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 Project area 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 86,097.67 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 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.

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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>.

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 25,680.81 ha of deforestation, equating to around 8,199,069 tCO_2e 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.

General eligibility criteria:

1) Projects must be located within the Reference Region described in Section 1.12.

2) The start date of the activity of each parcel and instance must be the same as or after the start date of the grouped project as established in Section 1.8

3) Project activities eligible under Yellow Ipê Grouped REDD Project shall be defined as AFOLU – REDD AUD Project.

4) All carbon emissions and reductions must be calculated according to the approved VCS Methodology VM0015: Methodology for Avoided Unplanned Deforestation, version 1.1, published on 03-December-2012.

5) The Project must be considered in the same baseline scenario determined in Section 3.4.

Activity Eligibility Criteria

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

   a. 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.

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

   a. A new additionality and AFOLU non-permanence risk analyses shall be provided.

1.5 Project Proponent

Organization name	Ecológica Assessoria Ltda.: Project developer, Project participant and Project conceiver.
Contact person	Technical team
Title	Technical team
Address	Quadra 103 Sul, Rua SO-01, Lote 01, Sala 603 B, Edifício JK Business, Plano Diretor Sul, Palmas – TO, Brazil Postal Code: 77015-014 www.ecologica.org.br
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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
Contact person	Stefano Merlin
Title	CEO
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Telephone	+55 11 2649-0036
Email	smerlin@sustainablecarbon.com

Organization name	Grupo Leão
Contact person	Rafael Matias Pedroza
Title	Project owner
Address	Rua JK, n° 1785, Vila Fátima, Jataí – GO, Brazil Postal Code: 75803-019

Telephone	+55 64 98452 1911
Email	rafaelpedrozaadv@hotmail.com

Organization name	Uezu Planejamento Ambiental S/S LTDA
Role in the project	Geographic Information System – GIS
Contact person	Alexandre Uezu
Title	CEO
Address	Rodovia Dom Pedro I – KM 47, SN, Nazaré Paulista – SP
Telephone	-
Email	-

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, specifically in Appendix X.

1.8 Project Start Date

The project start date is 12-February-2020, and it was defined taking into consideration the date of contract signing 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.

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	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2020[6]	12,530
2021	19,345
2022	36,824
2023	42,022
2024	42,027
2025	50,074
2026	63,572
2027	61,452
2028	73,771
2029	89,133

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

[6] From 01-March-2020 to 31-December-2020

2030	103,851
2031	99,556
2032	124,006
2033	148,501
2034	184,206
2035	201,753
2036	240,784
2037	269,258
2038	331,098
2039	386,683
2040	405,652
2041	431,787
2042	486,199
2043	537,069
2044	522,005
2045	572,035
2046	612,105
2047	625,499
2048	637,595
2049	676,595
2050[7]	112,084
Total estimated ERs	**8,199,069**
Total number of crediting years	**30**
Average annual ERs	**273,302**

[7] From 01-Janurary-2050 to 28-February-2050

1.11 Description of the Project Activity

The principal objective of the present REDD project is the conservation of 86,097.67 ha of forest area within the Grupo Leão properties (Glebas 2 e 4). This will be achieved through avoidance of unplanned deforestation. It is important to note that this project is not located within a jurisdiction covered by a jurisdictional REDD+ program.

The *ex-ante* estimate for the predicted avoided deforestation within the project area over the 30-year project lifetime would be 25,860.81 ha. The avoided emissions due to the Yellow Ipê Grouped REDD AUD Project are expected to be 8,568,286 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.

1.12 Project Location

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,

[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.

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

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 4,703.57ha. This was excluded from the initial area of 90,801.24ha, resulting in 86,097.67ha, which was then defined as project area.

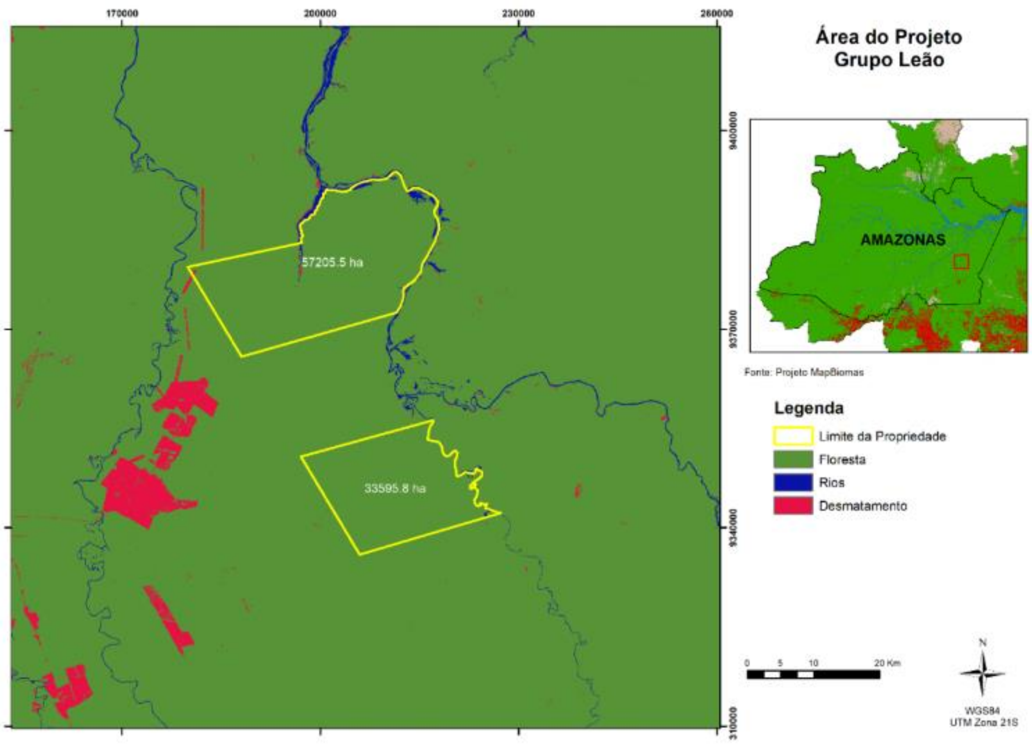

Figure 1 - Location of Grupo Leão properties in the state of Amazonas.

<u>**Definition of the property boundaries**</u>

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:

[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

- The methodology recommendation that projects over 100,000 ha in size should have RRs 5 to 7 times bigger than the project area.
- The conditions determining the likelihood of deforestation within the project area being similar or expected to become similar to those found within the reference region, depending on: the landscape configuration and ecological conditions (elevation, slope, vegetation and rainfall), socio-economic and cultural conditions, and agents and drivers of deforestation (agent groups, infrastructure or other drivers). The latter condition was the most important for adjusting the RR 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, which was 1,438,191.92 ha, 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 population 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.

Maps below show some of the criteria that were take into account in order to adjust the Yellow Ipê Grouped REDD Project's Reference Region.

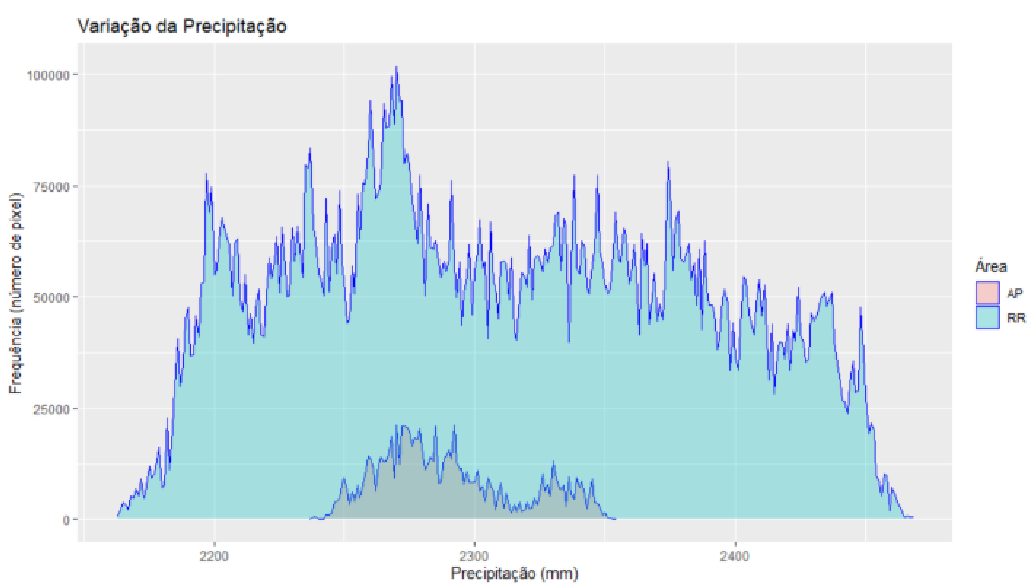

Figure 2 - Distribution of annual precipitation (mm), in number of pixels, in the Reference Region (RR) and in the Project Area (PA).

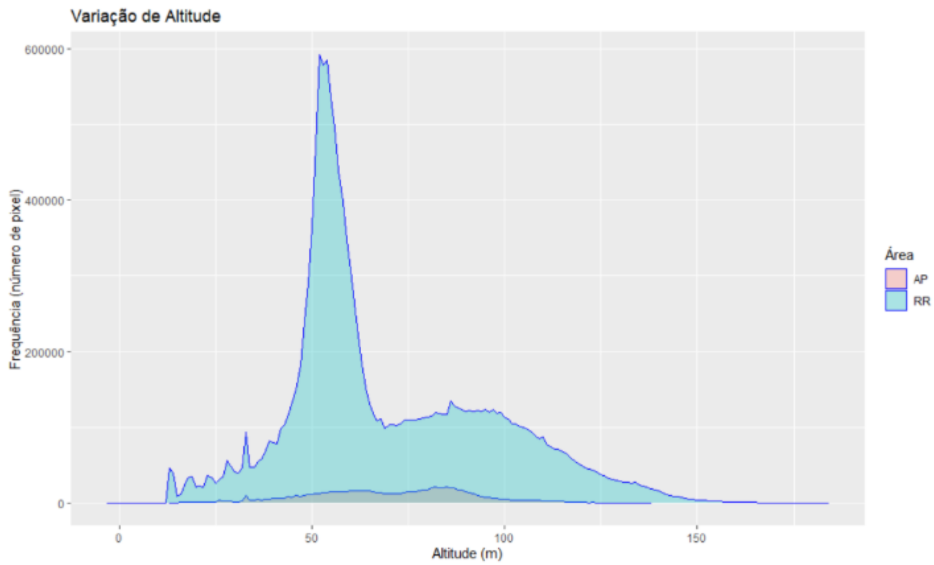

Figure 3 - Altitude distribution (m), in number of pixels, in the Reference Region (RR) and in the Project Area (PA).

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 4 represents the total distance in the reference region.

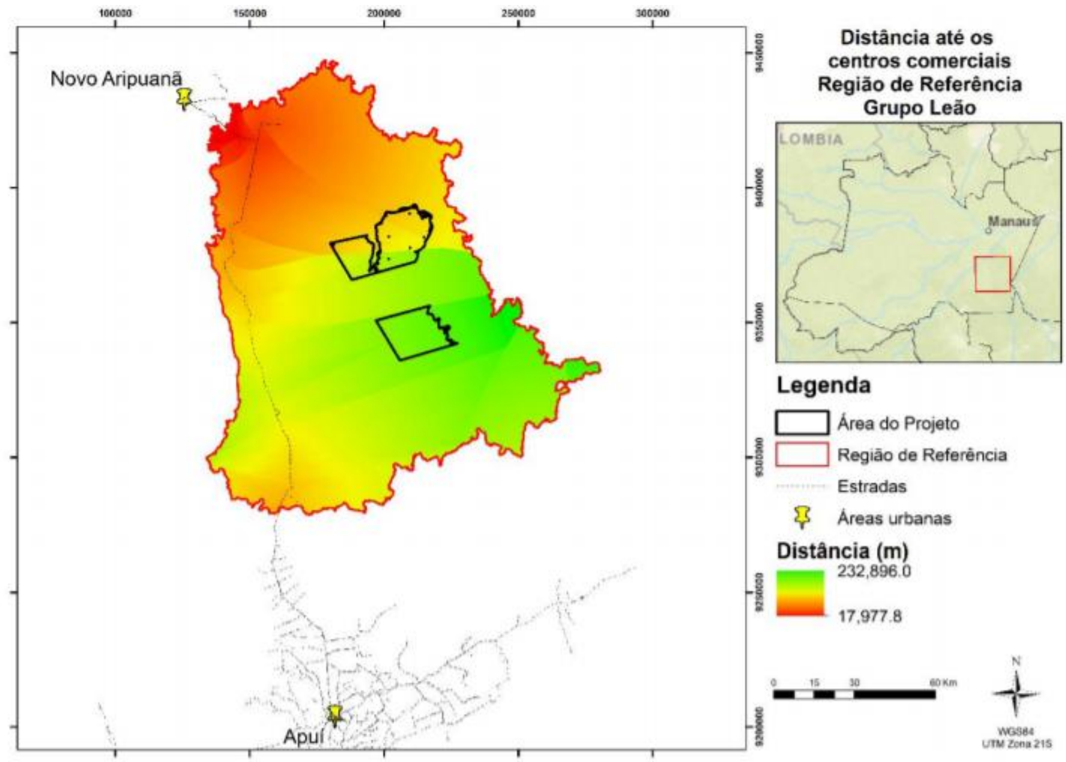

Figure 4 - Surface distances (m) to the nearest commercial centers (Apuí and Novo Aripuanã) in the Reference Region (RR)

For monetary costs, the freight table available in Resolution No. 5,890, of May 26, 2020, for road transportation of cargo capacity was considered. In Apuí, each animal weighs an average of 13 arrobas (CARRERO et al., 2015), 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 XX illustrates the freight values that would be paid at each point in the reference region.

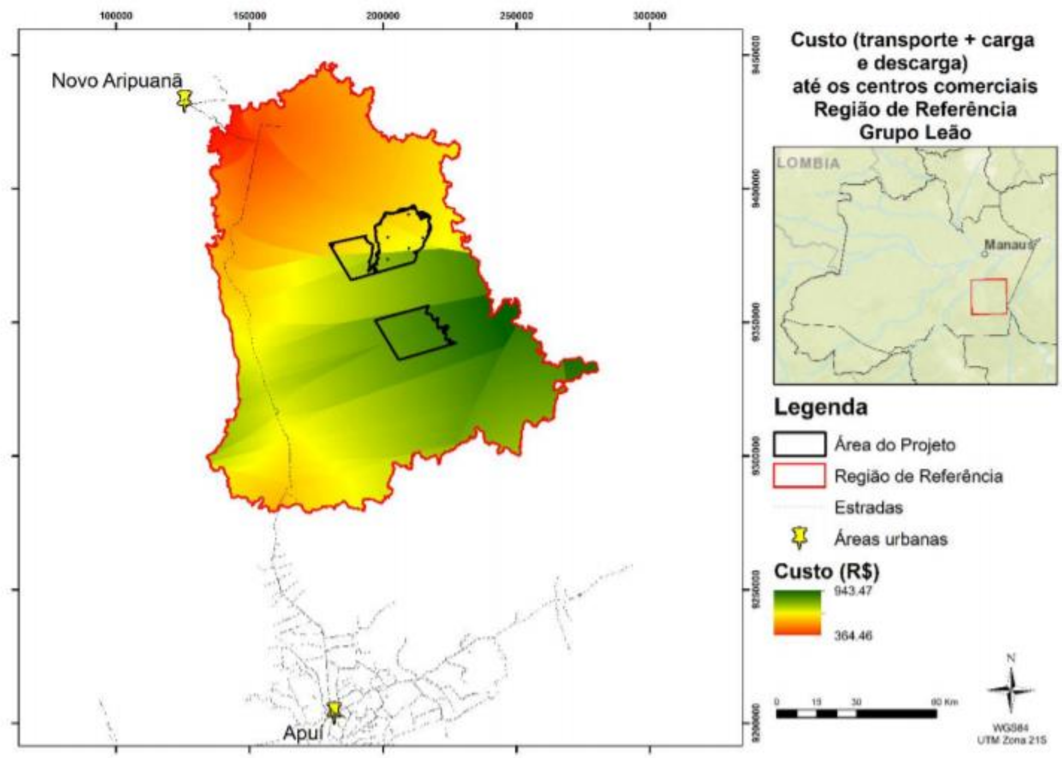

Figure 5 - Surface costs (R$) for road transportation to the nearest commercial centers (Apuí and Novo Aripuanã) in the Reference Region (RR).

