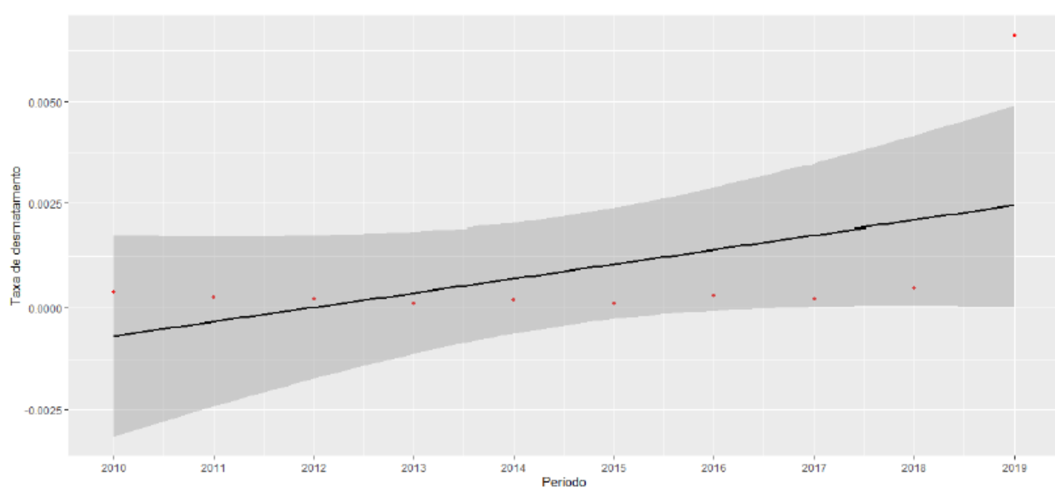
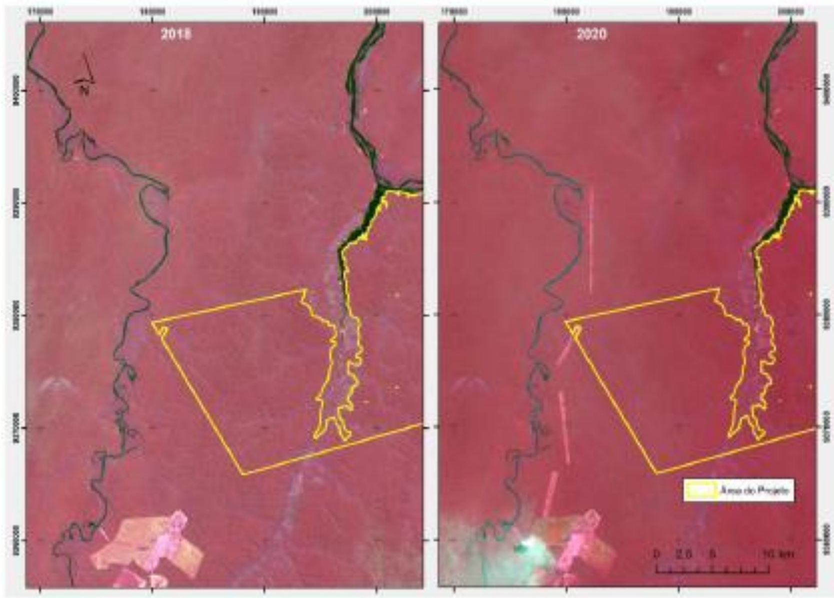


Figure 33. Variation in the deforestation rate in the leakage belt between the years 2010 and 2019. Source: MapBiomas



Furthermore, it can be noted that the classification identified deforestation with linear patterns indicating possible road creation (Figure below). 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.

Figure 34. Landsat images from 2018 and 2020 showing road creation in the reference region, close to the project area.



The deforestation activities caused the transformation from the initial land use and land cover (LU/LC) class of riparian dense tropical rainforest to the final class of non-forest. The annual deforestation values in the Reference Region, Project Area and Leakage Belt during the historical reference period can be seen in tables below.

Table 18. Annual deforestation in the Reference Region between 2010-2019

Year	Accumulated deforestation (ha)	Deforestation per year (ha)
2010	11,177.91	1,193.04
2011	12,254.4	1,076.49
2012	13,065.48	811.08
2013	14,507.73	1,442.25
2014	16,056.54	1,548.81
2015	18,619.83	2,563.29

2016	24,655.59	6,035.76
2017	30,854.25	6,198.66
2018	33,528.78	2,674.53
2019	39,466.98	5,938.20

Table 19. Annual deforestation in the leakage belt between 2010-2019

Year	Accumulated Deforestation (ha)	Deforestation per year (ha)
2010	133.47	25.92
2011	151.29	17.82
2012	165.60	14.31
2013	172.80	7.20
2014	184.95	12.15
2015	190.89	5.94
2016	211.59	20.70
2017	226.08	14.49
2018	254.79	28.71
2019	669.10	414.31

- Map accuracy assessment

The results of MapBiomas undergo an accuracy assessment, which for the entire Amazon Biome is on average 95%. However, to meet the particularities of the region, an independent evaluation was carried out for the reference using the Google Earth Engine supervised classification for the year 2019.

To assess the accuracy of the maps produced by the MapBiomas methodology, a confusion matrix was generated by calculating the user's and producer's percentage of correct answers, errors of omission and commission. For that, 300 samples points were randomly drawn on the reference region, 100 in each class (forest, hydrography and deforestation), and the degree of correctness classification was verified. As a reference, high resolution Landsat images were used, where was possible to visually determine the land use of the sample points drawn. The table below shows the accuracy analysis carried out for each year and each land use class.

Table 20. Summary of confusion matrices from the evaluation of MapBiomas from 2009 to 2019

	Producer accuracy			User accuracy		
Year	Forest	Hydrography	Deforestation	Forest	Hydrography	Deforestation
2009	97.98%	98.99%	96.08%	97.00%	98.00%	98.00%
2010	97.94%	97.73%	86.09%	95.00%	86.00%	99.00%
2011	100.00%	98.04%	99.00%	98.00%	100.00%	99.00%
2012	96.97%	95.19%	95.88%	96.00%	99.00%	93.00%
2013	98.98%	99.01%	98.02%	97.00%	100.00%	99.00%
2014	100.00%	94.29%	93.27%	91.00%	99.00%	97.00%
2015	97.89%	97.09%	95.10%	93.00%	100.00%	97.00%
2016	84.96%	96.08%	95.29%	96.00%	98.00%	81.00%
2017	98.97%	98.02%	98.04%	96.00%	99.00%	100.00%
2018	97.00%	99.00%	98.00%	97.00%	99.00%	98.00%
2019	91.00%	96.15%	90.63%	91.00%	100.00%	87.00%

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

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

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

In recent years, the project region has been deforested for the expansion of agricultural and livestock activities, mainly due to the advancement of the 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 region[73].

In 2019, until August 18th, Novo Aripuanã was the 9th municipality with most of the fire alarms on the period[74].

18% of the deforestation in the Legal Amazon detected in the period of January to April 2020 was located in the state of Amazonas. The accumulated deforestation was of 1.073 km^2, what represents an increase of 133% when compared to the same period in 2019. In April 2020, 60% of the deforestation happened in private areas.[75] The rest of deforestation was recorded in conservation Units (22%), Settlements (15%) and Indigenous Lands (3%).

The main agents of deforestation identified in the area are detailed below:

a) Cattle ranching

Cattle farming in the Amazon is primarily due to low land prices combined with adequate rainfall levels[76]. The Amazon region attends to national and regional demand. Analysis of supply and demand show that livestock farming could expand even more to attend to the majority of global demand. This scenario is extremely worrying in relation to Amazon deforestation levels.

Livestock farmers do not pay for the public lands which they acquire legally or illegally, and furthermore they harvest timber without paying the government and, in this way, they accumulate capital freely to reinvest into their operations. Thus, land speculation and cattle farming contribute to the advancement of deforestation in more isolated regions[77].

In Amazonas State, livestock represents 28% of the land use, equivalent to 1,141,768 ha. Until 2018, there was 80,959 agricultural establishments in the State[78]. In the project area's

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[73] 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

[74] Available in < https://noticias.uol.com.br/meio-ambiente/ultimas-noticias/redacao/2019/08/22/municipios-mais-desmatados-em-2019-lideram-numero-de-queimadas-na-amazonia.htm> Last visited on 29/12/2020

[75] Available in < https://imazon.org.br/publicacoes/boletim-do-desmatamento-da-amazonia-legal-abril-2020-sad/> Last visited on 29/12/2020

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

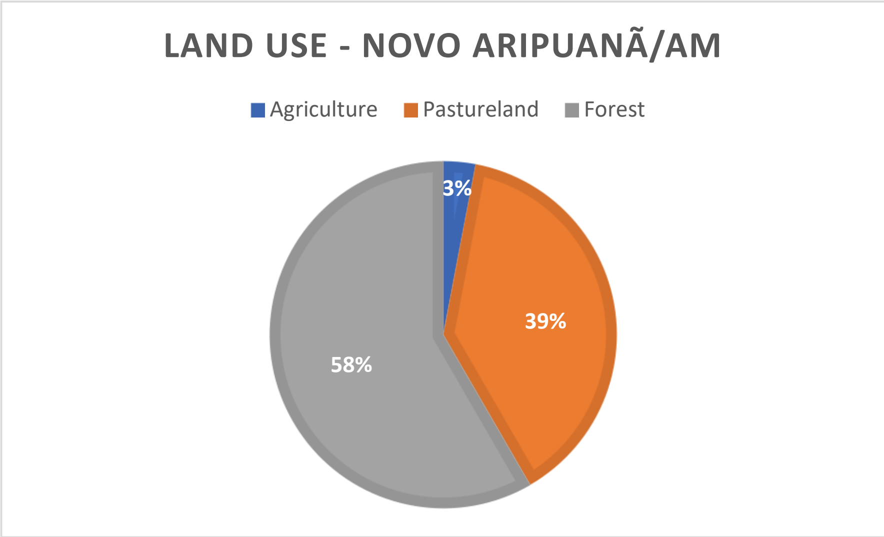
[77] RAZERA, Allan. Dinâmica do desmatamento em uma nova fronteira do sul do Amazonas: uma análise da pecuária de corte no município do Apuí. 2005. 109 f. Thesis (Master grade) - Curso de Biologia, Universidade Federal do Amazonas - UFAM, Amazônia, 2005.

[78] Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/estabelecimentos.html?localidade=13>Last visited on 29/12/2020

municipality, Novo Aripuanã, there are from 501 to 1000 establishments, and in Borba, municipality included in the reference region, from 1001 to 3000[79].

In the case of Borba and Novo Aripuanã municipalities, it is possible to observe, from the graphs below[80], that pastureland represents a large part of the land use:

Figure 35. Land use of Novo Aripuanã (2017)

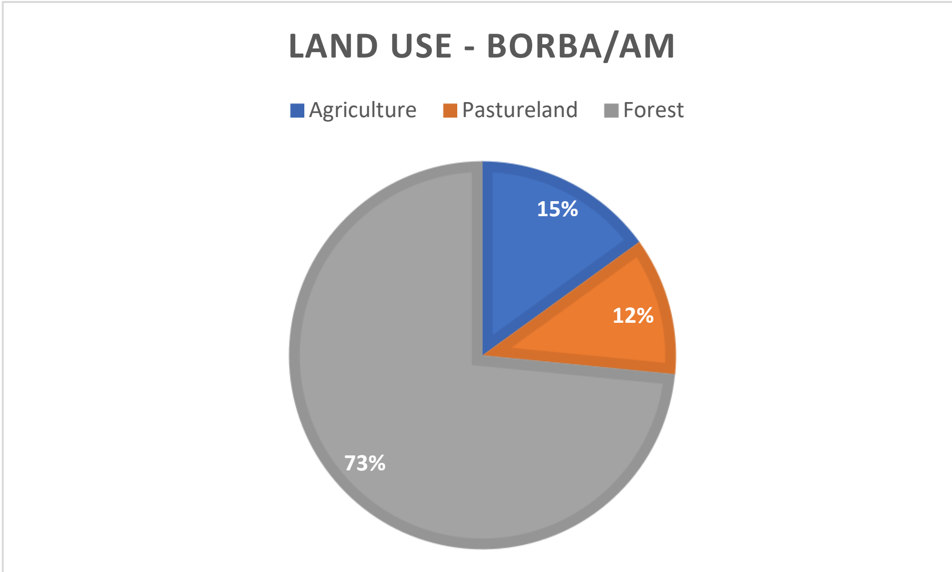


It can be observed that, second to forest, pastureland is the main land use in the municipality of Novo Aripuanã.

[79] Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/pdf/am.pdf> Last visited on 29/12/2020

[80] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

Figure 36. Land use of Borba (2017)



In Borba, however, there is a lower difference between pastureland and agriculture use, with agriculture having approximately 1,200 hectares more than pasture. Nevertheless, as the municipality of Borba represents 20,38% of the Reference Region, and Novo Aripuanã 79,62%, it was assumed that pasture represents the largest land use and agent of deforestation in the region, together with timber harvesting, also considering the context of the southern region of Amazonas, being one of the main producers of cattle meat in Brazil. This data may be reassessed when new information from Brazil's agricultural census is available.

Novo Aripuanã's herd has been increasing in the last 10 years. According to IBGE's data, from 2014 to 2018, the number of cattle increased by 21,323 animals, and the trend is to keep rising.

Graphs below relates deforestation numbers with cattle herd in the region. According to PRODES satellite data, it can be noticed that, in Novo Aripuanã, the increase in deforestation areas can be directly related to the increase in livestock activity.

The increase in the number of animals between 2016 and 2019 was accompanied by an increase in the number of hectares deforested in the same period. In Borba, although the relation is not so direct, mainly because the municipality has a significantly smaller cattle herd, it is possible to notice that the two parameters are related, with a tendency to increase and decrease in close periods, as can be seen between 2010 and 2014. The peak of deforestation in 2011 was followed by a peak in the number of animals in 2012, for example. There is also a tendency to increase deforestation starting in 2016.

Figure 37. Comparison of cattle herd and deforestation in Novo Aripuanã[81]

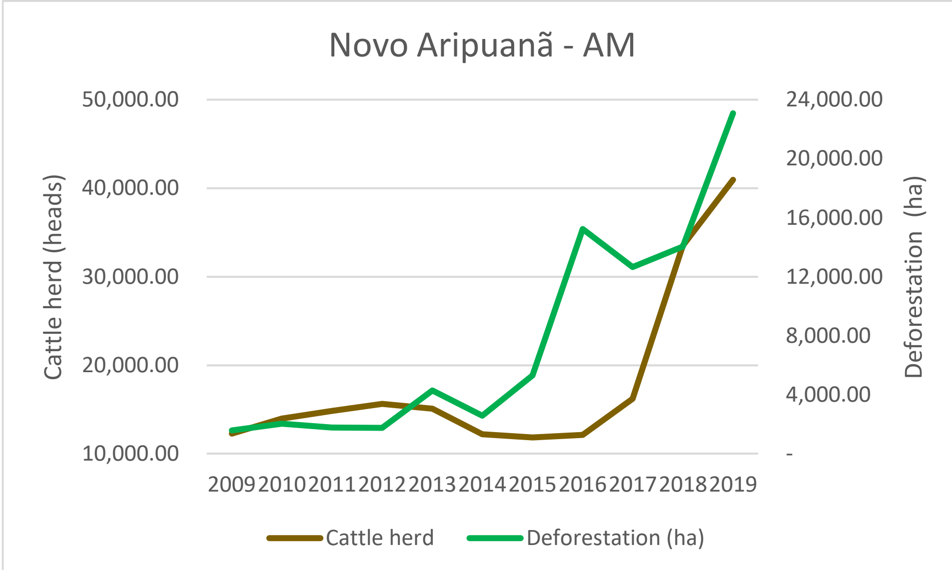
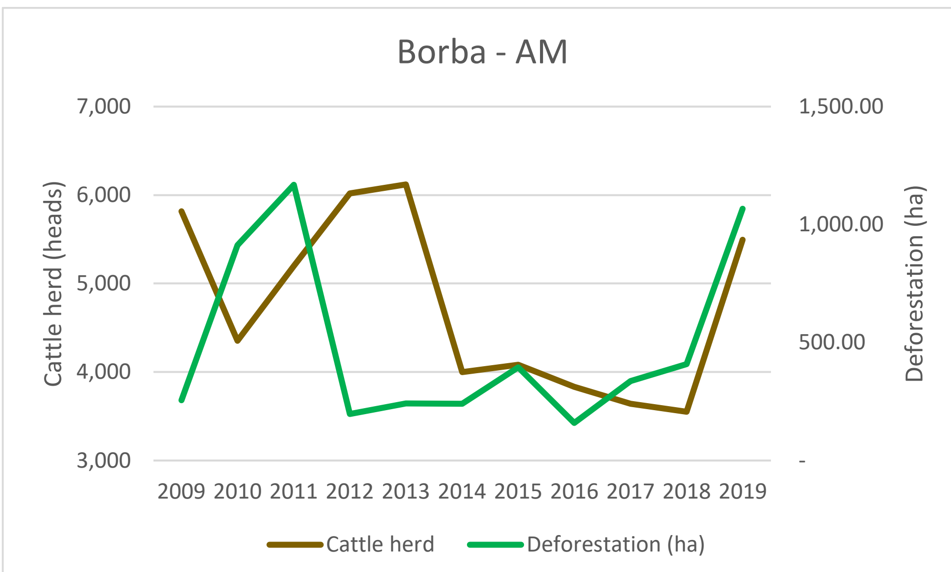


Figure 38. Comparison of cattle herd and deforestation in Borba[82]



The increase in livestock activity can be related to migrants that invested in buying animals in other regions, and credit lines available to buy cattle. As Borba and Novo Aripuanã are frontier municipalities, and close to Apuí, reference in livestock in the region, cattle ranching is preferred due to ease in selling to near states, with cheaper logistics and guarantee of disease-free meat.

[81] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> and < http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates> Last visited on 02/02/2021

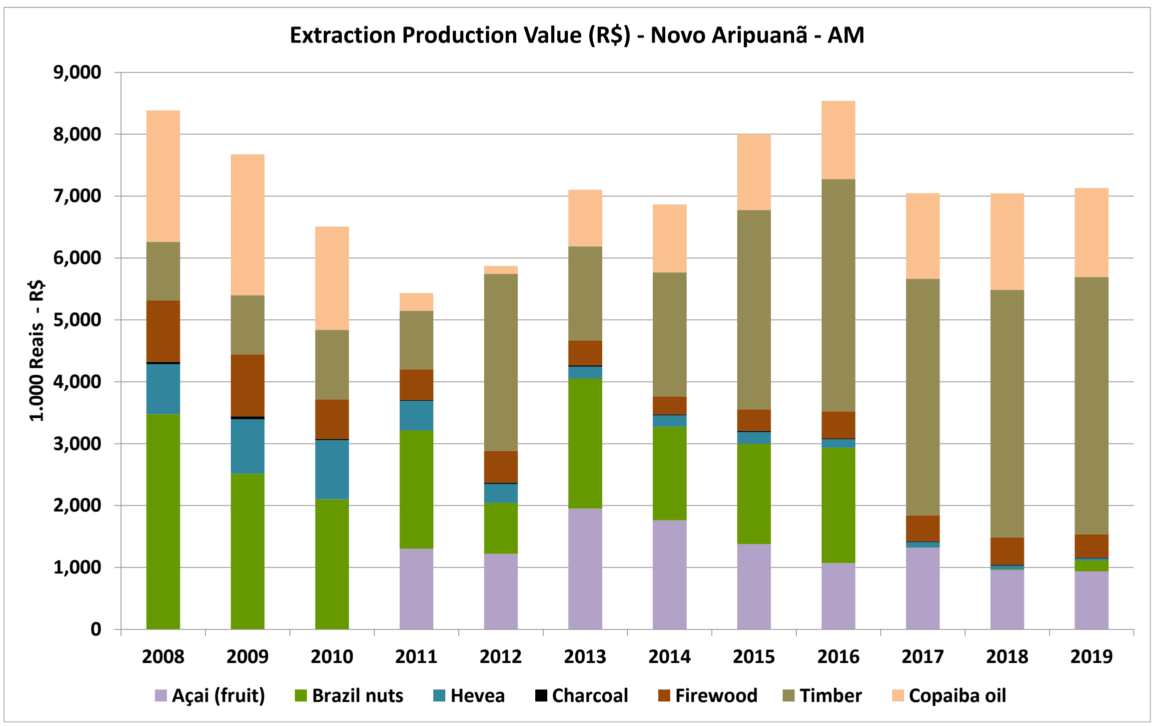
[82] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> and <http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates> Last visited on 02/02/2021

b) Timber harvesting

As previously mentioned in section 1 (socio-economic conditions) above, timber logging (both legal and illegal) is an important economic activity within the reference region. Economic data sources between 2008 and 2018 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.

In Novo Aripuanã, it can be noticed that between 2008 and 2013, the Brazil Nut production had the highest production value, that has been reducing while timber value has been increasing, reaching 4,000 reais.

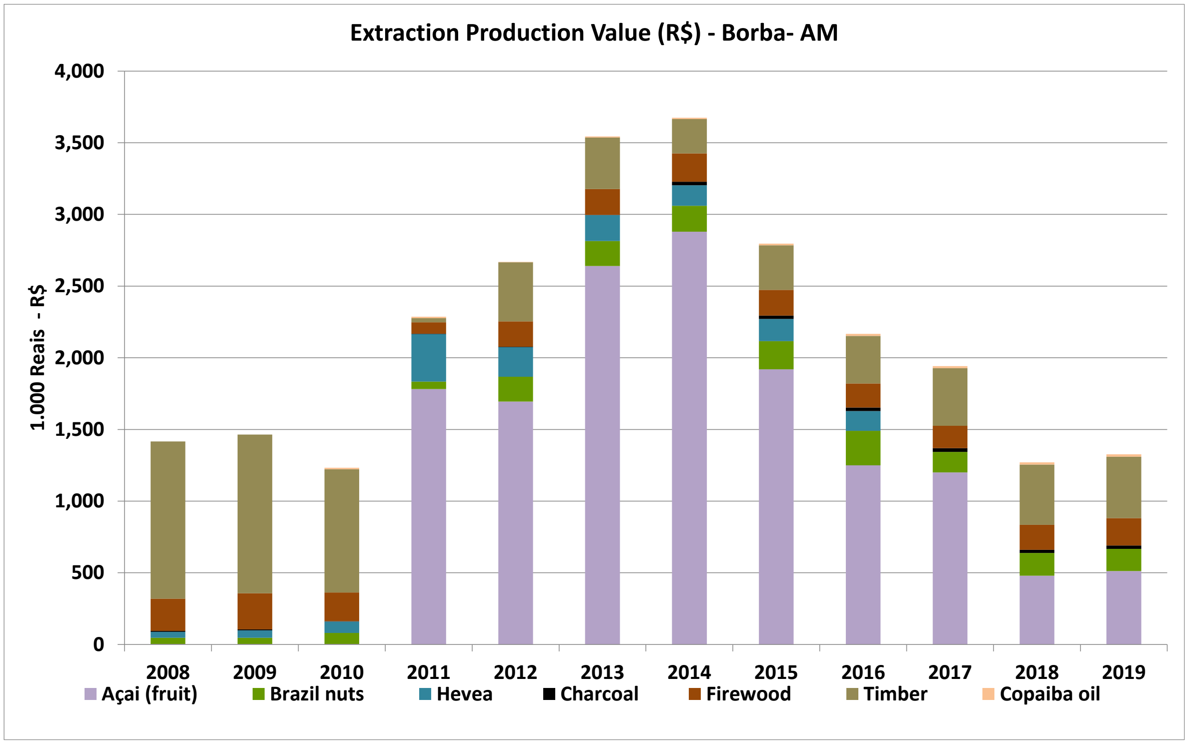
Figure 39. Extraction production Value (R$) in Novo Aripuanã[83]



In Borba, *açaí* value is the highest, when compared to other products of the region. Timber represented the biggest value from 2008 to 2010, and it is the second from 2011 to 2018.

[83] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

Figure 40. Extraction production value (R$) in Borba[84]



When assessing quantity produced, the timber production in both municipalities is also dominant, when compared to the other products:

[84] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

Figure 41. Produced wood quantity - Novo Aripuanã

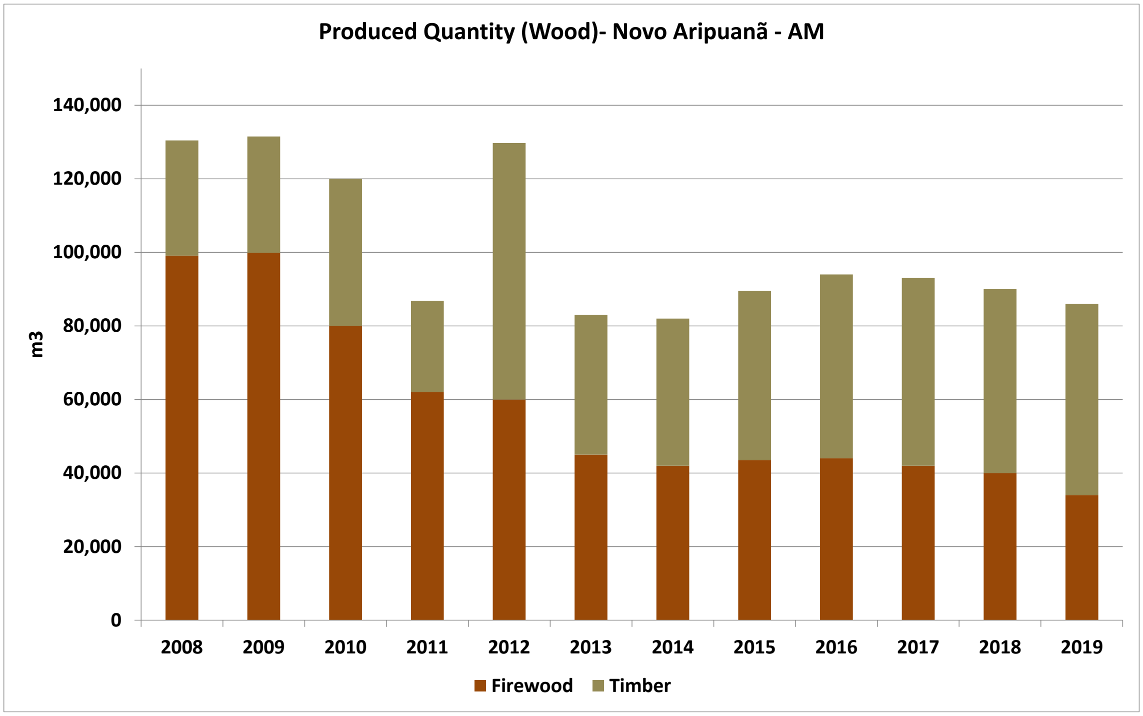


Figure 42. Produced quantity - Novo Aripuanã

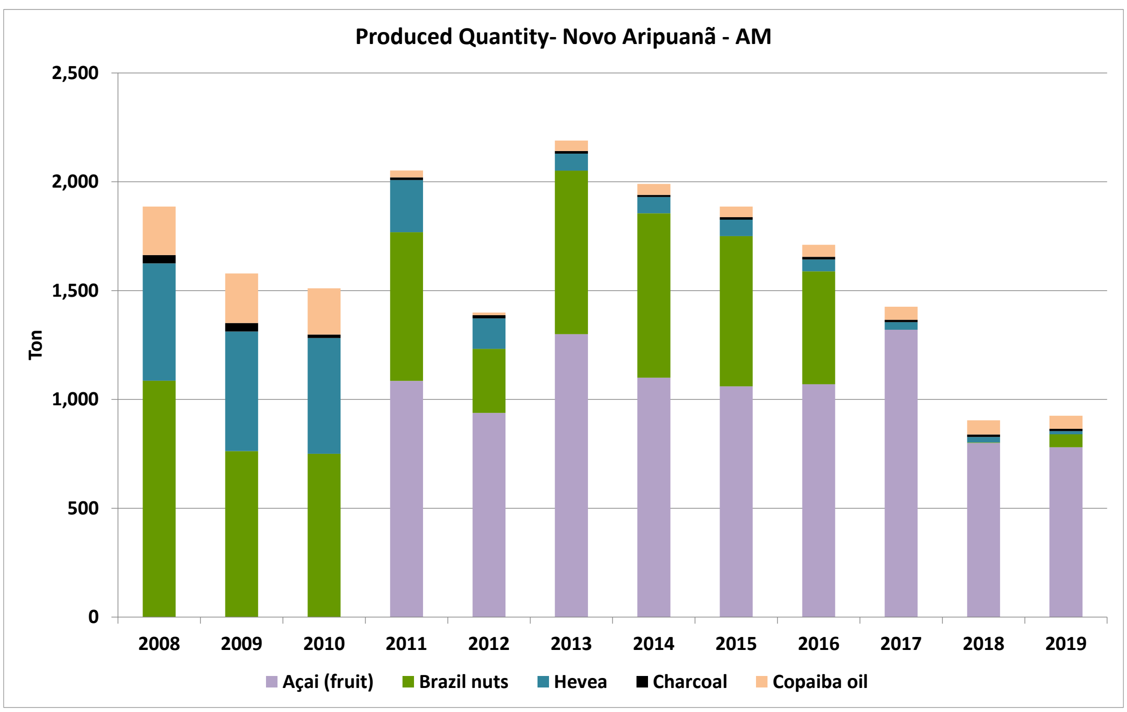


Figure 43. Produced wood quantity - Borba [85]

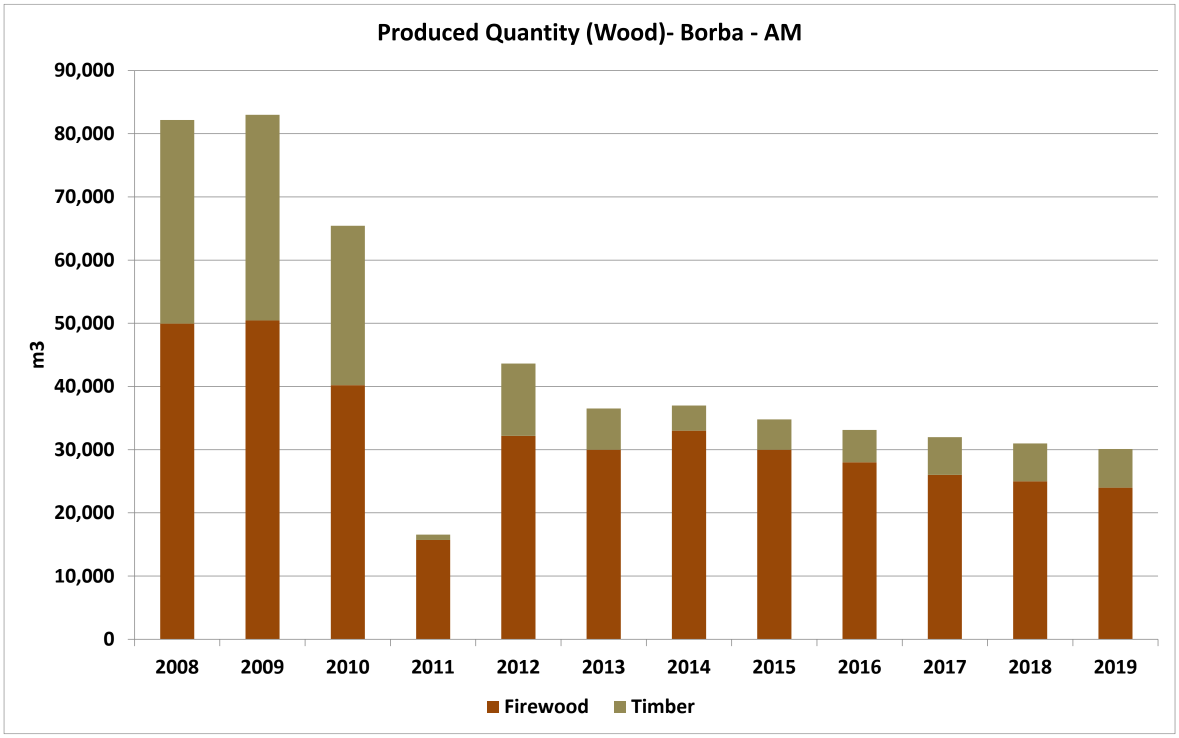
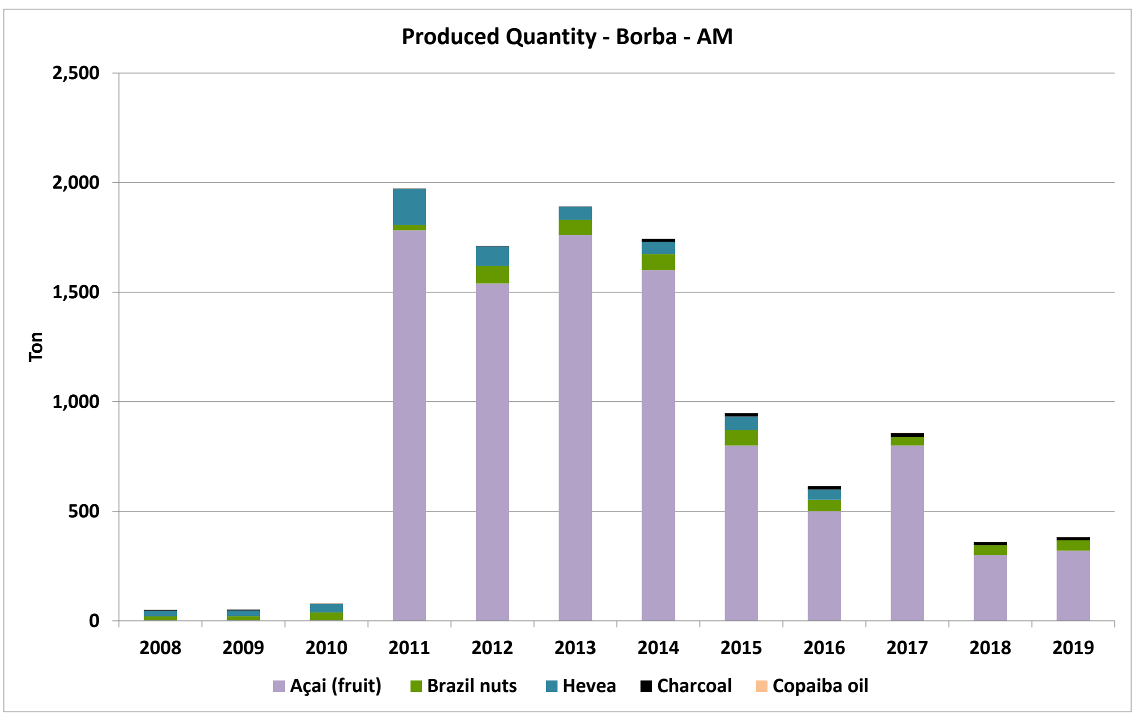


Figure 44. Produced quantity - Borba



[85] Available in < https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693?localidade1=130080> Last visited on 02/02/2021

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

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

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

Some of the factors that characterize and drive deforestation and subsequent cattle ranching are the low cost of the forested area; reasonable soil fertility (provided by the ashes after the burning of the forest); well-structured soil and mainly flat conditions of the area; tradition of farming existing in the municipalities and the meat market of the region[86].

Key driver variables are detailed in section below.

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

- Population growth and density

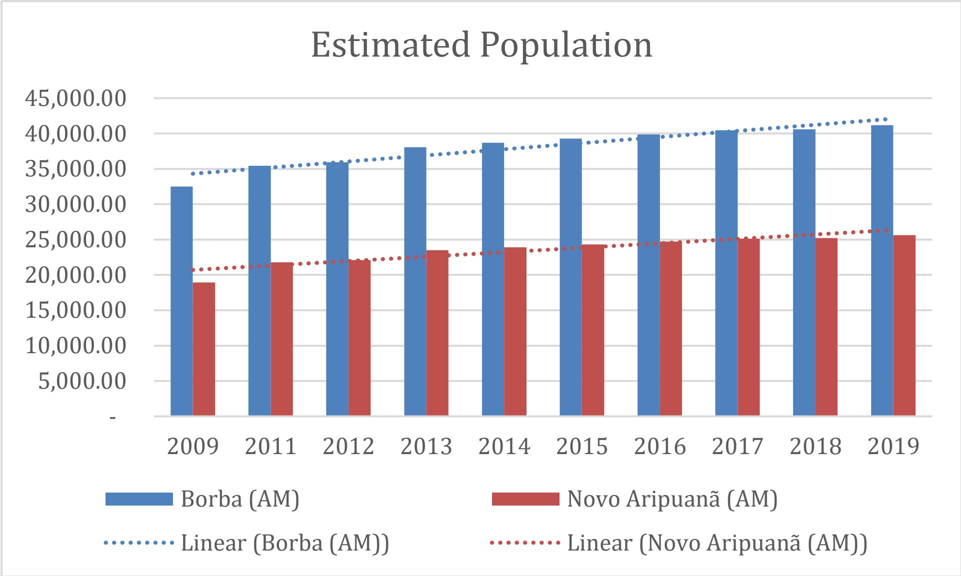
Population is a variable that significantly predicts future deforestation quantity. Local residents are expected to carry out unplanned deforestation, which involves economic activities.

Population growth data shows that reference and project area are in an increasing tendency, with growth rate of 2.39% per year in Borba and 3.07% in Novo Aripuanã[87].

[86] Available in <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf> Last visited on 29/12/2020

[87] Available in < https://sidra.ibge.gov.br/tabela/6579> Last visited on 06/04/2021

Figure 45. Population growth



The region has a low population density, as large landowners prevail in both municipalities. In Borba, it is 0.79 hab/km^2 and in Novo Aripuanã, 0.52 hab/km^2.

This population growth and characteristics are tightly correlated with deforestation. As mentioned previously, the local population is primarily composed of migrants, crop and livestock farmers, and timber harvesters, the majority of whom come from other regions of Brazil. The lack of economic alternatives then turns this population into the primary deforestation agents in the region. As these cities rely on livestock for income generation, forest areas will likely be deforested for cattle timber logging, cattle ranching and other land uses, following historical patterns.

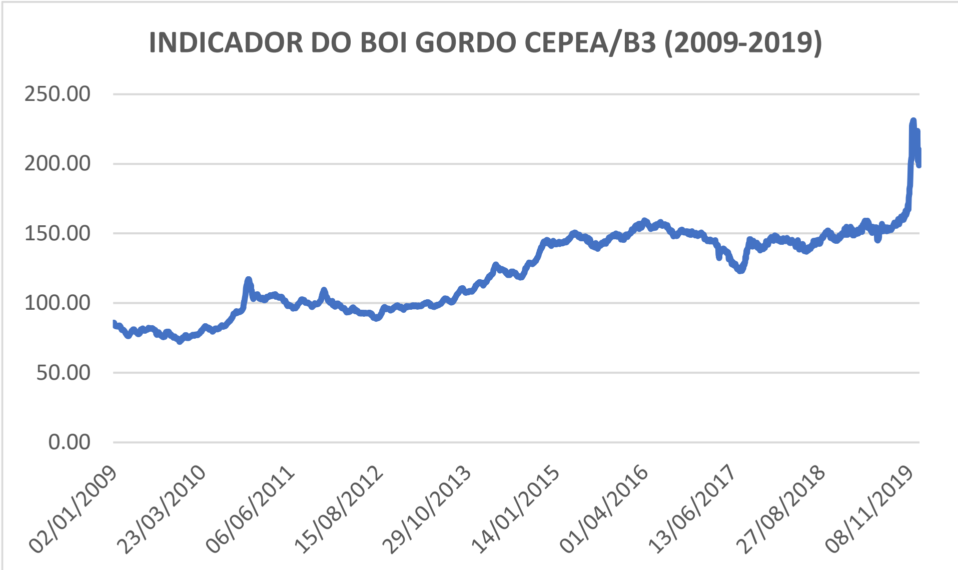
The increasing rate identified in the population data is an important variable affecting the amount of deforestation in the reference region.

- **Prices of timber and cattle**

As detailed in previous sections and in the description of deforestation agents above, timber and cattle prices have much higher value than other products exploited in the region.

Research developed to determine leakage belt accounted approximately R$1040,00 per animal in the region, on an average of R$80,00 per arroba. Considering data of 2019, that indicated 33,523 animals in Novo Aripuanã and 5,494 in Borba, the amount of money produced by the activity in the region would surpass 5 million reais per year.

The graph below shows the variation in the price of live cattle as a commodity on the Brazilian stock exchange, between 2009 and 2019[88]. It is possible to note the increase in prices, which demonstrates the valorisation of meat as an investment product in the market.



Timber and firewood production in the region represented the higher value when compared to other PFNM produced in the municipalities. Prices vary between 4,000 and 12,000 reais per m^3, as detailed previously in this PDD.

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[89]. Thus, this disparity promotes the purchase of new forested areas, deforestation, and further creation of new pasturelands.

b) Driver variables explaining the location of deforestation:

- Access to forests – Rivers and Highways

As previously mentioned, Novo Aripuanã is a frontier municipality, close to the States of Rondônia, Mato Grosso and Pará, in addition to other cities in Amazonas. This condition makes the land in these regions extremely attractive to agricultural and livestock activities, due to easy transportation and access to other regions.

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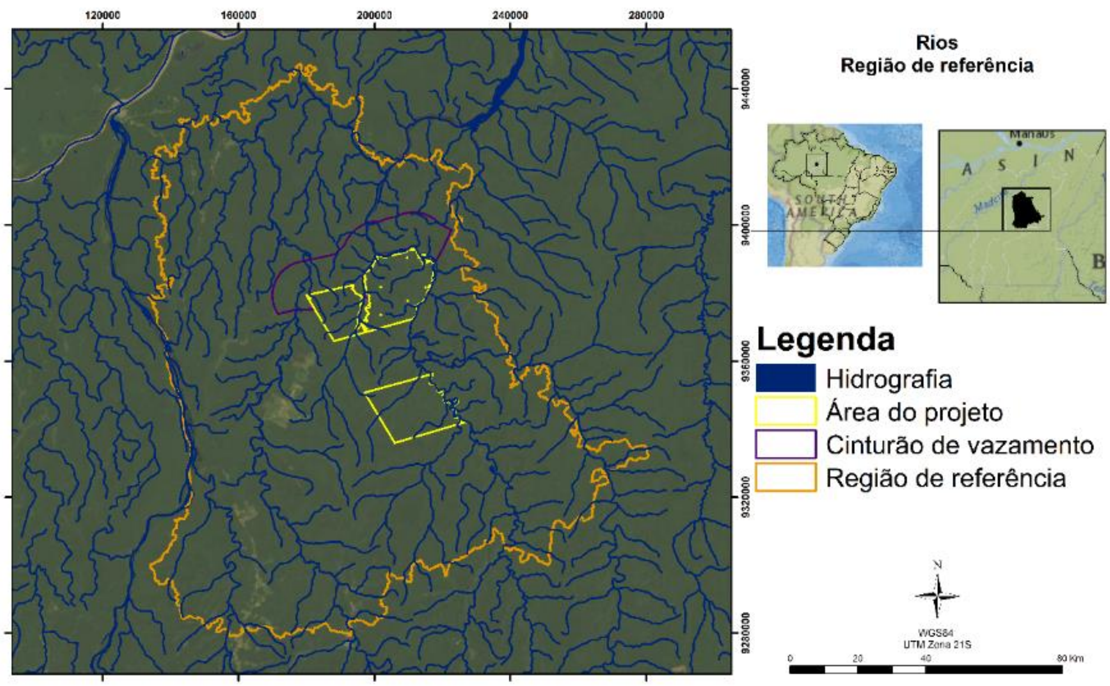
[88] Avaliable in <https://www.cepea.esalq.usp.br/br/indicador/boi-gordo.aspx>

[89] REYDON, Bastiaan Philip. O desmatamento da floresta amazônica: causas e soluções. **Economia Verde: Desafios e Oportunidades,** Campinas, v. 8, p.143-155, jun. 2011. Available at: <https://silo.tips/download/o-desmatamento-da-floresta-amazonica-causas-e-soluoes>. Last visited on: 29/12/2020.

In the municipalities of the State of Amazonas, transportation is done mostly through navigable rivers. The Project area is surrounded by many rivers, its borders having direct contact with three of them: Rio Sucunduri, Rio Camaiú and Rio Camaiuxazinho.

Figure 46. Rivers that allow access in the reference region of the project[90]

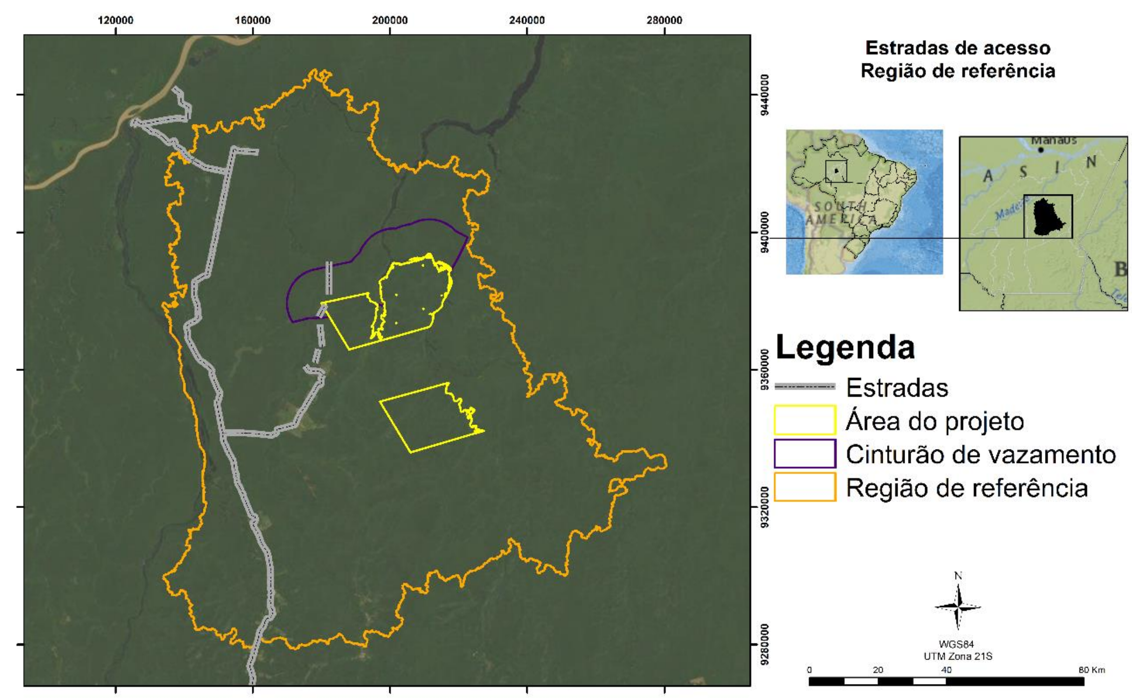


The proximity to waterways historically determined the locations of settlements in relation to extraction of non-timber forest products (NTFPs) and timber. Waterways remain the overwhelmingly predominant means of transport and access to forest products. The access to the project area itself can only be reached through the river Sucunduri.

The Trans-Amazonian Highway BR-230 is located south of the municipality. According to official information, this highway is the third largest Brazilian highway, with 4.223 km of extension, and crossing 7 States: Paraíba, Ceará, Piauí, Maranhão, Tocantins, Pará and Amazonas. It was constructed in the 70's to promote settlements along the road and connection with the rest of the country.

[90] The sources for the elaboration of this map can be found through the links: <https://metadados.ana.gov.br/geonetwork/srv/pt/metadata.show?id=588&currTab=distribution> ; <https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7d054e5a-8cc9-403c-9f1a-085fd933610c> ; <https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7bb15389-1016-4d5b-9480-5f1acdadd0f5>

Figure 47. Access roads in the reference region[91]



The main objective was to transform the Amazon into a region that supplied primary products to the domestic and foreign markets and to increase livestock, due to the high prices of meat in the 1970's market and the beginning of the development of the activity in the region[92].

In addition, as mentioned in sections above, satellite image and field verification showed a clandestine road opening crossing the project area, allowing direct access to the property. This illegal road was opened in 2019 and was probably created for illegal logging and the expansion of pasturelands in the region, as can be noted by the large pastureland located at the southwestern border of the project area, which was established during the historical reference period in the same road that now crosses the project area.

It is expected that this illegal road would be one of the main drivers of future deforestation in the region.

- Slope

As described in section 1, the project area has an average slope of 4.26%, and most of the reference region has 3.97%. This is the lowest slope class, considered mostly flat. This is a great condition to cattle ranching and occupation.

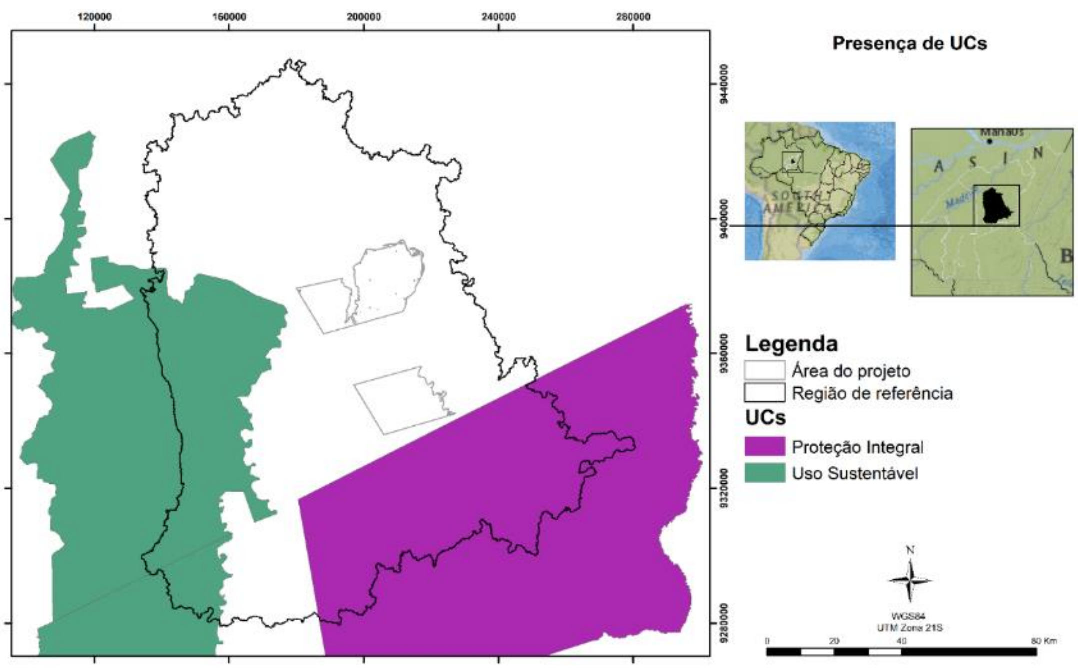
[91] The sources for the elaboration of this map can be found trough the link: ftp://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/informacoes_tecnicas/

[92] Available in < https://epg.unifesspa.edu.br/images/Artigos/NilzaLimaMarinho.pdf> Last visited on 29/12/2020

- Proximity to Conservation Units

The project region is between two Conservation Units: A Sustainable Development Reserve (Reserva de Desenvolvimento Sustentável do Juma) and a National Park (Parque Nacional do Acari). As the region is an important logging and livestock center, forested territories with no activity outside federal and state protected areas are targeted and susceptible to illegal occupation and deforestation, selling high-value wood and clearing the area for future livestock occupation.

Figure 48. Protection Areas in the Reference Region



- <u>Identification of underlying causes of deforestation</u>

Underlying causes of deforestation include the political scenario related to environment in the baseline period. This political instability would probably reflect in the increase of deforestation.

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

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

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

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 mention to combat of deforestation in the office's functions being highlighted by specialists[93].

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

The deforestation in the Amazon Rainforest was widely reported in 2019, as it was the third largest in history, with an increase of 29.5% in comparison to 2018. In total, 9,762 km^2 of the forest were deforested during the year. In August, during the peak of fire warnings in the forest, fact that caused climate effects in São Paulo, 2,790 km away from the Amazon[94], the government tried to deviate attention from the fires, claiming they were fake news[95]. The number of wildfires 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%.

Also, during August, Germany and Norway announced the suspension of transfers to Amazon Programs after affirming that the Brazilian Government was not playing its part in fighting

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[93] Available in < https://www.socioambiental.org/pt-br/blog/blog-do-isa/a-anatomia-do-desmonte-das-politicas-socioambientais > Last visited on 29/12/2020

[94] 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 29/12/2020

[95] Available in <https://www.theguardian.com/environment/2019/sep/09/amazon-fires-brazil-rainforest> Last visited on 29/12/2020

deforestation. The contribution to protecting the rainforest amounted to more than 133 million, destined to the Amazon Fund[96].

Even though fire alerts increased in the period between 2019 and 2020, the Brazilian Government reduced the budget for forest fire prevention and control personnel. A reduction of 58% reached the brigade teams, with budget ranging from 23.78 million reais in 2019 to 9.99 million in 2020[97].

In June 2020, investment funds that manage approximately 4 trillion American dollars in assets asked Brazilian government to suspend the deforestation in the Amazon Rainforest. In an open letter, they warned of the systematic, reputational, operation and regulatory risks of clients and projects in Brazil, in addition to the survival of the forest[98].

Government agencies such as INPE and IBAMA, responsible for deforestation monitoring have suffered funding cutoffs, dismissals and had their functions and increasing deforestation data publicly questioned and denied by the government[99].

The quantity of national parks and conservation units in the country's forests was already questioned by the government, that intended to extinguish those by decree[100], an unconstitutional action, after announcing the intention to review the conservation units law (SNUC) and the existing units[101]. In addition, the Minister of the Environment speaks publicly, in a video released during investigations, of his intention to take advantage of the Covid-19 pandemic to approve several controversial changes to environmental protection and avoid critics and Justice processes.

There are also several threats to the national environmental license process, which has existed since 1981, including from the Minister of the Economy, who wants to loosen the process to favor

96 Available in <https://brasil.elpais.com/brasil/2019/08/15/politica/1565898219_277747.html> Last visited on 29/12/2020

97 Avaliable 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 29/12/2020

98 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 29/12/2020

99 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 29/12/2020

100 Available in <http://www.ihu.unisinos.br/78-noticias/589958-em-live-bolsonaro-reclama-que-nao-consegue-extinguir-parques-por-decreto> Last visited on 29/12/2020

101 Available in <https://www.oeco.org.br/noticias/ricardo-salles-quer-rever-todas-as-unidades-de-conservacao-federais-do-pais-e-mudar-snuc/.> Last visited on 29/12/2020

mining companies, even with the several recent cases of environmental crimes of breaches of poorly executed and maintained mining dams from companies in the country[102].

Specialists affirm that, with the current pace of dismantling of the inspection structure and environmental legislation demonstrated since the first 6 months of the current government, the forest destruction can reach an irreversible limit in 4 to 8 years. Recent scientific researches show that if an area of 40% of the original forest gets deforested, the rest can't sustain the functioning of the tropical rainforest, and in this scenario, part of the forest may not be able to sustain itself. The Amazon has so far lost approximately 20% of its original coverage[103].

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 decreet, which is responsible for coordinate and monitor 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.

- 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.

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

Located near the Trans Amazônica, historical road that was built for the development and population of the forest, the project region has a strategic position in the meat and wood production distribution and logistics in the Amazon.

Furthermore, location of deforestation usually occurs nearby already deforested areas, along rivers, and in low sloped areas. In addition, roads are an important driver explaining the location of

102 Available in <https://brasil.elpais.com/brasil/2019/01/27/opinion/1548547908_087976.html> Last visited on 29/12/2020

103 Available in <https://www.bbc.com/portuguese/brasil-48805675> Last visited on 29/12/2020

future deforestation and thus, the illegal road crossing the project area, which was opened in 2019, is a key component in the future dynamic of deforestation in the 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 products in the region, such as Brazil nuts and *copaiba* oil.

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

The project area has no production activity or monitoring, which makes the area vulnerable to invasions and illegal deforestation, even more since it is located between two conservation units, state and federal.

The recent history of polemics and anti-environmentalism 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 allows to be taken advantage of by landowners, or the inspection mechanisms suffer dismantling by the interest parties, making the conservation of the extensive Brazilian biomes even more difficult.

- <u>Conclusion</u>

The conduction of the Step 3 and available evidence allows to analyze that the most likely future deforestation trend within the reference region and project area is conclusive.

The hypothesized relationships between agent groups, driver variables, underlying causes and historical levels of deforestation can be verified at hand of statistical tests, literature studies, or other verifiable sources of information, such as documented information provided by local experts, communities, deforestation agents and other groups with good knowledge about the project area and the reference region.

The increasing deforestation rate, added to the region’s cattle ranching advancement, population increase, lack of effective governmental control and environmental planning, and the recently opened illegal road crossing the reference region and project area are clear evidence that the overall trend in future baseline deforestation rates will be increasing, and this demonstrates the need for conservation measures that encourage a change in the business and production model in the region.

Projection of Future Deforestation

- Projection of the quantity 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 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.

Quantitative projection of future deforestation

For the deforestation baseline, a simple linear regression model was used from 2010 to 2019. As previously described, there was an increase in the deforestation rate between 2010 and 2019 (R^2 = 0.58 and p = 0,0065). The equation that describes this increase is:

$$y = 0.840497 + 0.000418 * t$$

For each year, there is an increase of 0.0004182719 in the deforestation rate. This pattern makes the linear model the most appropriate for future projections.

During analysis, no factor was identified in the region to limit deforestation, once the type of soil, slope, etc., are favorable and offer no impediment. There are limiting factors, such as the presence of conservation units, to the south of the property, however, the deforestation pressure identified comes from the west.

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 21. Annual areas of baseline deforestation in the reference region

Project year t	Stratum i in the reference region (ha)						Total (ha)	
	$ABSLRR_1$ Dense Alluvial Tropical Rainforest	$ABSLRR_2$ Dense Submontane Tropical Rainforest	$ABSLRR_3$ Dense Lowland Tropical Rainforest	$ABSLRR_4$ Open Alluvial Tropical Rainforest	$ABSLRR_5$ Open Submontane Tropical Rainforest	$ABSLRR_6$ Pioneer formations with fluvial influence	annual $ABSLRR_t$	cumulative ABSLRR
2020	294.36	3,444.74	2,269.61	52.51	15.70	87.18	6,164.10	6,164.10
2021	309.27	3,958.68	2,344.05	55.99	7.47	35.56	6,711.03	12,875.13
2022	385.80	4,243.46	2,523.11	58.02	4.35	35.20	7,249.95	20,125.08
2023	514.58	4,443.58	2,705.27	76.40	6.84	33.39	7,780.05	27,905.13
2024	572.19	4,687.15	2,879.20	110.68	8.82	42.75	8,300.79	36,205.92
2025	587.42	4,872.79	3,189.34	120.44	4.50	37.24	8,811.72	45,017.64
2026	668.43	5,039.48	3,430.63	136.73	3.06	33.70	9,312.03	54,329.67
2027	698.99	5,105.99	3,787.52	166.13	5.40	37.43	9,801.45	64,131.12
2028	762.47	5,278.35	3,987.56	197.72	8.46	44.52	10,279.08	74,410.20
2029	775.12	5,379.97	4,296.83	230.97	14.31	47.45	10,744.65	85,154.85
2030	831.20	5,483.14	4,508.58	292.87	18.81	63.02	11,197.62	96,352.47
2031	843.48	5,485.71	4,849.19	372.13	14.67	72.27	11,637.45	107,989.92
2032	862.56	5,491.34	5,225.61	358.48	24.57	101.13	12,063.69	120,053.61
2033	946.06	5,619.22	5,376.18	395.18	18.55	120.89	12,476.07	132,529.68
2034	1,020.48	5,610.95	5,665.17	403.08	18.72	155.65	12,874.05	145,403.73
2035	1,006.04	5,656.50	5,963.76	382.60	43.32	205.23	13,257.45	158,661.18
2036	1,104.25	5,573.80	6,303.80	356.94	57.36	229.39	13,625.55	172,286.73
2037	1,135.35	5,692.21	6,451.45	310.62	134.59	254.22	13,978.44	186,265.17
2038	1,129.40	5,826.36	6,544.35	343.10	174.85	297.60	14,315.67	200,580.84
2039	1,194.23	5,996.19	6,571.46	312.12	217.90	345.26	14,637.15	215,217.99
2040	1,258.23	6,263.77	6,581.59	261.20	227.47	349.99	14,942.25	230,160.24
2041	1,209.57	6,585.64	6,504.66	256.70	298.16	376.50	15,231.24	245,391.48
2042	1,238.00	6,670.46	6,573.04	268.88	352.46	401.00	15,503.85	260,895.33
2043	1,221.36	6,815.53	6,629.70	250.81	418.59	423.74	15,759.72	276,655.05
2044	1,209.53	6,966.78	6,726.54	208.59	457.89	429.60	15,998.94	292,653.99
2045	1,113.21	7,234.83	6,763.93	221.12	443.38	444.94	16,221.42	308,875.41
2046	1,103.39	7,421.75	6,820.98	232.81	403.71	444.62	16,427.25	325,302.66
2047	1,061.01	7,567.02	6,912.35	170.86	459.05	445.77	16,616.07	341,918.73
2048	1,021.31	7,702.09	6,971.66	193.64	444.60	454.85	16,788.15	358,706.88
2049	938.18	8,073.15	6,904.01	188.70	427.62	411.75	16,943.40	375,650.28
2050	887.83	8,358.46	6,838.08	188.33	383.37	426.02	17,082.09	392,732.37

Table 22. Deforested area projected in the project area

Project year t	Stratum i in the project area (ha)			Total (ha)	
	ABSLPA 1 Dense Alluvial Tropical Rainforest	ABSLPA 2 Dense Submontane Tropical Rainforest	ABSLPA 3 Dense Lowland Tropical Rainforest	annual $ABSLPA_t$	cumulative ABSLPA
2020	3.93	38.52	3.52	45.97	45.97
2021	0.23	49.18	3.19	52.60	98.56
2022	0.56	79.31	0.00	79.86	178.43
2023	1.44	90.71	0.00	92.15	270.58
2024	0.02	130.61	0.00	130.63	401.22
2025	0.51	122.64	4.14	127.29	528.50
2026	1.66	171.31	3.15	176.12	704.62
2027	0.00	228.71	2.52	231.23	935.85
2028	0.50	247.03	4.34	251.87	1,187.72
2029	1.39	277.10	4.59	283.08	1,470.80
2030	0.56	321.49	4.41	326.45	1,797.25
2031	1.62	319.98	3.15	324.75	2,122.00
2032	3.08	403.43	2.76	409.26	2,531.27
2033	1.89	425.82	6.03	433.74	2,965.01
2034	3.25	479.14	11.25	493.63	3,458.64
2035	4.40	567.88	9.38	581.66	4,040.30
2036	9.12	612.56	20.61	642.30	4,682.60
2037	10.60	715.30	27.02	752.92	5,435.51
2038	4.76	876.13	25.52	906.40	6,341.92
2039	12.35	1,014.07	52.20	1,078.61	7,420.53
2040	13.75	1,151.91	73.44	1,239.10	8,659.63
2041	14.46	1,261.07	80.34	1,355.87	10,015.50
2042	16.43	1,382.84	79.78	1,479.05	11,494.56
2043	22.19	1,445.96	95.80	1,563.95	13,058.51
2044	28.93	1,473.24	100.53	1,602.70	14,661.21
2045	32.04	1,626.43	120.14	1,778.61	16,439.82
2046	35.37	1,663.01	132.95	1,831.33	18,271.15
2047	42.54	1,635.72	156.23	1,834.50	20,105.65
2048	44.02	1,614.98	194.04	1,853.05	21,958.70
2049	39.77	1,494.34	206.40	1,740.51	23,699.20
2050	40.94	1,613.43	215.34	1,869.70	25,568.91

Table 23. Deforested area projected in the leakage belt

Project year t	Stratum i in the leakage belt (ha)				Total (ha)	
	ABSLLK $_1$ Dense Alluvial Tropical Rainforest	ABSLLK $_2$ Dense Submontane Tropical Rainforest	ABSLLK $_3$ Dense Lowland Tropical Rainforest	ABSLLK $_4$ Pioneer formations with fluvial influence	annual $ABSLLK_t$	cumulative ABSLLK
2020	72.84	204.78	25.79	3.44	306.85	306.85
2021	114.52	258.46	20.02	3.78	396.77	703.62
2022	144.75	301.60	19.27	5.22	470.84	1,174.47
2023	188.68	299.28	30.77	1.26	519.98	1,694.45
2024	219.90	323.74	53.62	1.80	599.07	2,293.52
2025	180.07	336.58	76.77	5.04	598.46	2,891.98
2026	181.31	377.44	92.53	0.72	652.00	3,543.98
2027	187.06	437.11	137.42	4.86	766.45	4,310.43
2028	190.09	435.21	141.51	1.53	768.34	5,078.77
2029	183.00	422.60	202.72	5.76	814.08	5,892.86
2030	170.12	445.07	231.22	7.74	854.15	6,747.00
2031	150.91	447.28	318.74	7.92	924.85	7,671.86
2032	137.69	431.54	418.73	18.09	1,006.05	8,677.91
2033	120.33	408.58	458.02	16.56	1,003.49	9,681.40
2034	132.80	415.30	491.15	17.11	1,056.36	10,737.76
2035	121.28	424.22	523.69	32.49	1,101.67	11,839.43
2036	99.32	390.35	565.80	27.08	1,082.55	12,921.98
2037	114.78	362.63	583.26	28.81	1,089.48	14,011.46
2038	119.47	378.42	606.02	39.74	1,143.66	15,155.12
2039	129.82	381.10	598.39	42.45	1,151.75	16,306.87
2040	121.56	360.40	579.45	38.04	1,099.44	17,406.32
2041	147.67	346.69	548.69	41.38	1,084.44	18,490.75
2042	124.77	309.27	493.49	49.86	977.39	19,468.14
2043	116.66	340.61	457.82	45.75	960.84	20,428.98
2044	129.87	323.99	437.02	73.30	964.18	21,393.16
2045	98.98	310.75	415.12	55.69	880.54	22,273.70
2046	111.53	288.36	392.03	57.07	849.00	23,122.70
2047	104.28	256.23	394.01	69.06	823.58	23,946.28
2048	98.69	271.07	389.45	70.70	829.90	24,776.18
2049	94.12	234.89	382.67	58.46	770.14	25,546.32
2050	95.06	243.10	322.96	68.00	729.12	26,275.43

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

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

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

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

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

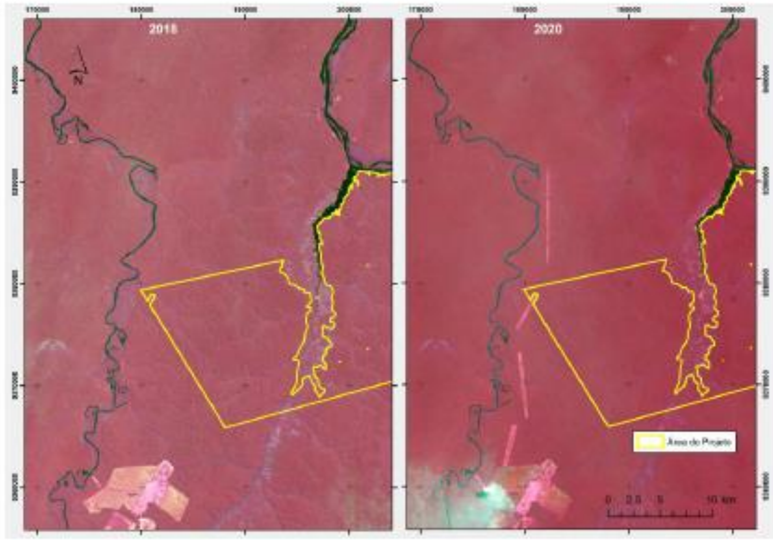
(iv) Development of scenarios, which is the creation of future scenarios using historical trends (2009 to 2019) through the Business-as-usual scenario.

Assigning weighs to change agents

The predictive variables considered to have the potential to influence the risk of deforestation in the region are the proximity to roads, proximity to cities, slope, altitude, presence of settlements, presence of strictly protected and sustainable use protection areas, proximity to small rivers and the proximity to large rivers. However, from preliminary results, the proximity to cities factor was removed from the analysis due to the long distance of urban areas in relation to the reference region (the nearest urban area is over 70 km from the Project Area and 15 km from the Reference Region boundary), and because the weights of evidence presented low values, with variation that did not represent a clear pattern of its effects.

For the future deforestation projection, for the factor proximity to roads, the new illegal roads were mapped, and are shown in satellite images between 2018 and 2020, as detailed in figure below:

Figure 49. Landsat images from 2018 and 2020 showing the illegal road opening in the reference region.



Deforestation risk maps show regions with the highest (risk = 1) or lowest (risk = 0) conditions for deforestation to occur. The risk map was created using Dinamica EGO Software[104], 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

[104] Dinamica Ego Software. Available at: <https://csr.ufmg.br/dinamica/>. Last visited on 29/12/2020

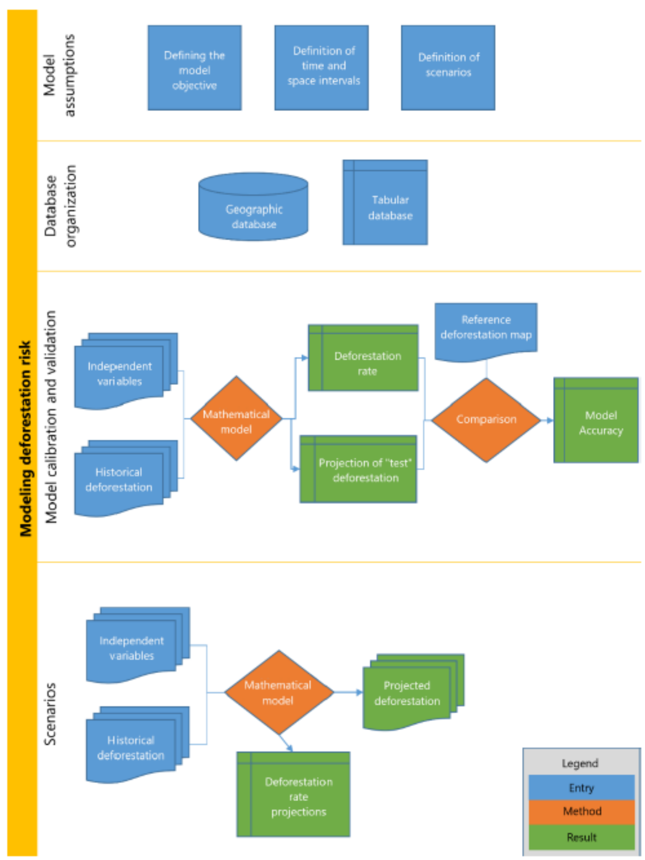
positive or negative, indicate greater weight to positively or negatively influence the calculation of the probability of deforestation in an area.

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

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

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

Figure 50. 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 are presented below.

Table 24. 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_edit_Estradasllegais.tif	IBGE[105]	Meter	Euclidean Distance from paved and unpaved roads	0-103,423	Lower values mean more proximity		Rodovias_IBGE_edit_c_Estradaslle gais	Euclidean Distance (ArcGis 10.6)	Quantitative variable
2	UCs.tif	MMA[106]		Sustainable Use Protected Areas						Categorical variable
3	UCs.tif	MMA[107]		Full protection Protected Areas						Categorical variable
4	Assentamentos.tif	INCRA[108]		Rural settlements						Categorical variable
5	d_rios_g.tif	ANA[109]	Meter	Euclidean Distance from water bodies	0 – 79,615	Lower values mean more proximity		Massas dagua	Euclidean Distance (ArcGis10.6)	Quantitative variable
6	d_rios.tif	ANA[110]	Meter	Euclidean distance from rivers	0 – 9,069.53	Lower values mean more proximity		Rios	Euclidean Distance (ArcGis 10.6)	Quantitative variable
7	d_AreasUrbanas.tif	IBGE[111]	Meter	Euclidean distance from urban centers	14,610.5 - 158,998	Lower values mean more proximity		AreasUrbanas_IBGE	Euclidean Distance (ArcGis 10.6)	Quantitative variable
8	DEM_extract_fill.tif	SRTM[112]	Meter	Average altitude variation	-3-184	Lower values mean lower altitude		DEM_srtm_mosaic		Quantitative variable
9	DEM_extract_fill_slope.tif	SRTM[113]	Degree	Average slope variation	0-94.6081	Lower values		DEM_srtm_mosaic	Slope (ArcGis 10.6)	Quantitative variable

105 Road shapefile available at <https://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/shapefile/>
106 Protection areas of Brazil shapefile available at <http://mapas.mma.gov.br/i3geo/datadownload.htm>
107 Protection areas of Brazil shapefile available at <http://mapas.mma.gov.br/i3geo/datadownload.htm>
108 Rural settlements shapefile available at <http://certificacao.incra.gov.br/csv_shp/export_shp.py>
109 Rivers from Brazil shapefile available at <https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7d054e5a-8cc9-403c-9f1a-085fd933610c>
110 Rivers from Brazil shapefile available at <https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7d054e5a-8cc9-403c-9f1a-085fd933610c>
111 Urban areas shapefile available at <https://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/shapefile/>
112 Altitude shapefile available at <https://earthexplorer.usgs.gov/>
113 Slope shapefile available at <https://earthexplorer.usgs.gov/>

						mean lower slope				

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

Table 25. Variation of the weights of evidence according to deforestation distance ranges

Distance to deforestation		Weights of evidence
0	100	3.46
100	400	2.23
400	700	1.58
700	1,000	1.21
1,000	1,300	0.91
1,300	1,400	0.69
1,400	1,700	0.49
1,700	1,800	0.31
1,800	2,100	0.23
2,100	2,400	0.06
2,400	2,600	-0.17
2,600	2,700	-0.42
2,700	3,100	-0.59
3,100	3,500	-0.79
3,500	3,600	-1.06
3,600	4,000	-1.14
4,000	4,200	-1.51
4,200	4,600	-1.74
4,600	5,000	-2.00
5,000	5,400	-1.83
5,400	5,700	-1.40
5,700	6,200	-1.29
6,200	6,700	-1.30
6,700	7,200	-1.36
7,200	7,800	-1.33
7,800	8,400	-1.27
8,400	9,100	-1.26
9,100	9,900	-1.49
9,900	10,000	-2.72
10,000	10,900	-2.79
10,900	12,000	-3.49
12,000	13,400	-2.36

13,400	13,500	-1.45
13,500	15,300	-1.93
15,300	17,800	-2.84
17,800	22,600	-3.99
22,600	25,400	0.00

Table 26. Variation of the weights of evidence according to the distance from roads

Distance from roads (m)	Weights of evidence	Distance from roads (m)	Weights of evidence
0 - 100	3.18	26,900 – 27,400	-0.63
100 - 1,300	2.32	27,400 – 27,500	-0.40
1,300 – 2,400	1.74	27,500 – 27,600	-0.63
2,400 – 3,500	1.40	27,600 – 27,700	-0.43
3,500 – 4,600	1.10	27,700 – 27,800	-0.63
4,600 – 4,700	0.79	27,800 – 29,800	-0.85
4,700 – 5,300	0.62	29,800 – 29,900	-1.60
5,300 – 5,400	0.30	29,900 – 32,500	-1.71
5,400 – 6,700	0.27	32,500 – 32,600	-1.22
6,700 – 6,800	-0.07	32,600 – 32,700	-1.84
6,800 – 7,300	-0.26	35,400 – 35,900	-2.04
7,300 – 7,400	-0.68	35,900 – 38,900	-2.76
7,400 – 7,600	-0.88	38,900 – 39,000	-1.76
7,600 – 8,000	-0.70	39,000 – 39,800	-2.43
8,000 – 8,400	-0.92	39,800 – 43,200	-1.92
8,400 – 9,900	-1.08	43,200 – 46,600	-2.20
9,900 – 11,200	-1.52	46,600 – 46,700	-1.20
11,200 – 12,800	-1.75	46,700 – 46,900	-1.75
12,800 – 12,900	-1.41	46,900 – 47,100	-2.46
12,900 – 14,400	-1.15	47,100 – 50,600	-3.11
14,400 – 16,300	-0.97	50,600 – 54,100	-4.32
16,300 – 18,100	-0.74	54,100 – 54,300	-2.33
18,100 – 18,200	0.14	54,300 – 58,400	-2.83
18,200 – 19,900	-0.03	58,400 – 59,800	-1.93
19,900 – 20,000	-0.69	59,800 – 59,900	-0.46
20,000 – 21,100	-0.94	59,900 – 60,000	-0,14
21,100 – 21,200	-2.84	60,000 – 60,100	-0.50
21,200 – 22,800	-1.98	60,100 – 60,200	-0.72
22,800 – 22,900	-1.48	60,200 – 60,300	-1.32
22,900 – 25,100	-1.41	60,300 – 60,500	-1.90

25,100 – 25,400	-1.91
25,400 – 25,500	-1.27
25,500 – 25,900	-0.95
25,900 – 26,000	-0.52
26,000 – 26,500	-0.71
26,500 – 26,600	-0.95
26,600 – 26,800	-1.22
26,800 – 26,900	-0.86

60,500 – 60,600	0.00
60,600 – 67,800	-4.40
67,800 – 68,000	-2.26
68,000 – 77,700	-3.73
77,700 – 91,200	-4.72
91,200 – 103,500	-3.69

Table 27. Variation of the weights of evidence according to the distance from rivers

Distance from rivers (m)	Weights of evidence
0 - 100	-0.47
100 - 200	-0.44
200 - 300	-0.46
300 - 400	-0.48
400 - 500	-0.43
500 – 600	-0.40
600 - 700	-0.46
700 - 800	-0.39
800 - 900	-0.45
900 – 1,000	-0.44
1,000 – 1,100	-0.40
1,100 – 1,200	-0.32
1,200 – 1,300	-0.29
1,300 – 1,500	-0.33
1,500 – 1,700	-0.21
1,700 – 1,900	-0.07
1,900 – 2,100	-0.06
2,100 – 2,300	-0.02
2,300 – 2,500	-0.01
2,500 – 2,700	0.07
2,700 – 2,900	0.25
2,900 – 3,200	0.40
3,200 – 3,600	0.54
3,600 – 3,900	0.79
3,900 – 4,300	1.07
4,300 – 4,800	1.41
4,800 – 7,200	1.27

Table 28. Variation of the weights of evidence according to slope

Slope		Weights of evidence
0	2	0.069
2	3	0.053
3	4	0.042
4	5	0.026
5	6	0.008
6	7	-0.010
7	8	-0.042
8	9	-0.055
9	10	-0.067
10	11	-0.060
11	13	-0.076
13	15	-0.079
15	18	-0.083
18	24	-0.019
24	95	0.086

Table 29. Variation of the weights of evidence according to altitude

Altitude	Weights of evidence	Altitude	Weights of evidence
0 - 14	0.03	70 - 71	0.21
14 – 18	0.25	71 – 76	0.27
18 - 19	-0.04	76 - 78	0.47
19 – 20	0.49	78 – 81	0.69
20 - 21	-0.01	81 - 85	0.70
21 – 22	0.23	85 – 89	0.93
22 - 23	0.01	89 - 93	0.76
23 - 24	0.35	93 – 94	0.35
24 - 25	-0.39	94 - 98	0.37
25 – 26	0.99	98 – 102	0.13
26 - 27	0.39	102 - 103	-0.60
27 – 37	0.47	103 – 105	-0.92
37 - 38	0.04	105 - 106	-1.22
38 – 39	0.23	106 – 111	-0.93
39 - 40	-0.09	111 - 112	-0.55