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 (CARRERO et al., 2014). As reported in interviews in Apuí, the average price of the arroba varies between R$ 80 and R$ 92 (CARRERO et al., 2015). The analysis used the minimum value of R$ 80. Thus, for an average of 13 arrobas per animal, R$ 1,040.00.

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

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

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 6 below.

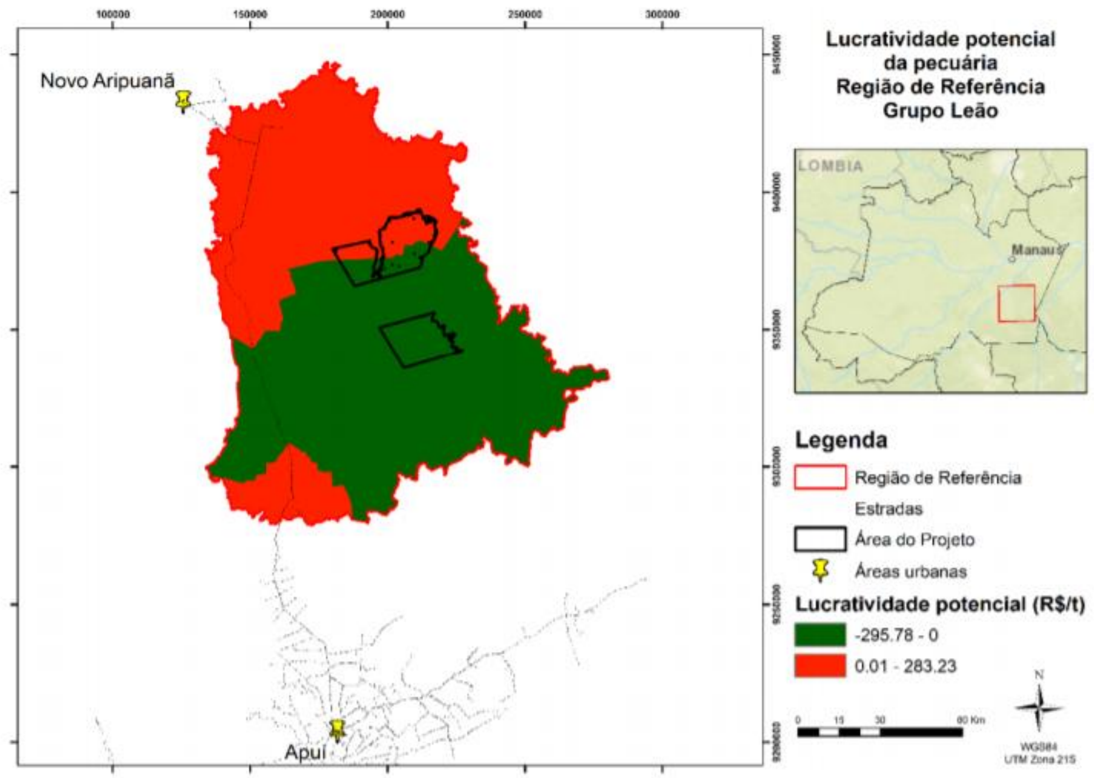

Figure 6 - Potential profitability areas for cattle ranching within the Reference Region (RR).

Leakage Management Area

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.

Climate

The Novo Aripuanã region is classified as Tropical rainforest climate type – category Af – in the Köppen climate classification[11]. This means that it has no dry season, and the average annual rainfall is high, averaging 2,289mm year^{-1} in the project area, while in the rest of the reference region it is 2,309.46 mm (Figure 8), 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. The relative humidity average in the region is 85%[12].

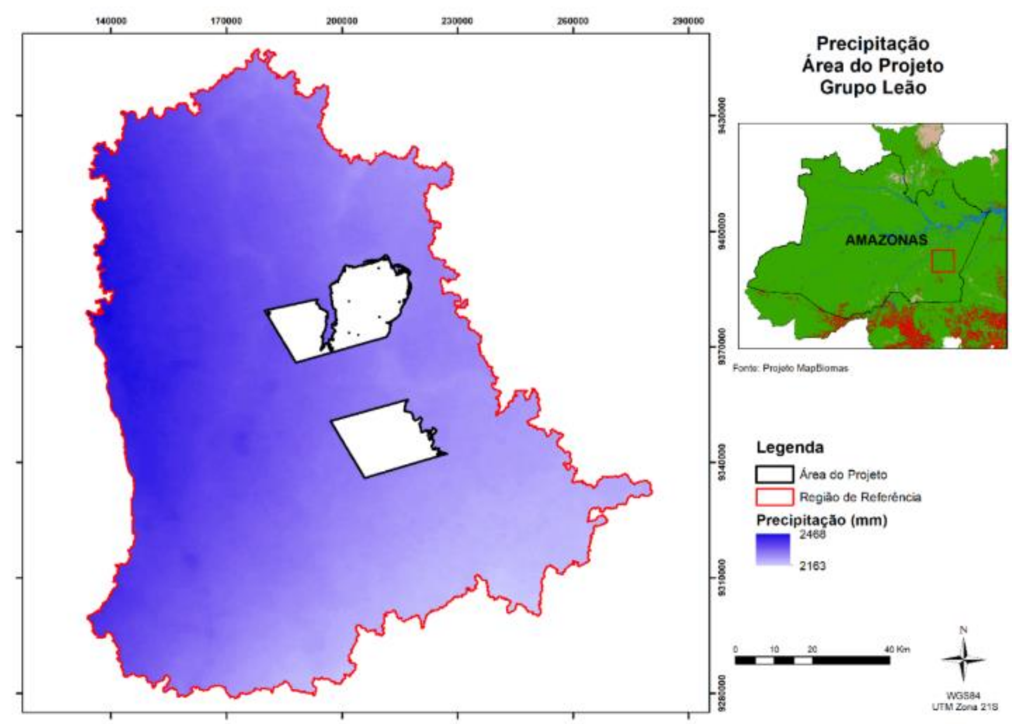

Figure 8 - Variation of annual precipitation in the Reference Region of the Yellow Ipê Grouped REDD Project.

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.

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

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

Geology, Topography and Soils

Relief and topography within the project area are from the middle plateau of the Sucunduri River, according to the figure 9 below. Plateaus are planed surfaces, characterized by the erosion factor and material deposition. The relief can assume different shapes, as escarpment, saw or plateau. In addition, the altitude in the project area ranges from 13 to 138 m (Figure 10) and these values are within 99% of the variation in the reference region.

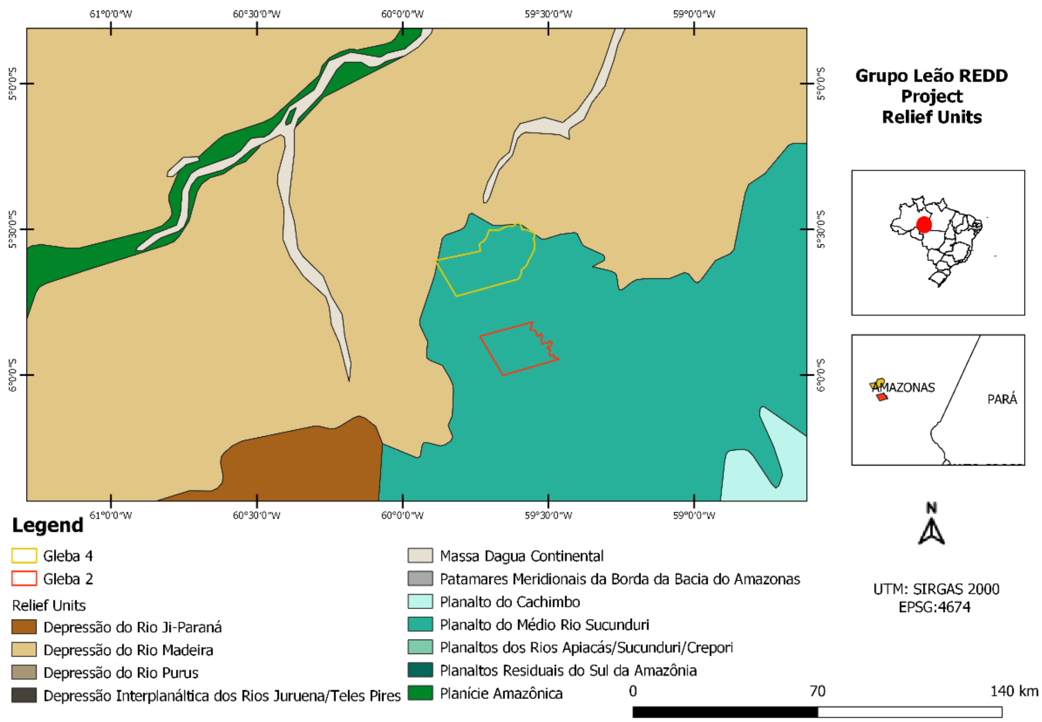

Figure 9 – Relief units in the Project Area

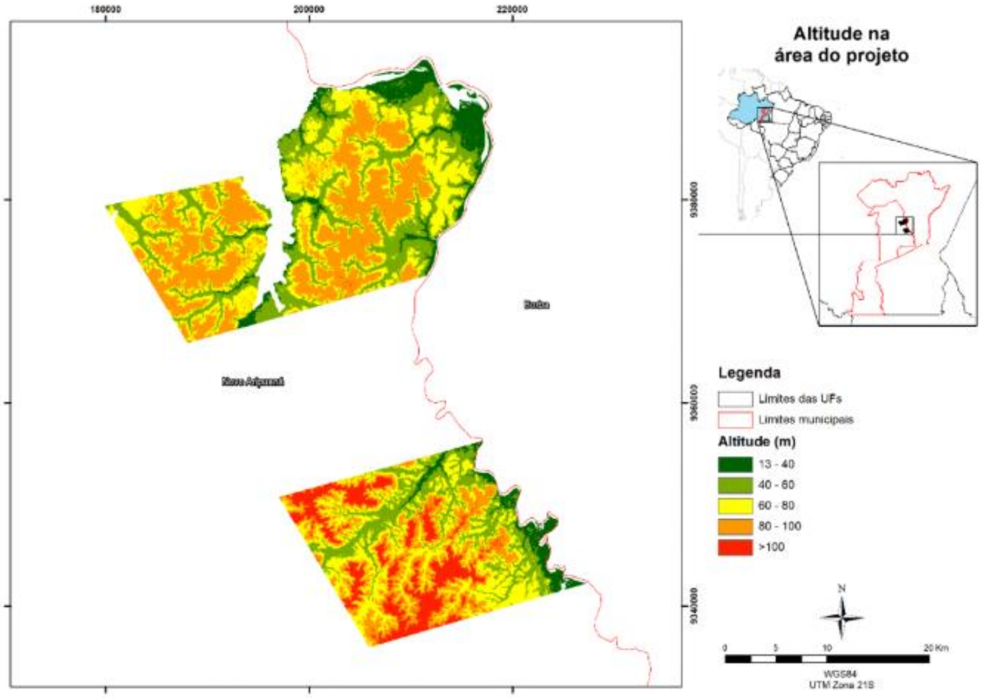

Figure 10 - Altitude variation in the Yellow Ipê Grouped REDD Project Area.

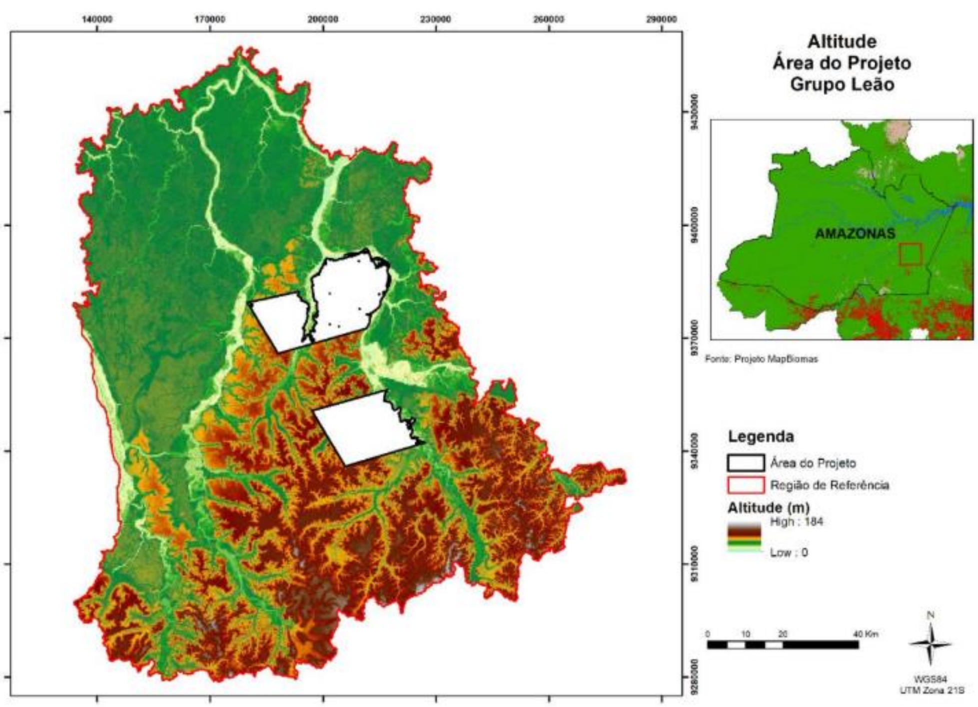

Figure 11 - Altitude variation in the Reference Region of Yellow Ipê Grouped REDD Project.

The municipality of Novo Aripuanã consists 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.

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. [13]

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.

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[14].

Furthermore, according to RADAMBRASIL (1978)[15], 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[16].

<u>Socio-economic conditions</u>

Industrial activity in the Novo Aripuanã micro-region is concentrated in timber production, açaí berries and Brazilian nuts. During the 2008-2018 period, in the municipality of Novo

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[13] According to the Territorial plan for sustainable rural development – Madeira Territory, 2010. Available at:

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

[15] RADAMBRASIL. Levantamento de Recursos Naturais: Geologia, Geomorfologia, Solos, Vegetação, Uso Potencial da Terra. Rio de Janeiro, 1978.

[16] 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.

Aripuanã in which the project is located, almost 36% of the total value of production from these three products was represented by logged timber, while around 27% was represented by açaí berries and 18% by Brazilian nuts[17]. In addition, other activities occur such as, copaiba oil extraction (around 13%) and hevea berries (6%), as depicted in the Table below.