40 – 44	-0.28
44 - 47	-0.52
47 – 49	-0.07
49 - 50	0.20
50 – 52	0.10
52 - 53	0.12
53 - 54	-0.32
54 - 55	-0.45
55 - 56	-0.44
56 - 57	-0.55
57 - 59	-0.74
59 - 61	-0.69
61 - 63	-0.70
63 - 65	-0.49
65 - 66	-0.26
66 - 70	-0.07

112 – 113	-0.87
113 - 115	-1.23
115 – 125	-1.39
125 - 126	-1.04
126 – 143	-0.76
143 - 144	0.36
144 – 147	0.56
147 - 148	1.27
148 – 155	0.89
155 - 156	-1.03
156 – 157	-2.03
157 - 158	-3.69
158 - 185	0.00

Table 30. Variation of the weights of evidence according to Protected Areas

Protected Areas	Weights of evidence
1	0.40
2	-0.89
3	-2.17

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

Figure 51. Factor map representing the distance from roads[114]

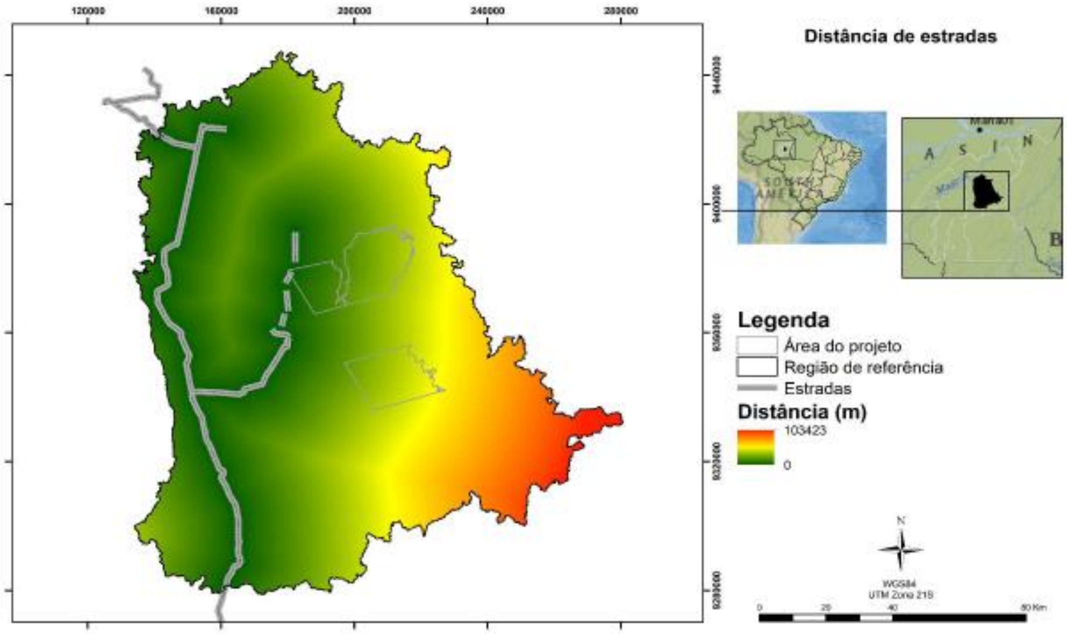
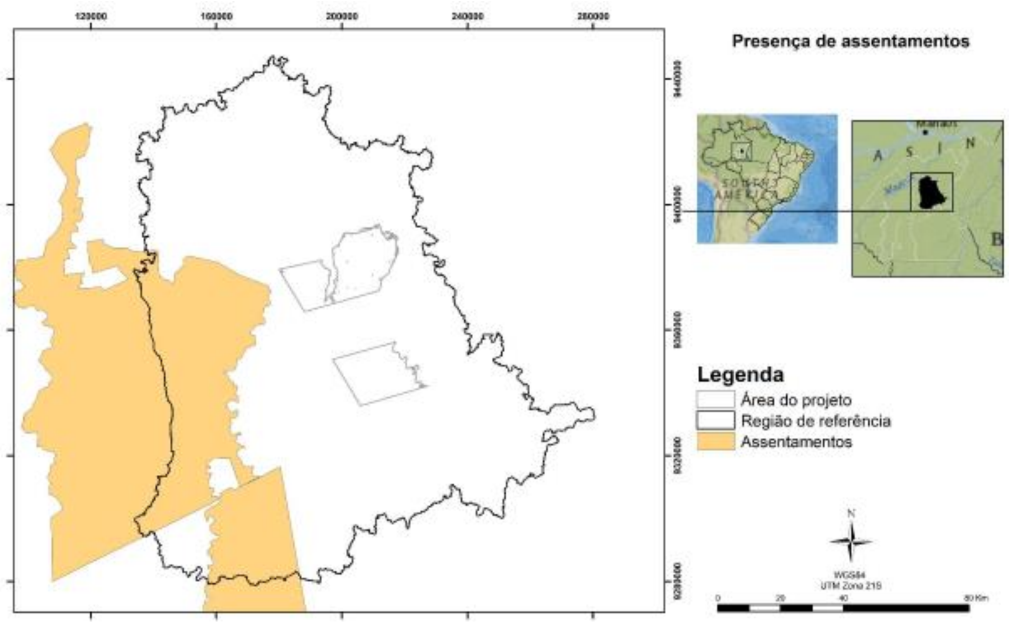


Figure 52. Factor map representing the distance from settlements[116]



[114] The source utilized to elaborate this map can be found through this link: <ftp://geoftp.ibge.gov.br/cartas_e_mapas/bases_cartograficas_continuas/bc250/versao2019/informacoes_tecnicas/>

[116] The sources for the elaboration of this map can be found through the link : < http://certificacao.incra.gov.br/csv_shp/export_shp.py>

Figure 53. Factor map representing the Protected Areas in the reference region[117]

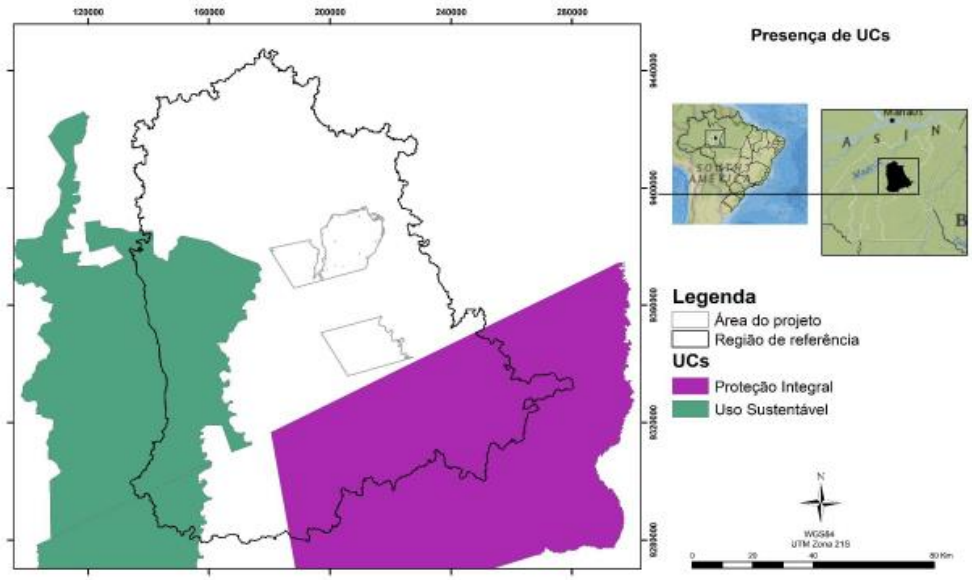
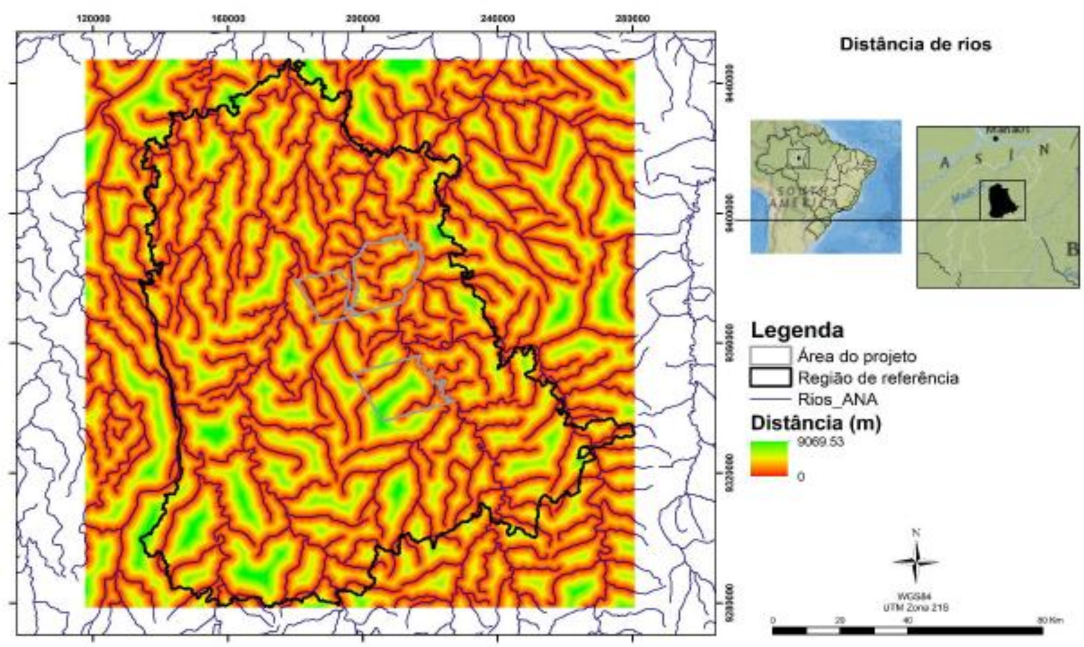


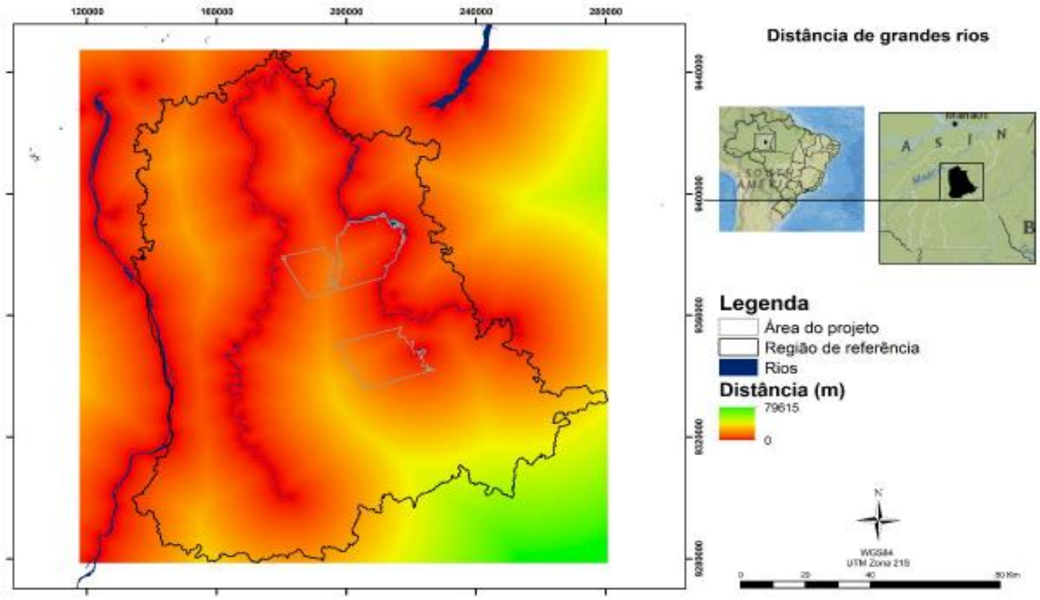
Figure 54. Factor map representing the distance from rivers[118]



[117] The sources for the elaboration of this map can be found through the link: <http://mapas.mma.gov.br/i3geo/datadownload.htm>

[118] The sources for the elaboration of this map can be found through the link: < https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7bb15389-1016-4d5b-9480-5f1acdadd0f5>

Figure 55. Factor map representing the distance from large rivers[119]



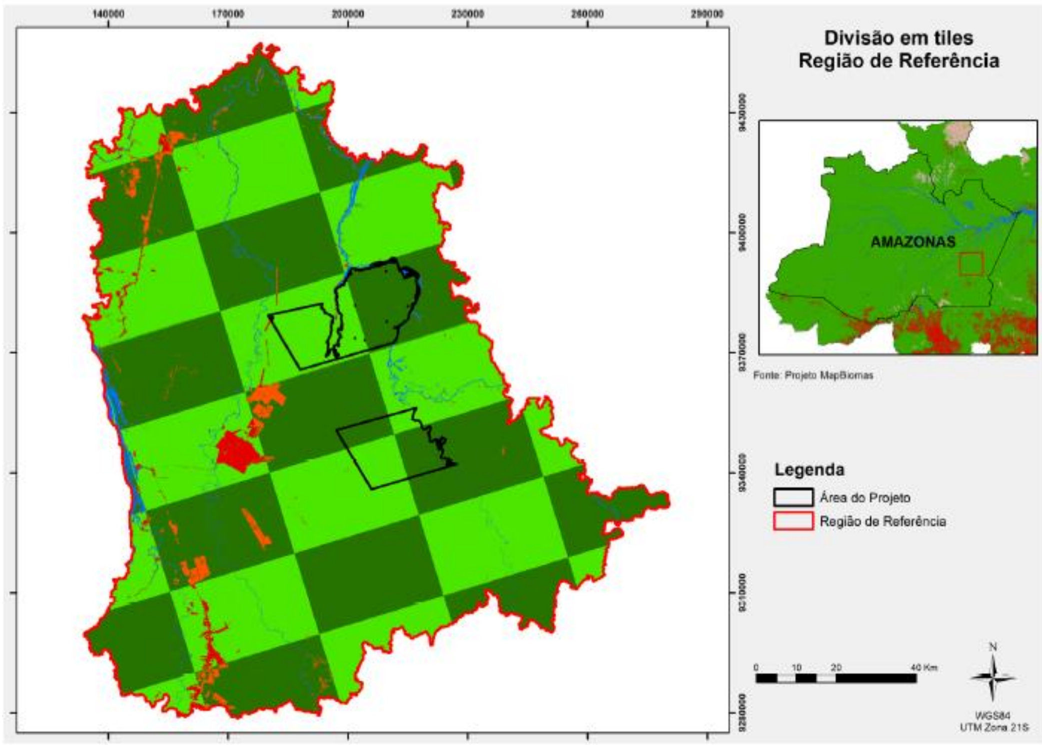
Selection of most accurate deforestation risk map

As previously noted, the time function approach was chosen to project the quantity of future deforestation, given the tendency to increase over time. In addition, to validate which are the best models to allocate where these deforestations tend to happen, it was used the tiles (plots) methodology to calibrate and confirm the model.

For this, the reference region was divided in a grid (tiles) with approximately 32 x 21 km cells. The grid was systematically divided into two, following the pattern of a chessboard. A part of this grid was selected to adjust and calibrate the model, relating the explanatory variables (factors) with the deforested areas, and the other part was used to project the deforestation, in order to assess and confirm the degree of accuracy of the models. In this model, the deforestation projection covered the entire historic period, from 2009 to 2019.

[119] The sources for the elaboration of this map can be found through the link: : < https://metadados.ana.gov.br/geonetwork/srv/pt/main.home?uuid=7bb15389-1016-4d5b-9480-5f1acdadd0f5>

Figure 56. Reference Region divided into tiles, where half of the area was used to calibrate the models, and the other half to validate.



For validation, the simulated scenarios for 2019 were compared to the actual deforestation that happened in the area, using the method of similarity with exponential decay due to the distance. This index ranges from 0 (no overlapping) to 1 (totally overlapped), and the closer to 1, the more similar is the simulated scenario in relation to the real. Two values are calculated for the indices, the comparison of the simulated map in relation to the real map of deforestation and, conversely, the real map in relation to the simulated map. Thus, to define the most accurate map, the average of these two values was used.

The results of this analysis are described in table below, indicating that model 12 was the most accurate.

Table 31. Deforestation projection models from 2009 to 2019. Each line corresponds to a model and was evaluated by the Similarity degree

Model	Similarity 01	Similarity 02	Average	Distance to deforestation	Settlements	Distance to roads	Distance to rivers	Distance to large rivers	Slope	Altitude	Protected areas
Md12	0.479	0.429	0.454	1	0	1	1	0	1	1	1
Md04	0.473	0.421	0.447	1	1	1	1	0	1	1	1
Md11	0.473	0.416	0.444	1	0	1	0	0	1	1	1
Md10	0.466	0.412	0.439	1	0	1	0	0	0	1	1
Md01	0.462	0.417	0.439	1	0	1	1	1	1	1	1
Md03	0.456	0.403	0.430	1	1	1	0	1	1	1	1
Md00	0.451	0.405	0.428	1	1	1	1	1	1	1	1
Md05	0.446	0.404	0.425	1	1	1	1	1	0	1	1
Md06	0.444	0.402	0.423	1	1	1	1	1	1	0	1
Md09	0.431	0.382	0.406	1	0	1	0	0	0	0	1
Md02	0.407	0.367	0.387	1	1	0	1	1	1	1	1
Md07	0.403	0.358	0.380	1	1	1	1	1	1	1	0
Md08	0.353	0.343	0.348	1	0	0	0	0	0	0	1

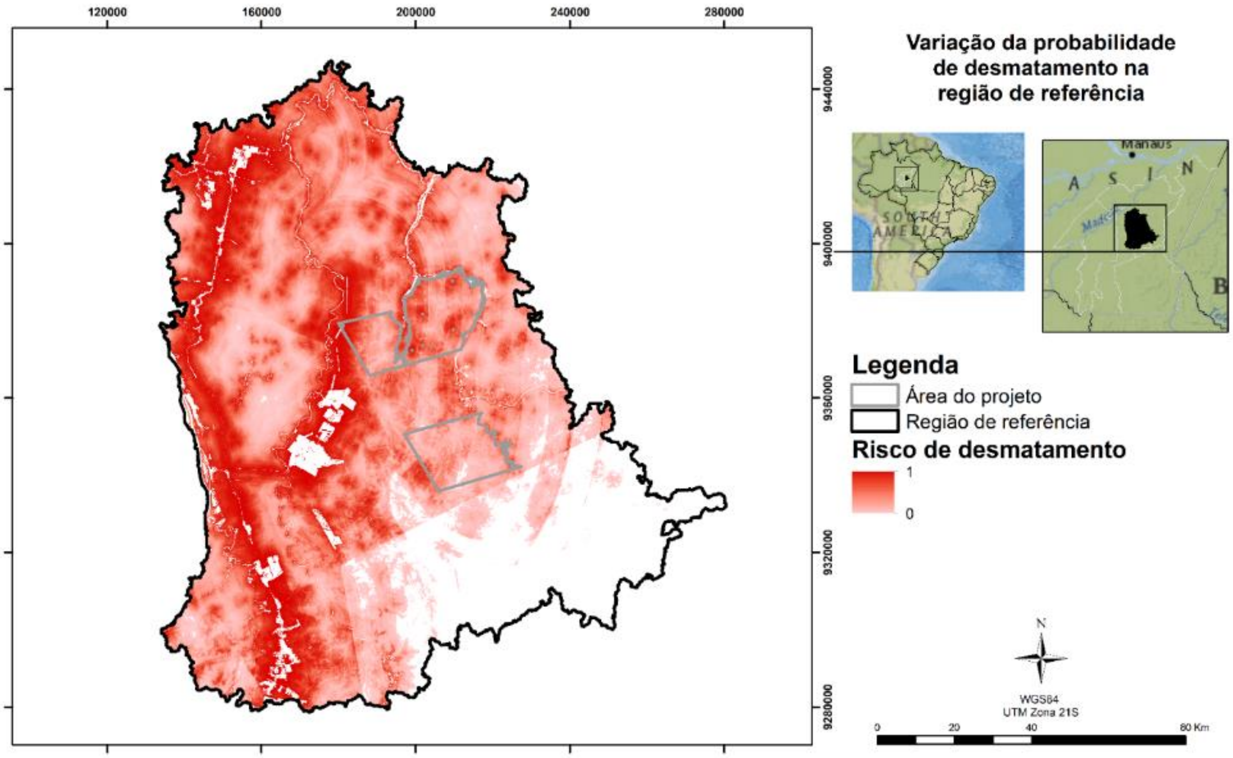
Additionally, for the most accurate model, a similarity analysis with multiple growing windows was used, in which it observes a window in the surroundings for each pixel and compares the degree of correctness between the simulated map and the map with real deforestation. Therefore, the larger the window, the greater the chance of success. According to Barni[120], a degree of correctness above 50% is considered satisfactory, which happens when the window is 7x7 in size.

Window	Similarity
1x1	30%
3x3	40%
5x5	46%
7x7	50%
9x9	53%
11x11	56%

Therefore, all the variables and deforestation patterns were analysed together to produce the risk map, which is illustrated in the figure below. Thus, the deforestation risk map was produced based on the information above, in accordance with the steps required by the methodology VM0015 v1.1.

[120] BARNI, P. E. Reconstrução e asfaltamento da Rodovia BR–319: Efeito "dominó" pode elevar as taxas de desmatamento no Sul do Estado de Roraima. 2009. 136f. Dissertação (Mestrado em Ciências de Florestas Tropicais.) – INPA, Universidade Federal da Amazônia, Manaus.

Figure 57. Potential risk map for the occurrence of deforestation in the reference region, using Dinâmica Ego Software



Mapping of the locations of future deforestation

The maps showing the annually deforested areas within the reference region, project area and leakage belt for the first 30 years, until 2050 are illustrated in figures below:

Figure 58. Projection of deforestation in the reference region, using Dinamica EGO

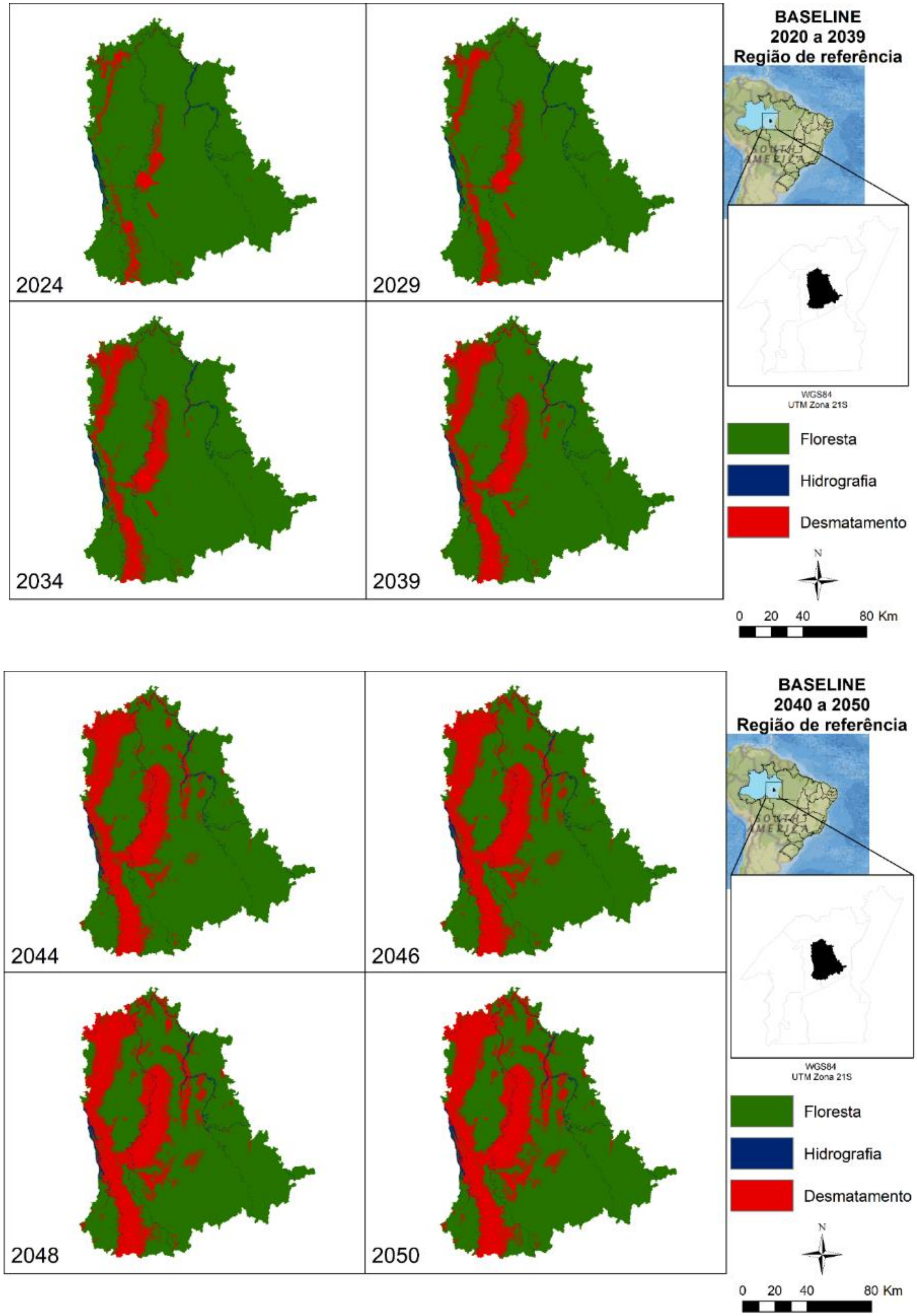


Figure 59. Projection of deforestation in the project area, using Dinamica EGO

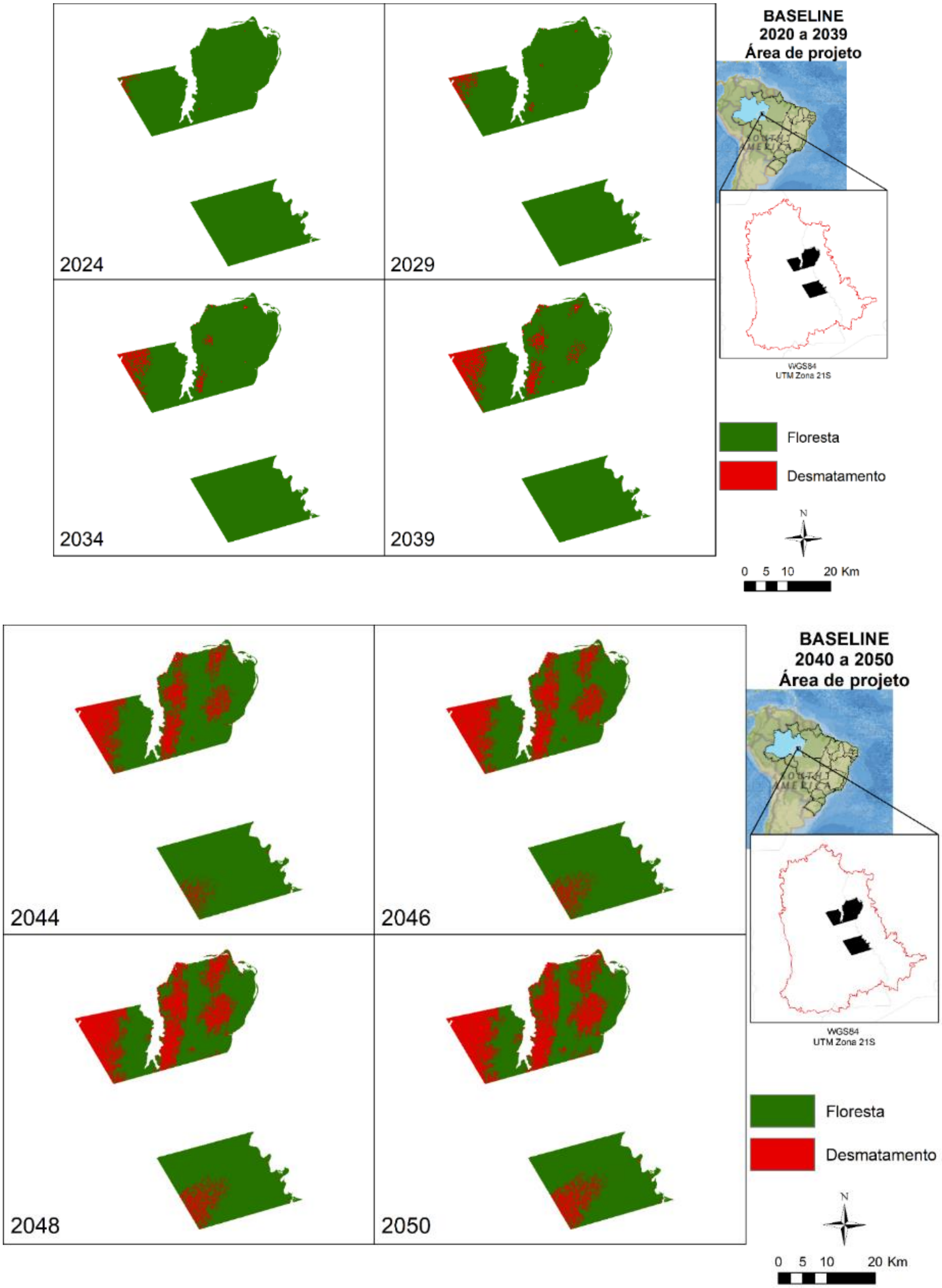


Figure 60. Projection of deforestation in the leakage belt, using Dinâmica EGO

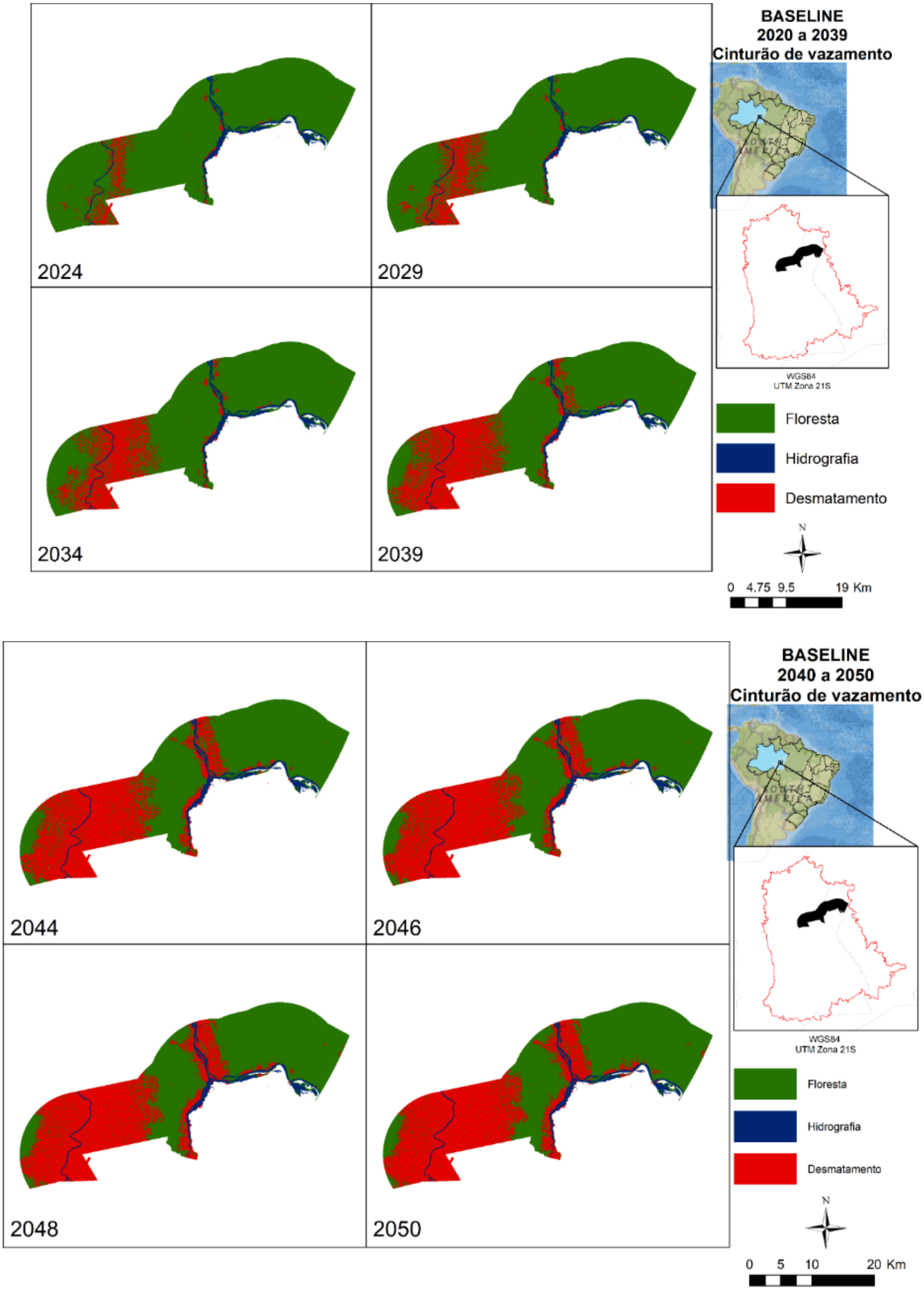
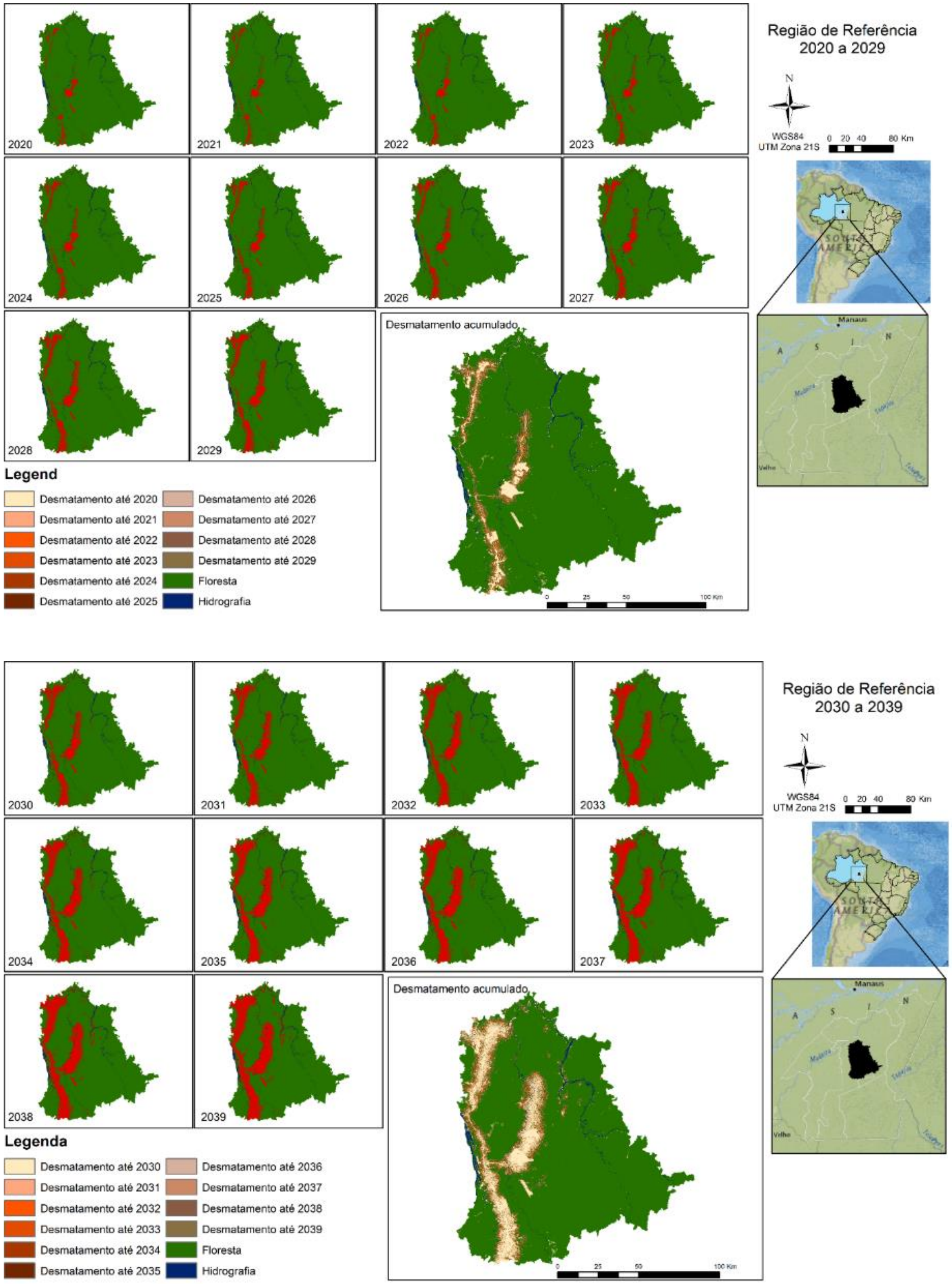
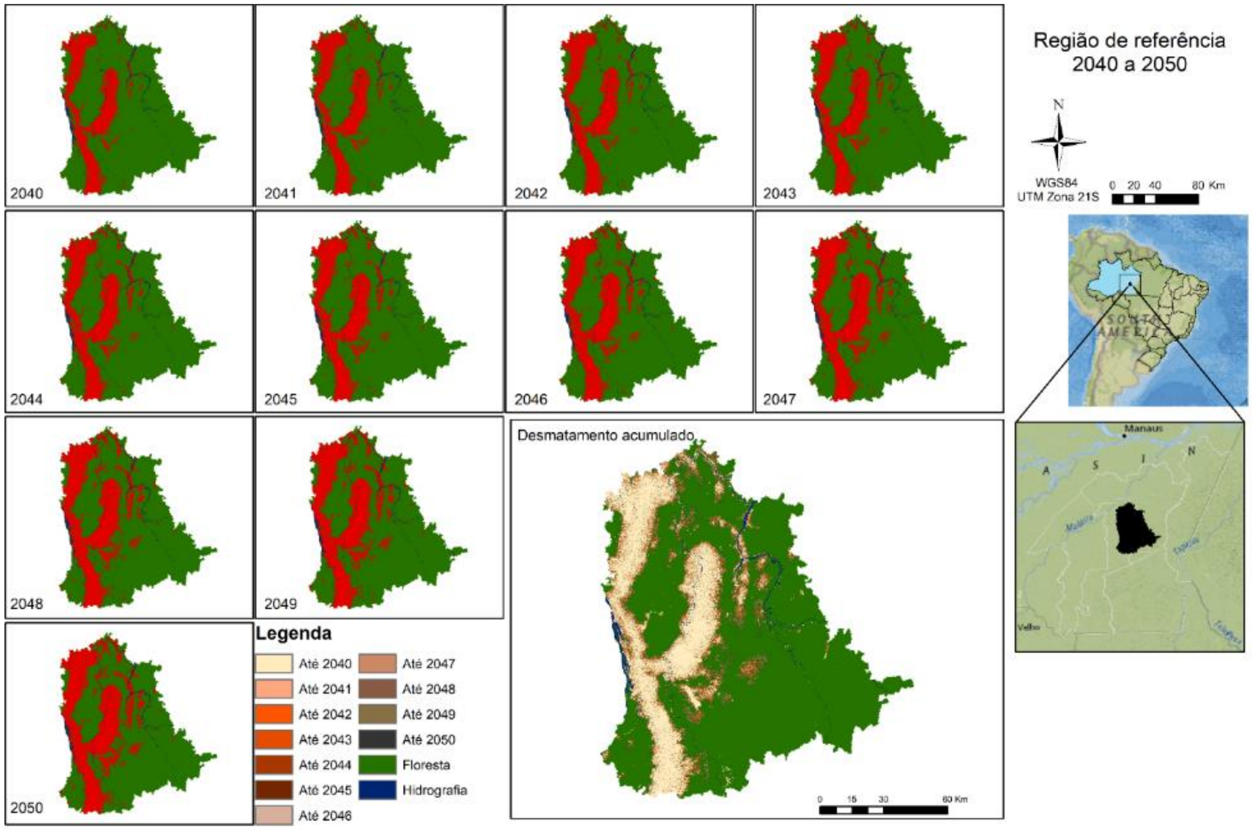


Figure 61. Deforestation projection in the reference region, year by year





Região de referência
2040 a 2050
N
WGS84
UTM Zona 21S
0 20 40 80 Km
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
Desmatamento acumulado
Legenda
Até 2040
Até 2041
Até 2042
Até 2043
Até 2044
Até 2045
Até 2046
Até 2047
Até 2048
Até 2049
Até 2050
Floresta
Hidrografia
0 15 30 60 Km
Manaus

Figure 62. Deforestation projection in the project area, year by year

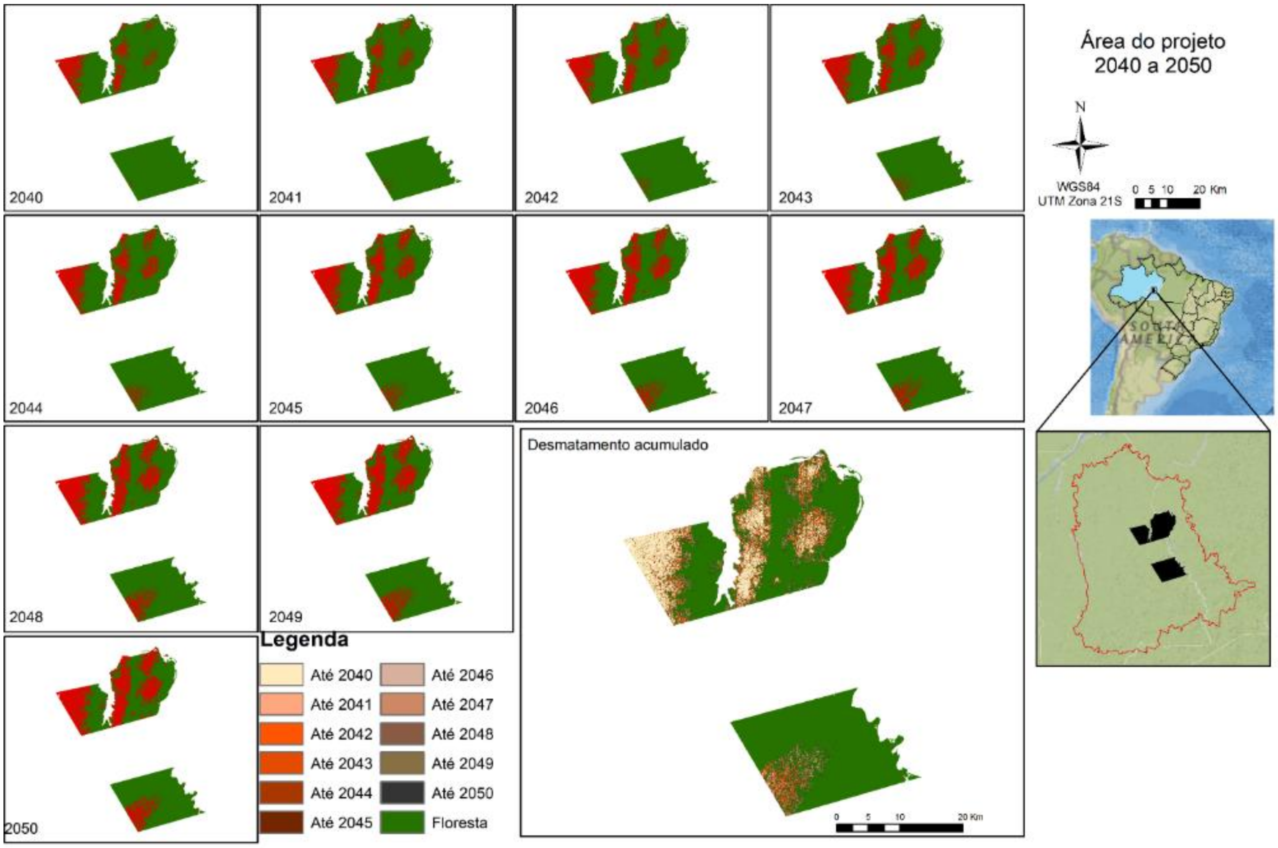
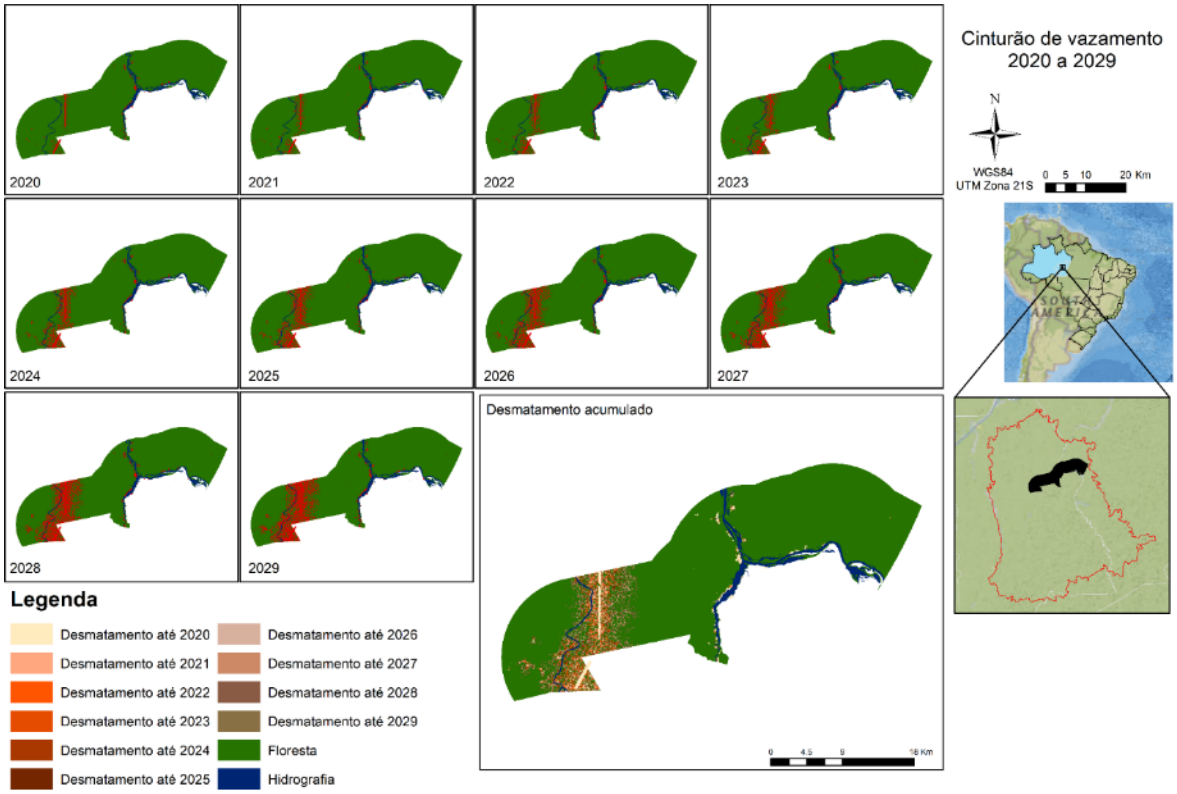
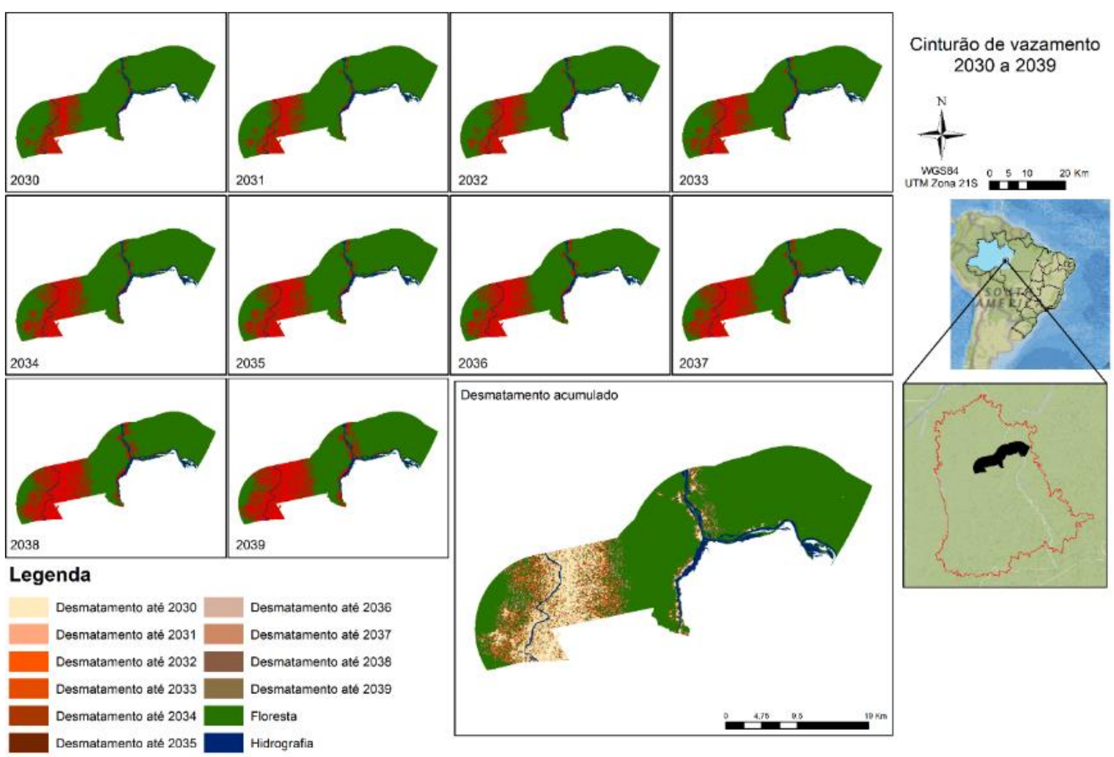
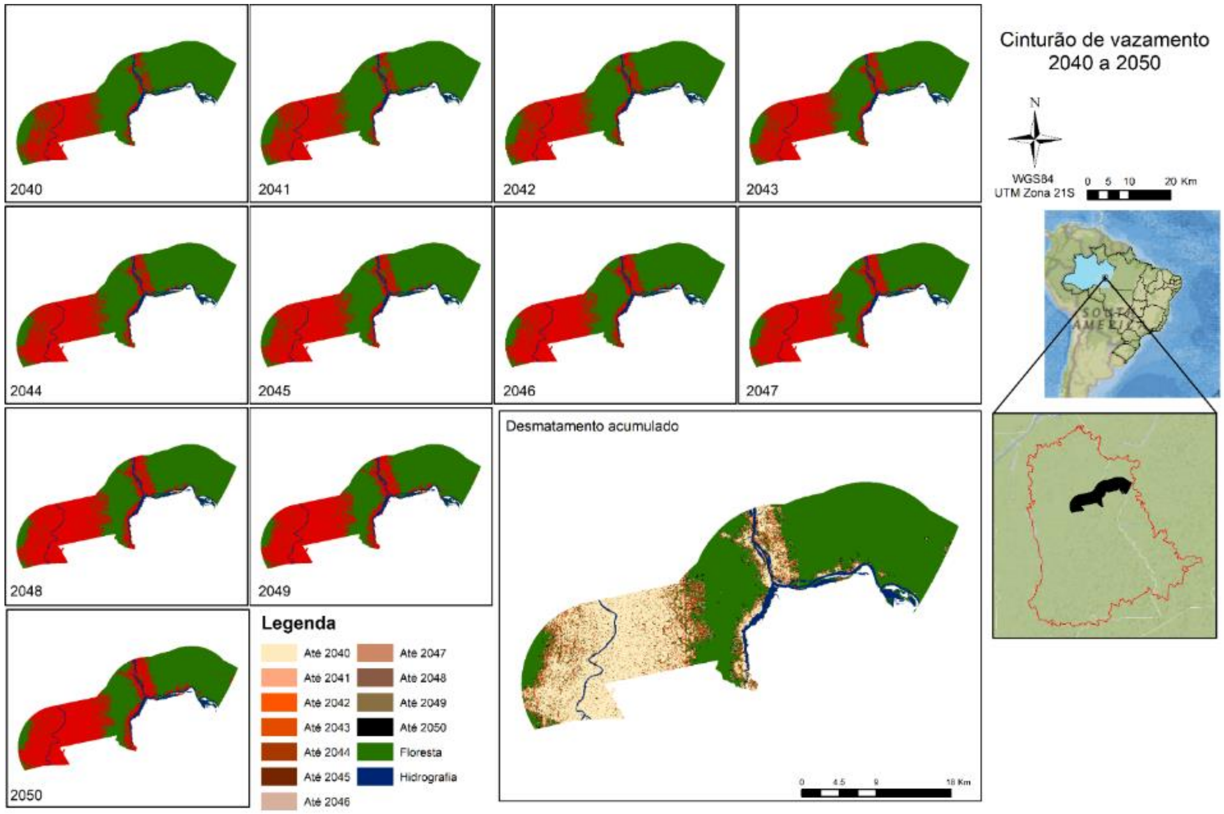

2040
2041
2042
2043
Área do projeto
2040 a 2050
N
WGS84
UTM Zona 21S
0 5 10 20 Km
2044
2045
2046
2047
2048
2049
Desmatamento acumulado
Legenda
Até 2040
Até 2041
Até 2042
Até 2043
Até 2044
Até 2045
Até 2046
Até 2047
Até 2048
Até 2049
Até 2050
Floresta
2050
0 5 10 20 Km

Figure 63. Deforestation projection in the leakage belt, year by year







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

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

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

Calculation of baseline activity data per forest class

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

The LU/LC-change within the project crediting period, caused by baseline deforestation consisted of initial forest classes being converted to the final LU/LC class of 'non-forest'. The number of hectares deforested in each forest class, within the reference region, project area and leakage belt are found in tables below.

Table 32. Annual areas deforested per forest class icl within the reference region in the baseline case (baseline activity data per forest class)

Area deforested per florest class *icl* within the reference region							Total baseline deforestation in the reference region	
IDicl	1	2	3	4	5	6		
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	annual ABSLRRt (ha)	ABSLRR cumulative (ha)
Project year *t*	ha	ha	ha	ha	ha	ha		
2020	294.36	3,444.74	2,269.61	52.51	15.70	87.18	6,164.10	6,164.10
2021	309.27	3,958.68	2,344.05	55.99	7.47	35.56	6,711.03	12,875.13
2022	385.80	4,243.46	2,523.11	58.02	4.35	35.20	7,249.95	20,125.08
2023	514.58	4,443.58	2,705.27	76.40	6.84	33.39	7,780.05	27,905.13
2024	572.19	4,687.15	2,879.20	110.68	8.82	42.75	8,300.79	36,205.92
2025	587.42	4,872.79	3,189.34	120.44	4.50	37.24	8,811.72	45,017.64
2026	668.43	5,039.48	3,430.63	136.73	3.06	33.70	9,312.03	54,329.67
2027	698.99	5,105.99	3,787.52	166.13	5.40	37.43	9,801.45	64,131.12
2028	762.47	5,278.35	3,987.56	197.72	8.46	44.52	10,279.08	74,410.20
2029	775.12	5,379.97	4,296.83	230.97	14.31	47.45	10,744.65	85,154.85
2030	831.20	5,483.14	4,508.58	292.87	18.81	63.02	11,197.62	96,352.47
2031	843.48	5,485.71	4,849.19	372.13	14.67	72.27	11,637.45	107,989.92
2032	862.56	5,491.34	5,225.61	358.48	24.57	101.13	12,063.69	120,053.61
2033	946.06	5,619.22	5,376.18	395.18	18.55	120.89	12,476.07	132,529.68
2034	1,020.48	5,610.95	5,665.17	403.08	18.72	155.65	12,874.05	145,403.73
2035	1,006.04	5,656.50	5,963.76	382.60	43.32	205.23	13,257.45	158,661.18
2036	1,104.25	5,573.80	6,303.80	356.94	57.36	229.39	13,625.55	172,286.73
2037	1,135.35	5,692.21	6,451.45	310.62	134.59	254.22	13,978.44	186,265.17
2038	1,129.40	5,826.36	6,544.35	343.10	174.85	297.60	14,315.67	200,580.84
2039	1,194.23	5,996.19	6,571.46	312.12	217.90	345.26	14,637.15	215,217.99
2040	1,258.23	6,263.77	6,581.59	261.20	227.47	349.99	14,942.25	230,160.24
2041	1,209.57	6,585.64	6,504.66	256.70	298.16	376.50	15,231.24	245,391.48
2042	1,238.00	6,670.46	6,573.04	268.88	352.46	401.00	15,503.85	260,895.33
2043	1,221.36	6,815.53	6,629.70	250.81	418.59	423.74	15,759.72	276,655.05
2044	1,209.53	6,966.78	6,726.54	208.59	457.89	429.60	15,998.94	292,653.99
2045	1,113.21	7,234.83	6,763.93	221.12	443.38	444.94	16,221.42	308,875.41
2046	1,103.39	7,421.75	6,820.98	232.81	403.71	444.62	16,427.25	325,302.66
2047	1,061.01	7,567.02	6,912.35	170.86	459.05	445.77	16,616.07	341,918.73

2048	1,021.31	7,702.09	6,971.66	193.64	444.60	454.85	16,788.15	358,706.88
2049	938.18	8,073.15	6,904.01	188.70	427.62	411.75	16,943.40	375,650.28
2050	887.83	8,358.46	6,838.08	188.33	383.37	426.02	17,082.09	392,732.37

Table 33. Annual areas deforested per forest class icl within the project area in the baseline case (baseline activity data per forest class)

Area deforested per florest class icl within the project area				Total baseline deforestation in the project area	
IDicl	**1**	**2**	**3**		
Name	**Dense Alluvial Tropical Rainforest**	**Dense Submontane Tropical Rainforest**	**Dense Lowland Tropical Rainforest**	**annual ABSLPAt (ha)**	**ABSLPA cumulative (ha)**
Project year *t*	**ha**	**ha**	**ha**		
2020	3.93	38.52	3.52	45.97	45.97
2021	0.23	49.18	3.19	52.60	98.56
2022	0.56	79.31	0.00	79.86	178.43
2023	1.44	90.71	0.00	92.15	270.58
2024	0.02	130.61	0.00	130.63	401.22
2025	0.51	122.64	4.14	127.29	528.50
2026	1.66	171.31	3.15	176.12	704.62
2027	0.00	228.71	2.52	231.23	935.85
2028	0.50	247.03	4.34	251.87	1,187.72
2029	1.39	277.10	4.59	283.08	1,470.80
2030	0.56	321.49	4.41	326.45	1,797.25
2031	1.62	319.98	3.15	324.75	2,122.00
2032	3.08	403.43	2.76	409.26	2,531.27
2033	1.89	425.82	6.03	433.74	2,965.01
2034	3.25	479.14	11.25	493.63	3,458.64
2035	4.40	567.88	9.38	581.66	4,040.30
2036	9.12	612.56	20.61	642.30	4,682.60
2037	10.60	715.30	27.02	752.92	5,435.51
2038	4.76	876.13	25.52	906.40	6,341.92
2039	12.35	1,014.07	52.20	1,078.61	7,420.53
2040	13.75	1,151.91	73.44	1,239.10	8,659.63
2041	14.46	1,261.07	80.34	1,355.87	10,015.50
2042	16.43	1,382.84	79.78	1,479.05	11,494.56
2043	22.19	1,445.96	95.80	1,563.95	13,058.51
2044	28.93	1,473.24	100.53	1,602.70	14,661.21
2045	32.04	1,626.43	120.14	1,778.61	16,439.82
2046	35.37	1,663.01	132.95	1,831.33	18,271.15
2047	42.54	1,635.72	156.23	1,834.50	20,105.65
2048	44.02	1,614.98	194.04	1,853.05	21,958.70

2049	39.77	1,494.34	206.40	1,740.51	23,699.20
2050	40.94	1,613.43	215.34	1,869.70	25,568.91

Table 34. Annual areas deforested per forest class icl within the leakage belt in the baseline case (baseline activity data per forest class)

Leakage Belt						
Area deforested per florest class icl within the leakage belt					Total baseline deforestation in the leakage belt	
IDicl	1	2	3	4	annual ABSLLKt (ha)	ABSLLK cumulative (ha)
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Pioneer formations with fluvial influence		
Project year *t*	ha	ha	ha	ha		
2020	72.84	204.78	25.79	3.44	306.85	306.85
2021	114.52	258.46	20.02	3.78	396.77	703.62
2022	144.75	301.60	19.27	5.22	470.84	1,174.47
2023	188.68	299.28	30.77	1.26	519.98	1,694.45
2024	219.90	323.74	53.62	1.80	599.07	2,293.52
2025	180.07	336.58	76.77	5.04	598.46	2,891.98
2026	181.31	377.44	92.53	0.72	652.00	3,543.98
2027	187.06	437.11	137.42	4.86	766.45	4,310.43
2028	190.09	435.21	141.51	1.53	768.34	5,078.77
2029	183.00	422.60	202.72	5.76	814.08	5,892.86
2030	170.12	445.07	231.22	7.74	854.15	6,747.00
2031	150.91	447.28	318.74	7.92	924.85	7,671.86
2032	137.69	431.54	418.73	18.09	1,006.05	8,677.91
2033	120.33	408.58	458.02	16.56	1,003.49	9,681.40
2034	132.80	415.30	491.15	17.11	1,056.36	10,737.76
2035	121.28	424.22	523.69	32.49	1,101.67	11,839.43
2036	99.32	390.35	565.80	27.08	1,082.55	12,921.98
2037	114.78	362.63	583.26	28.81	1,089.48	14,011.46
2038	119.47	378.42	606.02	39.74	1,143.66	15,155.12
2039	129.82	381.10	598.39	42.45	1,151.75	16,306.87
2040	121.56	360.40	579.45	38.04	1,099.44	17,406.32
2041	147.67	346.69	548.69	41.38	1,084.44	18,490.75
2042	124.77	309.27	493.49	49.86	977.39	19,468.14
2043	116.66	340.61	457.82	45.75	960.84	20,428.98
2044	129.87	323.99	437.02	73.30	964.18	21,393.16
2045	98.98	310.75	415.12	55.69	880.54	22,273.70

2046	111.53	288.36	392.03	57.07	849.00	23,122.70
2047	104.28	256.23	394.01	69.06	823.58	23,946.28
2048	98.69	271.07	389.45	70.70	829.90	24,776.18
2049	94.12	234.89	382.67	58.46	770.14	25,546.32
2050	95.06	243.10	322.96	68.00	729.12	26,275.43

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

Zone		Name		Total area of each zone	
		Non-forest			
		ID_{fcl}	1		
		Area	% of zone	Area	% of zone
IDz	Name	ha	%	ha	%
1	Reference region	392,732.37	28%	392,732.37	28%
Total area of each class *fcl*		392,732.37	28%	392,732.37	28%

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

Area established after deforestation per zone within the reference region		Total baseline deforestation in the reference region	
ID_{fcl}	1	$ABSLRR_t$	$ABSLRR$
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2020	6,164.10	6,164.10	6,164.10
2021	6,711.03	6,711.03	12,875.13
2022	7,249.95	7,249.95	20,125.08
2023	7,780.05	7,780.05	27,905.13
2024	8,300.79	8,300.79	36,205.92
2025	8,811.72	8,811.72	45,017.64
2026	9,312.03	9,312.03	54,329.67
2027	9,801.45	9,801.45	64,131.12
2028	10,279.08	10,279.08	74,410.20
2029	10,744.65	10,744.65	85,154.85
2030	11,197.62	11,197.62	96,352.47
2031	11,637.45	11,637.45	107,989.92
2032	12,063.69	12,063.69	120,053.61
2033	12,476.07	12,476.07	132,529.68
2034	12,874.05	12,874.05	145,403.73
2035	13,257.45	13,257.45	158,661.18
2036	13,625.55	13,625.55	172,286.73
2037	13,978.44	13,978.44	186,265.17
2038	14,315.67	14,315.67	200,580.84
2039	14,637.15	14,637.15	215,217.99
2040	14,942.25	14,942.25	230,160.24
2041	15,231.24	15,231.24	245,391.48
2042	15,503.85	15,503.85	260,895.33
2043	15,759.72	15,759.72	276,655.05
2044	15,998.94	15,998.94	292,653.99
2045	16,221.42	16,221.42	308,875.41
2046	16,427.25	16,427.25	325,302.66
2047	16,616.07	16,616.07	341,918.73
2048	16,788.15	16,788.15	358,706.88
2049	16,943.40	16,943.40	375,650.28
2050	17,082.09	17,082.09	392,732.37

Table 37. Annual areas deforested in each zone within the project area in the baseline case (baseline activity data per zone)

Area established after deforestation per zone within the project area		Total baseline deforestation in the project area	
ID_{fcl}	1	$ABSLPA_t$	ABSLPA
Name	No forest	annual	cumulative
Project year	ha	ha	ha
2020	45.97	45.97	45.97
2021	52.60	52.60	98.56
2022	79.86	79.86	178.43
2023	92.15	92.15	270.58
2024	130.63	130.63	401.22
2025	127.29	127.29	528.50
2026	176.12	176.12	704.62
2027	231.23	231.23	935.85
2028	251.87	251.87	1,187.72
2029	283.08	283.08	1,470.80
2030	326.45	326.45	1,797.25
2031	324.75	324.75	2,122.00
2032	409.26	409.26	2,531.27
2033	433.74	433.74	2,965.01
2034	493.63	493.63	3,458.64
2035	581.66	581.66	4,040.30
2036	642.30	642.30	4,682.60
2037	752.92	752.92	5,435.51
2038	906.40	906.40	6,341.92
2039	1,078.61	1,078.61	7,420.53
2040	1,239.10	1,239.10	8,659.63
2041	1,355.87	1,355.87	10,015.50
2042	1,479.05	1,479.05	11,494.56
2043	1,563.95	1,563.95	13,058.51
2044	1,602.70	1,602.70	14,661.21
2045	1,778.61	1,778.61	16,439.82
2046	1,831.33	1,831.33	18,271.15
2047	1,834.50	1,834.50	20,105.65
2048	1,853.05	1,853.05	21,958.70
2049	1,740.51	1,740.51	23,699.20
2050	1,869.70	1,869.70	25,568.91

Table 38. Annual areas deforested in each zone within the leakage belt in the baseline case (baseline activity data per zone)

Leakage Belt			
Area established after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
ID_{fcl}	1	$ABSLLK_t$	$ABSLLK$
Name	Non forest	annual	cumulative
Project year	ha	ha	ha
2020	306.85	306.85	306.85
2021	396.77	396.77	703.62
2022	470.84	470.84	1,174.47
2023	519.98	519.98	1,694.45
2024	599.07	599.07	2,293.52
2025	598.46	598.46	2,891.98
2026	652.00	652.00	3,543.98
2027	766.45	766.45	4,310.43
2028	768.34	768.34	5,078.77
2029	814.08	814.08	5,892.86
2030	854.15	854.15	6,747.00
2031	924.85	924.85	7,671.86
2032	1,006.05	1,006.05	8,677.91
2033	1,003.49	1,003.49	9,681.40
2034	1,056.36	1,056.36	10,737.76
2035	1,101.67	1,101.67	11,839.43
2036	1,082.55	1,082.55	12,921.98
2037	1,089.48	1,089.48	14,011.46
2038	1,143.66	1,143.66	15,155.12
2039	1,151.75	1,151.75	16,306.87
2040	1,099.44	1,099.44	17,406.32
2041	1,084.44	1,084.44	18,490.75
2042	977.39	977.39	19,468.14
2043	960.84	960.84	20,428.98
2044	964.18	964.18	21,393.16
2045	880.54	880.54	22,273.70
2046	849.00	849.00	23,122.70
2047	823.58	823.58	23,946.28
2048	829.90	829.90	24,776.18
2049	770.14	770.14	25,546.32
2050	729.12	729.12	26,275.43

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 VT0001 VCS Tool for the demonstration and assessment of additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) project activities, version 3.0[121] was applied below for the first project instance, i.e. Grupo Leão REDD project activity. This instance does not 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 alternative land use scenarios to the proposed VCS AFOLU project activity.

As described in section above of the present VCS PD, and according to the applied methodological tool, the considered alternatives to the project activity are:

- Timber production

[121] Available in: <https://verra.org/wp-content/uploads/2017/11/VT0001v3.0.pdf> Last visited on 29/12/2020

- Cattle raising
- Continuation of pre-project land use
- Project activity on the land within the project boundary performed without being registered as the VCS AFOLU project

These activities are considered credible alternatives, as shown by official data[122]. Cattle raising is an important economic activity in Brazil, especially in the south of Amazon, where the project is located, being an expressive deforestation agent. Meanwhile, timber production represents 32% of the total value of production from the two municipalities in which the reference region is located.

The pre-project land use is the maintenance of the area as it is, without any activity and actions for conservation. Although no economic activities are carried out in the pre-project scenario, the area is exposed to invasions and illegal deforestation, as detailed in section 3.4.

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

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

Timber production:

Timber production may be authorized in the Amazon as long as the property has an approved Sustainable Forest Management Plan and an Exploration Authorization (AUTEX) issued by the Brazilian Environmental Agency. Furthermore, the land shall follow the Brazilian Federal Law 12,651/2012, that classifies at least 80% of the property located in the Amazon biome as Legal Reserve, which restricts the activities that could be developed in the area. In addition, there are other mandatory restriction regulations that limits the legal exploring area, such as the Permanent Preservation Areas.

122 Sources: Instituto Brasileiro de Geografia e Estatística (IBGE) - IBGE Cidades - Censo Agropecuário. Available at <https://cidades.ibge.gov.br/brasil/am/novo-aripuana/pesquisa/24/76693> Last visited on 29/12/2020

The landowner of the project area has no timber production in the area but demonstrated interest in issuing an authorization in the absence of the present project activity.

However, Brazilian legislation and other legal restrictions are not enough to prevent the illegal deforestation of the Brazilian Amazon Rainforest, which is a common practice in the country. According to INPE[123], the estimated deforestation rate (complete removal of primary forest cover by clear cutting, regardless of the future use of these areas) between August 2018 and July 2019 was 9,762 km^2, an increase of 29.54% over the rate calculated during the previous annual period. The State of Amazonas was the third State with the highest deforestation rate within the biome, with 14.56% of the total.

IPAM estimates that 44% of the deforestation in the period was illegal, registered in non-designated lands or protected areas[124].

Thus, the Project area is exposed to legal and illegal timber activity, which is a common practice in the region; moreover, the related environmental legislation are systematically not enforced.

Cattle raising

Cattle raising in the Amazon Forest is legal as long as the owner follows the 80% Legal Reserve and Permanent Preservation Areas restriction described in the Brazilian legislation, as explained above. The landowner must also provide a deforestation authorization for clearing the area for pasture. Therefore, livestock in the region is legalized.

According to IPAM[125], rural credit is the main funding for the Brazilian livestock production and is essential in the transition to sustainable land use, but in the Amazon area, it is used for conventional practices and activities, associated with deforestation. Despite the fact that, since 2014, the Brazilian Central Bank demands an assessment of socio-environmental risks from banks to approve public financing[126], and the existence of credit and financing opportunities for sustainable practices and producers in compliance with environmental laws, conventional livestock still represents 20% of the conversion of forest coverage to pasture and other agricultural crops[127]. These practices are still used mainly due to its low implementation costs and maintenance, along with non-intensive use of labor, and as long as it's held in areas with legal

[123] Available at <http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294> Last visited on 29/12/2020

[124] Available at <https://ipam.org.br/35-do-desmatamento-na-amazonia-e-grilagem-indica-analise-do-ipam/> Last visited on 29/12/2020

[125] Available at < https://ipam.org.br/wp-content/uploads/2020/01/Fluxos-financeiros-pecu%C3%A1ria.pdf> Last visited on 29/12/2020

[126] Available at < https://www.bcb.gov.br/pre/normativos/res/2014/pdf/res_4327_v1_O.pdf> Last visited on 29/12/2020

[127] Available at <https://idesam.org/viabilidade-pecuaria-sustentavel-leite/> Last visited on 29/12/2020

authorization, are legal, although inefficient, with low productivity and high environmental impact[128].

Continuation of pre-project activity:

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

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

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

Thus, all the land uses listed under sub-step 1a are retained in 1b, being either in accordance with the law or a widespread illegal practice in respect to which the law is not enforced.

Outcome of substep 1b:

List of plausible alternative land use scenarios to the VCS AFOLU activity that are in compliance with mandatory legislation and regulations taking into account their enforcement:

- Timber extraction;
- Cattle raising;
- No activities.
- Project activity without VCS registration

Sub-step 1c. Selection of the baseline scenario

The area held no activity in the baseline scenario. There are no economic activities implemented in the area, nor exploration of non-timber forest products (NTFPs) or other land use activities.

Therefore, the lack of presence and monitoring of the area makes it exposed to invasions and illegal deforestation, without any control of the activities carried out within the area.

The identified agents and drivers, combined with underlying causes present in the region, will most likely continue to cause deforestation in the future, and therefore the continuation of the current (pre-project) land use scenario was defined as the most plausible baseline scenario. The future trend for baseline scenario is that deforestation rate in the reference region will probably increase, as verified during the historical reference period.

STEP 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

128 Available at <https://idesam.org/publicacao/viabilidade-pecuaria-leite-apui.pdf> Last visited on 29/12/2020

Sub-step 2b. Simple Cost Analysis

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

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

Table 39. Estimated annual costs for the REDD Project[129]

Activity	Estimated Annual Costs of Conservation (R$)
Monitoring: hiring of the riverside population living near the project area to supervise the property, including taxes) (2 employees)	R$ 41,184.00
Boat purchase, equipment maintenance and monitoring costs	R$39,700.00
Accountancy and taxes	R$6,080.00
Forest conservation and social environmental activities	R$ 14,640.00
TOTAL	R$101,604.00

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

STEP 4. Common practice analysis

Given that no financial benefits were found in the results of the simple cost analysis, the following step according to the VCS additionality tool is the common practice analysis.

The practice of conservation of privately-owned forest areas in the Amazonas State as a whole, is extremely rare. Conservation activities are usually made in public areas, such as Conservation Units, federal and state protected areas.

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

In the Verra Registry[130], there are 22 REDD projects registered in Brazil, three of them located in the State of Amazonas. Despite being located in Novo Aripuanã, the "Juma REDD+ Project[131]" is a project in partnership with the Government of the State of Amazonas, characterized by the creation and implementation of a State-owned Sustainable Development Reserve, a type of Conservation Unit, thus, a public area.

The "Amazon Rio REDD+ IFM Project"[132] involves the cessation of a legally authorized logging plan that was operational since 1999, and the implementation of a Management Plan in the area.

The Agrocortex REDD Project is an AUD project with a Sustainable Management Plan to maintain the logging activity, establishing a barrier against the advancement of illegal deforestation.

In conclusion, the development of a carbon project is not a common practice in the area, and those that exist have essential distinctions between them and the present VCS AFOLU activity.

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

- **Private Reserve of Natural Heritage (RPPN):** it is a category of conservation unit created voluntarily by the landowner. When the area is categorized as RPPN, the owner is committed to nature conservation, without land expropriation. The benefits of the private reserve are preference in the analysis of applications to acquire rural credit, tax benefits and the possibility of cooperation with private and public entities in the protection, and management of the land. In the Amazonas State, there are 14 registered RPPNs[133]. None of them is located in Novo Aripuanã, and they are much smaller properties compared to the project area.
- **Payment for Environmental Services (PSA):** PSA is a voluntary transaction, with the main objective of providing economic incentives to owners of rural or urban properties that have natural areas capable of providing environmental services. Many law projects are in discussion in Brazil's National Congress, and some federal laws mention the service, but currently there is no valid regulation in the entire country. The Amazon State created, with a state decree, in 2017, the Bolsa Floresta, a payment from the government to benefit traditional communities that live in State Conservation Units in Amazonas, to encourage the conservation and

130 Available in: <https://registry.verra.org/> Last visited on 29/12/2020

131 Available in: <https://registry.verra.org/app/projectDetail/CCB/1596> Last visited on 29/12/2020

132 Available in: <https://registry.verra.org/app/projectDetail/CCB/1147> Last visited on 29/12/2020

133 Available in: <http://sistemas.icmbio.gov.br/simrppn/publico/rppn/AM/> Last visited on 29/12/2020

maintenance of the forest[134]. This program, however, does not benefit landowners of areas outside these protected areas. The search for investment and payment for these areas is up to the owners, usually being agreed with banks or private companies, without government participation.

For the aforementioned reasons of the essential difference between the present project instance and similar projects in the area, the proposed VCS AFOLU project activity is not the baseline scenario, and hence it is additional.

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 tCO2e using the following equations:

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

Where,

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

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

Where,

[134] More information available in: https://www.amazonia.org.br/wp-content/uploads/2012/07/Marco-Regulatorio-PSA.pdf

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

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

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

Where,

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

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

Where,

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

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

Where,

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

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

Estimation of the average carbon stocks

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

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

Project carbon stocks were calculated on the basis of biomass values from the studies from Nogueira, 2015[135] and Higuchi, 2015[136]. Both studies fulfil the criteria mentioned above.

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

Pires & Prance (1985)[137] classified the forest formation of the Amazon biome into two major groups, Forest on *terra firme* (dense forest) and *Várzeas and igapós* forests, and their respective subdivisions. The authors classify that *terra firme* forests dominate the largest percentage of area in the Amazon. Most of it consist of low-lying undulating terrain, rarely above 200 m, and most below 100 m.

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[135] Nogueira, E.M., Yanai, A.M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. Global Change Biology 21: 1271-1292.

[136] HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015. Available at: https://acervodigital.ufpr.br/bitstream/handle/1884/41822/R%20-%20T%20-%20FRANCISCO%20GASPARETTO%20HIGUCHI.pdf?sequence=1&isAllowed=y. Last visited on: 21/March/2021.

[137] Pires & Prance (J.M.Pires, & Prance, G.T.. (1985). The vegetation types of the Brazilian Amazon. Available at https://www.researchgate.net/publication/259688522_The_vegetation_types_of_the_Brazilian_Amazon Last visited on 21/March/2021.

The IBGE "Technical Manual for Brazilian Vegetation" (1992)[138] divides forestry formation into two types: Ombrophilous and Seasonal, being Ombrophilous, open and dense, predominant in the Brazilian Amazon.

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

Table 40. Comparison of forest classifications by Pires & Prance and IBGE

Pires & Prance (1985)		Technical Manual of the Brazilian vegetation (2012)
Forest on *Terra firme* (dense forest)	Dense forest Dense forest is the formation with the greatest biomass, with a clear litter and occurs where environmental conditions are optimal and there are no limiting factors such as scarcity or excess of water.	Dense Ombrophylous rainforest (tropical rain forest) The ombrothermal characteristic of the Dense Ombrophilous Forest is linked to tropical climatic factors of high temperatures and high rainfall, well distributed throughout the year, with practically no biologically dry period. It can be of uniform or emergent canopy. It is subdivided into five formations ordered according to topographic hierarchy, which reflect different physiognomies: **Alluvial, low land, submontane, montane and high montane formations.**
	Open forest without palms Since there is a greater penetration of light, because of its lower trees, there is a tendency for shrub and liana species to develop well, and the forest floor is much more densely covered by vegetation. In this forest, even though it is much lower, occasional scattered individuals of very large trees occur. The lower biomass can be caused by a lower water table, by the impermeability of the soil, by poor drainage or by conditions which do not permit good root penetration, or by the occurrence of relatively long dry seasons and a lower relative humidity. These forests are not	Open Ombrophylous forest This type of vegetation was considered for years as a type of transition between the Amazon rainforest and the extra-Amazonian areas. It presents four floristic factions that alter the ecological physiognomy of the dense rainforest, giving it a clear appearance, hence the name adopted, in addition to the climatic gradients with more than 60 dry days per year. It is divided into: **Lowland** – predominance of palm trees **Submontane** – predominance of palm trees, vines, sororoca and bamboo **Montane** – predominance of palms and vines, the latter much more common. **Alluvial** – on ancient terraces located along the river; riverside formation that

[138] Manual Técnico da Vegetação Brasileira – IBGE, 1992. Available at: https://biblioteca.ibge.gov.br/visualizacao/monografias/GEBIS%20-%20RJ/ManuaisdeGeociencias/Manual%20Tecnico%20da%20Vegetacao%20Brasileira%20n.1.pdf Last visited on 21/March/2021.