	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	52.05%	5.03%				42.92%	100%

Table 1. Annual average values of production in municipalities of project area (2008 - 2018) (R$)[18]

The socio-economic climate described is 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[19], aims to deliver appropriate, integrated and quantifiable ecological and socio-economic benefits to the population of the project area.

Biodiversity

The Brazilian Government Ministry for the environment (Ministério do Meio Ambiente) included Novo Aripuanã in its 2003 survey of Brazil's 900 priority areas for conservation[20]. The entire Project Area is classed within the ministry's highest priority category: "extremely high", as demonstrated in the figure 08 below.

[17] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE).

[18] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE).

[19] Currently under negotiation

[20] MMA (2003): http://www.mma.gov.br/estruturas/chm/_arquivos/maparea.pdf

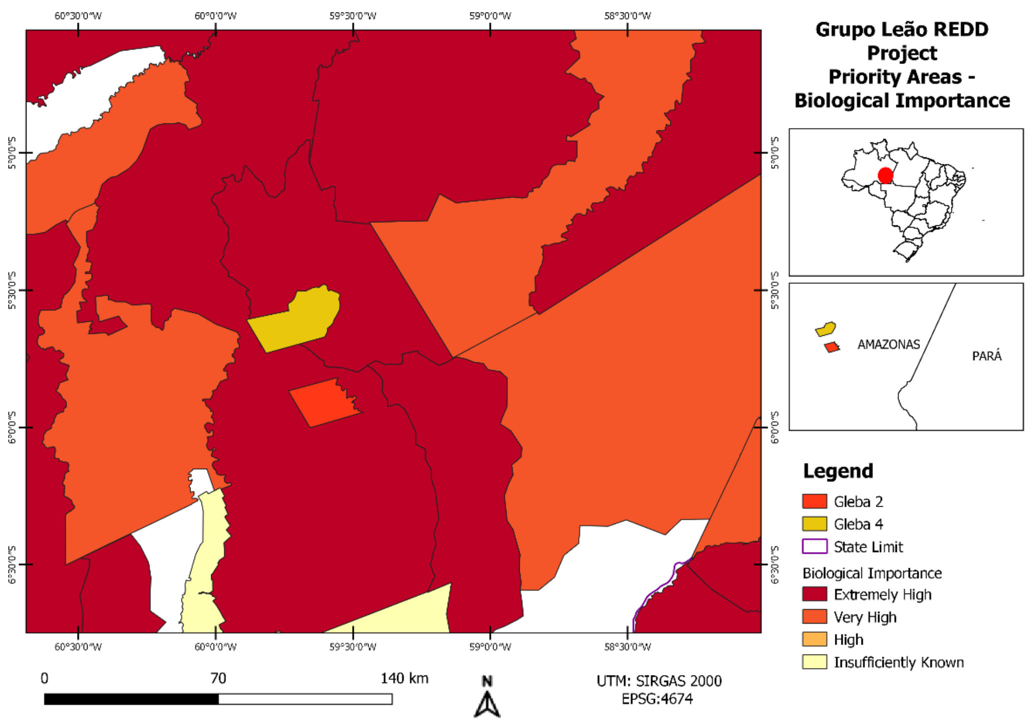

Figure 12 – Priority areas – Biological importance

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[21].

In the regional context, the Southern Amazon Mosaic is within areas of high richness of birds, mammals and amphibian species, according to Figure 28 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[22].

[21] 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>. Last visit on: January 26th, 2015.

[22] 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.

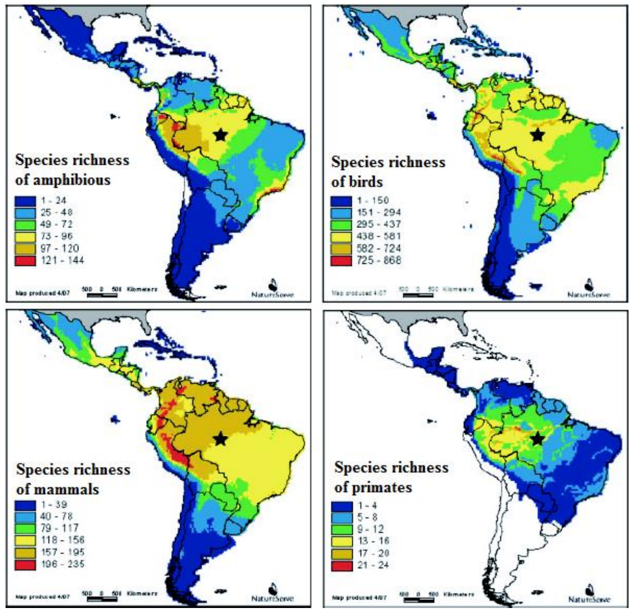

Figure 13. Species richness of amphibians, birds, mammals and primates within the project region

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*)[23]. Table 10 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.

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%

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

Fish	54	0	0%
TOTAL	**741**	**13**	**2%**

Table 2. Species listed by IUCN as vulnerable or endangered categories in Brazil and project region[24]

Turning to 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[25]:

- Sucunduri State Park: a forest inventory was conducted over 5ha, 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.

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[26].

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

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

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

[26] Nelson, B.W. e A. A. Oliveira. 1999. Avaliação e Ações prioritárias para a Conservação do bioma Floresta Amazônia: Ações Prioritárias para a Conservação da Biodiversidade da Amazônia. Programa Nacional da Diversidade Biológica- PROBIO, MMA.

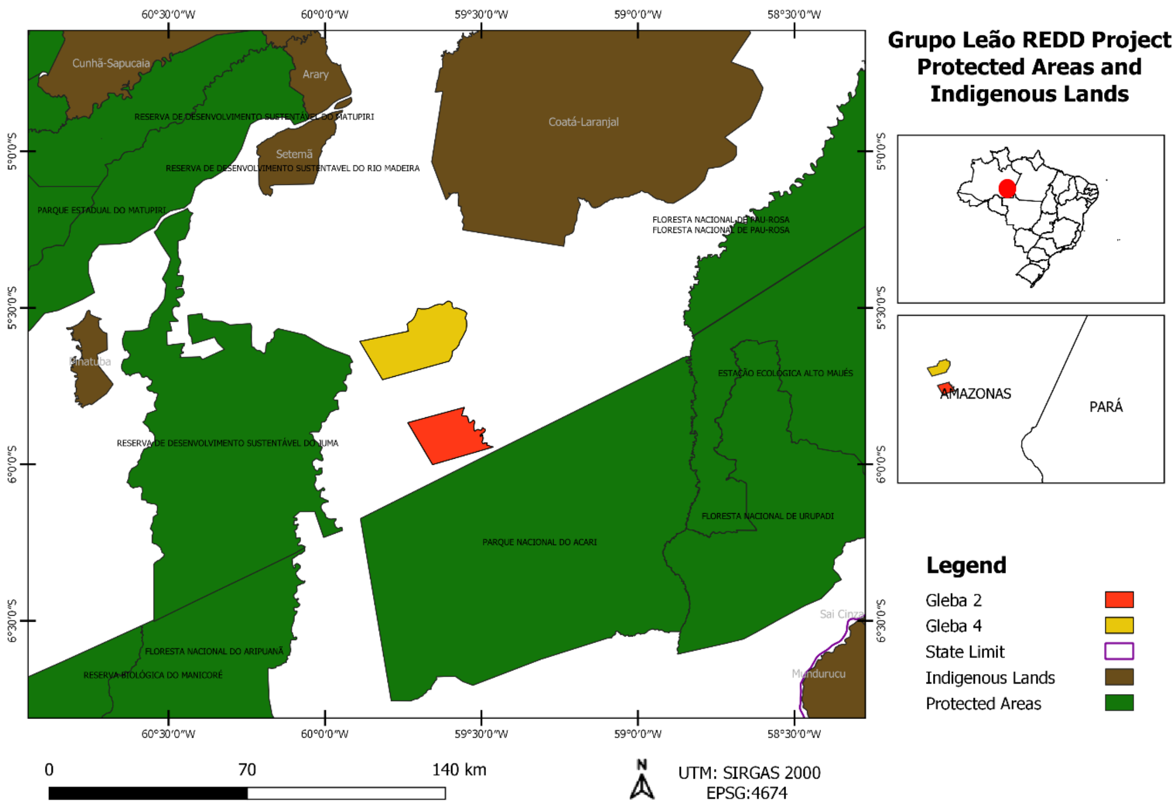

Figure 14 – Protected areas and indigenous lands

Vegetation Cover

The vegetation in the present project was mapped on the basis of SIVAM Amazônia information sources[27]. Three vegetation types were found to be present in the project area: Alluvial Dense Rainforest, Submontane Dense Ombrophilous Forest and Lowland Dense Ombrophilous Forest. In the reference region, these phytophysiognomies occupy 89.1%, however, retiring areas of water bodies and pasturelands, this value reaches 90.7%.

The Alluvial Dense 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.[28]

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[27]Sistema de vigilância da Amazônia: SIVAM

[28] Alluvial Dense Ombrophilous Forest – Embrapa. Available at: <http://www.agencia.cnptia.embrapa.br/gestor/territorio_mata_sul_pernambucana/arvore/CONT000gt7eon7I0

The Submontane Dense Ombrophilous Forest 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.[29]

The Lowland Dense Ombrophilous Forest is a formation that generally occupies the coastal plains, covered by Pliopleistocene boards of the Barreiras Group. It occurs from the Amazon, extending 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 area and reference region fall within the class of alluvial dense rainforest, submontane dense ombrophilous forest and lowland dense ombrophilous forest.

2wx7ha087apz2tjys6j3.html#:~:text=A%20floresta%20ombr%C3%B3fila%20densa%20aluvial,mesmo%20em%20%C3%A1reas%20alagadas%20temporariamente> Last visited: 05/07/2020.

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

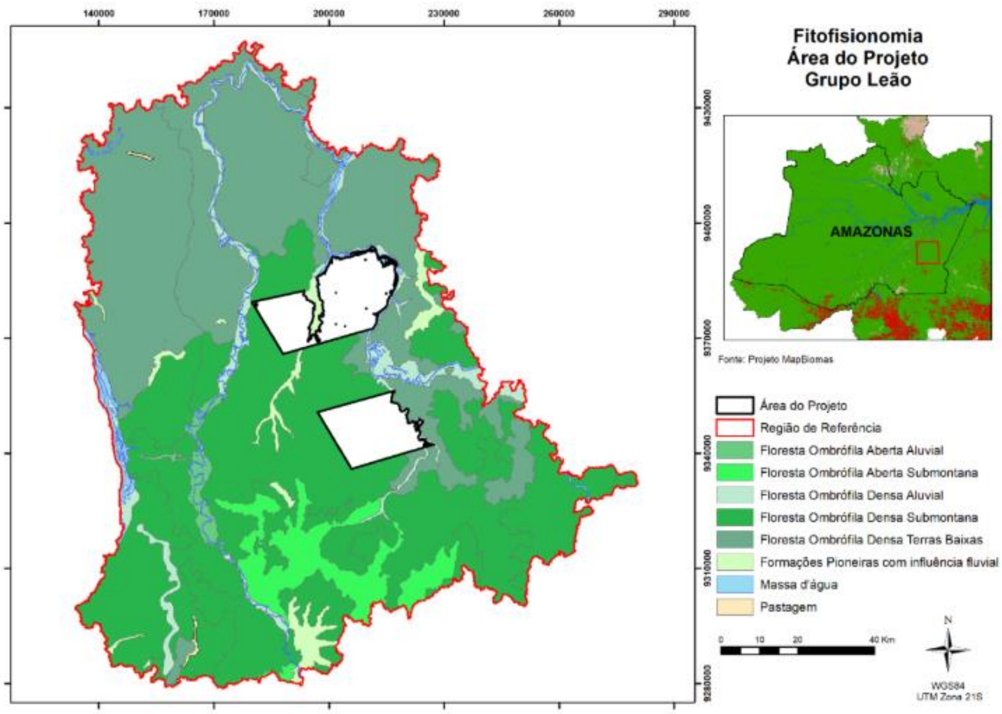

Figure 15 – Vegetation cover of the reference region

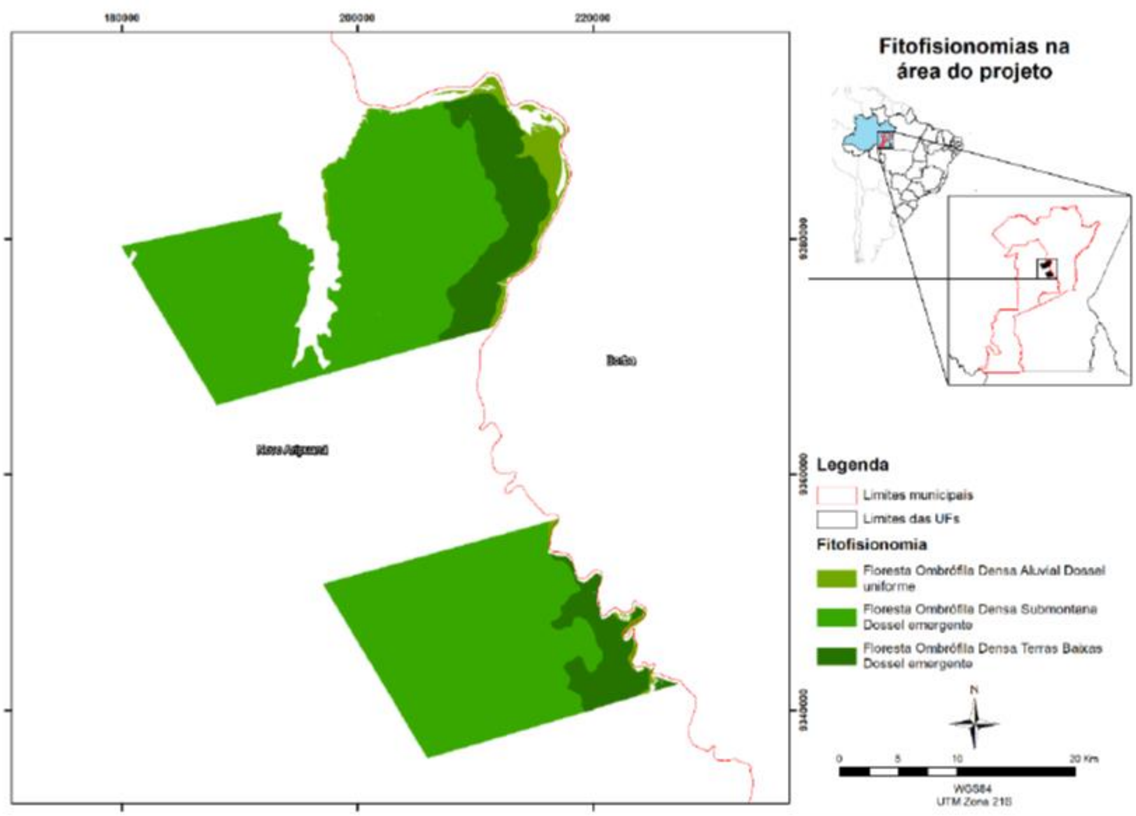

Figure 16 – Vegetation cover of the reference region

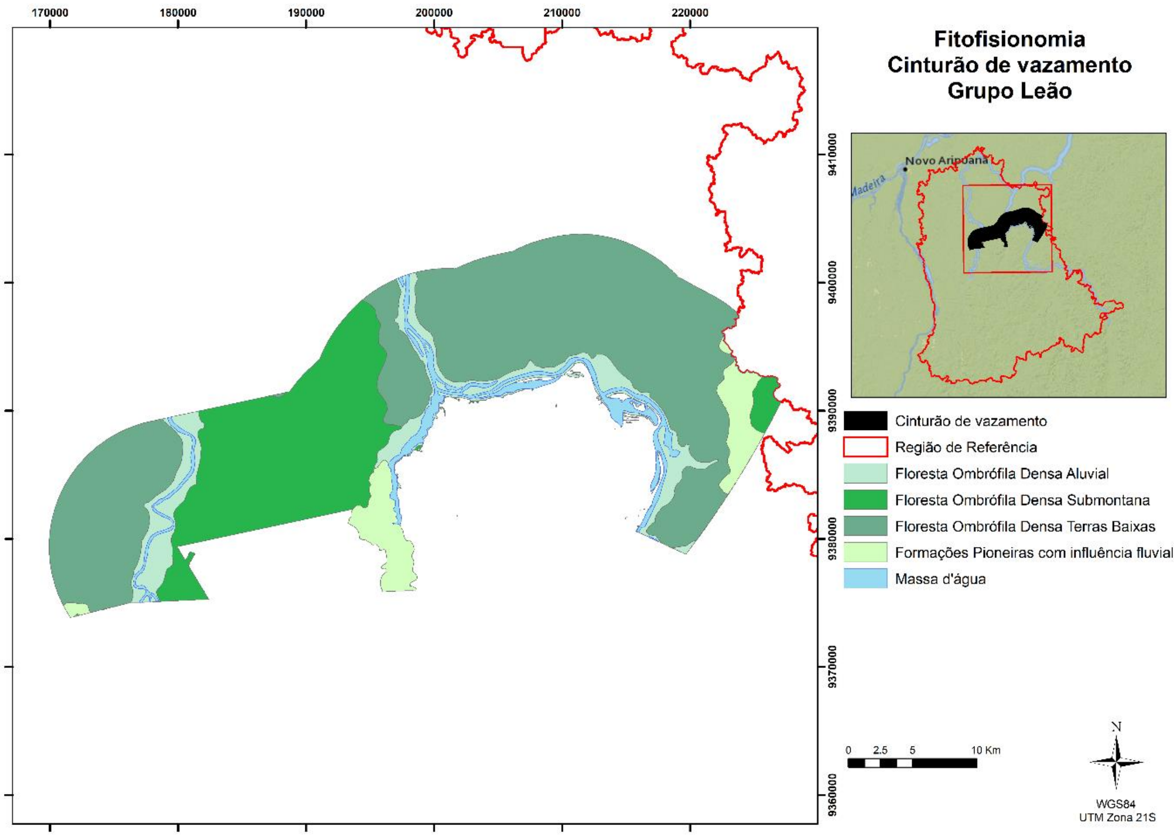

Figure 17 – Vegetation cover of the Leakage Belt

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the Brazilian Forest Code (Law Nº 12.651, 25/05/2012[30]), 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

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

shelter, and protection of native flora and fauna. In the Brazilian Legal Amazon[31], 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 effected in most regions of the country, because the weakness 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[32].

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[33].

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.

1.15 Participation under Other GHG Programs

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

1.15.2 Projects Rejected by Other GHG Programs

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

1.16.2 Other Forms of Environmental Credit

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[31] The concept of Legal Amazonia was originated in 1953 and its boundarias arise from the necessity of planning the economic development of the region. For this reason, Legal Amazonia's boundaries do not correspond to those of the Amazon biome. The former has an area of approximately 5 million km², distributed through the entirety or a proportion of 9 Brazilian states.

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

[33] 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.

1.17 Additional Information to the Project

Leakage Management

Commercially Sensitive Information

Sustainable Development

Further Information

2 SAFEGUARDS

2.1 No Net Harm

2.2 Local Stakeholder Consultation

2.3 Environmental Impact

2.4 Public Comments

2.5 AFOLU-Specific Safeguards

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

Applicability Conditions	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.	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: clearing for timber collection and cattle ranching, 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 methodology (table 1 and figure 2).	Within the categories of Table 1 and Figure 2 of the methodology, the present grouped project falls within category A, "Avoided Deforestation with Logging in the Project Case". The first instance contains alluvial dense rainforest, submontane dense ombrophilous forest, lowland dense ombrophilous forest and degradation is not included in either the baseline or project scenario.
c) The project area can include different types of forest, such as, but not limited to, old growth forest, degraded forest, secondary forests, planted forests and agro-forestry systems 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.	The project 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 [34]. This was ascertained using satellite images, as described

[34] Brazil adopts the FAO forest definition: "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity *in situ*." Available at: <http://www.fao.org/docrep/006/ad665e/ad665e06.htm>.

	in the 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 described in the section Conditions Prior to Project Initiation of the present VCS PD, all soil types are mineral. Therefore, none of the project area 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 instance project area is composed of two properties as described in the section Project Location (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 area – defined in accordance with the methodology's rules governing the latter – as well as the size of the leakage belt, are displayed in the Table below.

Name	Area (ha)
Project Area	86,097.67
Leakage Belt	73,753.9

Table 3. Forested areas within the Project Area and Leakage Belt

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.

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	Excluded	Not significant
Litter	Excluded	Not to be measured according to VCS Methodology Requirements, 4.0.
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.

Table 4. Carbon pools included or excluded within the boundary of the proposed AUD project activity

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.

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.

Source		Gas	Included?	Justification/Explanation
		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.

Table 5. Sources and GHG included or excluded within the boundary of the proposed AUD 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.

3.4 Baseline Scenario

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

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

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

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

To carry out the assessment of land use and land cover (LU/LC) for the baseline period (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 past fixed baseline 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 6). The final mapping resolution was of 30 m pixel.

MapBiomas is a multi-institutional initiative of the Greenhouse Gases Emissions Estimation System[35] promoted by the Climate Observatory. The MapBiomas creation involves NGOs, universities, and technology companies. In MapBiomas, the image classification methodology utilizes for each year, all Landsat images available in each period (Landsat 5 [L5], Landsat [L7] and Landsat [L8]) with a cloud cover less than or equal 50%. Thus, a representative mosaic of each year is generated by selecting cloudless pixels from the available images. For each pixel, metrics that describe its behaviour during the year are extracted and can contain up to 105 layers of information with an artificial intelligence classifier, Random Forest. The acquisition of Landsat images is done via Google Earth Engine, with sources from NASA (American Space Agency) and USGS (US Geological Survey).

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

For the supervised classification of 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.

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

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

Table 6 – Data used for historical LU/LC change analysis

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

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.

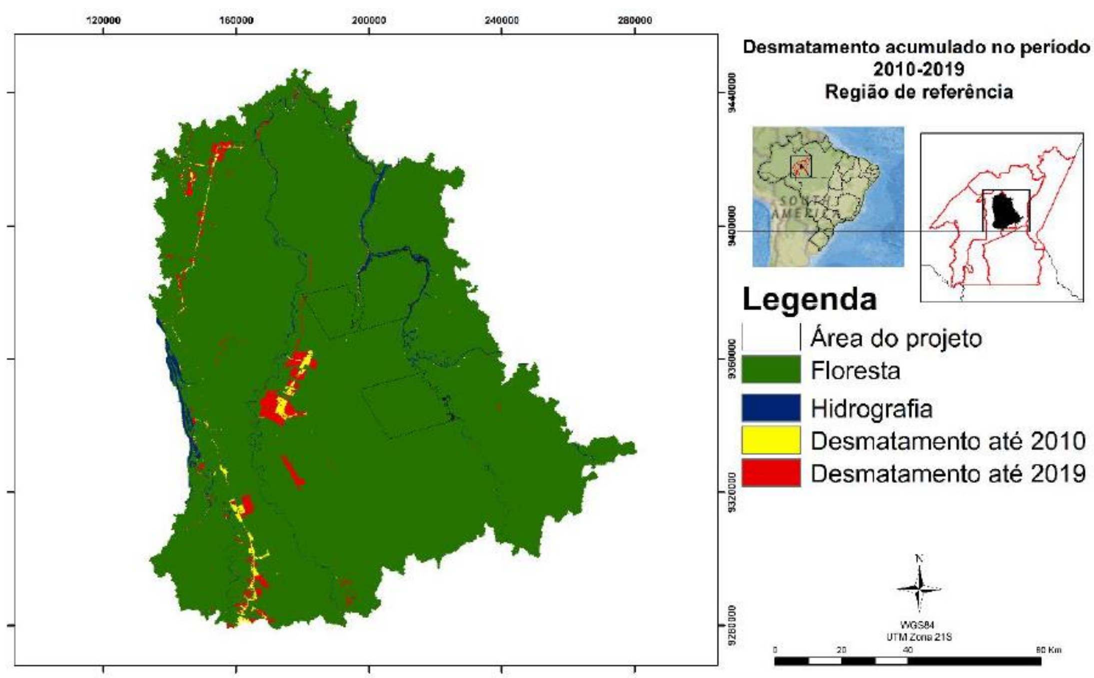

Figure 18 – Land use and land cover map comparing 2010 and 2019

Class identifier		Trend in carbon stock[1]	Presence in[2]	Baseline activity[3]			Description (including criteria for unambiguous boundary definition)
IDcl	Name			LG	FW	CP	
1	Forest	decreasing	RR, PA, LK	no	no	no	The categories were defined through analysis of the histogram of bands used, identifying its peaks and using them as a reference for grouping the most common values, associating them with the most common LU/LC types, followed by refinement through visual interpretation of the results.
2	Non forest	increasing	RR, PA, LK	no	no	no	Same as above.
3	Hydrography	constant	RR, PA, LK	no	no	no	Same as above.

Table 7 – List of land use and land cover change categories

- <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 8 below 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.

			Initial LU/LC class (2010)			Total (ha)
		Name	Forest	Hydrography	Deforestation	
			I1	I2	I3	
Final LU/LC	F1	Forest	1,379,444	0	0	1,379,444.22
	F2	Hydrography	0	21,493.71	0	21,493.71

class (2019)	F3	Deforestation	28,289.07	0	39,466.98	67,756.05
Total (ha)			1,407,733	21,493.71	39,466.98	1,468,693.98

Table 8 - Land use change matrix in the reference region between 2010 and 2019

Table 9 also shows that no classes were predicted to have growth in carbon stocks, this is because secondary forest was not considered as a category.

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

Table 9 – List of land use and land cover change categories

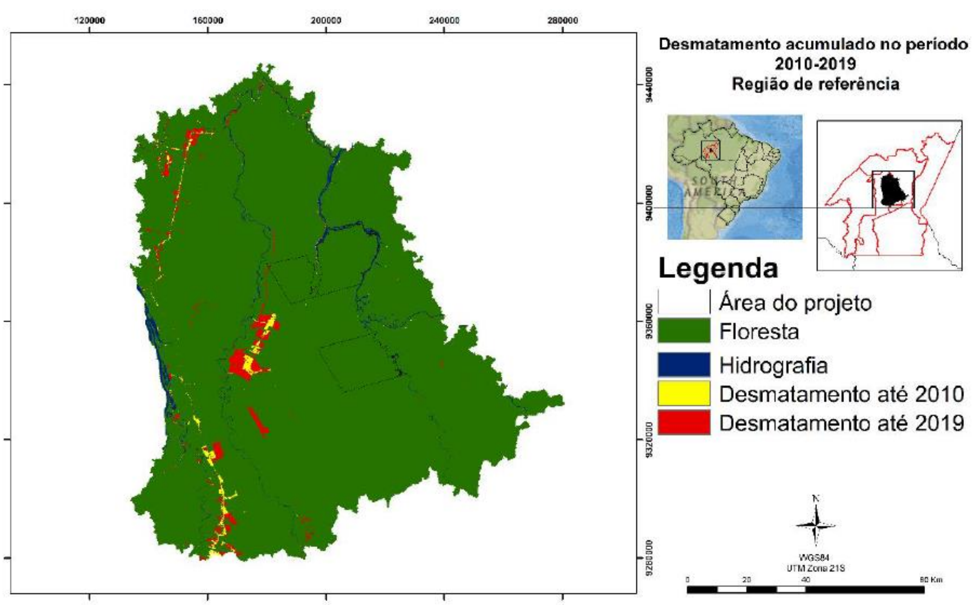

Figure 19 – Cumulative deforestation between 2010-2019 in Reference Region

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

According to the GIS analysis, between 2010 and 2019, there was a deforestation of 28,289.07 ha within the reference region, with an average oscillation of approximately 3,143.23 ha / year. The location of these areas can be seen in figures xx and xx and the table xx indicates these values quantitatively per year. There was a significant increase in deforestation rate during that period (R2 = 0.58, p = 0.0065) (Figure 21).

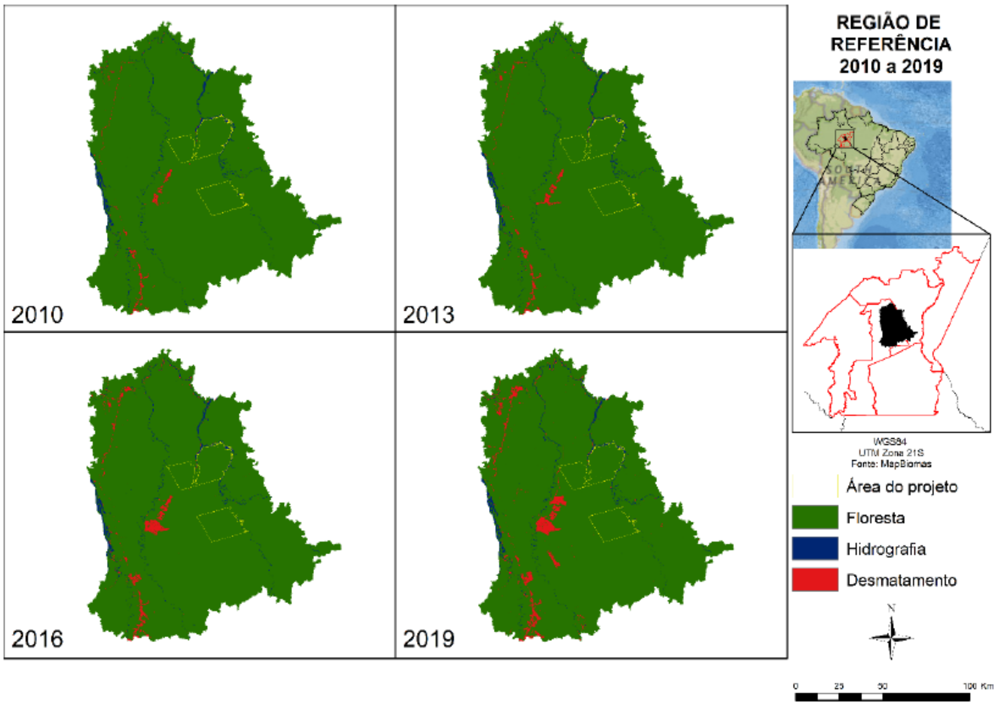

Figure 20 - Deforestation dynamics, between the years 2010 and 2019, in the region of reference (RR) and project area. Source: MapBiomas and IPE data

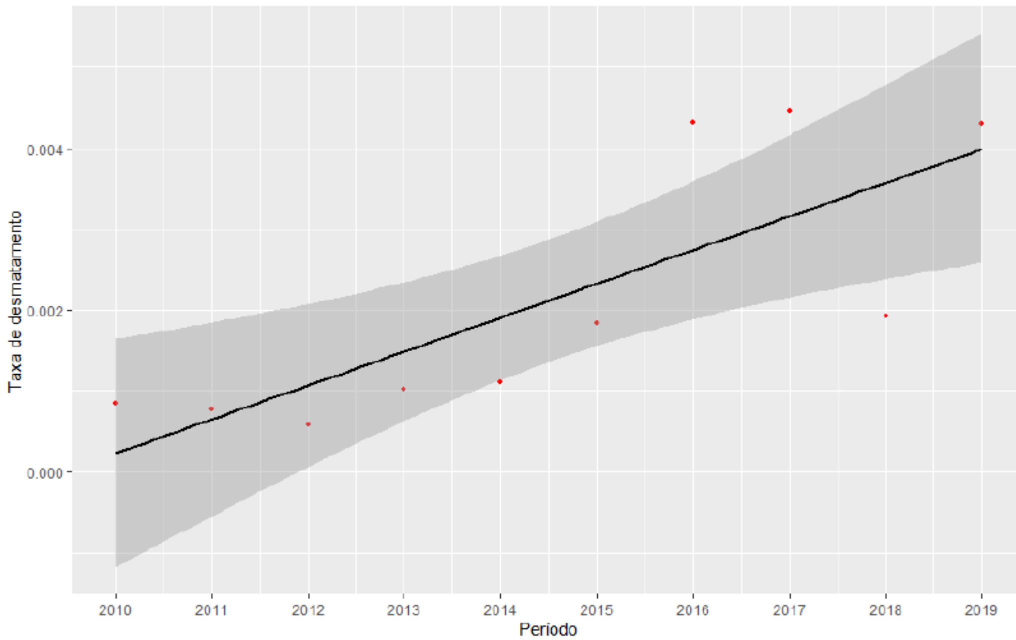

Figure 21 - Variation in the deforestation rate in the reference region between the years 2010 and 2019. Source: MapBiomas.