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<td>notably seasonally deciduous, and they are also not affected by fire.

<u>Open forest with palms</u>
Similar to the preceding, with trees of about the same height in the same density and of a similar floristic composition. It occurs more frequently than the forest without palms.

<u>Liana forest:</u>
Generally has an abundance of lianas. Generally not continuous. Usually intermeshed with dense forests wthout lianas forming a complex mosaic.

<u>Dry forest:</u>
Formation of transition forest that is occasionally found in the southeastern part of Amazonia on the border between Amazonia and Central Brazil. In this region, the climate is much more seasonal and dryer with lower relative humidity, with the result that in the dry season, the trees lose some of their leaves. Dry forest occurs in small clusters that do not occupy large areas.

<u>Montane forests:</u>
Forest formations which are differentiated by their altitude and rocky soil types. It occurs only at the extremities of Amazonia.</td>
<td>always occupies alluvial lands located in the fluvia of coastal mountains or plateaus.</td>
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<tr>
<td colspan="2"><u>Inundated forests (várzeas and igapós)</u>
Várzeas and igapós are regional terms applied both to types of soil and vegetation, noting the excess of humidity or swampy conditions, i.e., any ground that is not terra firme. Igapó is located in black and clearwater areas, while Várzea to muddy water inundation. Várzeas are formed by sedimentar ground that during its formation were influenced by fluctuation in sea levels.</td>
<td>Classification of forests by location - alluvial.
While Pires and Prance unified the marshy characteristic in a classification, the manual divides them according to the context of the other formations, with respective information on species, cover, etc. Thus, the term alluvial represents, as a whole, riverside formation or riparian forest that occurs along water courses, occupying the old terraces of quaternary plains. It can occur in dense, open and</td>
</tr>
</table>

	mixed rain forest within the classifications above.

Thus, it can be concluded that the general definition of Dense Ombrophylous rainforest is similar to the definition of *terra firme* forests, while the alluvial forest classification is similar to flooded forests (*várzeas* and *igapós*), as described by Higuchi (2015).

Therefore, the study of volume and biomass dynamics of the Amazonian forest (HIGUCHI, 2015) was adopted to define the carbon stock of the three categories of dense ombrophylous forest (alluvial, submontane and lowland) located in PA, RR and LK. It is important to highlight that the three types of vegetation are characterized as Dense Ombrophylous Forest.

This choice was motivated by the focus of the study, which covered upland forests in the State of Amazonas, with a large number of sample plots and low uncertainty, with a 95% confidence interval.

The data will be updated and may be stratified if new and more updated references for each phytophysiognomy are published. It is also important to note that revenues from carbon credits will be an important factor in encouraging specific studies in the project area, which would produce direct data on the region's carbon dynamics.

For the other phytophysiognomies, identified in the reference region and leakage belt, Open Alluvial Tropical Rainforest, Open Submontane Tropical Rainforest and Pioneer formations with fluvial influence, the study of Nogueira (2015) was utilized, with data from the entire Amazon biome, stratified by phytophysiognomy.

The methodology of both studies is summarized below:

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

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

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

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

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

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

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

Figure 64. Biomass and correction equations used in Higuchi (2015)

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

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

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

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

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

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

<u>**Nogueira, E.M., Yanai, A.M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia.**</u>

The study mapped and classified the vegetation of the Brazilian Amazon, based on a 1: 250,000 scale map. Areas that are currently degraded were identified and the original vegetation was assigned based on information about the previous vegetation. The total original vegetation cover of Brazilian Amazonia was classified, except for 587 km^2 identified as urban areas (0.01% of the area of Legal Amazonia). The final map distinguished 74 classes of vegetation.

The mean dry biomass of each vegetation type was estimated from a biomass dataset from 41 previous studies that conducted direct sampling in either forest (n= 2317 plots) or in non-forest vegetation types or contact zones (n=1830 plots and sub-plots of varied size). In non-forest vegetation types, biomass and carbon estimates were based on over 1270 plots and sub-plots obtained from 38 studies.

An allometric equation developed in central Amazonia (Higuchi et al., 1998) was used to estimate the above-ground biomass of trees and palms with diameter at breast height (DBH) ≥ 5 cm, correcting for effects of lower wood density and shorter trunks in southern Amazonia. Biomasses of trees and palms with DBH < 5 cm were estimated applying the equation developed by Nelson et al. (1999).

Finally, mean biomass values were attributed to each mapped vegetation type and a biomass map was generated with the distribution of dry biomass that existed in the Amazon biome in the “pre-modern” era. Uncertainties are shown by standard deviation values normalized by biomass means.

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

In addition, average values for the below-ground biomass were taken from the applied methodology VM0015 v1.1, which estimates a root-to-shoot ratio of 0.24 for tropical rainforest having above ground biomass values above 125 tons/ha, and 0.2 when below 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 41. Biomass to CO2 conversion factors[139]

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

Table 42. Biomass values used for the "forest" classes within the reference region.

REFERENCE REGION									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Open Alluvial Tropical Rainforest	298.39	149.20	547.05	71.61	35.81	131.29	370.00	185.00	678.34
Open Submontane Tropical Rainforest	280.24	140.12	513.77	67.26	33.63	123.31	347.50	173.75	637.08
Pioneer formations with fluvial influence	19.68	9.84	36.08	3.94	1.97	7.22	23.62	11.81	43.30

Table 43. Biomass values used for the "forest" classes within the Project area.

PROJECT AREA									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

[139] 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

Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

Table 44. Biomass values used for the "forest" classes within the Leakage belt.

LEAKAGE BELT									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Pioneer formations with fluvial influence	19.68	9.84	36.08	3.94	1.97	7.22	23.62	11.81	43.30

Average carbon stocks of post-deforestation classes

Fearnside (1996)[140] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO2e/ha. It is important to note that no sampling was applied to calculate this data.

Table 45. 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)

[140] FEARNSIDE, Philip M. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. Forest Ecology And Management, Manaus, v. 80, p.21-34, 1996

Anthropic areas in equilibrium (post-deforestation class)	12.80	46.93

The use of this value for non-forest vegetation carbon stocks in equilibrium is conservative because Fearnside (1996) considered that around 45% of deforested areas would be secondary forest from pasture, which has a biomass stock of around 50.5 tons/ha.

<u>Uncertainty assessment</u>

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

Nogueira (2013) present uncertainties as one standard deviation of the mean. Thus, confidence interval of this method was around 68.27%. This was converted to a confidence interval of 90% by multiplying the standard deviation by the value of 1.64[141].

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

[141] SOUZA, A. M. Intervalos de Confiança. Departamento de Estatística - PPGEMQ / PPGEP – UFSM. 2008. Available at: <http://w3.ufsm.br/adriano/aulas/ic/tintconf.pdf > . Last visited on: 29/12/2020

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

Boundaries	Initial forest class *icl*																							
	Average carbon stock 90% CI																							
	Name	Dense Alluvial Tropical Rainforest					Name	Dense Submontane Tropical Rainforest					Name	Dense Lowland Tropical Rainforest					Name	Pioneer formations with fluvial influence				
	ID_{icl}	1					ID_{icl}	2					ID_{icl}	3					ID_{icl}	6				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI	C stock	±90% CI
	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha
Project Area	600.23	37.23	144.06	8.94	744.29	46.17	600.23	37.23	144.06	8.94	744.29	46.17	600.23	37.23	144.06	8.94	744.29	46.17	-	-	-	-	-	-
Leakage Belt	600.23	37.23	144.06	8.94	744.29	46.17	600.23	37.23	144.06	8.94	744.29	46.17	600.23	37.23	144.06	8.94	744.29	46.17	36.08	7.15	7.22	1.43	43.30	8.58

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

Boundaries	Initial forest class *icl*																							
	Average carbon stock 90% CI																							
	Name	Dense Alluvial Tropical Rainforest					Name	Dense Submontane Tropical Rainforest					Name	Dense Lowland Tropical Rainforest					Name	Pioneer formations with fluvial influence				
	ID_{icl}	1					ID_{icl}	2					ID_{icl}	3					ID_{icl}	6				
	Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$		Cab_{icl}		Cbb_{icl}		$Ctot_{icl}$	
	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change	C stock	C stock change
	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha	tCO_2e/ha
Project Area	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	-	-	-	-	-	-
	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	-	-	-	-	-	-
Leakage Belt	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	36.08	43.23	7.22	8.65	43.30	51.87
	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	600.23	600.23	144.06	144.06	744.29	744.29	36.08	28.93	7.22	5.79	43.30	34.72

<u>Carbon stock change factors</u>

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

a) Above-ground biomass:

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

b) Below-ground biomass:

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

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

Table 48.Carbon stock change factors for initial forest classes (icl) in the reference region (Method 1)

Dense Alluvial Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$ tCO₂/ha	$\Delta Cbb_{icl,t}$ tCO₂/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0

Dense Submontane Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$ tCO_2/ha	$\Delta Cbb_{icl,t}$ tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0

13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Dense Lowland Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Open Alluvial Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-547.05	-13.13
2	t*+1	0	-13.13
2	t*+2	0	-13.13
4	t*+3	0	-13.13
5	t*+4	0	-13.13
6	t*+5	0	-13.13
7	t*+6	0	-13.13
8	t*+7	0	-13.13
9	t*+8	0	-13.13
10	t*+9	0	-13.13
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Open Submontane Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-513.77	-12.33
2	t*+1	0	-12.33
2	t*+2	0	-12.33
4	t*+3	0	-12.33
5	t*+4	0	-12.33
6	t*+5	0	-12.33
7	t*+6	0	-12.33

Pioneer formations with fluvial influence			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-36.08	-0.72
2	t*+1	0	-0.72
2	t*+2	0	-0.72
4	t*+3	0	-0.72
5	t*+4	0	-0.72
6	t*+5	0	-0.72
7	t*+6	0	-0.72

8	t*+7	0	-12.33
9	t*+8	0	-12.33
10	t*+9	0	-12.33
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

8	t*+7	0	-0.72
9	t*+8	0	-0.72
10	t*+9	0	-0.72
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Table 49. Carbon stock change factors for initial forest classes (icl) in the Project Area (Method 1)

Dense Alluvial Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Dense Submontane Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Dense Lowland Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$	$\Delta Cbb_{icl,t}$
		tCO_2/ha	tCO_2/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

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

Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest

Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0
20	t*+19	0	0
21-T	t*+20...	0	0

Dense Lowland Tropical Rainforest			
Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-600.23	-14.41
2	t*+1	0	-14.41
2	t*+2	0	-14.41
4	t*+3	0	-14.41
5	t*+4	0	-14.41
6	t*+5	0	-14.41
7	t*+6	0	-14.41
8	t*+7	0	-14.41
9	t*+8	0	-14.41
10	t*+9	0	-14.41
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0

Pioneer formations with fluvial influence			
Year after deforestation		$\Delta Cab_{icl,t}$ tCO$_2$/ha	$\Delta Cbb_{icl,t}$ tCO$_2$/ha
1	t*	-43.23	-0.86
2	t*+1	0	-0.86
2	t*+2	0	-0.86
4	t*+3	0	-0.86
5	t*+4	0	-0.86
6	t*+5	0	-0.86
7	t*+6	0	-0.86
8	t*+7	0	-0.86
9	t*+8	0	-0.86
10	t*+9	0	-0.86
11	t*+10	0	0
12	t*+11	0	0
13	t*+12	0	0
14	t*+13	0	0
15	t*+14	0	0
16	t*+15	0	0
17	t*+16	0	0
18	t*+17	0	0
19	t*+18	0	0

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

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

Year after deforestation		$\Delta Ctot_{fcl,t}$ (tCO_2e/ha)
1	t*	0.00
2	t*+1	4.69
3	t*+2	4.69
4	t*+3	4.69
5	t*+4	4.69
6	t*+5	4.69
7	t*+6	4.69
8	t*+7	4.69
9	t*+8	4.69
10	t*+9	4.69
11	t*+10	4.69
12	t*+11	0
13	t*+12	0
14	t*+13	0
15	t*+14	0
16	t*+15	0
17	t*+16	0
18	t*+17	0
19	t*+18	0
20	t*+19	0
21-T	t*+20...	0

Calculation of baseline carbon stock changes

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

Table 52. Baseline carbon stock change in the reference region

Carbon stock change in the above-ground biomass per initial forest class *icl*							Total carbon stock change in the above-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	6	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	176,687	2,067,646	1,362,298	28,723	8,067	3,145	3,646,566	3,646,566
2021	185,632	2,376,133	1,406,978	30,632	3,837	1,283	4,004,496	7,651,062
2022	231,568	2,547,067	1,514,456	31,740	2,237	1,270	4,328,338	11,979,400
2023	308,867	2,667,182	1,623,792	41,793	3,514	1,205	4,646,353	16,625,753
2024	343,449	2,813,383	1,728,194	60,545	4,531	1,542	4,951,645	21,577,399
2025	352,587	2,924,808	1,914,347	65,888	2,312	1,344	5,261,285	26,838,684
2026	401,213	3,024,866	2,059,180	74,795	1,572	1,216	5,562,843	32,401,527
2027	419,556	3,064,783	2,273,395	90,879	2,774	1,350	5,852,739	38,254,266
2028	457,661	3,168,241	2,393,465	108,161	4,347	1,606	6,133,481	44,387,746
2029	465,252	3,229,235	2,579,103	126,354	7,352	1,712	6,409,007	50,796,754
2030	498,913	3,291,166	2,706,202	160,214	9,664	2,274	6,668,432	57,465,186
2031	506,287	3,292,706	2,910,644	203,571	7,537	2,608	6,923,351	64,388,537
2032	517,739	3,296,084	3,136,586	196,107	12,623	3,649	7,162,788	71,551,325
2033	567,855	3,372,842	3,226,964	216,181	9,531	4,362	7,397,734	78,949,059
2034	612,528	3,367,881	3,400,421	220,504	9,618	5,616	7,616,568	86,565,627
2035	603,861	3,395,219	3,579,645	209,301	22,255	7,405	7,817,686	94,383,313
2036	662,810	3,345,581	3,783,753	195,261	29,472	8,276	8,025,154	102,408,467
2037	681,475	3,416,652	3,872,375	169,926	69,150	9,172	8,218,751	110,627,217
2038	677,905	3,497,175	3,928,136	187,693	89,835	10,738	8,391,483	119,018,700
2039	716,816	3,599,111	3,944,408	170,747	111,950	12,457	8,555,488	127,574,188
2040	755,232	3,759,724	3,950,489	142,887	116,868	12,628	8,737,827	136,312,016
2041	726,026	3,952,922	3,904,311	140,428	153,189	13,584	8,890,461	145,202,477
2042	743,090	4,003,833	3,945,358	147,090	181,087	14,468	9,034,926	154,237,403
2043	733,099	4,090,906	3,979,367	137,207	215,059	15,288	9,170,927	163,408,330
2044	726,002	4,181,696	4,037,493	114,110	235,253	15,500	9,310,053	172,718,383
2045	668,186	4,342,585	4,059,938	120,966	227,799	16,053	9,435,527	182,153,910
2046	662,291	4,454,779	4,094,179	127,357	207,418	16,042	9,562,065	191,715,975
2047	636,854	4,541,979	4,149,023	93,471	235,848	16,083	9,673,258	201,389,233
2048	613,026	4,623,053	4,184,620	105,932	228,423	16,411	9,771,464	211,160,698
2049	563,124	4,845,771	4,144,014	103,228	219,702	14,856	9,890,695	221,051,393
2050	532,904	5,017,028	4,104,444	103,026	196,964	15,371	9,969,737	231,021,130

Carbon stock change in the below-ground biomass per initial forest class *icl*							Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	6	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	4,240	49,624	32,695	689	194	63	87,505	87,505
2021	8,696	106,651	66,463	1,425	286	24	183,543	271,048
2022	14,253	167,780	102,810	2,186	339	31	287,400	558,448
2023	21,666	231,793	141,781	3,189	424	38	398,890	957,338
2024	29,909	299,314	183,257	4,642	532	46	517,701	1,475,039
2025	38,371	369,509	229,202	6,224	588	53	643,947	2,118,986
2026	48,000	442,106	278,622	8,019	626	60	777,433	2,896,419
2027	58,069	515,661	333,183	10,200	692	67	917,873	3,814,292
2028	69,053	591,699	390,627	12,796	797	76	1,065,047	4,879,339
2029	80,219	669,200	452,525	15,828	973	85	1,218,831	6,098,170
2030	87,953	698,565	484,779	18,984	1,011	98	1,291,390	7,389,560
2031	95,648	720,562	520,867	23,135	1,100	112	1,361,424	8,750,984
2032	102,517	738,539	559,798	27,079	1,349	132	1,429,414	10,180,398
2033	108,732	755,475	598,274	31,265	1,494	156	1,495,395	11,675,794
2034	115,190	768,783	638,407	35,104	1,616	186	1,559,286	13,235,080
2035	121,221	780,073	678,374	38,546	2,095	227	1,620,535	14,855,615
2036	127,499	787,770	719,764	41,437	2,764	272	1,679,506	16,535,121
2037	133,785	796,215	758,140	43,334	4,357	322	1,736,153	18,271,273
2038	139,071	804,109	794,972	45,243	6,409	381	1,790,184	20,061,457
2039	145,109	812,986	827,739	46,308	8,919	449	1,841,510	21,902,967
2040	151,260	824,231	857,602	45,892	11,492	517	1,890,995	23,793,962
2041	156,534	840,077	881,450	44,377	14,988	591	1,938,017	25,731,979
2042	161,942	857,063	900,861	43,200	19,031	670	1,982,767	27,714,747
2043	165,908	874,296	918,918	41,305	23,964	754	2,025,145	29,739,892
2044	168,632	893,828	934,208	38,752	29,379	838	2,065,636	31,805,528
2045	170,175	916,564	945,735	36,632	34,312	926	2,104,344	33,909,872
2046	170,163	943,185	953,185	35,002	38,583	1,013	2,141,131	36,051,003
2047	169,092	970,193	959,825	33,167	42,583	1,101	2,175,961	38,226,965
2048	167,535	997,214	965,980	31,205	45,909	1,191	2,209,034	40,435,999
2049	163,846	1,027,134	970,771	29,584	48,495	1,272	2,241,103	42,677,102
2050	158,510	1,057,309	974,466	28,628	50,418	1,356	2,270,686	44,947,788

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region		Total net carbon stock change in the reference region	
ID_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$	$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
Name	Non-forest	annual	cumulative	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0	3,734,071	3,734,071
2021	28,930	28,930	28,930	4,159,109	7,893,180
2022	60,427	60,427	89,357	4,555,311	12,448,491
2023	94,454	94,454	183,811	4,950,789	17,399,281
2024	130,968	130,968	314,779	5,338,378	22,737,659
2025	169,926	169,926	484,706	5,735,306	28,472,965
2026	211,283	211,283	695,988	6,128,992	34,601,957
2027	254,987	254,987	950,976	6,515,625	41,117,582
2028	300,989	300,989	1,251,964	6,897,539	48,015,121
2029	349,232	349,232	1,601,196	7,278,607	55,293,728
2030	399,660	399,660	2,000,856	7,560,162	62,853,889
2031	423,284	423,284	2,424,141	7,861,492	70,715,381
2032	446,405	446,405	2,870,546	8,145,796	78,861,177
2033	468,998	468,998	3,339,544	8,424,131	87,285,309
2034	491,038	491,038	3,830,582	8,684,816	95,970,125
2035	512,502	512,502	4,343,083	8,925,719	104,895,845
2036	533,367	533,367	4,876,450	9,171,293	114,067,137
2037	553,612	553,612	5,430,062	9,401,291	123,468,428
2038	573,216	573,216	6,003,278	9,608,451	133,076,879
2039	592,161	592,161	6,595,439	9,804,837	142,881,716
2040	610,430	610,430	7,205,869	10,018,393	152,900,109
2041	628,004	628,004	7,833,873	10,200,474	163,100,583
2042	644,871	644,871	8,478,744	10,372,822	173,473,405
2043	661,017	661,017	9,139,762	10,535,055	184,008,460
2044	676,428	676,428	9,816,190	10,699,261	194,707,721
2045	691,095	691,095	10,507,284	10,848,777	205,556,498
2046	705,005	705,005	11,212,290	10,998,191	216,554,688
2047	718,155	718,155	11,930,445	11,131,065	227,685,753
2048	730,534	730,534	12,660,979	11,249,965	238,935,718
2049	742,138	742,138	13,403,117	11,389,659	250,325,377
2050	752,962	752,962	14,156,079	11,487,461	261,812,838

Table 53. Baseline carbon stock change in the Project Area

Carbon stock change in the above-ground biomass per initial forest class *icl*				Total carbon stock change in the above-ground biomass of initial forest class in the project area	
ID_{cl}	1	2	3	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	2,356	23,122	2,112	27,591	27,591
2021	140	29,518	1,913	31,571	59,162
2022	333	47,604	0	47,937	107,099
2023	864	54,448	0	55,312	162,411
2024	12	78,399	0	78,411	240,823
2025	306	73,610	2,485	76,401	317,224
2026	994	102,826	1,891	105,711	422,935
2027	0	137,281	1,513	138,793	561,728
2028	303	148,276	2,603	151,181	712,910
2029	835	166,325	2,755	169,915	882,824
2030	334	192,966	2,647	195,947	1,078,771
2031	972	192,063	1,891	194,926	1,273,697
2032	1,849	242,149	1,655	245,653	1,519,350
2033	1,134	255,593	3,619	260,346	1,779,696
2034	1,950	287,593	6,751	296,294	2,075,989
2035	2,642	340,861	5,632	349,135	2,425,124
2036	5,477	367,679	12,372	385,527	2,810,651
2037	6,362	429,344	16,219	451,925	3,262,576
2038	2,855	525,879	15,318	544,053	3,806,629
2039	7,412	608,677	31,331	647,420	4,454,049
2040	8,251	691,417	44,082	743,751	5,197,800
2041	8,681	756,935	48,222	813,837	6,011,637
2042	9,864	830,029	47,886	887,778	6,899,415
2043	13,319	867,912	57,504	938,735	7,838,150
2044	17,363	884,290	60,343	961,996	8,800,146
2045	19,229	976,238	72,115	1,067,582	9,867,728
2046	21,231	998,197	79,799	1,099,226	10,966,955
2047	25,532	981,816	93,777	1,101,125	12,068,080
2048	26,425	969,366	116,470	1,112,261	13,180,341
2049	23,869	896,952	123,889	1,044,710	14,225,051
2050	24,571	968,435	129,253	1,122,259	15,347,309

Carbon stock change in the below-ground biomass per initial forest class *icl*				Total carbon stock change in the below-ground biomass of initial forest class in the project area	
ID_{cl}	1	2	3	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	57	555	51	662	662
2021	60	1,263	97	1,420	2,082
2022	68	2,406	97	2,570	4,652
2023	89	3,713	97	3,898	8,550
2024	89	5,594	97	5,780	14,330
2025	96	7,361	156	7,613	21,943
2026	120	9,829	202	10,150	32,094
2027	120	13,123	238	13,481	45,575
2028	127	16,682	300	17,110	62,685
2029	147	20,674	366	21,188	83,873
2030	99	24,750	379	25,228	109,101
2031	119	28,651	379	29,149	138,250
2032	155	33,320	419	33,894	172,144
2033	162	38,148	505	38,815	210,959
2034	208	43,168	667	44,044	255,003
2035	264	49,582	743	50,590	305,593
2036	372	55,939	994	57,305	362,898
2037	525	62,948	1,347	64,820	427,718
2038	586	72,011	1,653	74,249	501,967
2039	744	82,627	2,338	85,709	587,677
2040	934	94,590	3,333	98,857	686,533
2041	1,119	108,147	4,445	113,711	800,244
2042	1,311	122,256	5,554	129,122	929,366
2043	1,604	136,952	6,848	145,403	1,074,769
2044	1,973	151,273	8,134	161,380	1,236,148
2045	2,372	166,522	9,729	178,623	1,414,771
2046	2,750	181,654	11,348	195,751	1,610,522
2047	3,210	194,913	13,209	211,332	1,821,854
2048	3,775	205,557	15,637	224,969	2,046,823
2049	4,170	212,476	17,858	234,504	2,281,327
2050	4,562	219,124	19,902	243,588	2,524,916

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area	
ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_z$
Name	Non-forest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0
2021	216	216	216
2022	463	463	678
2023	837	837	1,516
2024	1,270	1,270	2,786
2025	1,883	1,883	4,669
2026	2,480	2,480	7,149
2027	3,307	3,307	10,456
2028	4,392	4,392	14,848
2029	5,574	5,574	20,423
2030	6,903	6,903	27,326
2031	8,219	8,219	35,545
2032	9,497	9,497	45,042
2033	11,043	11,043	56,084
2034	12,646	12,646	68,730
2035	14,349	14,349	83,080
2036	16,482	16,482	99,562
2037	18,670	18,670	118,232
2038	21,118	21,118	139,350
2039	24,190	24,190	163,541
2040	27,924	27,924	191,465
2041	32,207	32,207	223,672
2042	37,047	37,047	260,719
2043	42,068	42,068	302,787
2044	47,372	47,372	350,159
2045	52,577	52,577	402,736
2046	58,195	58,195	460,931
2047	63,776	63,776	524,707
2048	68,852	68,852	593,559
2049	73,295	73,295	666,853
2050	76,401	76,401	743,255

Total net carbon stock change in the project area	
$\Delta CBSLPA_t$	$\Delta CBSLPA$
annual	cumulative
tCO_2e	tCO_2e
28,253	28,253
32,775	61,028
50,045	111,073
58,373	169,446
82,921	252,367
82,132	334,499
113,381	447,880
148,968	596,848
163,899	760,746
185,528	946,274
214,272	1,160,547
215,855	1,376,402
270,051	1,646,452
288,118	1,934,570
327,692	2,262,262
385,375	2,647,637
426,350	3,073,987
498,076	3,572,063
597,184	4,169,246
708,939	4,878,185
814,684	5,692,869
895,340	6,588,209
979,853	7,568,062
1,042,070	8,610,132
1,076,003	9,686,136
1,193,627	10,879,763
1,236,783	12,116,546
1,248,682	13,365,227
1,268,378	14,633,605
1,205,919	15,839,525
1,289,446	17,128,970

Table 54. Baseline carbon stock change in the leakage belt

Carbon stock change in the above-ground biomass per initial forest class *icl*					Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	2	3	4	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	43,719	122,916	15,482	149	182,265	182,265
2021	68,737	155,134	12,014	163	236,049	418,314
2022	86,886	181,033	11,564	226	279,709	698,023
2023	113,250	179,636	18,470	54	311,410	1,009,433
2024	131,994	194,319	32,187	78	358,577	1,368,010
2025	108,085	202,026	46,080	218	356,409	1,724,419
2026	108,831	226,550	55,541	31	390,953	2,115,372
2027	112,278	262,370	82,483	210	457,340	2,572,713
2028	114,099	261,228	84,938	66	460,332	3,033,045
2029	109,840	253,660	121,682	249	485,432	3,518,476
2030	102,113	267,145	138,783	335	508,376	4,026,852
2031	90,583	268,473	191,320	342	550,717	4,577,569
2032	82,648	259,022	251,337	782	593,790	5,171,359
2033	72,225	245,246	274,920	716	593,107	5,764,466
2034	79,710	249,279	294,803	740	624,531	6,388,997
2035	72,794	254,630	314,337	1,404	643,165	7,032,161
2036	59,614	234,301	339,615	1,170	634,700	7,666,862
2037	68,895	217,665	350,090	1,245	637,895	8,304,757
2038	71,710	227,140	363,756	1,718	664,325	8,969,082
2039	77,921	228,747	359,171	1,835	667,674	9,636,756
2040	72,961	216,324	347,804	1,644	638,733	10,275,490
2041	88,636	208,098	329,340	1,789	627,863	10,903,353
2042	74,891	185,634	296,207	2,155	558,888	11,462,241
2043	70,025	204,447	274,797	1,978	551,246	12,013,487
2044	77,954	194,470	262,312	3,169	537,904	12,551,391
2045	59,409	186,525	249,171	2,407	497,512	13,048,903
2046	66,944	173,086	235,310	2,467	477,807	13,526,710
2047	62,590	153,796	236,499	2,985	455,870	13,982,580
2048	59,234	162,704	233,760	3,056	458,755	14,441,335
2049	56,493	140,987	229,692	2,527	429,699	14,871,034
2050	57,059	145,914	193,851	2,939	399,764	15,270,798

Carbon stock change in the below-ground biomass per initial forest class *icl*					Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	2	3	4	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	1,049	2,950	372	3	4,374	4,374
2021	2,699	6,673	660	6	10,038	14,412
2022	4,784	11,018	937	11	16,750	31,162
2023	7,502	15,329	1,381	12	24,224	55,386
2024	10,670	19,993	2,153	13	32,830	88,216
2025	13,264	24,842	3,259	18	41,383	129,599
2026	15,876	30,279	4,592	18	50,765	180,364
2027	18,571	36,576	6,572	23	61,741	242,104
2028	21,309	42,845	8,610	24	72,788	314,893
2029	23,945	48,933	11,531	29	84,438	399,330
2030	25,347	52,394	14,490	33	92,264	491,594
2031	25,871	55,115	18,793	36	99,815	591,409
2032	25,769	56,986	24,548	47	107,351	698,759
2033	24,785	58,561	30,703	61	114,109	812,868
2034	23,530	59,880	37,005	74	120,489	933,357
2035	22,683	61,142	43,443	98	127,366	1,060,723
2036	21,502	61,328	50,261	120	133,212	1,193,935
2037	20,460	60,256	56,684	141	137,541	1,331,476
2038	19,443	59,437	63,375	174	142,430	1,473,906
2039	18,677	58,840	69,075	206	146,798	1,620,704
2040	17,977	57,620	74,092	232	149,921	1,770,624
2041	17,931	56,171	77,404	261	151,767	1,922,391
2042	17,745	54,409	78,481	288	150,923	2,073,315
2043	17,692	53,430	78,478	314	149,914	2,223,228
2044	17,650	52,115	77,698	362	147,825	2,371,053
2045	17,328	50,480	76,134	382	144,325	2,515,379
2046	17,504	49,011	73,631	408	140,555	2,655,933
2047	17,353	47,478	70,905	443	136,179	2,792,113
2048	17,054	45,932	67,785	470	131,240	2,923,353
2049	16,539	43,826	64,677	484	125,526	3,048,879
2050	16,158	42,136	60,983	509	119,786	3,168,664

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt	
ID_{iz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulative
Year	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0
2021	1,440	1,440	1,440
2022	3,302	3,302	4,742
2017	5,512	5,512	10,255
2018	7,953	7,953	18,207
2019	10,764	10,764	28,972
2020	13,573	13,573	42,545
2021	16,633	16,633	59,178
2022	20,230	20,230	79,408
2023	23,836	23,836	103,244
2024	27,657	27,657	130,901
2025	30,226	30,226	161,127
2026	32,704	32,704	193,831
2027	35,216	35,216	229,048
2028	37,485	37,485	266,533
2029	39,632	39,632	306,165
2030	41,993	41,993	348,158
2031	44,014	44,014	392,172
2032	45,530	45,530	437,702
2033	47,292	47,292	484,994
2034	48,876	48,876	533,870
2035	50,028	50,028	583,898
2036	50,777	50,777	634,675
2037	50,642	50,642	685,317
2038	50,442	50,442	735,759
2039	50,009	50,009	785,768
2040	48,972	48,972	834,740
2041	47,875	47,875	882,615
2042	46,627	46,627	929,243
2043	45,155	45,155	974,397
2044	43,364	43,364	1,017,761

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulative
tCO_2e	tCO_2e
186,639	186,639
244,647	431,286
293,157	724,443
330,122	1,054,565
383,454	1,438,019
387,028	1,825,046
428,145	2,253,192
502,448	2,755,640
512,890	3,268,529
546,033	3,814,562
572,982	4,387,545
620,306	5,007,851
668,436	5,676,287
671,999	6,348,286
707,534	7,055,821
730,899	7,786,720
725,919	8,512,639
731,422	9,244,061
761,225	10,005,286
767,180	10,772,466
739,778	11,512,244
729,602	12,241,846
659,035	12,900,880
650,518	13,551,398
635,287	14,186,685
591,828	14,778,513
569,390	15,347,903
544,174	15,892,077
543,368	16,435,445
510,070	16,945,515
476,186	17,421,701

Baseline non-CO2 emissions from forest fires

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

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

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

Where,

$EBBtot_{icl,t}$	Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBN_2O_{icl,t}$	N_2O emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBCH_{4icl,t}$	CH_4 emission from biomass burning in forest class icl at year t; tCO_2e/ha

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

Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
NCR	Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
ER_{N2O}	Emission ratio for N_2O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N_2O (IPCC default value)[142]

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

Where,

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

[142] According to the VCS Standard 4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for N_2O = 298).

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

GWP_{CH4} Global Warming Potential for CH_4 (IPCC default value) [143]

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

Where,

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

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

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

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

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

p Carbon pool that could burn, above-ground biomass

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

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

Where,

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

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

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

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

[143] According to the VCS Standard v4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for CH_4 = 25).

Table 55. Parameters used to calculate non-CO2 emissions from forest fires

Initial Forest Class		Parameters								
		$Fburnt_{icl}$	Cab	$Pburnt_{ab,icl}$	$CE_{ab,icl}$	ECO2-ab	EBBCO2-tot	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
IDcl	Name	%	tCO2e/ha	%	%	tCO2e/ha	tCO2e/ha	tCO2 e/ha	tCO2e/h a	tCO2e/h a
1	Dense Alluvial Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42
2	Dense Submonta ne Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42
3	Dense Lowland Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42

The projected total non-CO_2 emissions from biomass burning are displayed in table below:

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

	Project year t	Emissions of non-CO_2 gasses from baseline forest fires						Total baseline non-CO_2 emissions from forest fires in the project area	
		ID_{cl} = 1 Riparian (Aluvial) Dense Tropical Rainforest		ID_{cl} = 2 Riparian (Aluvial) Dense Tropical Rainforest		ID_{cl} = 3 Riparian (Aluvial) Dense Tropical Rainforest		annual	cumulative
		$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	$EBBBSLPA$
		ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e
First baseline period	2020	3.93	35.42	38.52	35.42	3.52	35.42	1,628.28	1,628.28
	2021	0.23	35.42	49.18	35.42	3.19	35.42	1,863.18	3,491.45
	2022	0.56	35.42	79.31	35.42	0.00	35.42	2,829.05	6,320.50
	2023	1.44	35.42	90.71	35.42	0.00	35.42	3,264.28	9,584.79
	2024	0.02	35.42	130.61	35.42	0.00	35.42	4,627.47	14,212.26
	2025	0.51	35.42	122.64	35.42	4.14	35.42	4,508.87	18,721.13
	2026	1.66	35.42	171.31	35.42	3.15	35.42	6,238.57	24,959.70
	2027	0.00	35.42	228.71	35.42	2.52	35.42	8,190.96	33,150.65
	2028	0.50	35.42	247.03	35.42	4.34	35.42	8,922.03	42,072.68
	2029	1.39	35.42	277.10	35.42	4.59	35.42	10,027.58	52,100.26
Second baseline period	2030	0.56	35.42	321.49	35.42	4.41	35.42	11,563.89	63,664.16
	2031	1.62	35.42	319.98	35.42	3.15	35.42	11,503.62	75,167.78
	2032	3.08	35.42	403.43	35.42	2.76	35.42	14,497.35	89,665.13
	2033	1.89	35.42	425.82	35.42	6.03	35.42	15,364.41	105,029.54
	2034	3.25	35.42	479.14	35.42	11.25	35.42	17,485.90	122,515.44
	2035	4.40	35.42	567.88	35.42	9.38	35.42	20,604.34	143,119.79
	2036	9.12	35.42	612.56	35.42	20.61	35.42	22,752.07	165,871.85
	2037	10.60	35.42	715.30	35.42	27.02	35.42	26,670.58	192,542.43
	2038	4.76	35.42	876.13	35.42	25.52	35.42	32,107.52	224,649.95
	2039	12.35	35.42	1,014.07	35.42	52.20	35.42	38,207.80	262,857.74
Third baseline period	2040	13.75	35.42	1,151.91	35.42	73.44	35.42	43,892.80	306,750.54
	2041	14.46	35.42	1,261.07	35.42	80.34	35.42	48,028.96	354,779.50
	2042	16.43	35.42	1,382.84	35.42	79.78	35.42	52,392.63	407,172.13
	2043	22.19	35.42	1,445.96	35.42	95.80	35.42	55,399.88	462,572.00
	2044	28.93	35.42	1,473.24	35.42	100.53	35.42	56,772.62	519,344.63
	2045	32.04	35.42	1,626.43	35.42	120.14	35.42	63,003.85	582,348.47
	2046	35.37	35.42	1,663.01	35.42	132.95	35.42	64,871.35	647,219.83
	2047	42.54	35.42	1,635.72	35.42	156.23	35.42	64,983.41	712,203.24
	2048	44.02	35.42	1,614.98	35.42	194.04	35.42	65,640.57	777,843.81
	2049	39.77	35.42	1,494.34	35.42	206.40	35.42	61,654.04	839,497.84
	2050	40.94	35.42	1,613.43	35.42	215.34	35.42	66,230.60	905,728.44

4.2 Project Emissions

The present instance does not include planned deforestation and planned logging activities within the project area. However, as detailed in section 1.4, other instances may have a SFMP as a project activity. In this case, equation below presents an ex ante estimated carbon stock decrease due to planned deforestation in the project area:

$$\Delta CPDdPA_t = \sum_{icl=1}^{icl} (APDPA_{icl,t} \times \Delta Ctot_{icl})$$

Where,

$\Delta CPDdPA_t$	Total decrease in carbon stock due to planned deforestation at year t in the project area; tCO2e
$APDPA_{icl,t}$	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; tCO2e/ha

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). Thus, GHG emissions from logging activities include the volume of harvested timber plus the logging damage factor, as follows.

$$\Delta CLd_{icl} = (HI_{icl,t} + LDF) \times D_m \times CF \text{ x } 44 / 12$$

Where,

$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class icl at time t; tCO2e/ha
$HI_{icl,t}$	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); 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 CO2 to carbon; dimensionless

Carbon stocks in wood products are those stocks that become wood products pool at the time of deforestation. They are divided in three fractions, as follows:

- Short-term wood products: wood products and waste that would decay within 3 years; all carbon shall be assumed to be lost immediately;
- Medium-term wood products: wood products that are retired between 3 and 100 years; for this group of wood products, a 20-year linear decay function shall be applied;
- Long-term wood products: wood products that are considered permanent (i.e. carbon is stored for 100 years or more); it may be assumed that no carbon is released.