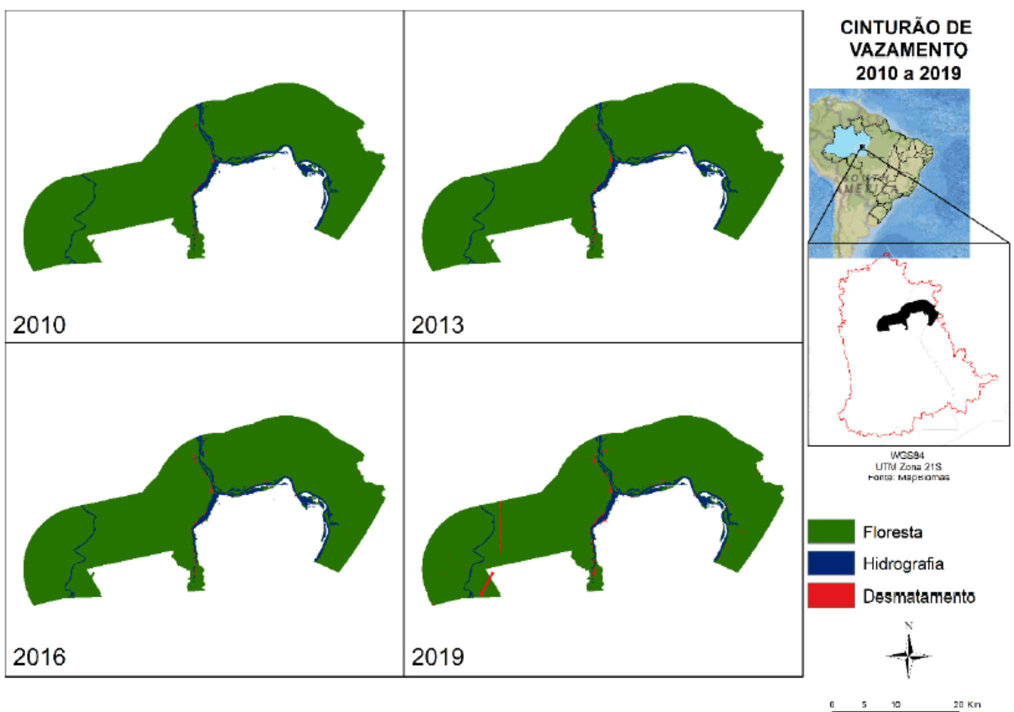

Figure 22 - Deforestation dynamics, between the years 2010 and 2019, in the leakage belt. Source: MapBiomas and IPE data

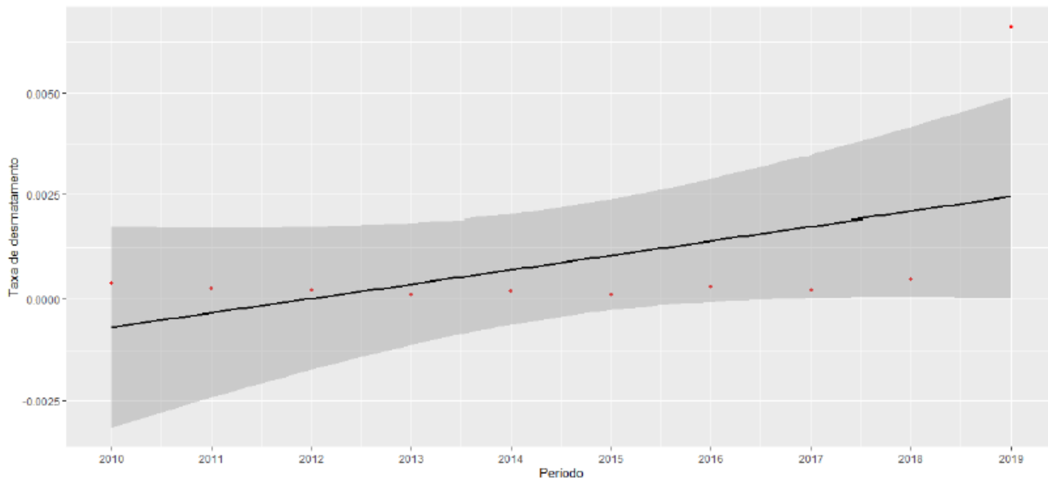

Figure 23 - Variation in the deforestation rate in the leakage belt between the years 2010 and 2019. Source: MapBiomas.

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.

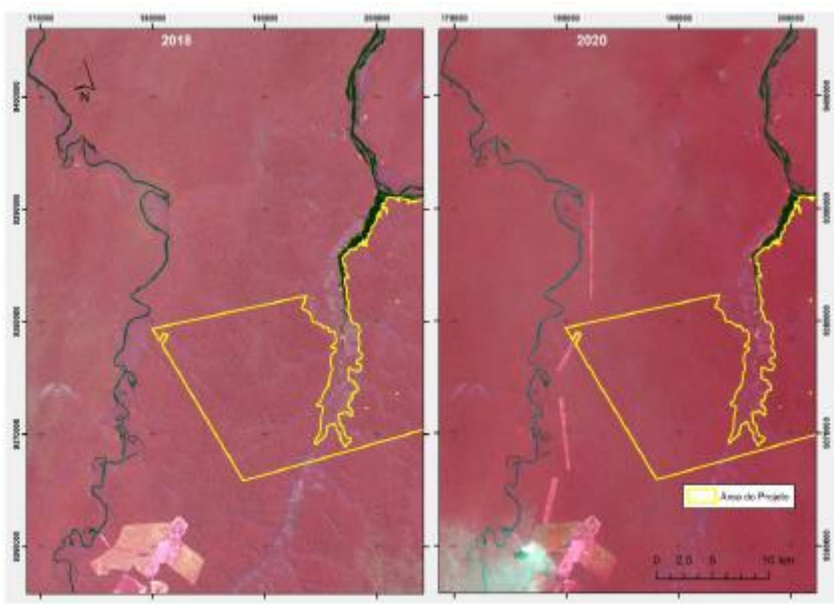

Figure 24 – Landsat images from 2018 and 2020 showing road creation in the reference region, close to the project area

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.

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	5,938.2

Table 10 – Annual deforestation in the Reference Region between 2010-2019

Year	Accumulated Deforestation (ha)	Deforestation per year (ha)
2010	149.85	27.72
2011	167.76	17.91
2012	182.43	14.67
2013	189.63	7.2
2014	203.67	14.04
2015	211.23	7.56
2016	232.92	21.69
2017	247.5	14.58
2018	281.25	33.75
2019	743.04	461.79

Table 11 – Annual deforestation in the Leakage Belt between 2010-2019

- 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 generated confusion matrix can be seen in table 12 below.

		REFERENCE				
CLASSIFIED		Forest	Hydrography	Deforestation	Total	Producer's accuracy
	Forest	91		9	100	91%
	Hydrography		100		100	100%
	Deforestation	9	4	87	100	87%
	Total	100	104	96	300	
	Producer's accuracy	91%	96%	91%		

Table 12 - Confusion matrix of the supervised classification data evaluation of 2019

Analysis of agents, drivers, and underlying causes of deforestation

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

- Identification of agents of deforestation

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[36].

In 2019, until August 18th, Apuí presented the highest number of fire alerts, and Novo Aripuanã was the 9th municipality with most of the fire alarms on the period[37].

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.[38] 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[39]. 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[40].

[36] 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

[37] 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>

[38] Available in < https://imazon.org.br/publicacoes/boletim-do-desmatamento-da-amazonia-legal-abril-2020-sad/>

[39] 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.

40 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.

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[41].

In the project area's municipality, Novo Aripuanã, there are from 501 to 1000 establishments, and in Borba, municipality included in the reference region, from 1001 to 3000[42].

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.

Graph 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. In the same period of cattle herd rise, from 2014 to 2018, deforestation increased in 11,560 ha. In Borba, it can be noticed an increase tendency in deforestation, even with lower quantity of animals.

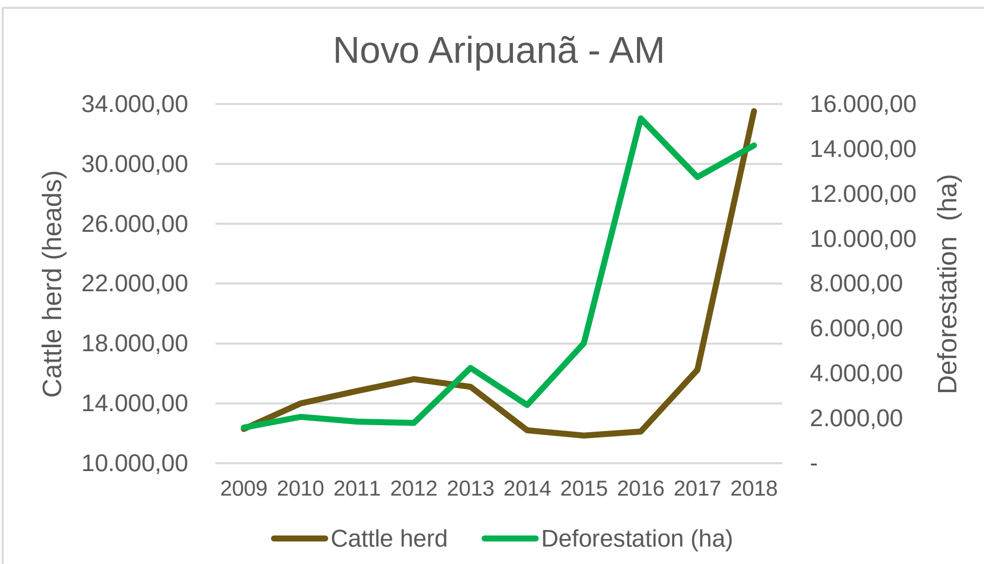

Figure 24

41 Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/estabelecimentos.html?localidade=13>

42 Available in <https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/pdf/am.pdf>

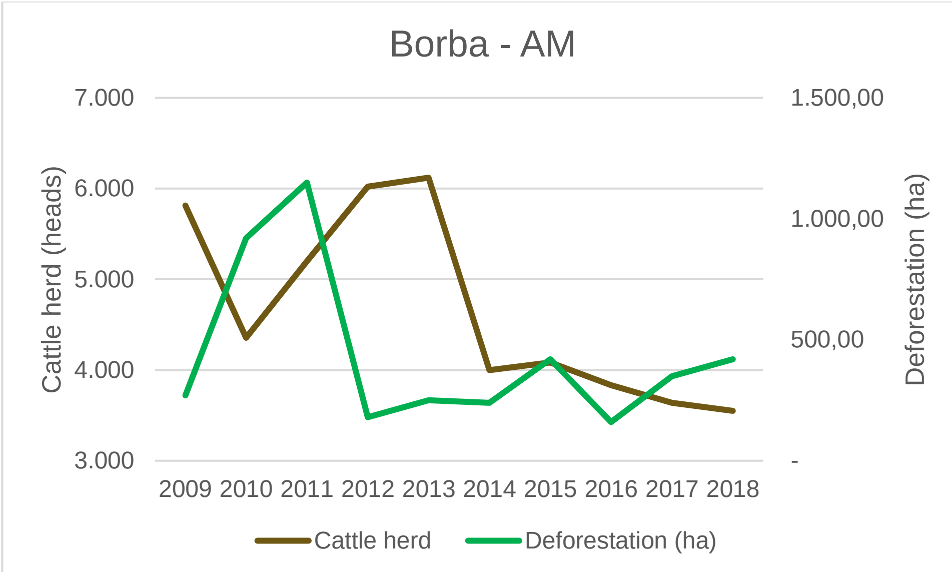

Figure 25

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 Apuí and Novo Aripuanã are frontier municipalities, cattle ranching is preferred due to ease in selling to near states, with cheaper logistics and guarantee of disease-free meat.

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.

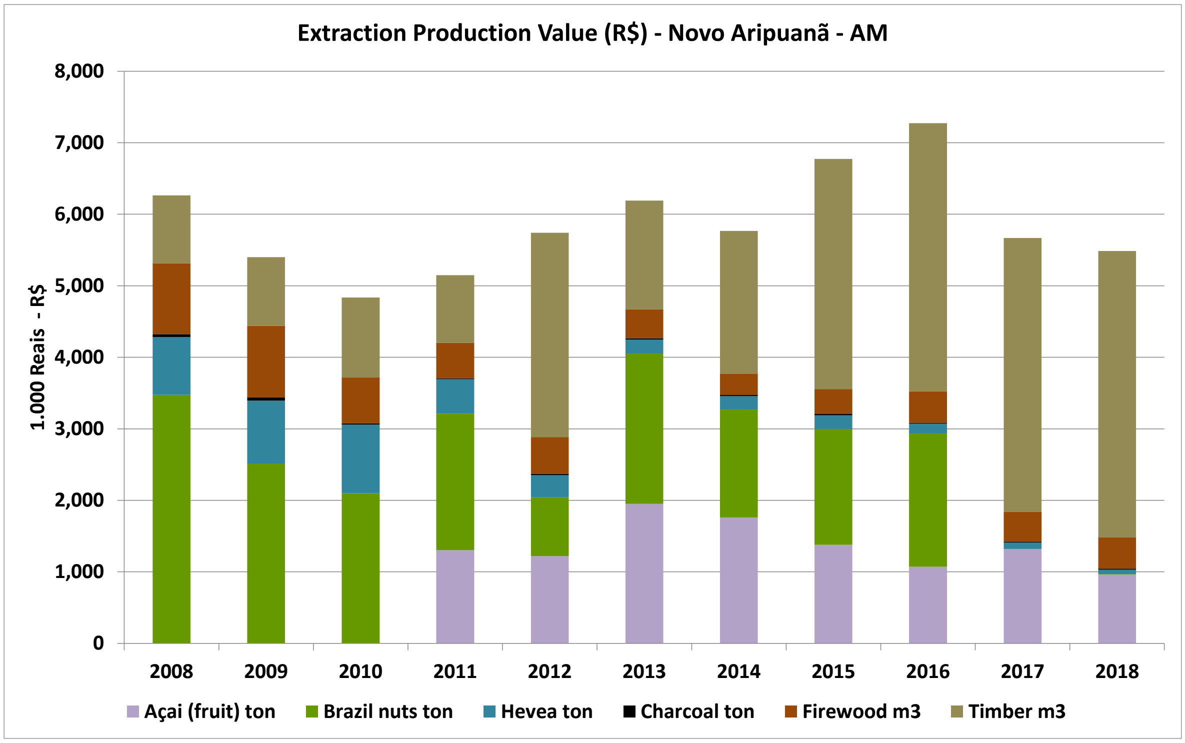

Figure 26 – Extraction production Value (R$) – Novo Aripuança - AM

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.

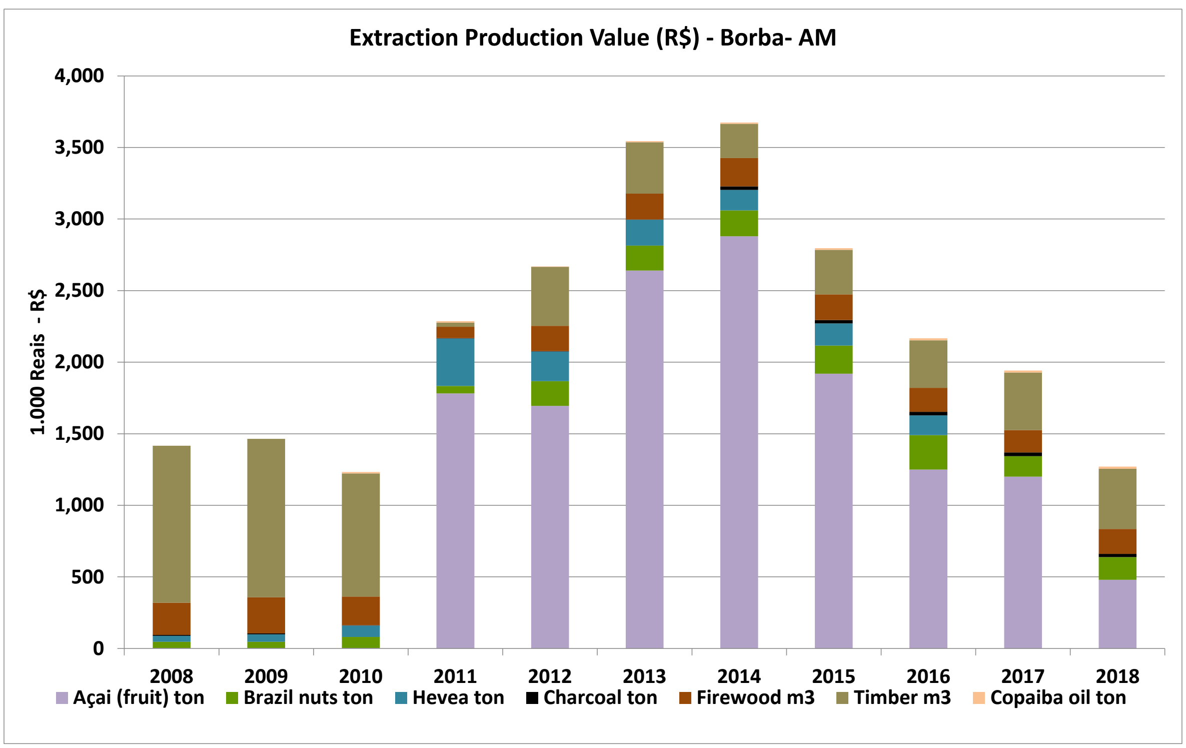

Figure 27 – Extraction production value (R$) – Borba - AM

When assessing quantity produced, the timber production in both municipalities is also dominant:

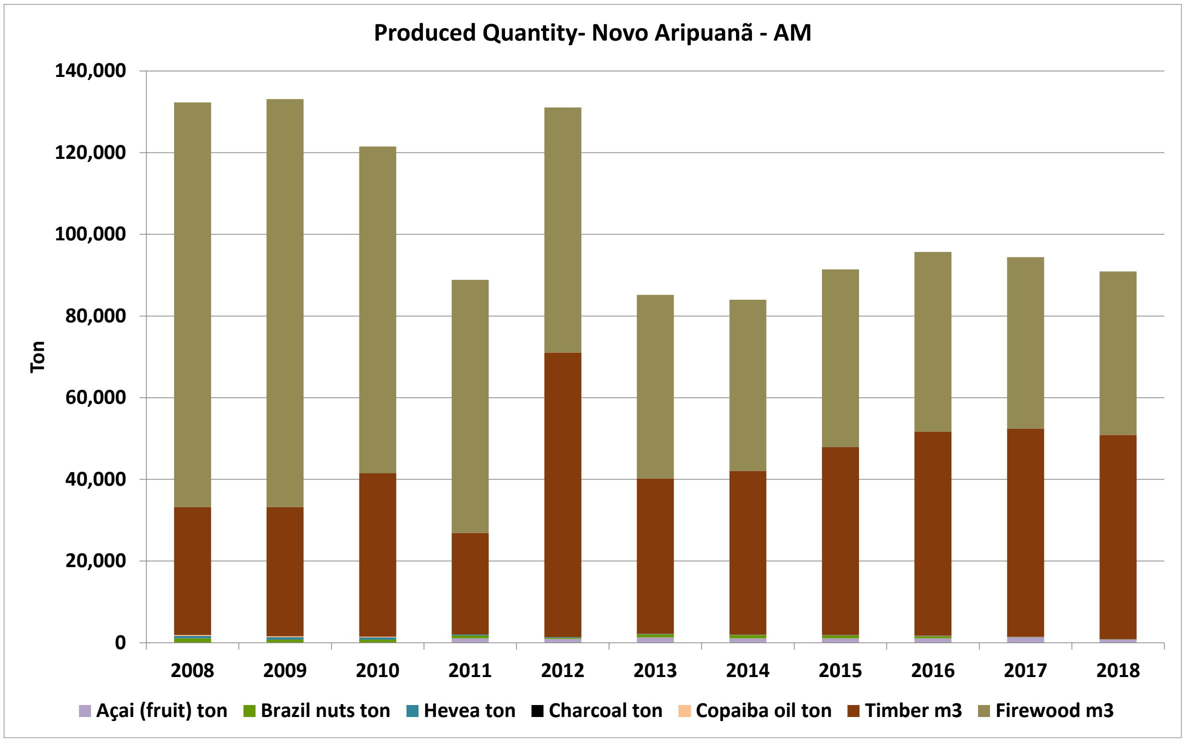

Figure 28 – Produced quantity – Novo Aripuanã - AM

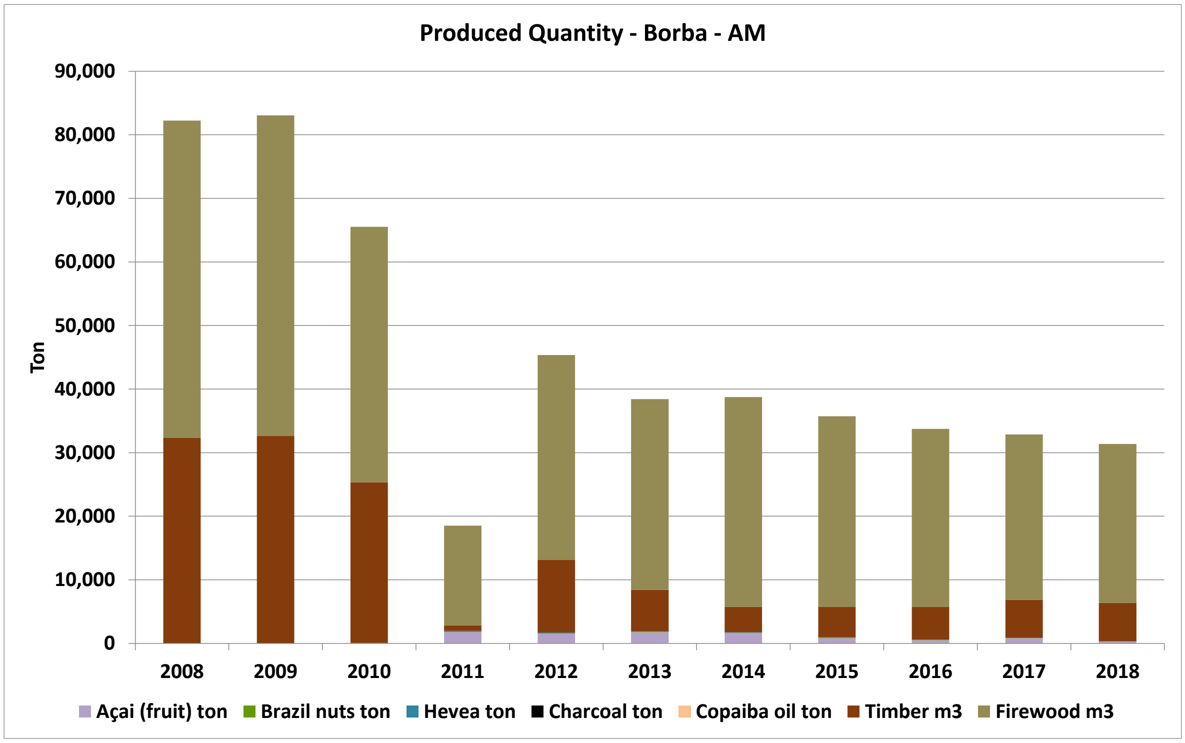

Figure 29 – Produced quantity – Borba - AM

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[43].

Key driver variables are detailed in section below.

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

[43] Available in <http://www.idesam.org.br/publicacao/cadeia-produtiva-corte-amazonas.pdf>

- Population growth and density

Population is a variable that significantly predict quantity of future deforestation. 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 de 1.68% per year in Apuí and 3.07% in Novo Aripuanã.

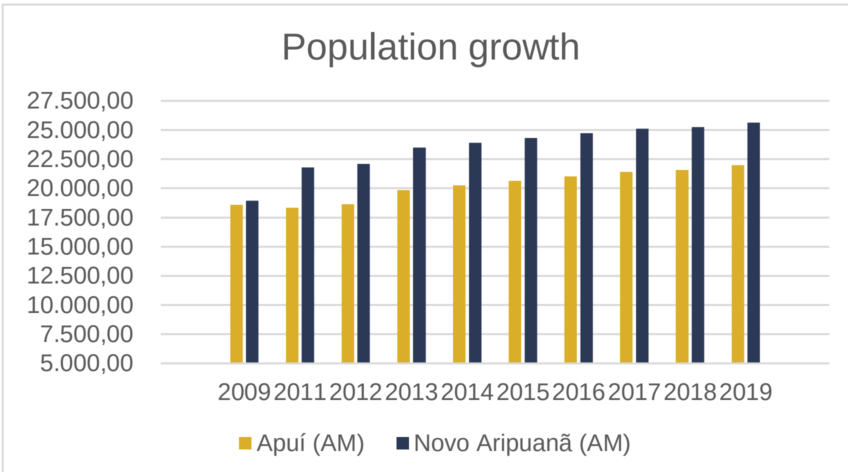

Figure 30 – Population growth

The region has a low population density, as large landowners prevail in both municipalities. In Apuí, it is 0.33 hab/km² and in Novo Aripuanã, 0.52 hab/km².

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.

Although the population growth rate is expected to decrease in the future, the increasing rate identified in the population data is an important variable affecting the amount of deforestation in the reference region.

However, an important factor that will probably contribute to the decrease in deforestation in the reference region was the human development index (HDI) improvement. The analysis of the average HDI in the municipalities covering the reference region shows higher indexes in income and education, as detailed in section 1. This can be a factor that may contribute to the decrease in the population growth rate in the region.

- Prices of timber and cattle

As detailed in section XXX and in the description of deforestation agents above, timber and cattle prices have much higher value than other products exploited in the region. Data analyzed includes Novo Aripuanã and Apuí, second largest cattle herd of the state and main producer in the region.

Research develop to determinate leakage belt accounted approximately R$1040,00 per animal in the region, in an average of R$80,00 per arroba. Considering data of 2018, that indicated 33,523 animals in Novo Aripuanã and 140,000 in Apuí, the amount of money produced by the activity in the region would surpass 180 million reais per year.

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.

Furthermore, forested property values are almost 4 times cheaper than established pasturelands[44]. 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.

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.

[44] 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: <http://www.gestaodaterra.com.br/arquivos/O_desmatamento_da_floresta_amazonia_causas_e_solucoes.pdf>. Last visited on: April 16th, 2017.

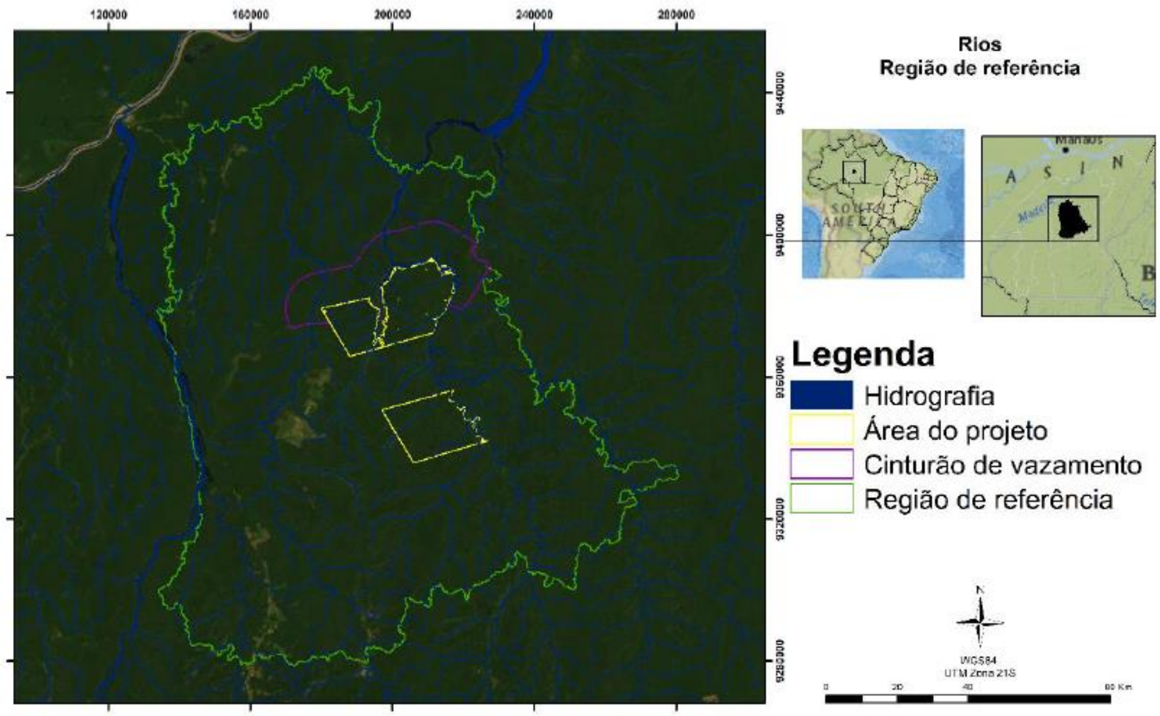

Figure 31 – Rivers that allow access in the reference region of the project

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.