Accounting for carbon stocks in wood products is carried out utilizing the Method 1 described in the applied Methodology: Direct Volume Extraction Estimation. This Method is applied because timber harvest plans specifying the harvest intensity per forest class in terms of volume extracted per hectare are available for the Project area. Furthermore, the proportion of carbon stock stored in each fraction of wood products was obtained from specific studies. The Method 1 contains the following steps:

Step 1: Calculate the biomass carbon of the commercial volume extracted since the project start date and in the process of logging activities as follows:

$$CXB_{w,icl,t} = \frac{1}{ABSLPA_{icl,t}} * \left(\sum_{t=1}^{t^*} \sum_{j=1}^{J} \left(VEX_{w,j,icl,t} * D_j * CF_j * \frac{44}{12}\right)\right)$$

Where,

$CXB_{w,icl,t}$	Mean carbon stock per hectare of extracted biomass carbon by class of wood product w from forest class icl at time t; tCO2e/ha
icl	1, 2, 3, …*icl* initial pre-deforestation forest classes; dimensionless
w	1, 2, 3 … *w* wood product class (sawn-wood, wood-based panels, other industrial roundwood, paper and paper board, and other); dimensionless
t	1, 2, 3… *t* years, a year of the project crediting period; dimensionless
t*	the year at which the area ABSLPAicl,t is deforested in the baseline case; dimensionless
j	1, 2, 3 … *j* tree species; dimensionless
$ABSLPA_{icl,t}$	Area of forest class *icl* deforested at year t*; ha
$VEX_{,w,j,fcl,t}$	Volume of timber for product class w, of species j, extracted from within forest class fcl at time t; m^3
D_j	Mean wood density of species j; t d.m.m-3
CF_j	Carbon fraction of biomass for tree species j; tC t-1 d.m.
44/12	Ratio of molecular weight of CO2 to carbon; dimensionless

A volumetric efficiency coefficient of 35%[144] was utilized to calculate the parameter $VEX_{,w,j,fcl,t}$, in order to convert the volume of timber harvested into volume of final wood products.

Step 2: Calculate the carbon stock in the wood products carbon pool extracted from the biomass at time t.

$$Cwp_{icl,t} = \sum_{w=1}^{W} CXB_{w,icl,t} * (1 - STF_w)$$

Where,

$Cwp_{icl,t}$ Carbon stock in the wood products carbon pool in initial forest class *icl* at time *t*; tCO2e/ha

STF_w Fraction of wood products and waste that will be emitted to the atmosphere within 3 years; all carbon shall be assumed to be lost immediately; dimensionless

Step 3: Calculate the biomass carbon extracted at time t that becomes the medium-term wood products at the time of harvesting.

$$Cwp_{mt,icl,t} = Cwp_{icl,t} - (Cwp_{icl,t} * (1 - STF_w) * (1 - LTF_w))$$

Where,

$Cwp_{mt,icl,t}$ Carbon stock in the medium-term wood products carbon pool at the time of deforestation t of the initial forest class *icl*; tCO2e/ha

LTF_w Fraction of wood products that are considered permanent (i.e. carbon is stored for 100 years or more); it may be assumed no carbon is released

Step 4: Calculate the biomass carbon extracted at time t that becomes the long-term wood products at the time of harvesting.

$$Cwp_{lt,icl,t} = Cwp_{icl,t} - (Cwp_{icl,t} * (1 - STF_w) * (1 - MTF_w))$$

Where,

[144] CONSELHO NACIONAL DO MEIO AMBIENTE (CONAMA). Resolução nº 474, de 6 de abril de 2016. **Altera a resolução no 411, de 6 de maio de 2009, que dispõe sobre procedimentos para inspeção de indústrias consumidoras ou transformadoras de produtos e subprodutos florestais madeireiros de origem nativa, bem como os respectivos padrões de nomenclatura e coeficientes de rendimento volumétricos, inclusive carvão vegetal e resíduos de serraria, e dá outras providências.**. Brasília, DF, 2016.

$Cwp_{lt,icl,t}$	Carbon stock in the long-term wood products carbon pool at the time of deforestation t of the initial forest class *icl*; tCO2e/ha
MTF_w	Fraction of wood products that are retired between 3 and 100 years; for this group of wood products, a 20-year linear decay function shall be applied

The average carbon stock per hectare in the harvested wood products carbon pool of initial forest class icl at time t (ΔCwpt) is calculated as follows:

$$\Delta Cwp_t = \sum_{icl=1}^{icl} (Cwp_{mt,icl,t} + Cwp_{lt,icl,t})$$

Therefore, the ex ante estimated carbon stock decrease due to planned logging activities in the project area was calculated using the following equation:

$$\Delta CPLdPA_{\boldsymbol{t}} = \sum_{icl=1}^{icl} (APLPA_{\boldsymbol{icl,t}} \times \Delta CLd_{\boldsymbol{icl},t}) - (\sum_{icl=1}^{icl} APLPA_{\boldsymbol{icl,t}}) \times \Delta Cwp_t$$

Where,

$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities at year t in the project area; tCO2e
$APLPA_{icl,t}$	Areas of planned logging activities in forest class icl at year t in the project area; ha
$\Delta CLd_{icl,t}$	Average carbon stock decrease due to logging activities in forest class icl at time t; tCO2e/ha
ΔCwp_t	Average carbon stock per hectare in the harvested wood products carbon pool at time t; tCO2e/ha

Forests that will be subject to planned logging activities under the project scenario have the potential to grow and accumulate significant carbon stocks after the periodical harvest cycle due to natural regeneration. The mean annual increment of managed forests in Brazil is estimated to be 0.86 m^3/ha/year[145].

Due to the periodical harvesting, the projected increase in carbon stocks of each forest class in the project case is estimated by assuming that the maximum carbon stock is the long term average carbon stock (the average of a production cycle). Therefore, once a class reaches this level of carbon stock, no more carbon stock increase can be attributed to it.

[145] BRASIL. Conselho Nacional do Meio Ambiente (CONAMA). Estabelece parâmetros técnicos a serem adotados na elaboração, apresentação, avaliação técnica e execução de Plano de Manejo Florestal Sustentável - PMFS com fins madeireiros, para florestas nativas e suas formas de sucessão no bioma Amazônia. Resolução nº. 406, de 02 de fevereiro de 2009. **Diário Oficial [da] República Federativa do Brasil**, Brasília, DF, 06 feb. 2009.

Ex ante estimate of carbon stock increase fol $\sum_{icl=1}^{icl}$ ng planned logging activities in the project area is calculated as follows:

$$\Delta CPLiPA_{t} = \quad (APLPA_{icl,t} \times \Delta CLi_{icl,t})$$

Where,

$\Delta CPLiPA_t$	Total increase in carbon stock due to planned logging activities at year t in the project area; tCO2e
$APLPA_{icl,t}$	Areas of planned logging activities in forest class *icl* at year *t* in the project area; ha
$\Delta CLi_{icl,t}$	Average carbon stock increase due to sustainable logging activities in forest class *icl* at time *t*; tCO_2e/ha

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 will not be 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.

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

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

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

Where,

$\Delta CUDdPA_t$	Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e

$\Delta CBSLPA_t$ Total baseline carbon stock change in the project area at year t; tCO_2e

EI *Ex ante* estimated Effectiveness Index; %

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

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

Where,

$\Delta CPSPA_t$ Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO_2e

$\Delta CPAdPA_t$ Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_2e

$\Delta CUDdPA_t$ Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e

$\Delta CPAiPA_t$ Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

Due to the importance of project activities, which is expected to generate improvements in the local economy and employment generation, the Effectiveness Index (EI) was conservatively assumed as 95,89%.

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

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	1,161.23	1,161.23	1,161.23	1,161.23
2021	0.00	0.00	0.00	0.00	1,347.10	2,508.33	1,347.10	2,508.33
2022	0.00	0.00	0.00	0.00	2,056.93	4,565.26	2,056.93	4,565.26
2023	0.00	0.00	0.00	0.00	2,399.20	6,964.47	2,399.20	6,964.47
2024	0.00	0.00	0.00	0.00	3,408.17	10,372.63	3,408.17	10,372.63
2025	0.00	0.00	0.00	0.00	3,375.73	13,748.37	3,375.73	13,748.37
2026	0.00	0.00	0.00	0.00	4,660.11	18,408.47	4,660.11	18,408.47
2027	0.00	0.00	0.00	0.00	6,122.79	24,531.26	6,122.79	24,531.26
2028	0.00	0.00	0.00	0.00	6,736.47	31,267.72	6,736.47	31,267.72
2029	0.00	0.00	0.00	0.00	7,625.45	38,893.18	7,625.45	38,893.18
2030	0.00	0.00	0.00	0.00	8,806.89	47,700.06	8,806.89	47,700.06
2031	0.00	0.00	0.00	0.00	8,871.94	56,572.01	8,871.94	56,572.01
2032	0.00	0.00	0.00	0.00	11,099.46	67,671.46	11,099.46	67,671.46
2033	0.00	0.00	0.00	0.00	11,842.04	79,513.50	11,842.04	79,513.50
2034	0.00	0.00	0.00	0.00	13,468.59	92,982.08	13,468.59	92,982.08
2035	0.00	0.00	0.00	0.00	15,839.44	108,821.52	15,839.44	108,821.52
2036	0.00	0.00	0.00	0.00	17,523.59	126,345.11	17,523.59	126,345.11
2037	0.00	0.00	0.00	0.00	20,471.60	146,816.71	20,471.60	146,816.71
2038	0.00	0.00	0.00	0.00	24,545.07	171,361.78	24,545.07	171,361.78
2039	0.00	0.00	0.00	0.00	29,138.38	200,500.16	29,138.38	200,500.16
2040	0.00	0.00	0.00	0.00	33,484.62	233,984.77	33,484.62	233,984.77
2041	0.00	0.00	0.00	0.00	36,799.72	270,784.49	36,799.72	270,784.49
2042	0.00	0.00	0.00	0.00	40,273.30	311,057.79	40,273.30	311,057.79
2043	0.00	0.00	0.00	0.00	42,830.53	353,888.32	42,830.53	353,888.32
2044	0.00	0.00	0.00	0.00	44,225.23	398,113.55	44,225.23	398,113.55
2045	0.00	0.00	0.00	0.00	49,059.73	447,173.28	49,059.73	447,173.28
2046	0.00	0.00	0.00	0.00	50,833.48	498,006.75	50,833.48	498,006.75
2047	0.00	0.00	0.00	0.00	51,322.55	549,329.30	51,322.55	549,329.30
2048	0.00	0.00	0.00	0.00	52,132.08	601,461.38	52,132.08	601,461.38
2049	0.00	0.00	0.00	0.00	49,564.95	651,026.33	49,564.95	651,026.33
2050	0.00	0.00	0.00	0.00	52,997.99	704,024.32	52,997.99	704,024.32

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

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

Where,

$EBBPSPA_t$ Total *ex ante* actual non-CO_2 emissions from forest fire due to unavoided unplanned deforestationat at year t in the project area; tCO_2e/ha

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

EI *Ex ante* estimated Effectiveness Index; %

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

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

Table 58. Total ex ante estimated actual emissions of non-CO2 gases due to forest fires in the project area

Project year *t*	Total ex ante estimated actual non-CO_2 emissions from forest fires in the Project area	
	$EBBPSPA_t$	EBBPSPA
	annual	cumulative
	tCO_2e	tCO_2e
2020	66.92	66.92
2021	76.58	143.50
2022	116.28	259.78
2023	134.17	393.95
2024	190.20	584.14
2025	185.32	769.46
2026	256.41	1,025.88
2027	336.66	1,362.54
2028	366.71	1,729.25
2029	412.15	2,141.39
2030	475.29	2,616.68
2031	472.81	3,089.50
2032	595.86	3,685.36
2033	631.50	4,316.86
2034	718.69	5,035.55

2035	846.87	5,882.42
2036	935.14	6,817.56
2037	1,096.20	7,913.76
2038	1,319.66	9,233.42
2039	1,570.39	10,803.82
2040	1,804.05	12,607.87
2041	1,974.06	14,581.93
2042	2,153.41	16,735.34
2043	2,277.01	19,012.35
2044	2,333.43	21,345.78
2045	2,589.55	23,935.33
2046	2,666.30	26,601.63
2047	2,670.91	29,272.54
2048	2,697.92	31,970.45
2049	2,534.07	34,504.52
2050	2,722.17	37,226.69

Total *ex ante* estimations for the project area

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

Table 59. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area

Project year *t*	Total *ex ante* carbon stock decrease due to planned activities		Total *ex ante* carbon stock increase due to planned activities		Total *ex ante* carbon stock decrease due to unavoided unplanned deforestation		Total *ex ante* carbon stock change		Total *ex ante* estimated actual non-CO_2 emissions from forest fires in the project area	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	$\Delta CPAdPA$	$\Delta CPAiPA_t$	$\Delta CPAiPA$	$\Delta CUDdPA_t$	$\Delta CUDdPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	1,161.23	1,161.23	1,161.23	1,161.23	66.92	66.92
2021	0.00	0.00	0.00	0.00	1,347.10	2,508.33	1,347.10	2,508.33	76.58	143.50
2022	0.00	0.00	0.00	0.00	2,056.93	4,565.26	2,056.93	4,565.26	116.28	259.78
2023	0.00	0.00	0.00	0.00	2,399.20	6,964.47	2,399.20	6,964.47	134.17	393.95
2024	0.00	0.00	0.00	0.00	3,408.17	10,372.63	3,408.17	10,372.63	190.20	584.14
2025	0.00	0.00	0.00	0.00	3,375.73	13,748.37	3,375.73	13,748.37	185.32	769.46
2026	0.00	0.00	0.00	0.00	4,660.11	18,408.47	4,660.11	18,408.47	256.41	1,025.88
2027	0.00	0.00	0.00	0.00	6,122.79	24,531.26	6,122.79	24,531.26	336.66	1,362.54
2028	0.00	0.00	0.00	0.00	6,736.47	31,267.72	6,736.47	31,267.72	366.71	1,729.25
2029	0.00	0.00	0.00	0.00	7,625.45	38,893.18	7,625.45	38,893.18	412.15	2,141.39
2030	0.00	0.00	0.00	0.00	8,806.89	47,700.06	8,806.89	47,700.06	475.29	2,616.68
2031	0.00	0.00	0.00	0.00	8,871.94	56,572.01	8,871.94	56,572.01	472.81	3,089.50
2032	0.00	0.00	0.00	0.00	11,099.46	67,671.46	11,099.46	67,671.46	595.86	3,685.36
2033	0.00	0.00	0.00	0.00	11,842.04	79,513.50	11,842.04	79,513.50	631.50	4,316.86
2034	0.00	0.00	0.00	0.00	13,468.59	92,982.08	13,468.59	92,982.08	718.69	5,035.55
2035	0.00	0.00	0.00	0.00	15,839.44	108,821.52	15,839.44	108,821.52	846.87	5,882.42
2036	0.00	0.00	0.00	0.00	17,523.59	126,345.11	17,523.59	126,345.11	935.14	6,817.56
2037	0.00	0.00	0.00	0.00	20,471.60	146,816.71	20,471.60	146,816.71	1,096.20	7,913.76
2038	0.00	0.00	0.00	0.00	24,545.07	171,361.78	24,545.07	171,361.78	1,319.66	9,233.42
2039	0.00	0.00	0.00	0.00	29,138.38	200,500.16	29,138.38	200,500.16	1,570.39	10,803.82
2040	0.00	0.00	0.00	0.00	33,484.62	233,984.77	33,484.62	233,984.77	1,804.05	12,607.87
2041	0.00	0.00	0.00	0.00	36,799.72	270,784.49	36,799.72	270,784.49	1,974.06	14,581.93
2042	0.00	0.00	0.00	0.00	40,273.30	311,057.79	40,273.30	311,057.79	2,153.41	16,735.34
2043	0.00	0.00	0.00	0.00	42,830.53	353,888.32	42,830.53	353,888.32	2,277.01	19,012.35
2044	0.00	0.00	0.00	0.00	44,225.23	398,113.55	44,225.23	398,113.55	2,333.43	21,345.78
2045	0.00	0.00	0.00	0.00	49,059.73	447,173.28	49,059.73	447,173.28	2,589.55	23,935.33
2046	0.00	0.00	0.00	0.00	50,833.48	498,006.75	50,833.48	498,006.75	2,666.30	26,601.63
2047	0.00	0.00	0.00	0.00	51,322.55	549,329.30	51,322.55	549,329.30	2,670.91	29,272.54
2048	0.00	0.00	0.00	0.00	52,132.08	601,461.38	52,132.08	601,461.38	2,697.92	31,970.45
2049	0.00	0.00	0.00	0.00	49,564.95	651,026.33	49,564.95	651,026.33	2,534.07	34,504.52
2050	0.00	0.00	0.00	0.00	52,997.99	704,024.32	52,997.99	704,024.32	2,722.17	37,226.69

4.3 Leakage

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

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

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

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

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

- Carbon stock changes due to activities implemented in leakage management areas;
- Methane (CH_4) and nitrous oxide (N_2O) emissions from livestock intensification (involving a change in the animal diet and/or animal numbers).

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

Where,

ΔCLPMLKt Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

ΔCBSLLKt Annual carbon stock changes in leakage management areas in the baseline case at year t; tCO_2e

ΔCPSLKt Annual carbon stock change in leakage management areas in the project case; tCO_2e

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

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

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

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

Table 60. Ex ante estimated total emissions above the baseline from leakage prevention activities

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 $\Delta CBSLLK_t$ tCO_2e	cumulatve $\Delta CBSLLK$ tCO_2e	annual $\Delta CPSLK_t$ tCO_2e	cumulatve $\Delta CPSLK$ tCO_2e	annual $\Delta CLPMLK_t$ tCO_2e	cumulatve $\Delta CLPMLK$ tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00
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

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

Table 61. Ex ante estimated total emissions above the baseline from leakage prevention activities

Project year	Carbon stock decrease due to leakage prevention measures		Total *ex ante* GHG emissions from increased grazing activities		Total *ex ante* increase in GHG emissions due to leakage prevention measures	
	annual	cumulative	annual	cumulative	annual	cumulative
	ΔCLPMLK t	ΔCLPMLK	EgLKt	EgLK	ELPMLKt	ELPMLK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00	0.00
2038	0.00	0.00	0.00	0.00	0.00	0.00
2039	0.00	0.00	0.00	0.00	0.00	0.00
2040	0.00	0.00	0.00	0.00	0.00	0.00
2041	0.00	0.00	0.00	0.00	0.00	0.00
2042	0.00	0.00	0.00	0.00	0.00	0.00
2043	0.00	0.00	0.00	0.00	0.00	0.00
2044	0.00	0.00	0.00	0.00	0.00	0.00
2045	0.00	0.00	0.00	0.00	0.00	0.00
2046	0.00	0.00	0.00	0.00	0.00	0.00
2047	0.00	0.00	0.00	0.00	0.00	0.00
2048	0.00	0.00	0.00	0.00	0.00	0.00
2049	0.00	0.00	0.00	0.00	0.00	0.00
2050	0.00	0.00	0.00	0.00	0.00	0.00

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

Activities that will cause deforestation within the project area in the baseline case could be displaced outside the project boundary due to the implementation of the AUD project activity. A greater decrease in carbon stocks within the leakage belt during the project scenario than those predicted ex-ante would indicate displacement of deforestation activities due to the project.

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

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

Where,

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

The displacement leakage factor used was assumed as 0%.

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 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 DLF used to estimate the decrease in carbon stocks, as follows.

$$EADLKt_t = EBBBSPA_t * DLF$$

Where,

$EADLKt_t$	Total *ex ante* estimated increase in GHG emissions due to displaced forest fires; tCO_2e
$EBBBSPA_t$	Total non-CO_2 emissions from forest fire at year t in the project area; tCO_2e
DLF	Displacement leakage factor; %
t	1, 2, 3 … t, a year of the proposed project crediting period; dimensionless

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

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

Table 62. Ex ante estimated leakage due to activity displacement

Project year	Total ex ante estimated decrease in carbon stocks due to displaced deforestation		Total ex ante estimated increase in GHG emissions due to displaced forest fires	
	annual	cumulative	annual	cumulative
	$\Delta CADLK_t$ tCO$_2$e	$\Delta CADLK$ tCO$_2$e	$EADLK_t$ tCO$_2$e	$EADLK$ tCO$_2$e
2020	0.00	0.00	0.00	0.00
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

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

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

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

Where,

ΔCLKt Total decrease in carbon stocks within the leakage belt at year t; tCO_2e

ΔCADLKt Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e

ΔCLPMLKt Carbon stock decrease due to leakage prevention measures at year t; tCO_2e

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

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

$$ELK_t = EgLK_t + EADLK_t$$

Where,

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

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

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

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

Table 63. Ex ante estimated total leakage

Project year	Total ex ante GHG emissions from increased grazing activities		Total ex ante increase in GHG emissions due to displaced forest fires		Total ex ante decrease in carbon stocks due to displaced deforestation		Carbon stock decrease due to leakage prevention measures		Total net carbon stock change due to leakage		Total net increase in emissions due to leakage	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$EgLK_t$	$EgLK$	$EADLK_t$	$EADLK$	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	0.00	0.00	0.00	0.00	0.00	0.00

4.4 Net GHG Emission Reductions and Removals

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

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

Where:

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

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

$$VCUt = \Delta REDDt - VBCt$$

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

Where:

VCUt	Number of Verified Carbon Units that can be traded at time t; t CO2e

ΔREDDt	Ex ante estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e
VBCt	Number of Buffer Credits deposited in the VCS Buffer at time t; t CO2e
ΔCBSLPAt	Sum of baseline carbon stock changes in the project area at year t; tCO2e
ΔCPSPAt	Sum of ex ante estimated actual carbon stock changes in the project area at year t; tCO2e ha-1
Ft	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless.

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value of RFt for the first project instance activity was 19%.

The net GHG emission reductions and removals by the first project instance within the Yellow Ipê Grouped REDD project are summarized in the table below.

Table 64. Summary of net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	*Ex ante* buffer credits (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2020	24,901	1,023	0	4,290	19,587
2021	34,638	1,424	0	5,971	27,243
2022	52,874	2,173	0	9,118	41,583
2023	61,637	2,533	0	10,635	48,468
2024	87,549	3,598	0	15,107	68,842
2025	86,641	3,561	0	14,964	68,115
2026	119,619	4,917	0	20,657	94,045
2027	157,159	6,459	0	27,141	123,558
2028	172,821	7,103	0	29,861	135,856
2029	195,556	8,038	0	33,801	153,716
2030	225,836	9,282	0	39,038	177,515
2031	227,359	9,345	0	39,327	178,687
2032	284,548	11,695	0	49,201	223,652
2033	303,482	12,474	0	52,492	238,516
2034	345,178	14,187	0	59,702	271,288
2035	405,979	16,686	0	70,212	319,081
2036	449,102	18,459	0	77,677	352,966
2037	524,746	21,568	0	90,745	412,433
2038	629,291	25,865	0	108,801	494,625
2039	747,147	30,709	0	129,162	587,276
2040	858,576	35,289	0	148,428	674,859
2041	943,369	38,774	0	163,123	741,472
2042	1,032,245	42,427	0	178,520	811,298
2043	1,097,470	45,108	0	189,856	862,507
2044	1,132,776	46,559	0	196,038	890,179
2045	1,256,631	51,649	0	217,468	987,514
2046	1,301,654	53,500	0	225,330	1,022,823
2047	1,313,665	53,993	0	227,498	1,032,173
2048	1,334,018	54,830	0	231,087	1,048,101
2049	1,267,573	52,099	0	219,707	995,766
2050	225,946	9,287	0	39,154	177,505
Total	**16,899,988**	**694,613**	**0**	**2,924,111**	**13,281,249**

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

Table 65. Ex ante estimated net anthropogenic GHG emission reductions (REDDt) and verified carbon units (VCUt)

Project year	Baseline carbon stock changes		Baseline GHG emissions from biomass burning		Ex ante project carbon stock changes		Ex ante project GHG emissions from biomass burning		Ex ante leakage carbon stock changes		Ex ante leakage GHG emissions		Ex ante net anthropogenic GHG emission reductions		Ex ante VCUs tradable		Ex ante buffer credits	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020 (01/03/2020 to 31/12/2020)	23,544	23,544	1,357	1,357	968	968	56	56	0	0	0	0	23,877	23,877	19,587	19,587	4,290	4,290
2021	32,775	56,319	1,863	3,220	1,347	2,315	77	132	0	0	0	0	33,215	57,092	27,243	46,830	5,971	10,261
2022	50,045	106,364	2,829	6,049	2,057	4,372	116	249	0	0	0	0	50,701	107,793	41,583	88,413	9,118	19,379
2023	58,373	164,737	3,264	9,313	2,399	6,771	134	383	0	0	0	0	59,104	166,897	48,468	136,881	10,635	30,014
2024	82,921	247,658	4,627	13,941	3,408	10,179	190	573	0	0	0	0	83,950	250,847	68,842	205,723	15,107	45,121
2025	82,132	329,790	4,509	18,450	3,376	13,555	185	758	0	0	0	0	83,080	333,927	68,115	273,838	14,964	60,085
2026	113,381	443,171	6,239	24,688	4,660	18,215	256	1,015	0	0	0	0	114,703	448,629	94,045	367,883	20,657	80,742
2027	148,968	592,139	8,191	32,879	6,123	24,338	337	1,351	0	0	0	0	150,699	599,329	123,558	491,441	27,141	107,882
2028	163,899	756,037	8,922	41,801	6,736	31,074	367	1,718	0	0	0	0	165,718	765,047	135,856	627,297	29,861	137,743
2029	185,528	941,565	10,028	51,829	7,625	38,700	412	2,130	0	0	0	0	187,518	952,564	153,716	781,013	33,801	171,545
2030	214,272	1,155,838	11,564	63,393	8,807	47,507	475	2,606	0	0	0	0	216,554	1,169,118	177,515	958,528	39,038	210,583
2031	215,855	1,371,693	11,504	74,896	8,872	56,378	473	3,078	0	0	0	0	218,014	1,387,132	178,687	1,137,215	39,327	249,910
2032	270,051	1,641,744	14,497	89,394	11,099	67,478	596	3,674	0	0	0	0	272,853	1,659,985	223,652	1,360,867	49,201	299,110
2033	288,118	1,929,861	15,364	104,758	11,842	79,320	631	4,306	0	0	0	0	291,009	1,950,994	238,516	1,599,383	52,492	351,603
2034	327,692	2,257,553	17,486	122,244	13,469	92,789	719	5,024	0	0	0	0	330,990	2,281,984	271,288	1,870,671	59,702	411,305
2035	385,375	2,642,928	20,604	142,848	15,839	108,628	847	5,871	0	0	0	0	389,293	2,671,277	319,081	2,189,752	70,212	481,517
2036	426,350	3,069,278	22,752	165,600	17,524	126,152	935	6,806	0	0	0	0	430,644	3,101,921	352,966	2,542,718	77,677	559,194
2037	498,076	3,567,354	26,671	192,271	20,472	146,623	1,096	7,903	0	0	0	0	503,178	3,605,099	412,433	2,955,151	90,745	649,939
2038	597,184	4,164,537	32,108	224,379	24,545	171,168	1,320	9,222	0	0	0	0	603,426	4,208,526	494,625	3,449,776	108,801	758,740
2039	708,939	4,873,477	38,208	262,586	29,138	200,307	1,570	10,793	0	0	0	0	716,438	4,924,964	587,276	4,037,052	129,162	887,902
2040	814,684	5,688,160	43,893	306,479	33,485	233,791	1,804	12,597	0	0	0	0	823,288	5,748,251	674,859	4,711,911	148,428	1,036,330
2041	895,340	6,583,500	48,029	354,508	36,800	270,591	1,974	14,571	0	0	0	0	904,595	6,652,847	741,472	5,453,383	163,123	1,199,453
2042	979,853	7,563,353	52,393	406,901	40,273	310,864	2,153	16,724	0	0	0	0	989,819	7,642,666	811,298	6,264,681	178,520	1,377,973
2043	1,042,070	8,605,423	55,400	462,301	42,831	353,695	2,277	19,001	0	0	0	0	1,052,363	8,695,028	862,507	7,127,188	189,856	1,567,828
2044	1,076,003	9,681,427	56,773	519,073	44,225	397,920	2,333	21,335	0	0	0	0	1,086,217	9,781,245	890,179	8,017,367	196,038	1,763,866
2045	1,193,627	10,875,054	63,004	582,077	49,060	446,980	2,590	23,924	0	0	0	0	1,204,982	10,986,227	987,514	9,004,881	217,468	1,981,334
2046	1,236,783	12,111,837	64,871	646,948	50,833	497,813	2,666	26,590	0	0	0	0	1,248,154	12,234,382	1,022,823	10,027,704	225,330	2,206,664
2047	1,248,682	13,360,519	64,983	711,932	51,323	549,136	2,671	29,261	0	0	0	0	1,259,672	13,494,053	1,032,173	11,059,877	227,498	2,434,163
2048	1,268,378	14,628,897	65,641	777,572	52,132	601,268	2,698	31,959	0	0	0	0	1,279,188	14,773,242	1,048,101	12,107,978	231,087	2,665,249
2049	1,205,919	15,834,816	61,654	839,226	49,565	650,833	2,534	34,493	0	0	0	0	1,215,474	15,988,716	995,766	13,103,744	219,707	2,884,957
2050 (01/01/2050 to 28/02/2050)	214,908	16,049,724	11,038	850,265	8,833	659,666	454	34,947	0	0	0	0	216,659	16,205,376	177,505	13,281,249	39,154	2,924,111

5 Monitoring

5.1 Data and Parameters Available at Validation

<table>
<tr><td>Data / Parameter</td><td>ab_{icl}</td></tr>
<tr><td>Data unit</td><td>Mg/ha</td></tr>
<tr><td>Description</td><td>Average biomass stock per hectare in the above-ground biomass pool of initial forest class icl in Mg/ha.</td></tr>
<tr><td>Source of data</td><td>Average values for the above-ground biomass were taken from the following studies:
Open Alluvial Tropical and Open Submontane Tropical Rainforests; Pioneer formations with fluvial influence:
NOGUEIRA, E.M., Yanai, A. M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. Global Change Biology 21: 1271-1292

Dense Alluvial, Submontane and Lowland Tropical Rainforest:
HIGUCHI, Francisco Gasparetto. Dinâmica de volume e biomassa da floresta de terra firme do Amazonas. 2015. 201 f. Tese (Doutorado) - Curso de Engenharia Florestal, Setor de Ciências Agrárias, Universidade Federal do Paraná, Curitiba, 2015.</td></tr>
<tr><td>Value applied</td><td>
<table>
<tr><th colspan="4">Above-ground biomass
ab_{icl} (Mg/ha)</th></tr>
<tr><th>Vegetation</th><th>Reference Region</th><th>Project Area</th><th>Leakage Belt</th></tr>
<tr><td>Dense Alluvial Tropical Rainforest</td><td>327.40</td><td>327.40</td><td>327.40</td></tr>
<tr><td>Dense Submontane Tropical Rainforest</td><td>327.40</td><td>327.40</td><td>327.40</td></tr>
</table>
</td></tr>
</table>

	Dense Lowland Tropical Rainforest	327.40	327.40	327.40
	Open Alluvial Tropical Rainforest	298.39	-	-
	Open Submontane Tropical Rainforest	280.24	-	-
	Pioneer formations with fluvial influence	19.68	-	23.58
Justification of choice of data or description of measurement methods and procedures applied	Following a literature search the above-ground biomass values of this study was used as they were determined to accurately represent the values of vegetation within the project reference region. In addition, the results from this study were adjusted with uncertainty of 90% CI. As the studies are from 2015, they must be updated according to the methodology requirements, which requires the literature data to be less than 10 years old. Thus, the sources must be updated before the end of the first baseline period (2020-2030).			
Purpose of Data	This parameter is used to calculate baseline emissions and leakage emissions in the project scenario.			
Comments	The values will be reassessed every 10 years or when data is more than 10 years old, whichever occurs first. Data shall be in accordance with VM0015 v1.1 requirements			

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.
Value applied	**Below-ground biomass** bb_{icl} **(Mg/ha)** **Vegetation** | **Reference Region** | **Project Area** | **Leakage Belt** Dense Alluvial Tropical Rainforest | 78.58 | 78.58 | 78.58 Dense Submontane Tropical Rainforest | 78.58 | 78.58 | 78.58 Dense Lowland Tropical Rainforest | 78.58 | 78.58 | 78.58 Open Alluvial Tropical Rainforest | 71.61 | - | - Open Submontane Tropical Rainforest | 67.26 | - | - Pioneer formations with fluvial influence | 3.94 | - | 4.72
Justification of choice of data or description of measurement methods and procedures applied	Following a literature search the below-ground biomass values of this study was use as they were determined to accurately represent the values of vegetation within the project reference region. In addition, the results from this study were adjusted with uncertainty of 90% CI.
Purpose of Data	This parameter is used to calculate baseline emissions and leakage emissions in the project scenario.
Comments	The values will be reassessed every 10 years or when data is more than 10 years old, whichever occurs first. Data shall be in accordance with VM0015 v1.1 requirements

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

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

	in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996.
Value applied	46.93
Justification of choice of data or description of measurement methods and procedures applied	Fearnside (1996) is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas.
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 project 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	EI
Data unit	%
Description	*Ex ante* estimated effectiveness index
Source of data	Estimate from project proponent based on proposed project activities to be developed in the region.
Value applied	95.94%
Justification of choice of data or description of measurement methods and procedures applied	Due to the proposed project activities for the local economy and employment generation, the Effectiveness index was conservatively assumed as 95.94%
Purpose of Data	This parameter is used to calculate project emissions in the baseline scenario. Provides an *ex ante* estimation of the carbon stock changes due to unavoidable unplanned deforestation within the project area, based on the effectiveness of the proposed project activities to reduce the deforestation.
Comments	*Ex post* monitoring of the project area will be done to determine deforestation rate and the project emissions.

	This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	DLF
Data unit	%
Description	Displacement Leakage Factor
Source of data	DLF was adopted as 0% based on previous REDD projects developed by Ecologica Assessoria Ltda, where no leakage due to displaced deforestation occurred during all the verified monitoring periods.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	DLF was adopted as 0% based on previous REDD projects developed by Ecologica Assessoria Ltda, where no leakage due to displaced deforestation occurred during all the verified monitoring periods.
Purpose of Data	This parameter is used to calculate leakage emissions in the baseline scenario due to activity displacement leakage, providing an *ex ante* estimation of the decrease in carbon stocks and increase in GHG emissions. This value was calculated based on the percent of deforestation expected to be displaced outside the project boundary due to the implementation of the AUD project activity.
Comments	*Ex post* monitoring of the leakage belt will be done to determine deforestation rate outside the project area and the leakage emissions and carbon stock decrease. This parameter will be updated at each renewal of fixed baseline period.

Data / Parameter	$\Delta CBSLLK_t$
Data unit	tCO_2e
Description	Annual carbon stock changes in leakage management areas in the baseline case at year t
Source of data	- Planned interventions proposed by the project proponent.

	- Remote sensing and GIS.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	Leakage prevention activities generating a decrease in carbon stocks should be estimated *ex ante* and accounted. The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.
Purpose of Data	This parameter was used to calculate leakage emissions in the baseline scenario due to leakage prevention measures implemented in the leakage management area. It provides an *ex ante* estimation of the decrease in carbon stocks due to the activities implemented.
Comments	*Ex post* monitoring of the leakage management area will be done to determine the carbon stock decrease and the leakage emissions. This parameter will be updated at each renewal of fixed baseline period.
Justification of choice of data or description of measurement methods and procedures applied	The following sources will be monitored: - Biomass stock surveys - Periodic reports from area supervisor - Local Forest Inventories Data shall be in accordance to VM0015 v1.1 requirements. Following a literature search the above-ground biomass values of this study was used as they were determined to accurately represent the values of vegetation within the project reference region. In addition, the results from this study were adjusted with uncertainty of 90% CI.

5.2 Data and Parameters Monitored

Data / Parameter	ACPAt
Data unit	Ha
Description	Annual area within the Project Area affected by catastrophic events at year t.

Source of data	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied	The following sources will be monitored: - INMET[146] - Periodic reports from area supervisor - INPE[147]
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: - INMET - INPE - Periodic reports from area supervisor
Purpose of data	This parameter is used to calculate project emissions in the project scenario. Provides an ex post estimation of the area affected by catastrophic events within the project area
Calculation method	Remote sensing and GIS
Comments	The value will be calculated ex-post each time a catastrophic event occurs, when significant. 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.

[146] INMET. Instituto Nacional de Meteorologia. Available at: <http://www.inmet.gov.br/portal/index.php?r=home/page&page=rede_estacoes_conv_graf>. Last visited on 30/12/2020

[147] INPE. Instituto Nacional de Pesquisas Espaciais. Available at: <http://sigma.cptec.inpe.br/queimadas/index_old.php>. Last visited on 30/12/2020

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	847.59 (Annual average projected in the leakage belt during the 1st, 2nd, 3rd baseline periods)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing. Procedures according to VM0015's Map Accuracy Assessment that states that the minimum classification accuracy of each class or category in the Land-Use and Land-Cover Map and Land-Use and Land-Cover Change Map, respectively, should be 80%.
Purpose of data	This parameter is used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the deforested area within the leakage belt.
Calculation method	Analysis of satellite images and maps.
Comments	Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage. Annual information for ABSLLK parameter is available in Table 34 of the present Joint PD.

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	824.80 (Annual average projected in the project area during the 1st, 2nd, 3rd baseline periods)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing. Procedures according to VM0015's Map Accuracy Assessment that states that the minimum classification accuracy of each class or category in the Land-Use and Land-Cover Map and Land-Use and Land-Cover Change Map, respectively, should be 80%.
Purpose of data	This parameter will be used to calculate baseline emissions and project emissions in the project scenario. Provides the *ex ante* and *ex post* values of the deforested area per forest class within the project area.
Calculation method	Analysis of satellite images and maps.
Comments	Annual information for ABSLPA parameter is available in Table 33 of the present Joint PD.

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t

Source of data	- Remote sensing and GIS.
Description of measurement methods and procedures to be applied	Deforestation in the leakage belt area may be considered activity displacement leakage. Activity data for the leakage belt area will be determined using the same methods applied to monitoring deforestation activity data in the project area.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS.
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the decrease in carbon stocks due to displaced deforestation in the leakage belt.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	Where evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and therefore, not considered leakage.

Data / Parameter	$\Delta CPAdPA_t$
Data unit	tCO2e
Description	Total decrease in carbon stock due to all planned activities at year t in the project area
Source of data	Documents, remote sensing and GIS.
Description of measurement methods and	The planned activities in the project area that result in carbon stock decrease will be subject to monitoring, when significant.

procedures to be applied	
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 is used to calculate project emissions in the project scenario. Provides the ex post value of the decrease in carbon stocks due to planned activities in the project area.
Calculation method	This parameter is the sum of: carbon stock decrease due to planned deforestation, carbon stock decrease due to planned logging activities, and carbon stock decrease due to planned fuel-wood and charcoal activities.
Comments	N/A

Data / Parameter	$\Delta CPAiPA_t$
Data unit	tCO_2e
Description	Total increase in carbon stock due to all planned activities at year t in the project area
Source of data	- Documents, remote sensing and GIS.
Description of measurement methods and procedures to be applied	The planned activities in the project area that result in carbon stock increase 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 is used to calculate project emissions in the project scenario. Provides the ex post value of the increase in carbon stocks due to planned activities in the project area, which could reduce the decrease in carbon stocks in the project area.
Calculation method	Depends on the planned activity.
Comments	N/A

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing and GIS
Description of measurement methods and procedures to be applied	The planned activities in leakage management areas that result in carbon stock decrease will be subject to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate leakage emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to leakage prevention measures in the leakage management area.

Calculation method	Emissions from deforestation are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	The leakage prevention measures proposed by the present project do not include decrease in carbon stocks due to activities implemented in the leakage management area.

Data / Parameter	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Source of data	- Remote sensing and GIS - Supervisors 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	22,406.48 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter will be used to calculate project emissions in the project scenario. Provides the *ex post* value of the change in carbon stocks due to unavoided unplanned deforestation within the project area.
Calculation method	Emissions from deforestation at each forest class are estimated by multiplying the detected area of forest loss by the average forest carbon stock per unit area.
Comments	N/A

Data / Parameter	$EBBBSLPA_t$
Data unit	tCO2e
Description	Sum of (or total) baseline non-CO2 emissions from forest fire at year t in the project area
Source of data	Remote sensing data and GIS, Supervisor reports.
Description of measurement methods and procedures to be applied	Slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt.
Frequency of monitoring/recording	Annually
Value applied	27,428 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing.
Purpose of data	This parameter is used to calculate non-CO2 emissions due to forest fires within the project area in the baseline scenario, providing an ex ante estimation.
Calculation method	Non-CO2 emissions from biomass burning are calculated according to requirements of methodology VM0015 v1.1. Baseline deforestation in the project area involves fire and all above ground biomass is burnt to clear the area to subsistence agriculture. Therefore, this parameter is estimated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the baseline scenario (ABSLPAicl,t) times the total GHG emission from biomass burning in initial forest classes (EBBtoticl,t).
Comments	Ex post monitoring of forest fires and non-CO2 emissions (EBBPSPAt) will be done to determine GHG emissions within the project area (when the forest fire was significant).

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) actual non-CO_2 emissions from forest fire at year t in the project area
Source of data	- Remote sensing data and GIS, - Supervisor reports.
Description of measurement methods and procedures to be applied	If forest fires occur, these non-CO_2 emissions will be subject to monitoring and accounting, when significant. In addition to remote sensing data and GIS, which can identify the area affected by forest fire, periodic reports from area supervisors, who live inside the project area, could also confirm the data obtained.
Frequency of monitoring/recording	Annually
Value applied	1,184.79 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate *non-*CO_2 emissions due to forest fires within the project area in the project scenario, providing an *ex post* value.
Calculation method	If forest fires occur, *non-*CO_2 emissions from biomass burning will calculated according to requirements of methodology VM0015 v1.1. Therefore, this parameter will be calculated as the multiplication of the annual area of deforestation of initial forest classes in the project area in the project scenario times the total GHG emission from biomass burning in initial forest classes ($EBBtot_{icl,t}$), when significant.
Comments	N/A

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Source of data	- Activities report related to leakage prevention measures - Field assessment - Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	GHG emissions from grazing animals in the leakage management area (i.e. enteric fermentation or manure management) will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate GHG emissions from activities implemented in the leakage management area in the project scenario, providing an *ex post* value.
Calculation method	Described in the methodology VM0015 v1.1, section 8.1.2: *Ex ante* estimation of CH_4 and N_2O emissions from grazing animals.
Comments	There are no predicted activities in the leakage management area that will result in GHG emissions during the crediting period.

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex ante* and *ex post* increase in GHG emissions due to displaced forest fires at year t.

Source of data	Remote sensing data and GIS.
Description of measurement methods and procedures to be applied	Forest fires in the leakage belt area may be considered activity displacement leakage. GHG emissions due displaced forest fires will be subjected to monitoring, when significant.
Frequency of monitoring/recording	Annually
Value applied	0 tCO2e/year
Monitoring equipment	Remote sensing and GIS
QA/QC procedures to be applied	Best practices in remote sensing and GIS.
Purpose of data	This parameter will be used to calculate leakage emissions in the baseline and project scenario. Provides the *ex ante* and *ex post* value of the increase in GHG emissions due to displaced forest fires in the leakage belt.
Calculation method	GHG emissions from deforestation are estimated by multiplying the detected area of forest loss in the leakage belt times the average forest carbon stock per unit area. This is done separately for the baseline and project scenarios.
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	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits
Source of data	- VCS Non-Permanence Risk Report – Yellow Ipê Grouped REDD Project; - Remote sensing data and GIS; - Supervisor report; - 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	19
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, v. 1.1.

Revision of the baseline

The current baseline is valid for 10 years, i.e. through February 2030. The baseline will be reassessed every 10 years, and it will be validated at the same time as the subsequent verification. If an applicable sub-national or national jurisdictional baseline becomes available, the baseline shall be used for the subsequent period.

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.

Furthermore, 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.

Monitoring Deforestation and Project Emissions

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

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

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

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

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

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

Monitoring of non-CO_2 emissions from forest fires

If forest fires and biomass burning occur during the project scenario, these non-CO2 emissions will be subject to monitoring and accounting, when significant.

Monitoring Leakage

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 first 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 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 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. Furthermore, GHG emissions from displaced forest fires within the leakage belt will also be accounted, if significant.

Leakage will be calculated by comparing the *ex ante* and the *ex post* assessment. However, where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation will not be attributed to the project activity, thus not considered leakage.

Monitoring of Natural Disturbance and catastrophic events

The carbon stock losses within the project area will be estimated as soon as possible after the natural event, e.g. uncontrolled forest fires and other catastrophic events.

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.

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 Ecológica Assessoria Ltda.

Ecológica Assessoria Ltda. Will also keep a digital copy of all documents generated during the development of the VCS PD (first fixed baseline period) and the subsequent baseline reports and monitoring periods.

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

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

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

Quality Assurance/Quality Control

According to the applied methodology, the minimum overall accuracy of the Forest Cover Benchmark Map should be 90%; and the minimum classification accuracy of each class or category in the Land-Use and Land-Cover Map and Land-Use and Land-Cover Change Map, respectively, should be 80%.

Furthermore, according to the applied methodology, usually the same source of remotely sensed data and data analysis techniques must be used within a period for which the baseline is fixed (fixed baseline period). However, if remotely sensed data have become available from new and higher resolution sources (e.g. from a different sensor system) during this period, these can only be used if the images based on interpretation of the new data overlap the images based on interpretation of the old data by at least 1 year and they cross calibrate to acceptable levels based on commonly used methods in the remote sensing community.

Therefore, to achieve a consistent time-series, the detailed methodological procedures used in pre-processing, classification, post classification processing, and accuracy assessment of the remotely sensed data during the first baseline period is described in the Appendix II below.

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 plans 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)[148] 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.

Each instance of the present grouped 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

[148] Available at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes> Last visited on 30/12/2020.

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 Yellow Ipê Grouped REDD Project; In-field verification, which basically consists of monitoring the procedures set out in the methodological guidelines and; Review of the monitoring reports prior to its delivery to the VVB, in order to confirm that the calculations, analysis and the conclusions are accurate and measured. This work is in charge of Ecológica Assessoria Ltda.

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

Organizational structure, responsibilities and competencies

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

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

Table 66.Type of Monitoring and Party Responsible for Monitoring

Variables to be monitored	Responsible	Frequency
Reassessment of the baseline	Ecologica Assessoria and external institutions qualified for the GIS analysis and monitoring	Every 10 years
Monitoring Deforestation and Project Emissions	Project instance landowner together with Ecologica Assessoria and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring of non-CO_2 emissions from forest fires	Project instance landowner together with Ecologia Assessoria and external institutions qualified for the GIS analysis and monitoring	Prior to each verification
Monitoring Leakage emissions	Project instance landowner together with Sustainable Carbon and external institutions qualified for the GIS analysis and monitoring	Prior to each verification

Monitoring of Natural Disturbance and catastrophic events	Project instance landowner	When a natural event occurs
Updating Forest Carbon Stocks Estimates	Project instance landowner	At least, every 10 years, only if necessary.

6 Achieved GHG Emission Reductions and Removals

6.1 Data and Parameters Monitored

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.

<table>
<tr><td>Data / Parameter</td><td>$ABSLLK_t$</td></tr>
<tr><td>Data unit</td><td>Hal</td></tr>
<tr><td>Description</td><td>Annual area of deforestation within the leakage belt at year t.</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><th>Year</th><th>ABSLLK 1 Dense Alluvial Tropical Rainforest</th><th>ABSLLK 2 Dense Submontane Tropical Rainforest</th><th>ABSLLK 3 Dense Lowland Tropical Rainforest</th><th>ABSLLK 4 Pioneer formations with fluvial influence</th><th>annual $ABSLLK_t$</th><th>cumulative ABSLLK</th></tr>
<tr><td>2020</td><td>14.65</td><td>7.47</td><td>7.06</td><td>4.42</td><td>33.60</td><td>33.60</td></tr>
</table>
</td></tr>
</table>

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:	see table below
Comments	N/A

Year	Stratum i in the project area (ha)			Total (ha)	
	ABSLPA 1 Dense Alluvial Tropical Rainforest	ABSLPA 2 Dense Submontane Tropical Rainforest	ABSLPA 3 Dense Lowland Tropical Rainforest	annual $ABSLPA_t$	cumulative ABSLPA
2020	2.10	3.69	1.08	6.87	6.87

Data / Parameter	$\Delta CADLK_t$
Data unit	tCO_2e
Description	Total decrease in carbon stocks due to displaced deforestation at year t
Value applied:	see table below
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.

Year	$\Delta CADLK_t$
2020	0

Data / Parameter	$\Delta CPSLK_t$
Data unit	tCO_2e
Description	Total annual carbon stock change in leakage management areas in the project case at year t
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	$\Delta CUDdPA_t$
Data unit	tCO_2e
Description	Total actual carbon stock change due to unavoided unplanned deforestation at year t in the project area
Value applied:	5,114.14 (Annual average decrease in carbon stocks due to unavoided unplanned deforestation within the project area during the crediting period)
Comments	N/A

Data / Parameter	$EBBPSPA_t$
Data unit	tCO_2e
Description	Sum of (or total) actual non-CO_2 emissions from forest fire at year t in the project area
Value applied:	243.40 (Annual average actual non-CO_2 emissions due to biomass burning within the project area during the crediting period)

Comments	N/A

Data / Parameter	$EgLK_t$
Data unit	tCO_2e
Description	Emissions from grazing animals in leakage management areas at year t.
Value applied:	0
Comments	There are no predicted activities in the leakage management area that will result in GHG emissions during the crediting period.

Data / Parameter	$EADLK_t$
Data unit	tCO_2e
Description	Total *ex ante* and *ex post* increase in GHG emissions due to displaced forest fires at year t.
Value applied:	0
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	RF_t
Data unit	%
Description	Risk factor used to calculate VCS buffer credits

Value applied:	19
Comments	N/A

6.2 Baseline Emissions

The total average biomass stock per hectare (Mg ha-1) was converted to tCO2e using the following equations:

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

Where,

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

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

Where,

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

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

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

Where,

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

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

Where,

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

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

Where,

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

Estimation of the average carbon stocks

Project carbon stocks were calculated on the basis of biomass values from the study from Nogueira, 2013[149].

[149] Nogueira, E.M., Yanai, A.M.; Fonseca, F.O.; Fearnside, P.M. 2015. Carbon stock loss from deforestation through 2013 in Brazilian Amazonia. Global Change Biology 21: 1271-1292.

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

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

In order to convert biomass into carbon, and carbon into carbon-dioxide, the conversion factors defined in table 60 were used.

Table 67. Biomass to CO2 conversion factors[150]

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

Table 68. Biomass values used for the "forest" classes within the reference region.

REFERENCE REGION									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Open Alluvial Tropical Rainforest	298.39	149.20	547.05	71.61	35.81	131.29	370.00	185.00	678.34
Open Submontane Tropical Rainforest	280.24	140.12	513.77	67.26	33.63	123.31	347.50	173.75	637.08
Pioneer formations with fluvial influence	19.68	9.84	36.08	3.94	1.97	7.22	23.62	11.81	43.30

150 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> Last visited on 30/12/2020

Table 69. Biomass values used for the "forest" classes within the Project area.

PROJECT AREA									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29

Table 70. Biomass values used for the "forest" classes within the Leakage belt.

LEAKAGE BELT									
Forest class	Aboveground*			Belowground**			TOTAL		
	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cab_{icl} (tCO2/ha)	Biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	Cbb_{icl} (tCO2/ha)	Total biomass (Mg ha^{-1})	Biomass to Carbon (tC/ha)	$Ctot_{icl}$ (tCO_2/ha)
Dense Alluvial Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Submontane Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Dense Lowland Tropical Rainforest	327.40	163.70	600.23	78.58	39.29	144.06	405.98	202.99	744.29
Pioneer formations with fluvial influence	19.68	9.84	36.08	3.94	1.97	7.22	23.62	11.81	43.30

Average carbon stocks of post-deforestation classes

Fearnside (1996)[151] is one of the most recognized studies for the Brazilian Amazon about long term carbon stocks in deforested areas. This study constructed a Markov matrix of annual transition probabilities to estimate landscape composition and to project future changes in the Brazilian Amazon. The average carbon stock value of non-forest vegetation in anthropic areas in equilibrium (post-deforestation class) was defined as 12.8 tC/ha, or 46.93 tCO_2e/ha.

Table 71. 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)	12.80	46.93

The use of this value for non-forest vegetation carbon stocks in equilibrium is conservative because Fearnside (1996) considered that around 45% of deforested areas would be secondary forest from pasture, which has a biomass stock of around 50.5 tons/ha.

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.

[151] FEARNSIDE, Philip M.. Amazonian deforestation and global warming: carbon stocks in vegetation replacing Brazil's Amazon forest. **Forest Ecology And Management,** Manaus, v. 80, p.21-34, 1996. Available at: <https://www.sciencedirect.com/science/article/abs/pii/0378112795036474> Last visited on 30/12/2020.

Table 72. Baseline carbon stock change in the reference region

Carbon stock change in the above-ground biomass per initial forest class *icl*							Total carbon stock change in the above-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	6	$\Delta CabBSLRR_{icl,t}$	$\Delta CabBSLRR_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	176,191	781,498	1,293,288	9,137	9,930	18,701	2,288,744	2,288,744

Carbon stock change in the below-ground biomass per initial forest class *icl*							Total carbon stock change in the below-ground biomass of initial forest class in the reference region	
ID_{cl}	1	2	3	4	5	6	$\Delta CbbBSLRR_{icl,t}$	$\Delta CbbBSLRR_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	Open Alluvial Tropical Rainforest	Open Submontane Tropical Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	4,229	18,756	31,039	219	238	374	54,855	54,855

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the reference region	
ID_{iz}	1	$\Delta CBSLRR_{z,t}$	$\Delta CBSLRR_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0

Total net carbon stock change in the reference region	
$\Delta CBSLRR_{t}$	$\Delta CBSLRR$
annual	cumulative
tCO_2e	tCO_2e
2,343,599	2,343,599

Table 73. Baseline carbon stock change in the project area

Carbon stock change in the above-ground biomass per initial forest class *icl*				Total carbon stock change in the above-ground biomass of initial forest class in the project area	
ID_{cl}	1	2	3	$\Delta CabBSLPA_{icl,t}$	$\Delta CabBSLPA_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	1,262	2,215	647	4,124	4,124

Carbon stock change in the below-ground biomass per initial forest class *icl*				Total carbon stock change in the below-ground biomass of initial forest class in the project area	
ID_{cl}	1	2	3	$\Delta CbbBSLPA_{icl,t}$	$\Delta CbbBSLPA_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Tropical Rainforest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	30	53	16	99	99

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the project area		Total net carbon stock change in the project area	
ID_{iz}	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$	$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
Name	Non-forest	annual	cumulative	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0	4,223	4,223

Table 74. Baseline carbon stock change in the leakage belt

Carbon stock change in the above-ground biomass per initial forest class *icl*					Total carbon stock change in the above-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	2	3	4	$\Delta CabBSLLK_{icl,t}$	$\Delta CabBSLLK_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	8,796	4,484	4,236	191	17,707	17,707

Carbon stock change in the below-ground biomass per initial forest class *icl*					Total carbon stock change in the below-ground biomass of initial forest class in the leakage belt	
ID_{cl}	1	2	3	4	$\Delta CbbBSLLK_{icl,t}$	$\Delta CbbBSLLK_{icl}$
Name	Dense Alluvial Tropical Rainforest	Dense Submontane Tropical Rainforest	Dense Lowland Rainforest	Pioneer formations with fluvial influence	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	211	108	102	4	424	424

Carbon stock changes in above-ground biomass per post-deforestation zone z		Total carbon stock change of post deforestation zones in the leakage belt	
ID_{iz}	1	$\Delta CtotBSLLK_{z,t}$	$\Delta CtotBSLLK_{z}$
Name	Non-forest	annual	cumulative
Project year	tCO_2e	tCO_2e	tCO_2e
2020	0	0	0

Total net carbon stock change in the leakage belt	
$\Delta CtotBSLLK_{t}$	$\Delta CtotBSLLK$
annual	cumulative
tCO_2e	tCO_2e
18,131	18,131

Baseline non-CO_2 emissions from forest fires

As described in baseline scenario, slash-and-burn deforestation to clear the area is carried out for subsistence agriculture, which is the main cause of deforestation within the project area. Therefore, baseline deforestation in the project area involves fire and all above ground biomass is burnt. It is worth mentioning that the effect of fire on CO_2 emissions is counted in the estimation of carbon stock changes; therefore, CO_2 emissions from biomass burning were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest fires ($EBBBSLPA_t$) were quantified and included as baseline emissions, as follows.

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

Where,

$EBBtot_{icl,t}$	Total GHG emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBN_2O_{icl,t}$	N_2O emission from biomass burning in forest class icl at year t; tCO_2e/ha
$EBBCH_{4icl,t}$	CH_4 emission from biomass burning in forest class icl at year t; tCO_2e/ha

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

Where,

$EBBCO_{2icl,t}$	Per hectare CO_2 emission from biomass burning in slash and burn in forest class icl at year t; tCO_2e/ha
NCR	Nitrogen to Carbon Ratio (IPCC default value = 0.01); dimensionless
ER_{N2O}	Emission ratio for N_2O (IPCC default value = 0.007)
GWP_{N2O}	Global Warming Potential for N_2O (IPCC default value = 310 for the first commitment period)[152]

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

Where,

[152] According to the VCS Standard 4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for N_2O = 298). However, the default value from the applied methodology was used (GWP for N_2O = 310) because it resulted in lower values of $EBBtot_{icl,t}$ (33.29 tCO_2e/ha instead of 38.93 tCO_2e/ha) and consequently, more conservative values of GHG emission reductions.

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

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

GWP_{CH4} Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period) [153]

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

Where,

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

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

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

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

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

p Carbon pool that could burn, above-ground biomass

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

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

Where,

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

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

[153] According to the VCS Standard v4.0, the six Kyoto Protocol greenhouse gases and ozone-depleting substances shall be converted using 100 year global warming potentials derived from the IPCC's Fourth Assessment Report (GWP for CH_4 = 25). However, the default value from the applied methodology was used (GWP for CH_4 = 21) because it resulted in lower values of $EBBtot_{icl,t}$ (33.29 tCO_2e/ha instead of 38.93 tCO_2e/ha) and consequently, more conservative values of GHG emission reductions.

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

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

Table 75. Parameters used to calculate non-CO2 emissions from forest fires

Initial Forest Class		Parameters								
IDcl	Name	$Fburnt_{icl}$	Cab	$Pburnt_{ab,icl}$	$CE_{ab,icl}$	ECO2-ab	EBBCO2-tot	$EBBN2O_{icl}$	$EBBCH4_{icl}$	$EBBtot_{icl}$
		%	tCO2e/ha	%	%	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha	tCO2e/ha
1	Dense Alluvial Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42
2	Dense Submontane Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42
3	Dense Lowland Tropical Rainforest	100%	600.23	100%	50%	300.12	300.12	2.68	32.74	35.42

The projected total non-CO_2 emissions from biomass burning are displayed in table below.

Table 76. Baseline non-CO2 emissions from forest fires in the

	Project year *t*	Emissions of non-CO_2 gasses from baseline forest fires						Total baseline non-CO_2 emissions from forest fires in the project area	
		ID_{cl} = 1 Riparian (Aluvial) Dense Tropical Rainforest		ID_{cl} = 2 Riparian (Aluvial) Dense Tropical Rainforest		ID_{cl} = 3 Riparian (Aluvial) Dense Tropical Rainforest		annual	cumulative
		$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$ABSLPA_{icl,t}$	$EBBBSLtot_{icl}$	$EBBBSLPA_t$	EBBBSLPA
		ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e
First baseline period	2020	3.93	35.42	38.52	35.42	3.52	35.42	1,628.28	1,628.28

6.3 Project Emissions

During this monitoring period, there was no planned deforestation within the project area. However, unplanned deforestation occurred in the project area during the monitoring period. The ex post carbon stock decrease due to unplanned deforestation in the project area was calculated using the following equation:

$$\Delta CUDdPA_t = \sum_{icl=1}^{icl} (AUDPA_{icl,t} \times \Delta Ctot_{icl,t})$$

Where,

$\Delta CUDdPA_t$	Total *ex post* actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e
$AUDPA_{icl,t}$	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_2e/ha
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless

Therefore, the total carbon stock decrease due to unplanned deforestation in the project area could be calculated, as depicted in Table below.

Table 77. Ex post carbon stock decrease due to planned and unplanned deforestation in the project area

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						Total carbon stock decrease due to unplanned deforestation		Total carbon stock decrease due to planned and unplanned deforestation in the project area	
	ID_{cl} = 1 Dense Alluvial Tropical Rainforest		IDcl = 2 Dense Submontane Tropical Rainforest		IDcl = 3 Dense Lowland Tropical Rainforest		annual	cumulative	ID_{cl} = 1 Dense Alluvial Tropical Rainforest		IDcl = 2 Dense Submontane Tropical Rainforest		IDcl = 3 Dense Lowland Tropical Rainforest		annual	cumulative	annual	cumulative
	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$AUDPA_{icl,t}$	$Ctot_{icl,t}$	$AUDPA_{icl,t}$	$Ctot_{icl,t}$	$AUDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CUDdPA_t$	$\Delta CUDdPA$		
	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	744.29	0.00	744.29	0.00	744.29	0.00	0.00	2.10	744.29	3.69	744.29	1.08	744.29	5,114.14	5,114.14	5,114.14	5,114.14

Fossil fuel emissions from REDD project activities are likely to be less than 5% of the total GHG emissions reductions benefits generated by the present project. In addition, according to VCS Standard Requirements, fossil fuel emissions from transport and machinery use in REDD project activities can be considered de minimis.

No planned production of logged timber, fuel wood or charcoal occurred within the project area during the monitoring period. Furthermore, there were no planned activities that resulted in carbon stock increase during this monitoring period.

The calculation of the ex post net carbon stock change in the project area under the project scenario (ΔCPSPAt) is described as follows.

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

Where,

$\Delta CPSPA_t$ Sum of ex post actual carbon stock changes in the project area at year t; tCO_2e

$\Delta CPAdPA_t$ Total decrease in carbon stock due to all planned activities at year t in the project area; tCO_2e

$\Delta CUDdPA_t$ Total ex ante actual carbon stock change due to unavoided unplanned deforestation at year t in the project area; tCO_2e

$\Delta CPAiPA_t$ Total increase in carbon stock due to all planned activities at year t in the project area; tCO_2e

Ex post carbon stock change in the project area under the project scenario is shown below.

Table 78. Ex post estimated net carbon stock change in the project area under the project scenario

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAiPA_t$	ΔCPAiPA	$\Delta CUDdPA_t$	ΔCUDdPA	$\Delta CPSPA_t$	ΔCPSPA
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	5,114.14	5,114.14	5,114.14	5,114.14

Furthermore, it was conservatively assumed that all unplanned deforestation and catastrophic events within the project area involved fire and all above ground biomass was burnt. It is worth mentioning that the effect of fire on CO_2 emissions is counted in the estimation of carbon stock changes in the parameter ΔCUDdPAt; therefore, CO_2 emissions from forest fires were ignored to avoid double counting. However, non-CO_2 emissions (CH_4 and N_2O) from forest fires ($EBBPSPA_t$) were quantified and included as project emissions.

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

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

Where,

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

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

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

Table 79. Total ex post estimated actual emissions of non-CO2 gases due to forest fires in the project area

Project year *t*	Emissions of non-CO_2 gases from forest fires in the project scenario						Total ex post estimated actual non-CO_2 emissions from forest fires in the Project area	
	ID_{cl} = 1 Dense Alluvial Tropical Rainforest		IDcl = 2 Dense Submontane Tropical Rainforest		IDcl = 3 Dense Lowland Tropical Rainforest		$EBBPSPA_t$	EBBPSPA
	ABSLPAicl,t	EBBPSPAt	ABSLPAicl,t	EBBPSPAt	ABSLPAicl,t	EBBPSPAt	annual	cumulative
	ha	tCO_2e/ha	ha	tCO_2e/ha	ha	tCO_2e/ha	tCO_2e	tCO_2e
2020	2.10	35.42	3.69	35.42	1.08	35.42	243.40	243.40

<u>Total ex post estimations for the project area</u>

The results of all ex post carbon stock changes and non-CO_2 emissions in the Project area during the monitoring period are summarized in the Table below. As detailed in this Table, the major cause of project emissions within the project area during this monitoring period was the carbon stock decrease due to unavoided unplanned deforestation.

Table 80. Total ex ante estimated actual net carbon stock changes and emissions of non-CO2 gases in the project area

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
	$\Delta CPAdPA_t$	ΔCPAdPA	$\Delta CPAiPA_t$	ΔCPAiPA	$\Delta CUDdPA_t$	ΔCUDdPA	$\Delta CPSPA_t$	ΔCPSPA	$EBBPSPA_t$	EBBPSPA
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	5,114.14	5,114.14	5,114.14	5,114.14	243.40	243.40

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, as follows.

$$\Delta CLPMLK_t = \Delta CBSLLK_t - \Delta CPSLK_t$$

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 proposed by Grupo Leão REDD Project, no decrease in carbon stocks and/or increase in GHG emissions due to activities implemented in the leakage management area were identified, thus $\Delta CBSLLK = 0$.

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

Table 81. Ex post estimated net carbon stock change in leakage management areas

Project year	Total carbon stock change in the baseline case		Total carbon stock change in the project case		Net carbon stock change due to leakage prevention measures	
	annual $\Delta CBSLLK_t$ tCO_2e	cumulatve $\Delta CBSLLK$ tCO_2e	annual $\Delta CPSLK_t$ tCO_2e	cumulatve $\Delta CPSLK$ tCO_2e	annual $\Delta CLPMLK_t$ tCO_2e	cumulatve $\Delta CLPMLK$ tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00

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

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. As the project will not involve grazing animals or crop plantations in the leakage management area, actions to avoid leakage involves containing the displacement leakage risk. Thus, the main plan for mitigating leakage is to involve the community in monitoring and inspecting deforestation, training, alternative income generation and other actions described in the Social Carbon and Conservation Plan. Therefore, emissions from grazing animals in leakage management areas ($EgLK_t$), which calculation is detailed below, equals to zero.

$$EgLK_t = ECH_4ferm_t + ECH_4man_t + EN_2Oman_t$$

Where,

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

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

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

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

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

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. These emissions were also zero.

$$ELPMLK_t = EgLK_t + \Delta CLPMLK_t$$

Where,

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

Table 82. Ex post estimated total emissions above the baseline from leakage prevention activities

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
	$\Delta CLPMLK_t$	$\Delta CLPMLK$	$EgLK_t$	$EgLK$	$ELPMLK_t$	$ELPMLK$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00

<u>Ex post decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage</u>

Activities that 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.

It is important to note that activity data for the leakage belt area was determined using the same methods applied to monitoring deforestation activity data in the project area. Leakage due to displacement activity was monitored by mapping forest cover change in the leakage belt.

As defined in the VCS Methodology VM0015 v1.1, if carbon stocks in the leakage belt area decrease more during project implementation than projected in the baseline case, this will be an indication that leakage due to displacement of baseline activities has occurred. 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 may not be attributed to the project activity and considered leakage.

Thus, leakage emissions due to activity displacement is calculated as the difference between the ex ante and the ex post assessments, as detailed in the Table below.

Table 83. Total net carbon stock change in the leakage belt

Project year	Total ex ante net baseline carbon stock change		Total ex post net actual carbon stock change		Total ex post leakage	
	$\Delta CBSLLK_t$ annual	$\Delta CBSLLK_t$ cumulative	$\Delta CBSLLK_t$ annual	$\Delta CBSLLK_t$ cumulative	$\Delta CBSLLK_t$ annual	$\Delta CBSLLK_t$ cumulative
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	186,638.90	186,638.90	18,130.84	18,130.84	0.00	0.00

Furthermore, the monitoring of increases in GHG emissions within leakage belt ($EADLK_t$) was also carried out. However, as could be observed in the table above, no increase in GHG emissions within the leakage belt happened, thus non-CO2 emissions from biomass burning in the leakage belt were not associated with the project activity.

<u>Ex post estimation of total leakage</u>

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

$$\Delta CLK_t = \Delta CLPMLK_t + \Delta CADLK_t$$

Where:

ΔCLK_t	Total decrease in carbon stocks within the leakage belt at year t; tCO_2e
$\Delta CLPMLK_t$	Carbon stock decrease due to leakage prevention measures at year t; tCO_2e
$\Delta CADLK_t$	Total decrease in carbon stocks due to displaced deforestation at year t; tCO_2e

$$ELK_t = EgLK_t + EADLK_t$$

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

During this monitoring period, no leakage was accounted for. The results of all ex post estimations of leakage are summarized in the table below.

Table 84. Ex post estimated total leakage

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	$EADLK_t$	EADLK	$\Delta CADLK_t$	$\Delta CADLK$	$\Delta CLPMLK_t$	$\Delta CLPMLK$	ΔCLK_t	ΔCLK	ELK_t	ELK
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6.5 Net GHG Emission Reductions and Removals

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

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

Where:

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

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

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

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

	Note: If ΔCPSPAt represents a net increase in carbon stocks, a negative sign before the absolute value of ΔCPSPAt shall be used. If ΔCPSPAt represents a net decrease, the positive sign shall be used.
EBBPSPAt	Sum of actual emissions from biomass burning in the project area at year t; tCO2e
ΔCLKt	Sum of ex post estimated leakage net carbon stock changes at year t; tCO2e
	Note: If the cumulative sum of ΔCLKt within a fixed baseline period is > 0, ΔCLKt shall be set to zero.
ELKt	Sum of ex 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 each year is calculated as follows:

$$VCUt = \Delta REDDt - VBCt$$

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

Where:

VCUt	Number of Verified Carbon Units that can be traded at time t; t CO2e
ΔREDDt	Ex post estimated net anthropogenic greenhouse gas emission reduction attributable to the AUD project activity at year t; tCO2e
VBCt	Number of Buffer Credits deposited in the VCS Buffer at time t; t CO2e
ΔCBSLPAt	Sum of baseline carbon stock changes in the project area at year t; tCO2e
ΔCPSPAt	Sum of ex post estimated actual carbon stock changes in the project area at year t; tCO2e ha-1
Rft	Risk factor used to calculate VCS buffer credits; %
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless.

The RFt was estimated using the most recent version of the VCS-approved AFOLU Non-Permanence Risk Tool and the resulting value of RFt for this estimated period was 19%.

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

Table 85. Ex post estimated net anthropogenic GHG emission reductions (ΔREDDt) and Verified Carbon Units (VCUt)

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		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
	$\Delta CBSLPA_t$	$\Delta CBSLPA$	$EBBBSLPA_t$	$EBBBSLPA$	$\Delta CPSPA_t$	$\Delta CPSPA$	$EBBPSPA_t$	$EBBPSPA$	ΔCLK_t	ΔCLK	ELK_t	ELK	$\Delta REDD_t$	$\Delta REDD$	VCU_t	VCU	VBC_t	VBC
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2020 (01/03/2020 to 31/12/2020)	23,544	23,544	1,357	1,357	4,262	4,262	203	203	0	0	0	0	20,436	20,436	16,772	16,772	3,664	3,664

The net GHG emission reductions and removals for the first monitoring period of the Yellow Ipê Grouped REDD Project are summarized in the table below:

Table 86. Net GHG emission reductions and removals in the Yellow Ipê Grouped REDD Project

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	*Buffer pool allocation* (tCO_2e)	VCUs eligible for issuance
2020	24,901	4,465	0	3,664	16,772
Total	**24,901**	**4,465**	**0**	**3,664**	**16,772**

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
1	211456.34	9393797.16	45	198281.42	9386756.42	89	216237.64	9353314.79	133	223409.95	9346640.29
2	211837.71	9393600.90	46	198456.18	9387079.17	90	216398.28	9353262.26	134	223509.06	9346638.95
3	212191.91	9393135.93	47	198689.03	9387268.86	91	217353.88	9353057.38	135	223503.07	9346442.65
4	212674.24	9391731.36	48	198839.04	9387375.69	92	217718.32	9353083.96	136	223447.09	9346224.08
5	213170.03	9390842.32	49	199013.47	9387368.19	93	218075.33	9352762.47	137	223522.84	9345960.80
6	213519.83	9390997.03	50	199195.67	9387506.62	94	218075.47	9352757.03	138	223710.48	9345769.00
7	214098.32	9391372.00	51	199145.14	9387867.53	95	218438.37	9352180.65	139	223825.45	9345571.73
8	214676.65	9391378.22	52	199444.56	9388076.95	96	218488.90	9351658.91	140	223756.95	9345193.07
9	214904.21	9391334.14	53	199450.43	9388416.47	97	218626.25	9351236.23	141	223638.75	9344795.56
10	216130.72	9390663.30	54	199764.81	9388689.49	98	218888.62	9350894.80	142	223480.17	9344438.16
11	217011.41	9390210.18	55	200129.58	9389702.17	99	219190.87	9350801.56	143	223301.54	9344236.59
12	217498.47	9389747.41	56	200386.50	9389947.96	100	219562.96	9350970.30	144	223284.72	9344021.74
13	217793.87	9389188.90	57	200390.29	9390326.76	101	220204.68	9351597.26	145	223448.59	9343619.81
14	217745.97	9388694.24	58	200433.36	9390529.56	102	220437.40	9351625.02	146	223674.97	9343319.50
15	217250.94	9387960.20	59	200706.45	9390578.11	103	220749.88	9351282.15	147	223830.98	9343261.53
16	217266.86	9387436.98	60	200779.33	9390692.58	104	220673.39	9350816.19	148	224035.76	9343355.80
17	217833.75	9386375.82	61	200770.07	9390888.01	105	220663.57	9350790.88	149	224181.39	9343341.24
18	218041.33	9385226.90	62	200859.12	9391031.14	106	220416.21	9350188.11	150	224270.57	9343430.65
19	217298.37	9383147.95	63	200948.09	9391035.23	107	220361.30	9349445.61	151	224264.03	9343535.92
20	216204.50	9381113.39	64	201005.46	9391113.75	108	220522.46	9348693.89	152	224195.13	9343610.51
21	215468.94	9379967.26	65	201525.14	9391028.92	109	220584.95	9347990.29	153	224159.10	9343704.86
22	215221.43	9378610.89	66	202073.49	9391048.30	110	220757.16	9347729.07	154	224299.64	9343747.05
23	214295.26	9377422.09	67	202468.99	9390925.37	111	221354.61	9347983.07	155	224669.17	9343591.53
24	212839.37	9376356.24	68	203288.91	9390781.93	112	221906.08	9348410.91	156	224870.76	9343459.22
25	212583.88	9376053.05	69	203888.22	9390849.70	113	222346.36	9348265.26	157	224990.86	9343405.42
26	212599.85	9374928.07	70	204558.28	9391058.15	114	223151.58	9348162.78	158	225081.55	9343461.34
27	212152.73	9373499.88	71	204533.21	9391201.87	115	223463.74	9348462.16	159	225115.62	9343604.22
28	211558.71	9372516.87	72	204783.69	9391422.93	116	223504.10	9348905.51	160	225206.89	9343618.96
29	188054.21	9365872.92	73	205514.74	9391880.47	117	223599.63	9348949.21	161	225207.62	9343538.95
30	179923.76	9379389.91	74	206506.09	9392299.29	118	223787.29	9348740.07	162	225119.24	9343401.51
31	197221.85	9383092.03	75	207081.07	9392436.71	119	224336.82	9348558.79	163	225002.06	9343035.02
32	197085.43	9383279.44	76	207948.11	9392619.71	120	224517.59	9348272.31	164	224998.55	9342864.36
33	197088.03	9383915.63	77	208643.41	9392552.10	121	224417.63	9347837.18	165	225224.71	9342870.73
34	197320.56	9384024.33	78	209235.30	9392578.34	122	224037.24	9347443.57	166	225478.02	9342780.95
35	197378.79	9384178.71	79	210047.17	9392758.70	123	223450.85	9347079.65	167	225633.92	9342745.35
36	197114.37	9384465.43	80	210931.90	9393524.98	124	223086.56	9346761.93	168	225827.11	9342698.33
37	197170.49	9384858.01	81	210942.02	9393669.49	125	222888.49	9346547.80	169	226096.52	9342542.88
38	196913.57	9385112.89	82	217049.76	9356240.54	126	222656.41	9346369.47	170	226505.18	9342402.89
39	196951.09	9385386.50	83	217090.43	9356117.43	127	222619.20	9346193.13	171	226841.10	9342340.22
40	196868.63	9385632.67	84	216967.97	9355800.26	128	222636.25	9346000.55	172	227117.05	9342304.63
41	196987.04	9385878.74	85	216644.19	9355382.46	129	222767.53	9345888.01	173	227354.89	9342243.08
42	197272.09	9386120.48	86	216466.22	9354817.60	130	222936.26	9345905.27	174	205927.71	9335921.99
43	197658.79	9386516.54	87	216362.49	9354347.57	131	223264.35	9346200.98	175	197034.09	9350719.42
44	197863.20	9386507.16	88	216227.45	9353423.25	132	223357.13	9346442.42			

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

Table 87. Source of the remotely sense data used for historical reference period

Vector	Sensor	Resolution		Coverage	Acquisition date	Scene	
		Spatial (m)	Spectral (µm)	(Km^2)	DD/MM/YY	Path	Row
Satellite	Landsat TM	30	0.45 – 2.35	34,225	2009-2018	230	64

The forest dynamics data, the deforestation vectors and other base data from the studied region, which were used for the project's baseline construction, should be organized in a spatialized database. For this purpose, the software used in this baseline reassessment was the File

Geodatabase format from ArcGIS 10.6. The files are stored in vector and matrix format (raster). In order to standardize spatial references, all data has been projected for the UTM and Datum WGS84, Zone 22S projection.

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

Table 88. List, description and reference of bands, fractions and indexes available in the feature space[154]

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

Where,

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

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

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

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

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

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

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

Data classification and post-processing

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

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

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

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

The image classification methodology for each year involves all Landsat images available for each period (Landsat 5 [L5], Landsat 7 [L7] and Landsat 8 [L8]) or other sensor available) with a cloud cover less than or equal to 50%. Thus, a representative mosaic of each year could be

[154] Source: MapBiomas. Description of each column below.

generated, selecting cloud free pixels from the available images. Metrics should be extracted for each pixel that describes its behavior during the year and could contain up to 105 layers of information. The mapping should be done with an artificial intelligence classifier, such as the Randon Forest. The Landsat images acquisition could be made through Google Earth Engine, with data from NASA and USGS (U.S. Geological Survey).

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

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

Gap Fill

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

Spatial Filter

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

Temporal Filter

The temporal filter uses sequential classifications in a three-to-five-years unidirectional moving window to identify temporally non-permitted transitions. Based on generic rules (GR), the temporal filter inspects the central positions of three to five consecutive years, and if the extremities of the consecutive years are identical but the centre position is not, then the central pixels are reclassified to match its temporal 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 spam. All pixels that changed more than eight times and are connected to less than 6 pixels were replaced by the MODE value of that given pixel position in the stack of years.

Classification accuracy assessment

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

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

A total of 210 random points was drawn on the reference region (70 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.