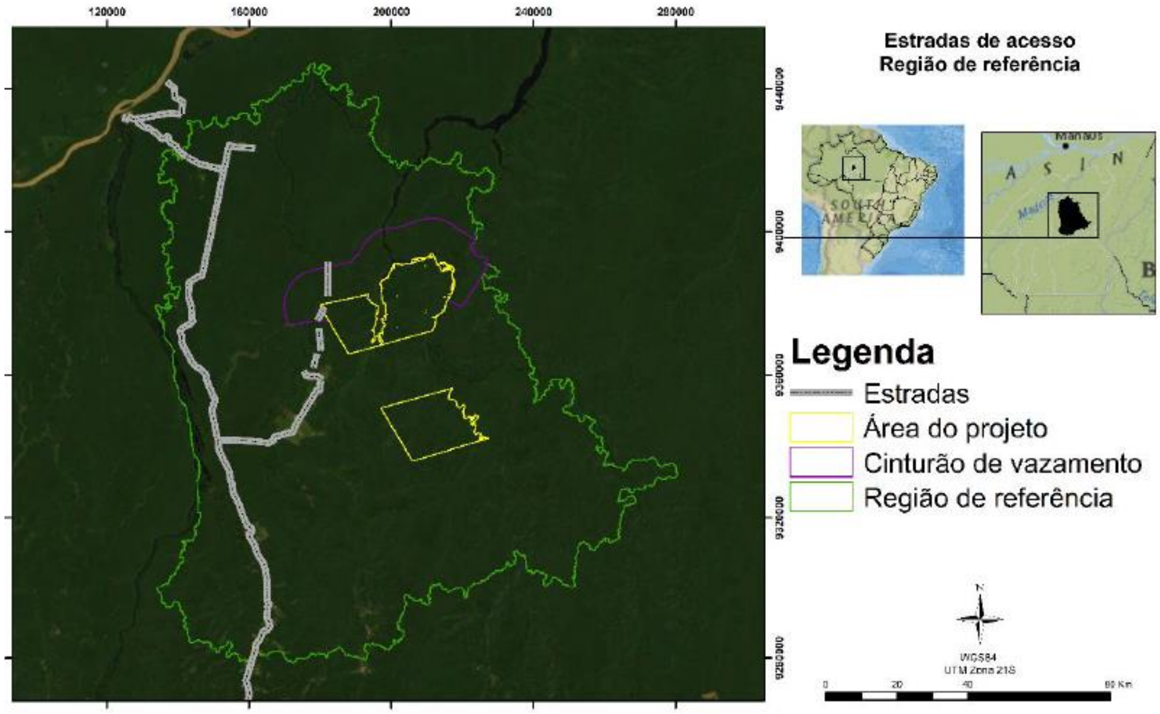

Figure 32 – Access roads in the reference region

The main objective was 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[45].

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.

45 Available in < https://epg.unifesspa.edu.br/images/Artigos/NilzaLimaMarinho.pdf>

- Proximity to Conservation Units

The project area 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.

- Identification of underlying causes of deforestation

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[46].

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

In addition, the transference of policies and instruments of water resources, including the National Water Agency (ANA) to the Ministry of Regional Development 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[47], the government tried to deviate attention from the fires, claiming they were fake news[48]. The number of wildfires in Brazilian forests increased 70% in 2019, the highest rate in 7 years. According to National Spatial Researches 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 deforestation. The contribution to protecting the rainforest amounted to more than 133 million, destined to the Amazon Fund[49].

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[50].

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[51].

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

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

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

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

51 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>

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[52].

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[53], an unconstitutional action, after announcing the intention to review the conservation units law (SNUC) and the existing units[54]. 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 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[55].

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[56].

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

[52] 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>

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

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

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

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

landowners and project developers, since there is no guideline or effective planning from the government to amplify the development of new projects.

- <u>Analysis of chain of events leading to deforestation</u>

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 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 evidences 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 evidences 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.

<u>Projection of Future Deforestation</u>

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

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 (approximately 1,337.05 hectares/year in the reference region). 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.

Year	Cumulative deforestation (ha)	Annual Deforestation (ha)
2020	45,631.08	6,164.10
2021	52,342.11	6,711.03
2022	59,592.06	7,249.95
2023	67,372.11	7,780.05
2024	75,672.90	8,300.79
2025	84,484.62	8,811.72
2026	93,796.65	9,312.03
2027	103,598.10	9,801.45
2028	113,877.18	10,279.08
2029	124,621.83	10,744.65
2030	135,819.45	11,197.62
2031	147,456.90	11,637.45
2032	159,520.59	12,063.69
2033	171,996.66	12,476.07
2034	184,870.71	12,874.05
2035	198,128.16	13,257.45
2036	211,753.71	13,625.55

2037	225,732.15	13,978.44
2038	240,047.82	14,315.67
2039	254,684.97	14,637.15
2040	269,627.76	14,942.79
2041	284,859.09	15,231.33
2042	300,362.67	15,503.58
2043	316,123.02	15,760.35
2044	332,122.14	15,999.12
2045	348,343.47	16,221.33
2046	364,770.27	16,426.80
2047	381,386.61	16,616.34
2048	398,174.76	16,788.15
2049	415,117.89	16,943.13
2050	432,199.98	17,082.09

Table 13 – Deforested area projected in the reference region

Year	Cumulative deforestation (ha)	Annual Deforestation (ha)
2020	50.31	50.31
2021	114.48	64.17
2022	236.43	121.95
2023	374.31	137.88
2024	510.39	136.08
2025	672.03	161.64
2026	876.60	204.57
2027	1,072.08	195.48
2028	1,306.71	234.63
2029	1,589.76	283.05
2030	1,920.24	330.48
2031	2,233.44	313.20
2032	2,626.74	393.30
2033	3,099.33	472.59
2034	3,687.30	587.97
2035	4,327.65	640.35
2036	5,093.37	765.72

2037	5,945.49	852.12
2038	6,995.70	1,050.21
2039	8,219.61	1,223.91
2040	9,495.45	1,275.84
2041	10,844.28	1,348.83
2042	12,362.40	1,518.12
2043	14,032.62	1,670.22
2044	15,638.49	1,605.87
2045	17,397.18	1,758.69
2046	19,275.48	1,878.30
2047	21,185.28	1,909.80
2048	23,122.62	1,937.34
2049	25,186.50	2,063.88
2050	27,226.62	2,040.12

Table 14 – Deforested area projected in the project area

Year	Cumulative deforestation (ha)	Annual Deforestation (ha)
2020	1,035.72	292.68
2021	1,418.85	383.13
2022	1,889.10	470.25
2023	2,439.90	550.80
2024	3,079.80	639.90
2025	3,799.53	719.73
2026	4,508.37	708.84
2027	5,320.53	812.16
2028	6,151.32	830.79
2029	7,027.74	876.42
2030	7,904.07	876.33
2031	8,878.14	974.07
2032	9,923.49	1,045.35
2033	11,008.71	1,085.22
2034	12,064.41	1,055.70
2035	13,189.77	1,125.36
2036	14,285.61	1,095.84

2037	15,363.00	1,077.39
2038	16,526.88	1,163.88
2039	17,679.33	1,152.45
2040	18,795.42	1,116.09
2041	19,903.41	1,107.99
2042	21,013.11	1,109.70
2043	22,062.33	1,049.22
2044	23,119.11	1,056.78
2045	24,169.50	1,050.39
2046	25,149.51	980.01
2047	26,098.38	948.87
2048	26,990.73	892.35
2049	27,878.22	887.49
2050	28,803.60	925.38

Table 15 – Deforested area projected in the leakage belt

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

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

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

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

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

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

Assigning weightings to change agents

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

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:

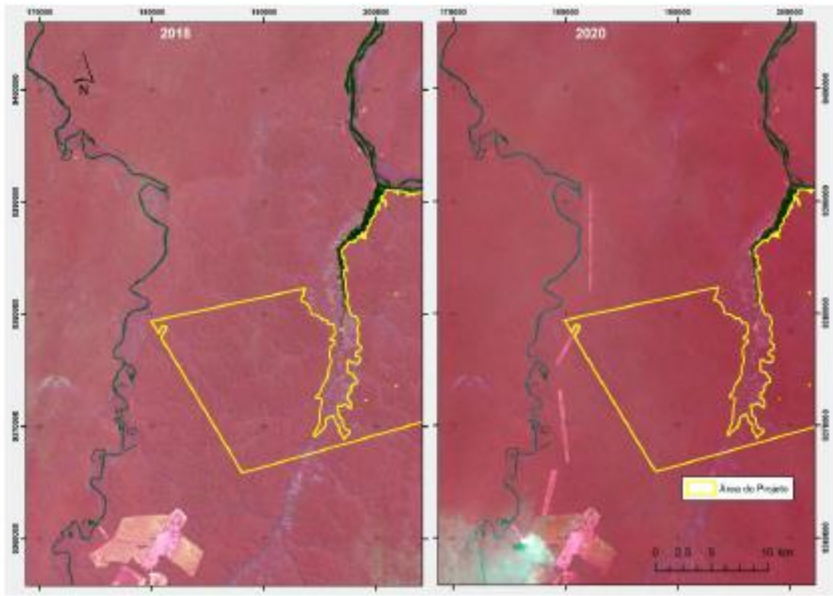

Figura 27 – Imagens Landsat de 2018 e 2020 mostrando a abertura de estrada na região de refência, próxima à Área do Projeto.

Figure 33

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, which modeling techniques are used for calibrating, running and validating space-time models.

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

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

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

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

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.

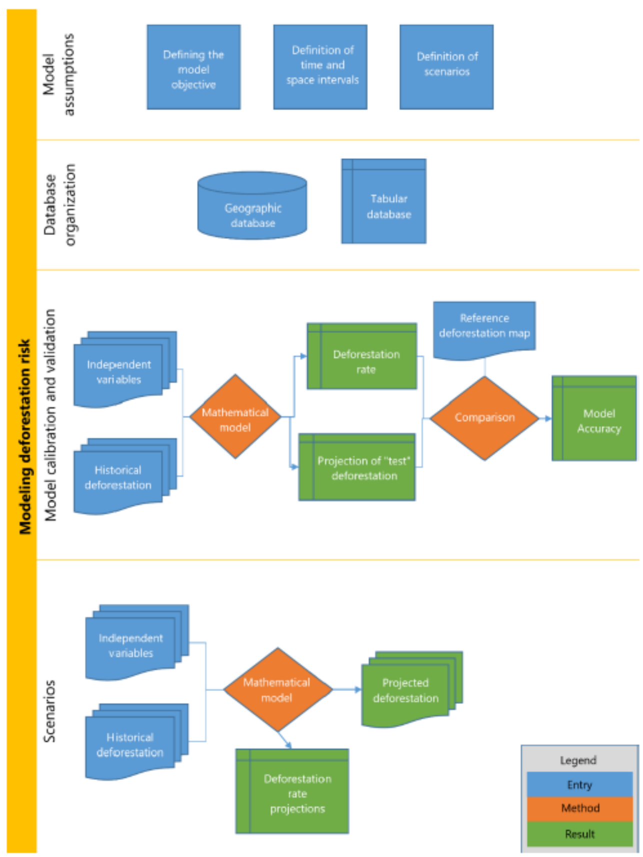

Figure 34 - Modelling steps focusing on the creation of the deforestation risk map and the projection of future deforestation

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.

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_EstradasIlegais.tif	IBGE	Meter	Euclidean Distance from paved and unpaved roads	0-103,423	Lower values mean more proximity		Rodovias_IBGE_edit_c_EstradasIlegais	Euclidean Distance (ArcGis 10.6)	Quantitative variable
2	UCs.tif	MMA		Sustainable Use Protected Areas						Categorical variable
3	UCs.tif	MMA		Full protection Protected Areas						Categorical variable
4	Assentamentos.tif	INCRA		Rural settlements						Categorical variable
5	d_rios_g.tif	ANA	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	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	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	Meter	Average altitude variation	-3-184	Lower values mean lower altitude		DEM_srtm_mosaic		Quantitative variable
9	DEM_extract_fill_slope.tif	SRTM	Degree	Average slope variation	0-94.6081	Lower values mean lower slope		DEM_srtm_mosaic	Slope (ArcGis 10.6)	Quantitative variable

Table 16. List of variables, maps and factor maps

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.

Distance from deforested areas (m)	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 17 - Variation of the weights of evidence according to deforestation distance ranges

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	60,500 – 60,600	0.00
25,400 – 25,500	-1.27	60,600 – 67,800	-4.40
25,500 – 25,900	-0.95	67,800 – 68,000	-2.26

25,900 – 26,000	-0.52		68,000 – 77,700	-3.73
26,000 – 26,500	-0.71		77,700 – 91,200	-4.72
26,500 – 26,600	-0.95		91,200 – 103,500	-3.69
26,600 – 26,800	-1.22			
26,800 – 26,900	-0.86			

Table 18 - Variation of the weights of evidence according to the distance from roads

Distance from water bodies (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 19 - Variation of the weights of evidence according to the distance from water bodies

Distance from large rivers (m)	Weights of evidence		Distance from large rivers (m)	Weights of evidence

0 - 100	-0.03	18,800 – 18,900	0.10
100 – 200	0.18	18,900 – 20,200	0.29
200 - 600	-0.07	20,200 – 20,300	0.51
600 - 700	-0.48	20,300 – 22,200	0.53
700 – 1,300	-0.45	22,200 – 22,300	0.31
1,300 – 1,500	-0.20	22,300 – 22,500	0.10
1,500 – 1,900	-0.01	22,500 – 23,000	-0.08
1,900 – 2,400	0.18	23,000 – 23,100	-0.64
2,400 – 3,100	0.28	23,100 – 24,200	-0.42
3,100 – 3,800	0.42	24,200 – 24,700	-0.22
3,800 – 4,500	0.56	24,700 – 24,900	-0.02
4,500 – 5,200	0.54	24,900 – 25,100	-0.24
5,200 – 5,800	0.34	25,100 – 25,300	-0.44
5,800 – 5,900	0.05	25,300 – 25,400	-0.96
5,900 – 6,600	0.08	25,400 – 25,500	-2.18
6,600 – 7,300	0.01	25,500 – 28,500	-2.81
7,300 – 8,000	0.19	28,500 – 29,600	-1.84
8,000 – 8,700	0.32	29,600 – 29,700	-0.43
8,700 – 9,500	0.17	29,700 – 30,300	-0.68
9,500 – 9,600	-0.06	30,900 – 31,00	0.00
9,600 – 10,400	-0.18	31,000 – 37,200	-3.87
10,400 – 11,300	-0.21	37,200 – 53,400	-5.17
11,300 – 11,400	0.00		
11,400 – 12,300	0.03		
12,300 – 13,300	-0.08		
13,300 – 13,500	0.09		
13,500 – 14,500	0.11		
14,500 – 15,200	-0.10		
15,200 – 15,300	-0.28		
15,300 – 15,500	-0.07		
15,500 – 15,700	-0.24		
15,700 – 16,900	-0.14		
16,900 – 17,600	-0.32		
17,600 – 17,800	-0.53		
17,800 – 18,800	-0.27		