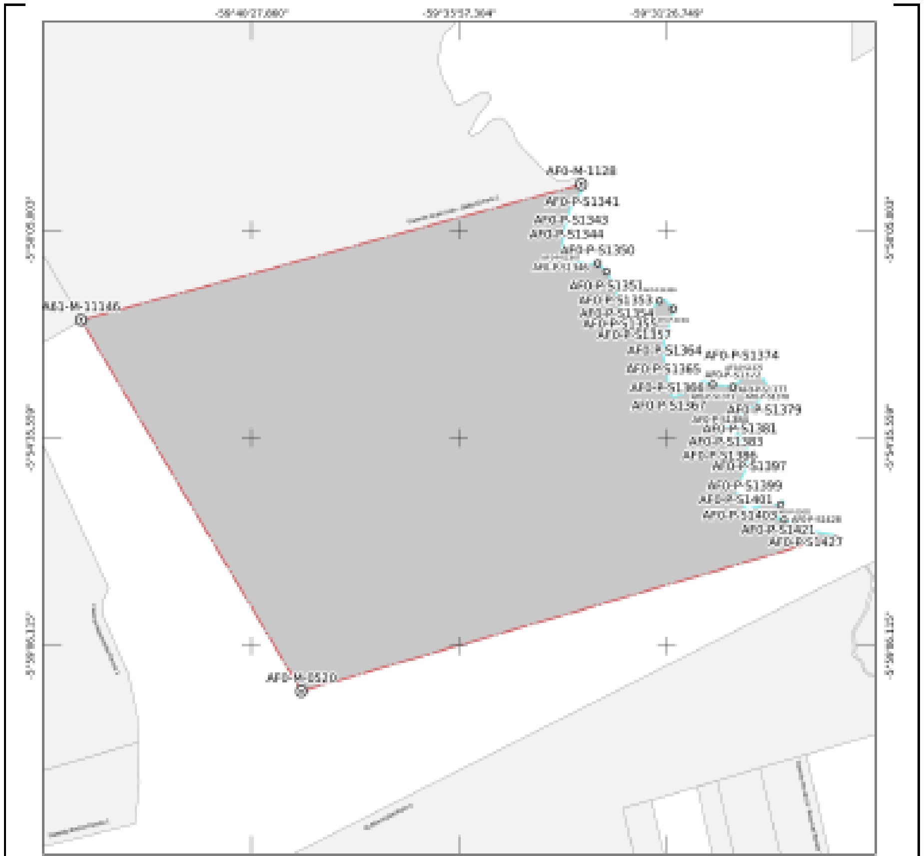
The table below shows the final accuracy analysis carried out for each year and each land use class during the analyzed monitoring period.

Table 89. Summary of confusion matrices from the evaluation of MapBiomas from 2009 to 2019

	Producer accuracy			User accuracy		
Year	Forest	Hydrography	Deforestation	Forest	Hydrography	Deforestation

2009	97.98%	98.99%	96.08%	97.00%	98.00%	98.00%
2010	97.94%	97.73%	86.09%	95.00%	86.00%	99.00%
2011	100.00%	98.04%	99.00%	98.00%	100.00%	99.00%
2012	96.97%	95.19%	95.88%	96.00%	99.00%	93.00%
2013	98.98%	99.01%	98.02%	97.00%	100.00%	99.00%
2014	100.00%	94.29%	93.27%	91.00%	99.00%	97.00%
2015	97.89%	97.09%	95.10%	93.00%	100.00%	97.00%
2016	84.96%	96.08%	95.29%	96.00%	98.00%	81.00%
2017	98.97%	98.02%	98.04%	96.00%	99.00%	100.00%
2018	97.00%	99.00%	98.00%	97.00%	99.00%	98.00%
2019	91.00%	96.15%	90.63%	91.00%	100.00%	87.00%

APPENDIX III – SIGEF Maps



Certificada - Sem Confirmação de Registro em Cartório
Parcela certificada pelo SIGEF de acordo com a Lei 6.015/73 e pendente de confirmação do registro da certificação em cartório

MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO
INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA

Denominação: Fazenda Grupo Leão - Gleba 02
Proprietário: Getulio Matias da Silva
CPF: 044.607.741-00
Matrícula do Imóvel: 1813
Cartório de Registro de Imóveis: (00.477-0) Novo Aripuanã - AM
Código INCRA/SNCR: 9510301389168
Município: Novo Aripuanã-AM

Natureza da Área: Particular
Responsável Técnico: LUÍS ALBERTO DA COSTA
Formação: Técnico de Grau Médio em Agrimensura
Conselho Profissional: 040681508503/AM
Cód. Credenciado: AF0
Documento de RT: AM20180125409 - AM

Área (Sistema Geodésico Local):	Perímetro:	Sistema Geodésico:	Sistema de Coordenadas:	Escala:	Formato:
33564.4922 ha	91.962.50 m	SIRGAS 2000	Lat./Long. - não projetado	1:192899	A4

Vértice tipo M — Linha ideal — Cerca
Vértice tipo P — Limite artificial não tipificado
Vértice tipo V — Corpo d'água ou curso d'água
Vértice tipo O — Linha de cumeada
Muro — Grota — Imóvel em estudo
Estrada — Crista de encosta — Imóveis confrontantes
Vala — Pé de encosta
Canal — Limite natural não tipificado

CERTIFICAÇÃO: 25977034-8959-4230-b195-4a2656069ab1

Em atendimento ao § 5° do art. 176 da Lei 6.015/73, certificamos que a poligonal objeto deste memorial descritivo não se sobrepõe, nesta data, a nenhuma outra poligonal constante do cadastro georreferenciado do INCRA.

Data Certificação: 23/05/2018 12:01
Data de Geração: 14/06/2021 13:33

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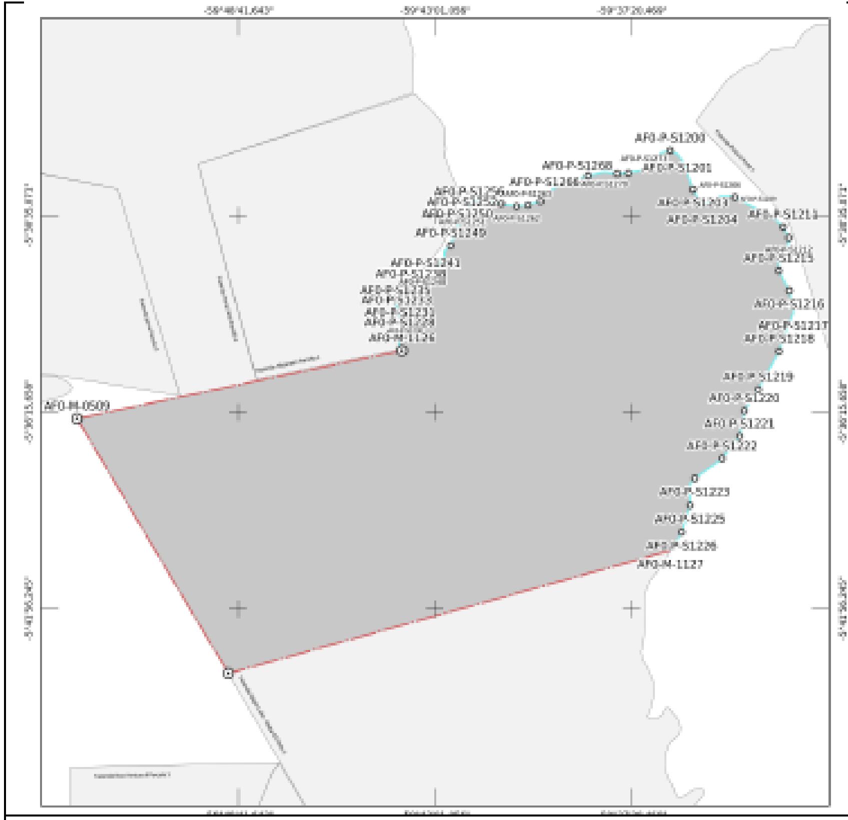

Certificada - Sem Confirmação de Registro em Cartório
Parcela certificada pelo SIGEF de acordo com a Lei 6.015/73 e pendente de confirmação do registro da certificação em cartório

MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO
INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA

Denominação: Fazenda Grupo Leão - Gleba 04
Proprietário: Getulio Matias da Silva
CPF: 044.607.741-00
Matrícula do imóvel: 1818
Cartório de Registro de Imóveis: (00.477-0) Novo Aripuanã - AM
Código INCRA/SNCR: 9510301381698
Município: Novo Aripuanã-AM

Natureza da Área: Particular
Responsável Técnico: LUÍS ALBERTO DA COSTA
Formação: Técnico de Grau Médio em Agrimensura
Conselho Profissional: 0406815080/AN
Cód. Credenciado: AFO
Documento de RT: AM20180125409 - AM

Área (Sistema Geodésico Local):	Perímetro:	Sistema Geodésico:	Sistema de Coordenadas:	Escala:	Formato:
57124,5958 ha	107.993,99 m	SIRGAS 2000	Lat./Long. - não projetado	1:242827	A4

Vértice tipo M — Vértice tipo P — Vértice tipo V — Vértice tipo O — Muro — Estrada — Vala — Canal — Limite ideal — Limite artificial não tipificado — Corpo d'água ou curso d'água — Linha de cumeada — Grota — Crista de encosta — Pé de encosta — Limite natural não tipificado — Cerca — Imóvel em estudo — Imóveis confrontantes

CERTIFICAÇÃO: [illegible]

Em atendimento ao § 5° do art. 176 da Lei 6.015/73, certificamos que a poligonal objeto deste memorial descritivo não se sobrepõe, nesta data, a nenhuma outra poligonal constante do cadastro georreferenciado do INCRA.

Data Certificação: 23/05/2018 11:56
Data de Geração: 14/06/2021 13:35

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APPENDIX IV – SIGEF Descriptive Memorial

MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO
INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA

MEMORIAL DESCRITIVO

Denominação: Fazenda Grupo Leão - Gleba 02
Proprietário: Getulio Matias da Silva
Matrícula do imóvel: 1813
Município/UF: Novo Aripuanã-AM

Natureza da Área: Particular
CPF: 044.607.741-00
Código INCRA/SNCR: 9510301389168
Cartório (CNS): (00.477-0) Novo Aripuanã - AM

Responsável Técnico: LUÍS ALBERTO DA COSTA
Formação: Técnico de Grau Médio em Agrimensura
Código de credenciamento: AF0

Conselho Profissional: 04068150893/AM
Documento de RT: AM20180125409 - AM

Sistema Geodésico de referência: SIRGAS 2000
Área (Sistema Geodésico Local): 33554,4922 ha

Coordenadas: Latitude, longitude e altitude geodésicas
Perímetro (m): 91.962,50 m **Azimutes:** Azimutes geodésicos

DESCRIÇÃO DA PARCELA

VÉRTICE				SEGMENTO VANTE			
Código	Longitude	Latitude	Altitude (m)	Código	Azimute	Dist. (m)	Confrontações
AF0-M-1128	-59°33'18,167"	-5°49'05,895"	12,3	AF0-P-S1341	161°58'	129,56	Rio Camuru
AF0-P-S1341	-59°33'16,864"	-5°49'09,906"	11,93	AF0-P-S1342	201°22'	339,8	Rio Camuru
AF0-P-S1342	-59°33'20,889"	-5°49'20,207"	12,55	AF0-P-S1343	218°01'	528,26	Rio Camuru
AF0-P-S1343	-59°33'31,469"	-5°49'33,752"	12,53	AF0-P-S1344	197°45'	591,9	Rio Camuru
AF0-P-S1344	-59°33'37,334"	-5°49'52,103"	12,68	AF0-P-S1345	192°42'	481,04	Rio Camuru
AF0-P-S1345	-59°33'40,773"	-5°50'07,380"	12,48	AF0-P-S1346	188°34'	933,58	Rio Camuru
AF0-P-S1346	-59°33'45,297"	-5°50'37,432"	12,23	AF0-P-S1347	174°53'	108,86	Rio Camuru
AF0-P-S1347	-59°33'44,982"	-5°50'40,962"	12,16	AF0-P-S1348	108°22'	168,89	Rio Camuru
AF0-P-S1348	-59°33'39,771"	-5°50'42,695"	12,51	AF0-P-S1349	102°21'	976,76	Rio Camuru
AF0-P-S1349	-59°33'08,756"	-5°50'49,502"	12,75	AF0-P-S1350	86°05'	365,17	Rio Camuru
AF0-P-S1350	-59°32'56,912"	-5°50'48,691"	12,62	AF0-P-S1351	132°15'	480,16	Rio Camuru
AF0-P-S1351	-59°32'45,361"	-5°50'59,203"	12,38	AF0-P-S1352	178°40'	5,44	Rio Camuru
AF0-P-S1352	-59°32'45,357"	-5°50'59,380"	12,16	AF0-P-S1353	148°03'	680,71	Rio Camuru
AF0-P-S1353	-59°32'33,652"	-5°51'18,186"	12,51	AF0-P-S1354	174°43'	523,88	Rio Camuru
AF0-P-S1354	-59°32'32,087"	-5°51'35,168"	12,75	AF0-P-S1355	162°15'	444,2	Rio Camuru
AF0-P-S1355	-59°32'27,687"	-5°51'48,940"	12,62	AF0-P-S1356	142°43'	430,34	Rio Camuru
AF0-P-S1356	-59°32'19,213"	-5°52'00,087"	12,38	AF0-P-S1357	107°24'	316,12	Rio Camuru
AF0-P-S1357	-59°32'09,407"	-5°52'03,165"	12,32	AF0-P-S1358	65°51'	408,33	Rio Camuru
AF0-P-S1358	-59°31'57,293"	-5°51'57,730"	11,52	AF0-P-S1359	45°55'	896,62	Rio Camuru

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AF0-P-S1359	-59°31'36,352"	-5°51'37,426"	11,65	AF0-P-S1360	83°27'	234,24	Rio Camuru
AF0-P-S1360	-59°31'28,787"	-5°51'36,557"	12,48	AF0-P-S1361	137°54'	463,66	Rio Camuru
AF0-P-S1361	-59°31'18,685"	-5°51'47,758"	12,84	AF0-P-S1362	189°34'	471,93	Rio Camuru
AF0-P-S1362	-59°31'21,238"	-5°52'02,907"	12,32	AF0-P-S1363	201°27'	27,11	Rio Camuru
AF0-P-S1363	-59°31'21,561"	-5°52'03,729"	12,17	AF0-P-S1364	202°34'	651,2	Rio Camuru
AF0-P-S1364	-59°31'29,686"	-5°52'23,304"	12,2	AF0-P-S1365	184°29'	744,11	Rio Camuru
AF0-P-S1365	-59°31'31,579"	-5°52'47,453"	12,75	AF0-P-S1366	168°09'	768,36	Rio Camuru
AF0-P-S1366	-59°31'26,453"	-5°53'11,934"	12,62	AF0-P-S1367	175°11'	705,98	Rio Camuru
AF0-P-S1367	-59°31'24,526"	-5°53'34,835"	12,38	AF0-P-S1368	146°51'	312,69	Rio Camuru
AF0-P-S1368	-59°31'18,969"	-5°53'43,359"	12,32	AF0-P-S1369	67°13'	648,82	Rio Camuru
AF0-P-S1369	-59°30'59,520"	-5°53'35,183"	11,52	AF0-P-S1370	52°27'	697,59	Rio Camuru
AF0-P-S1370	-59°30'41,539"	-5°53'21,344"	11,65	AF0-P-S1371	108°33'	463,48	Rio Camuru
AF0-P-S1371	-59°30'27,255"	-5°53'26,147"	12,17	AF0-P-S1372	97°30'	811,26	Rio Camuru
AF0-P-S1372	-59°30'01,107"	-5°53'29,599"	12,2	AF0-P-S1373	46°27'	432,28	Rio Camuru
AF0-P-S1373	-59°29'50,921"	-5°53'19,904"	12,75	AF0-P-S1374	05°27'	444,95	Rio Camuru
AF0-P-S1374	-59°29'49,545"	-5°53'05,485"	12,06	AF0-P-S1375	65°40'	105,0	Rio Camuru
AF0-P-S1375	-59°29'46,435"	-5°53'04,077"	10,73	AF0-P-S1376	138°21'	280,83	Rio Camuru
AF0-P-S1376	-59°29'40,368"	-5°53'10,909"	12,2	AF0-P-S1377	108°30'	578,35	Rio Camuru
AF0-P-S1377	-59°29'22,539"	-5°53'16,887"	12,75	AF0-P-S1378	148°00'	338,55	Rio Camuru
AF0-P-S1378	-59°29'16,707"	-5°53'26,234"	12,06	AF0-P-S1379	193°11'	446,23	Rio Camuru
AF0-P-S1379	-59°29'20,018"	-5°53'40,377"	10,73	AF0-P-S1380	224°16'	547,09	Rio Camuru
AF0-P-S1380	-59°29'32,435"	-5°53'53,128"	10,43	AF0-P-S1381	238°25'	689,74	Rio Camuru
AF0-P-S1381	-59°29'51,541"	-5°54'04,883"	10,3	AF0-P-S1382	229°09'	483,12	Rio Camuru
AF0-P-S1382	-59°30'03,424"	-5°54'15,167"	10,58	AF0-P-S1383	223°01'	291,53	Rio Camuru
AF0-P-S1383	-59°30'09,891"	-5°54'22,105"	12,55	AF0-P-S1384	232°43'	292,51	Rio Camuru
AF0-P-S1384	-59°30'17,458"	-5°54'27,873"	12,14	AF0-P-S1385	192°10'	180,14	Rio Camuru
AF0-P-S1385	-59°30'18,693"	-5°54'33,605"	11,93	AF0-P-S1386	175°12'	193,22	Rio Camuru
AF0-P-S1386	-59°30'18,167"	-5°54'39,873"	12,55	AF0-P-S1387	130°51'	172,83	Rio Camuru
AF0-P-S1387	-59°30'13,918"	-5°54'43,554"	11,82	AF0-P-S1388	84°25'	169,51	Rio Camuru
AF0-P-S1388	-59°30'08,433"	-5°54'43,017"	12,71	AF0-P-S1389	48°13'	441,45	Rio Camuru
AF0-P-S1389	-59°29'57,729"	-5°54'33,444"	12,62	AF0-P-S1390	21°16'	258,51	Rio Camuru
AF0-P-S1390	-59°29'54,679"	-5°54'25,602"	12,38	AF0-P-S1391	15°12'	204,69	Rio Camuru
AF0-P-S1391	-59°29'52,934"	-5°54'19,172"	12,32	AF0-P-S1392	91°02'	99,07	Rio Camuru
AF0-P-S1392	-59°29'49,714"	-5°54'19,230"	12,86	AF0-P-S1393	182°00'	196,29	Rio Camuru
AF0-P-S1393	-59°29'49,937"	-5°54'25,616"	12,86	AF0-P-S1394	194°37'	225,5	Rio Camuru
AF0-P-S1394	-59°29'51,788"	-5°54'32,719"	12,32	AF0-P-S1395	164°12'	273,83	Rio Camuru
AF0-P-S1395	-59°29'49,365"	-5°54'41,296"	12,32	AF0-P-S1396	135°53'	268,15	Rio Camuru
AF0-P-S1396	-59°29'43,296"	-5°54'47,564"	12,86	AF0-P-S1397	150°01'	228,22	Rio Camuru
AF0-P-S1397	-59°29'39,589"	-5°54'53,999"	12,86	AF0-P-S1398	190°30'	384,6	Rio Camuru
AF0-P-S1398	-59°29'41,870"	-5°55'06,309"	12,32	AF0-P-S1399	196°48'	414,48	Rio Camuru
AF0-P-S1399	-59°29'45,769"	-5°55'19,225"	11,8	AF0-P-S1400	204°11'	390,78	Rio Camuru
AF0-P-S1400	-59°29'50,974"	-5°55'30,830"	11,94	AF0-P-S1401	221°48'	269,19	Rio Camuru
AF0-P-S1401	-59°29'56,808"	-5°55'37,362"	11,73	AF0-P-S1402	184°43'	215,4	Rio Camuru
AF0-P-S1402	-59°29'57,386"	-5°55'44,350"	12,55	AF0-P-S1403	158°04'	433,81	Rio Camuru
AF0-P-S1403	-59°29'52,120"	-5°55'57,451"	12,53	AF0-P-S1404	143°14'	375,87	Rio Camuru

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AF0-P-S1404	-59°29'44,808"	-5°56'07,255"	12,68	AF0-P-S1405	110°38'	166,33	Rio Camuru
AF0-P-S1405	-59°29'39,747"	-5°56'09,164"	12,48	AF0-P-S1406	65°32'	225,3	Rio Camuru
AF0-P-S1406	-59°29'33,079"	-5°56'06,127"	12,71	AF0-P-S1407	95°57'	146,29	Rio Camuru
AF0-P-S1407	-59°29'28,349"	-5°56'06,622"	12,38	AF0-P-S1408	45°11'	126,21	Rio Camuru
AF0-P-S1408	-59°29'25,438"	-5°56'03,726"	12,32	AF0-P-S1409	356°42'	105,41	Rio Camuru
AF0-P-S1409	-59°29'25,635"	-5°56'00,300"	12,86	AF0-P-S1410	317°31'	101,49	Rio Camuru
AF0-P-S1410	-59°29'27,863"	-5°55'57,863"	12,86	AF0-P-S1411	339°21'	100,95	Rio Camuru
AF0-P-S1411	-59°29'29,020"	-5°55'54,788"	12,32	AF0-P-S1412	73°33'	146,64	Rio Camuru
AF0-P-S1412	-59°29'24,447"	-5°55'53,436"	12,32	AF0-P-S1413	113°04'	400,71	Rio Camuru
AF0-P-S1413	-59°29'12,462"	-5°55'58,550"	12,86	AF0-P-S1414	123°32'	241,0	Rio Camuru
AF0-P-S1414	-59°29'05,931"	-5°56'02,884"	12,86	AF0-P-S1415	114°23'	131,52	Rio Camuru
AF0-P-S1415	-59°29'02,036"	-5°56'04,652"	12,32	AF0-P-S1416	58°35'	106,49	Rio Camuru
AF0-P-S1416	-59°28'59,081"	-5°56'02,846"	11,8	AF0-P-S1417	13°40'	146,81	Rio Camuru
AF0-P-S1417	-59°28'57,953"	-5°55'58,202"	12,71	AF0-P-S1418	81°05'	92,41	Rio Camuru
AF0-P-S1418	-59°28'54,985"	-5°55'57,736"	11,91	AF0-P-S1419	179°44'	79,96	Rio Camuru
AF0-P-S1419	-59°28'54,973"	-5°56'00,339"	12,75	AF0-P-S1420	212°59'	163,33	Rio Camuru
AF0-P-S1420	-59°28'57,865"	-5°56'04,798"	12,45	AF0-P-S1421	197°59'	384,57	Rio Camuru
AF0-P-S1421	-59°29'01,726"	-5°56'16,705"	12,44	AF0-P-S1422	181°26'	170,6	Rio Camuru
AF0-P-S1422	-59°29'01,865"	-5°56'22,257"	12,65	AF0-P-S1423	88°38'	226,13	Rio Camuru
AF0-P-S1423	-59°28'54,515"	-5°56'22,083"	12,17	AF0-P-S1424	109°46'	268,58	Rio Camuru
AF0-P-S1424	-59°28'46,297"	-5°56'25,041"	12,91	AF0-P-S1425	103°07'	159,84	Rio Camuru
AF0-P-S1425	-59°28'41,236"	-5°56'26,222"	13,03	AF0-P-S1426	103°55'	198,73	Rio Camuru
AF0-P-S1426	-59°28'34,965"	-5°56'27,780"	12,14	AF0-P-S1427	120°14'	310,89	Rio Camuru
AF0-P-S1427	-59°28'26,233"	-5°56'32,877"	11,93	AF0-P-S1428	109°10'	431,72	Rio Camuru
AF0-P-S1428	-59°28'12,974"	-5°56'37,491"	12,55	AF0-P-S1429	100°49'	341,54	Rio Camuru
AF0-P-S1429	-59°28'02,067"	-5°56'39,579"	12,32	AF0-P-S1430	97°36'	278,09	Rio Camuru
AF0-P-S1430	-59°27'53,105"	-5°56'40,777"	12,32	AF0-M-1129	104°45'	245,57	Rio Camuru
AF0-M-1129	-59°27'45,385"	-5°56'42,814"	13,61	AF0-M-0520	253°49'	22327,04	Fazenda Grupo Leão - Gleba 01
AF0-M-0520	-59°39'22,618"	-6°00'05,222"	110,32	A61-M-11146	329°16'	17252,64	Terras do Grupo GR
A61-M-11146	-59°44'09,224"	-5°52'02,445"	132,16	AF0-M-1128	74°51'	20749,65	Fazenda Grupo Leão - Gleba 03

Este Memorial Descritivo foi gerado automaticamente pelo Sigef com base nas informações transmitidas e assinadas digitalmente pelo Responsável Técnico (Credenciado).

CERTIFICAÇÃO: 2597703d-99b9-4230-b195-4e2656069ab1

Em atendimento ao § 5° do art. 176 da Lei 6.015/73, certificamos que a poligonal objeto deste memorial descritivo não se sobrepõe, nesta data, a nenhuma outra poligonal constante do cadastro georreferenciado do INCRA.

Data Certificação: 23/05/2018 12:01

Data da Geração: 14/06/2021 13:34

Certificada - Sem Confirmação de Registro em Cartório

Parcela certificada pelo SIGEF de acordo com a Lei 6.015/73 e pendente de confirmação do registro da certificação em cartório

A autenticidade desde documento pode ser verificada pelo endereço eletrônico http://sigef.incra.gov.br/autenticidade/2597703d-99b9-4230-b195-4e2656069ab1/

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MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO

INSTITUTO NACIONAL DE COLONIZAÇÃO E REFORMA AGRÁRIA

MEMORIAL DESCRITIVO

Denominação: Fazenda Grupo Leão - Gleba 04
Proprietário: Getulio Matias da Silva
Matrícula do imóvel: 1818
Município/UF: Novo Aripuanã-AM

Responsável Técnico: LUÍS ALBERTO DA COSTA
Formação: Técnico de Grau Médio em Agrimensura
Código de credenciamento: AF0

Sistema Geodésico de referência: SIRGAS 2000
Área (Sistema Geodésico Local): 57124,5958 ha

Natureza da Área: Particular
CPF: 044.607.741-00
Código INCRA/SNCR: 9510301381698
Cartório (CNS): (00.477-0) Novo Aripuanã - AM

Conselho Profissional: 04068150893/AM
Documento de RT: AM20180125409 - AM

Coordenadas: Latitude, longitude e altitude geodésicas
Perímetro (m): 107.993,99 m **Azimutes:** Azimutes geodésicos

DESCRIÇÃO DA PARCELA

VÉRTICE				SEGMENTO VANTE			
Código	Longitude	Latitude	Altitude (m)	Código	Azimute	Dist. (m)	Confrontações
AF0-P-S1200	-59°36'14,411"	-5°28'43,223"	13,2	AF0-P-S1201	117°28'	428,62	Rio Sucunduri
AF0-P-S1201	-59°36'02,057"	-5°28'49,662"	13,34	AF0-P-S1202	142°57'	584,16	Rio Sucunduri
AF0-P-S1202	-59°35'50,623"	-5°29'04,639"	13,11	AF0-P-S1203	161°17'	1484,15	Rio Sucunduri
AF0-P-S1203	-59°35'35,161"	-5°29'50,603"	13,67	AF0-P-S1204	151°06'	1017,32	Rio Sucunduri
AF0-P-S1204	-59°35'19,189"	-5°30'19,597"	13,44	AF0-P-S1205	66°23'	382,25	Rio Sucunduri
AF0-P-S1205	-59°35'07,810"	-5°30'14,613"	13,45	AF0-P-S1206	57°17'	688,99	Rio Sucunduri
AF0-P-S1206	-59°34'48,975"	-5°30'02,495"	13,44	AF0-P-S1207	89°37'	578,01	Rio Sucunduri
AF0-P-S1207	-59°34'30,197"	-5°30'02,374"	12,22	AF0-P-S1208	101°12'	231,63	Rio Sucunduri
AF0-P-S1208	-59°34'22,815"	-5°30'03,840"	13,44	AF0-P-S1209	118°55'	1397,16	Rio Sucunduri
AF0-P-S1209	-59°33'43,086"	-5°30'25,837"	13,45	AF0-P-S1210	117°28'	989,83	Rio Sucunduri
AF0-P-S1210	-59°33'14,554"	-5°30'40,702"	13,44	AF0-P-S1211	133°46'	671,44	Rio Sucunduri
AF0-P-S1211	-59°32'58,804"	-5°30'55,826"	11,61	AF0-P-S1212	152°22'	631,45	Rio Sucunduri
AF0-P-S1212	-59°32'49,290"	-5°31'14,038"	13,44	AF0-P-S1213	185°46'	496,7	Rio Sucunduri
AF0-P-S1213	-59°32'50,914"	-5°31'30,125"	13,45	AF0-P-S1214	214°14'	884,84	Rio Sucunduri
AF0-P-S1214	-59°33'07,090"	-5°31'53,938"	13,44	AF0-P-S1215	178°30'	523,16	Rio Sucunduri
AF0-P-S1215	-59°33'06,646"	-5°32'10,963"	13,61	AF0-P-S1216	152°08'	1202,39	Rio Sucunduri
AF0-P-S1216	-59°32'48,387"	-5°32'45,567"	13,6	AF0-P-S1217	170°00'	1166,84	Rio Sucunduri
AF0-P-S1217	-59°32'41,807"	-5°33'22,976"	13,45	AF0-P-S1218	199°54'	2206,42	Rio Sucunduri
AF0-P-S1218	-59°33'06,224"	-5°34'30,510"	13,44	AF0-P-S1219	208°30'	2308,59	Rio Sucunduri

Este Memorial Descritivo foi gerado automaticamente pelo Sigef com base nas informações transmitidas e assinadas digitalmente pelo Responsável Técnico (Credenciado).

AF0-P-S1219	-59°33'42,032"	-5°35'36,549"	13,46	AF0-P-S1220	212°56'	1361,06	Rio Sucunduri
AF0-P-S1220	-59°34'06,061"	-5°36'13,733"	13,47	AF0-P-S1221	190°35'	1377,94	Rio Sucunduri
AF0-P-S1221	-59°34'14,312"	-5°36'57,826"	14,46	AF0-P-S1222	218°10'	1506,09	Rio Sucunduri
AF0-P-S1222	-59°34'44,559"	-5°37'36,370"	13,1	AF0-P-S1223	234°02'	1803,22	Rio Sucunduri
AF0-P-S1223	-59°35'31,992"	-5°38'10,836"	13,48	AF0-P-S1224	220°22'	396,24	Rio Sucunduri
AF0-P-S1224	-59°35'40,333"	-5°38'20,663"	12,44	AF0-P-S1225	179°26'	1124,41	Rio Sucunduri
AF0-P-S1225	-59°35'39,977"	-5°38'57,265"	13,46	AF0-P-S1226	197°38'	1495,6	Rio Sucunduri
AF0-P-S1226	-59°35'54,705"	-5°39'43,664"	10,37	AF0-M-1127	211°24'	1147,85	Rio Sucunduri
AF0-M-1127	-59°36'14,140"	-5°40'15,558"	11,52	AF0-M-0508	254°28'	24408,02	Fazenda Grupo Leão – Gleba 03
AF0-M-0508	-59°48'58,472"	-5°43'48,093"	14,22	AF0-M-0509	329°15'	15760,65	Terras do Grupo QR
AF0-M-0509	-59°53'20,305"	-5°36'27,131"	14,98	AF0-M-1126	78°12'	17675,7	Terras de Terceiros
AF0-M-1126	-59°43'58,121"	-5°34'29,401"	14,68	AF0-P-S1227	324°12'	231,61	Rio Capirana
AF0-P-S1227	-59°44'02,522"	-5°34'23,284"	13,45	AF0-P-S1228	00°29'	635,73	Rio Capirana
AF0-P-S1228	-59°44'02,342"	-5°34'02,589"	13,44	AF0-P-S1229	65°12'	256,5	Rio Capirana
AF0-P-S1229	-59°43'54,776"	-5°33'59,088"	13,46	AF0-P-S1230	20°55'	164,88	Rio Capirana
AF0-P-S1230	-59°43'52,862"	-5°33'54,075"	13,47	AF0-P-S1231	317°34'	389,76	Rio Capirana
AF0-P-S1231	-59°44'01,404"	-5°33'44,708"	14,46	AF0-P-S1232	08°24'	396,28	Rio Capirana
AF0-P-S1232	-59°43'59,523"	-5°33'31,946"	13,1	AF0-P-S1233	315°02'	361,63	Rio Capirana
AF0-P-S1233	-59°44'07,826"	-5°33'23,616"	13,48	AF0-P-S1234	08°04'	275,97	Rio Capirana
AF0-P-S1234	-59°44'06,567"	-5°33'14,721"	13,46	AF0-P-S1235	341°44'	259,43	Rio Capirana
AF0-P-S1235	-59°44'09,207"	-5°33'06,701"	13,47	AF0-P-S1236	25°57'	272,86	Rio Capirana
AF0-P-S1236	-59°44'05,326"	-5°32'58,714"	14,46	AF0-P-S1237	49°57'	373,49	Rio Capirana
AF0-P-S1237	-59°43'56,035"	-5°32'50,893"	13,1	AF0-P-S1238	44°34'	553,12	Rio Capirana
AF0-P-S1238	-59°43'43,421"	-5°32'38,067"	13,47	AF0-P-S1239	92°53'	204,48	Rio Capirana
AF0-P-S1239	-59°43'36,786"	-5°32'38,403"	14,46	AF0-P-S1240	59°28'	486,5	Rio Capirana
AF0-P-S1240	-59°43'23,171"	-5°32'30,357"	13,1	AF0-P-S1241	28°41'	366,77	Rio Capirana
AF0-P-S1241	-59°43'17,449"	-5°32'19,884"	13,48	AF0-P-S1242	51°05'	300,12	Rio Capirana
AF0-P-S1242	-59°43'09,861"	-5°32'13,748"	13,46	AF0-P-S1243	54°48'	184,04	Rio Capirana
AF0-P-S1243	-59°43'04,975"	-5°32'10,295"	13,47	AF0-P-S1244	92°43'	174,45	Rio Capirana
AF0-P-S1244	-59°42'59,313"	-5°32'10,565"	13,96	AF0-P-S1245	53°02'	228,65	Rio Capirana
AF0-P-S1245	-59°42'53,377"	-5°32'06,089"	14,0	AF0-P-S1246	352°17'	364,17	Rio Capirana
AF0-P-S1246	-59°42'54,964"	-5°31'54,341"	14,04	AF0-P-S1247	55°17'	365,14	Rio Capirana
AF0-P-S1247	-59°42'45,212"	-5°31'47,573"	14,06	AF0-P-S1248	01°15'	339,33	Rio Capirana
AF0-P-S1248	-59°42'44,971"	-5°31'36,529"	14,11	AF0-P-S1249	49°17'	416,09	Rio Capirana
AF0-P-S1249	-59°42'34,724"	-5°31'27,694"	14,14	AF0-P-S1250	20°04'	1075,6	Rio Capirana
AF0-P-S1250	-59°42'22,732"	-5°30'54,805"	13,47	AF0-P-S1251	46°31'	355,3	Rio Capirana
AF0-P-S1251	-59°42'14,355"	-5°30'46,847"	13,96	AF0-P-S1252	00°50'	378,56	Rio Capirana
AF0-P-S1252	-59°42'14,176"	-5°30'34,525"	14,0	AF0-P-S1253	12°15'	207,17	Rio Capirana
AF0-P-S1253	-59°42'12,748"	-5°30'27,934"	14,04	AF0-P-S1254	80°10'	277,16	Rio Capirana
AF0-P-S1254	-59°42'03,875"	-5°30'26,395"	13,48	AF0-P-S1255	32°45'	135,62	Rio Capirana
AF0-P-S1255	-59°42'01,492"	-5°30'22,682"	12,44	AF0-P-S1256	357°32'	195,49	Rio Capirana
AF0-P-S1256	-59°42'01,764"	-5°30'16,323"	11,25	AF0-P-S1257	32°08'	168,46	Rio Capirana
AF0-P-S1257	-59°41'58,852"	-5°30'11,680"	13,65	AF0-M-1125	87°37'	89,0	Rio Capirana
AF0-M-1125	-59°41'55,963"	-5°30'11,560"	11,36	AF0-P-S1258	36°24'	97,19	Rio Sucunduri
AF0-P-S1258	-59°41'54,069"	-5°30'09,014"	13,45	AF0-P-S1259	99°31'	526,2	Rio Sucunduri

Este Memorial Descritivo foi gerado automaticamente pelo Sigef com base nas informações transmitidas e assinadas digitalmente pelo Responsável Técnico (Credenciado).

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AF0-P-S1259	-59°41'37,230"	-5°30'11,850"	13,85	AF0-P-S1260	88°14'	548,31	Rio Sucunduri
AF0-P-S1260	-59°41'19,425"	-5°30'11,300"	11,61	AF0-P-S1261	107°31'	413,88	Rio Sucunduri
AF0-P-S1261	-59°41'06,603"	-5°30'15,357"	13,2	AF0-P-S1262	100°10'	831,79	Rio Sucunduri
AF0-P-S1262	-59°40'40,005"	-5°30'20,143"	13,45	AF0-P-S1263	83°48'	602,73	Rio Sucunduri
AF0-P-S1263	-59°40'20,538"	-5°30'18,026"	13,7	AF0-P-S1264	72°58'	701,24	Rio Sucunduri
AF0-P-S1264	-59°39'58,754"	-5°30'11,342"	13,9	AF0-P-S1265	350°21'	145,79	Rio Sucunduri
AF0-P-S1265	-59°39'59,547"	-5°30'06,663"	14,56	AF0-P-S1266	48°49'	333,87	Rio Sucunduri
AF0-P-S1266	-59°39'51,383"	-5°29'59,508"	11,36	AF0-P-S1267	58°12'	861,83	Rio Sucunduri
AF0-P-S1267	-59°39'27,583"	-5°29'44,729"	13,45	AF0-P-S1268	67°21'	1075,48	Rio Sucunduri
AF0-P-S1268	-59°38'55,338"	-5°29'31,247"	13,85	AF0-P-S1269	76°48'	590,78	Rio Sucunduri
AF0-P-S1269	-59°38'36,651"	-5°29'26,859"	11,61	AF0-P-S1270	78°20'	885,56	Rio Sucunduri
AF0-P-S1270	-59°38'08,476"	-5°29'21,030"	13,9	AF0-P-S1271	95°48'	698,12	Rio Sucunduri
AF0-P-S1271	-59°37'45,912"	-5°29'23,329"	14,56	AF0-P-S1272	87°42'	592,08	Rio Sucunduri
AF0-P-S1272	-59°37'26,692"	-5°29'22,560"	11,36	AF0-P-S1273	77°43'	831,14	Rio Sucunduri
AF0-P-S1273	-59°37'00,308"	-5°29'16,808"	13,45	AF0-P-S1274	49°21'	1169,68	Rio Sucunduri
AF0-P-S1274	-59°36'31,476"	-5°28'52,004"	12,22	AF0-P-S1275	04°15'	144,79	Rio Sucunduri
AF0-P-S1275	-59°36'31,127"	-5°28'47,304"	11,78	AF0-P-S1200	76°18'	529,59	Rio Sucunduri

Este Memorial Descritivo foi gerado automaticamente pelo Sigef com base nas informações transmitidas e assinadas digitalmente pelo Responsável Técnico (Credenciado).

CERTIFICAÇÃO: d4773c4a-ab4d-4da0-aa90-eee9e710ee4f

Em atendimento ao § 5° do art. 176 da Lei 6.015/73, certificamos que a poligonal objeto deste memorial descritivo não se sobrepõe, nesta data, a nenhuma outra poligonal constante do cadastro georreferenciado do INCRA.

Data Certificação: 23/05/2018 11:56

Data da Geração: 14/06/2021 13:38

Certificada - Sem Confirmação de Registro em Cartório

Parcela certificada pelo SIGEF de acordo com a Lei 6.015/73 e pendente de confirmação do registro da certificação em cartório

A autenticidade desde documento pode ser verificada pelo endereço eletrônico http://sigef.incra.gov.br/autenticidade/d4773c4a-ab4d-4da0-aa90-eee9e710ee4f/