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

Slope	Weights of evidence	Slope	Weights of evidence
0 - 14	0.03	70 - 71	0.21

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

Conservation Unit	Weights of evidence
1	0.40
2	-0.89
3	-2.17

Table 22. Variation of the weights of evidence according to Conservation Unit

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

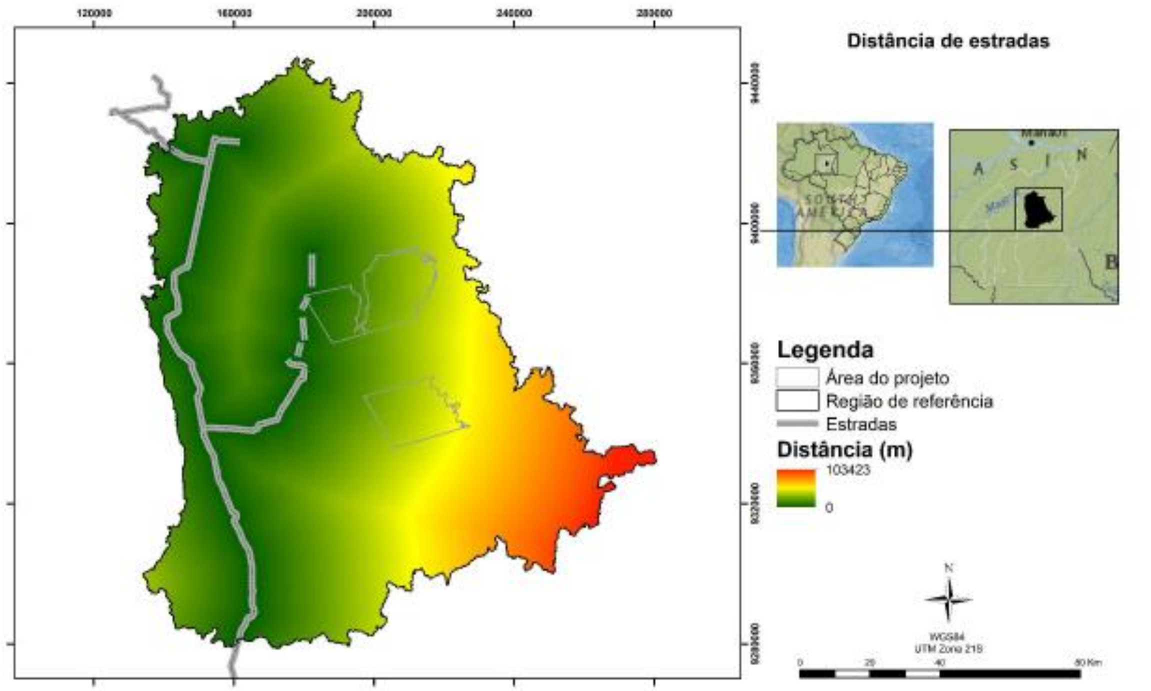

Figure 35. Factor map representing the distance from roads

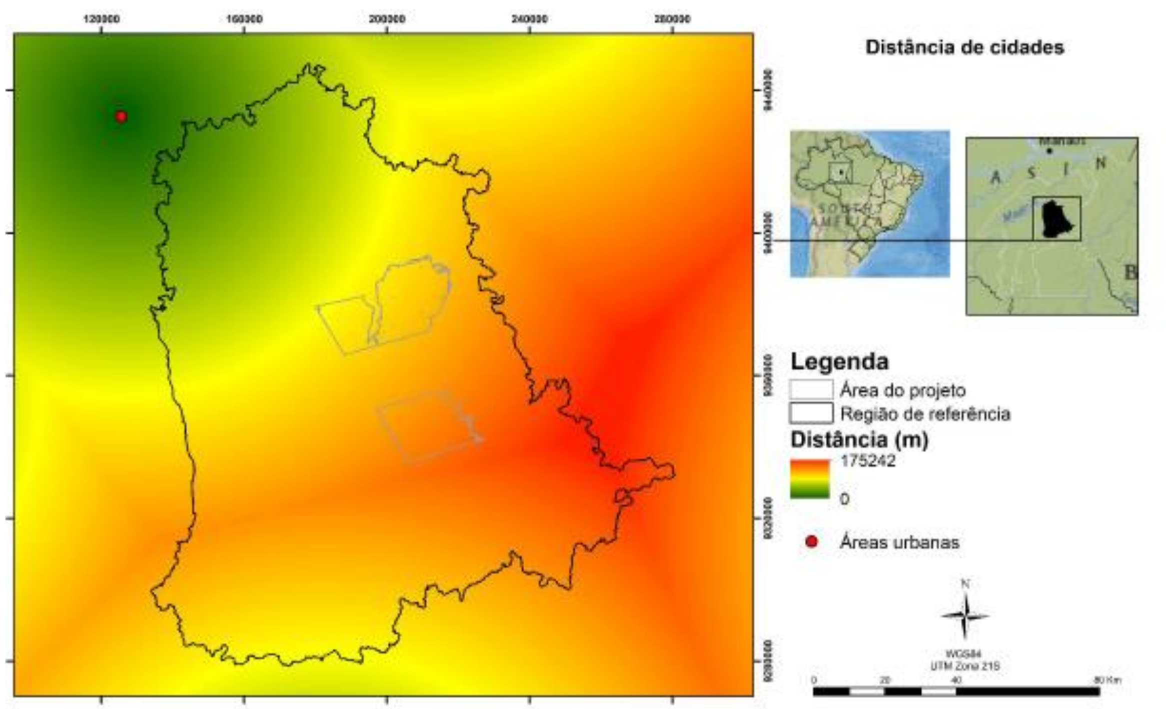

Figure 36. Factor map representing the distance from cities and main inhabitants' nuclei

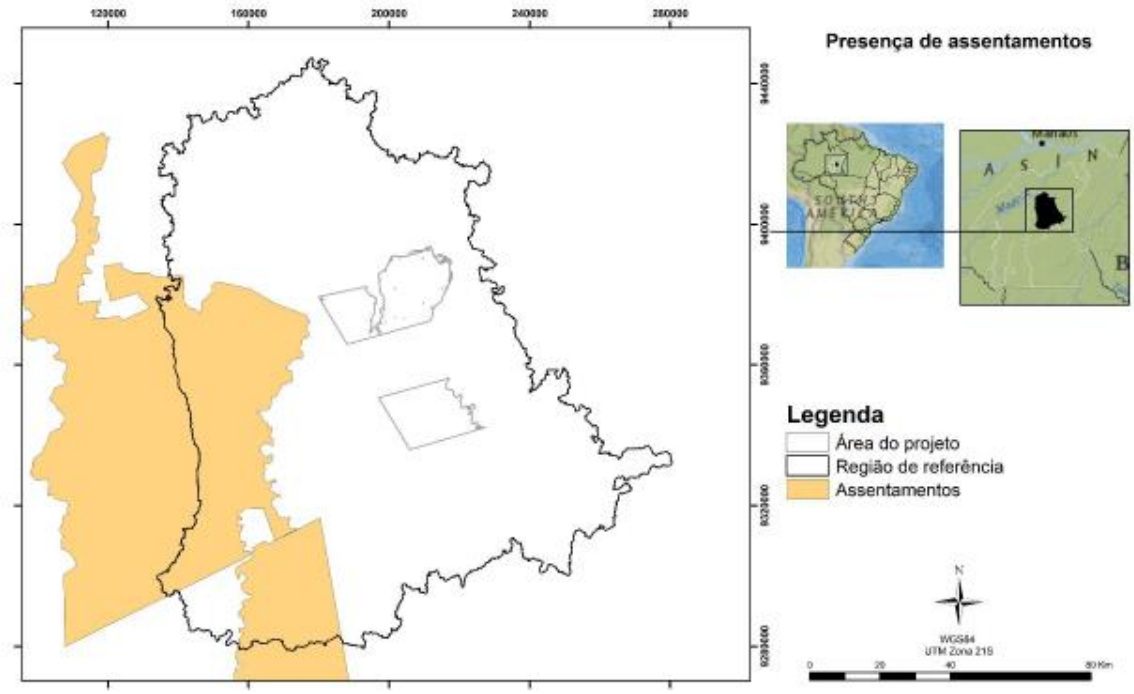

Figure 37. Factor map representing the distance from settlements

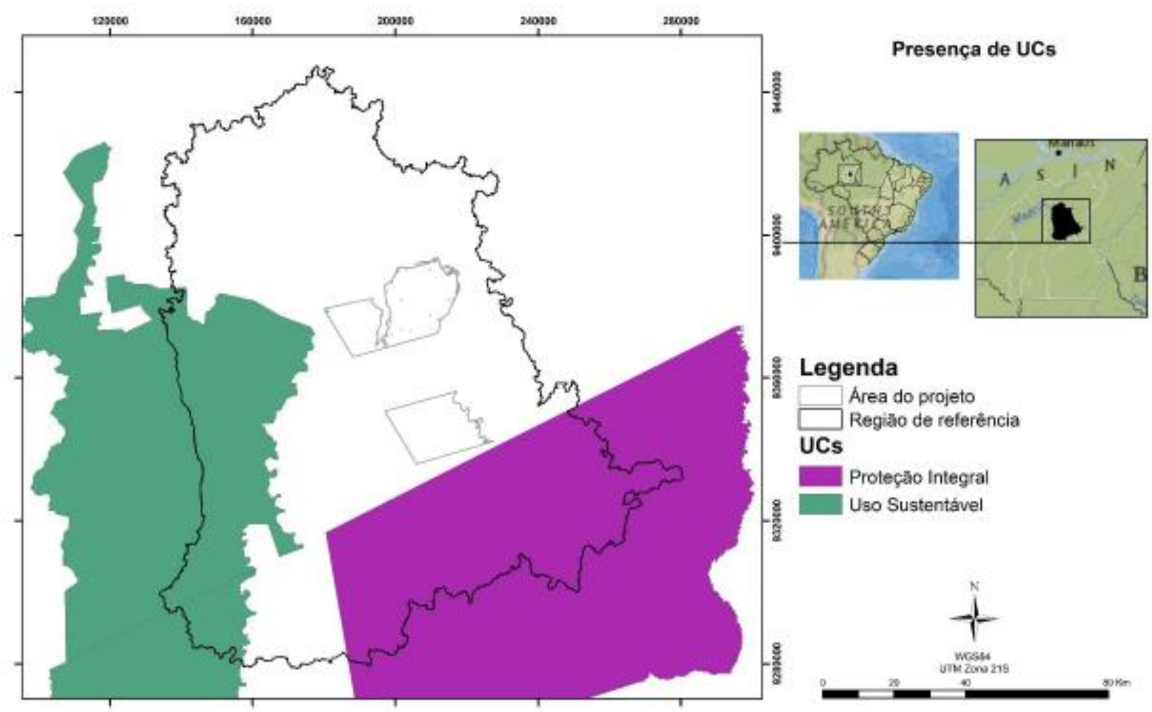

Figure 38. Factor map representing the Conservation Units in the reference region

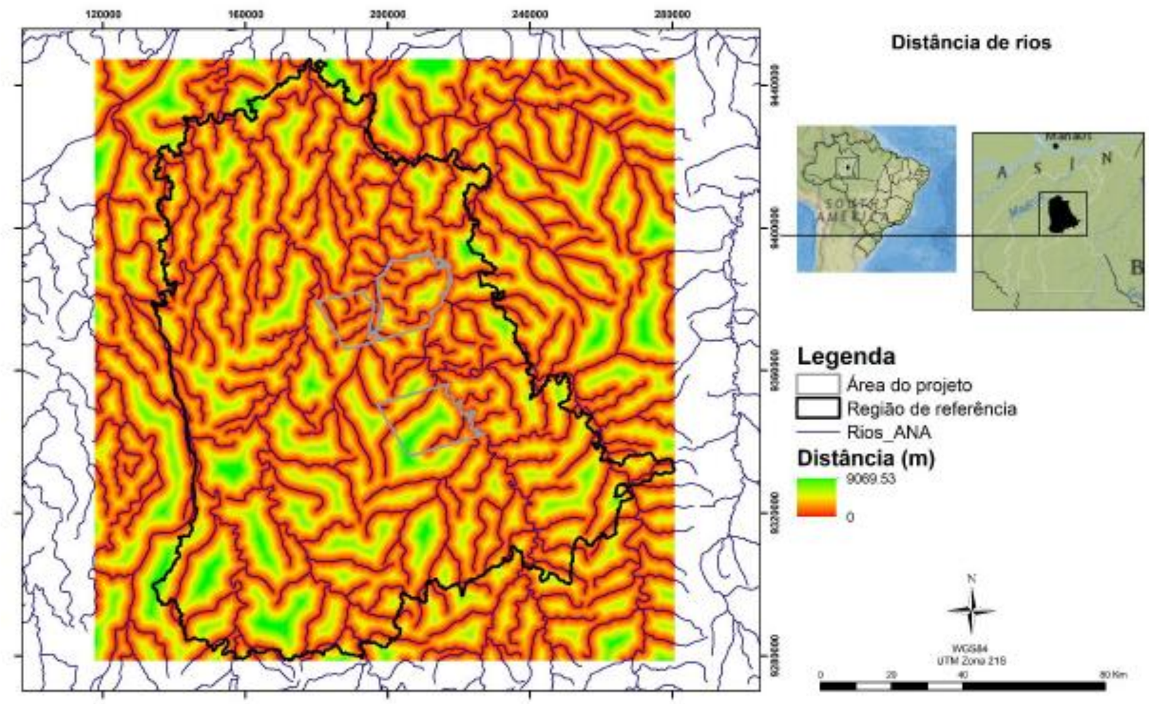

Figure 39. Factor map representing the distance from rivers

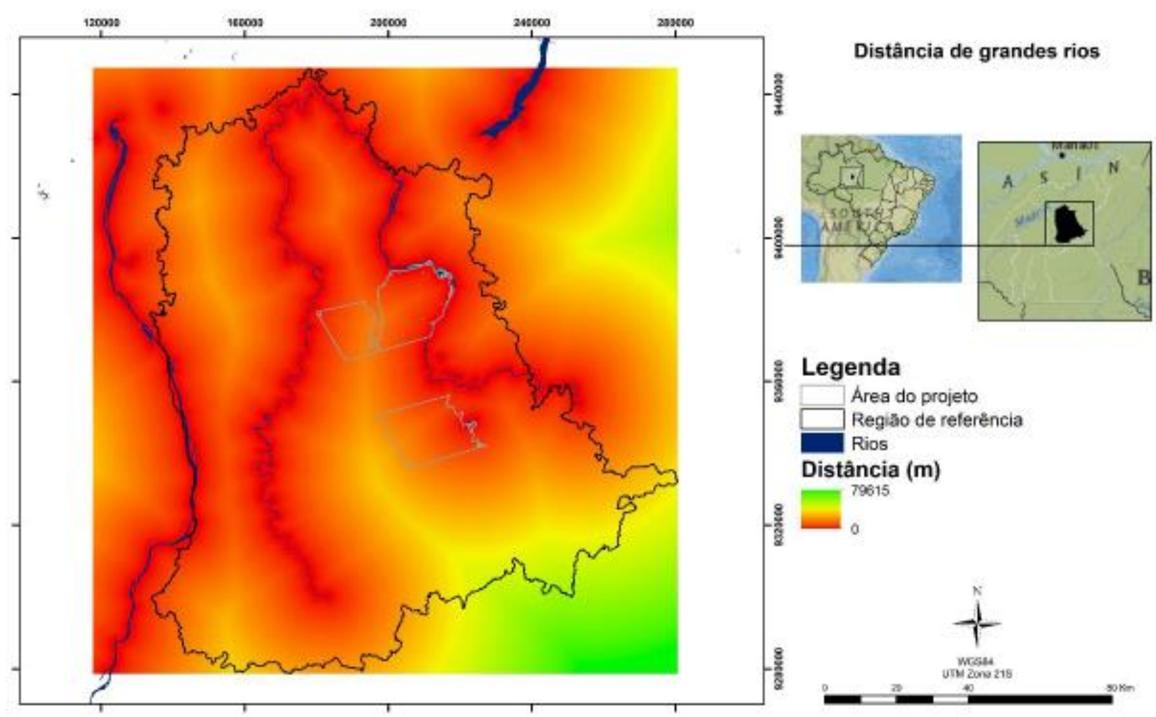

Figure 40. Factor map representing the distance from large rivers

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.

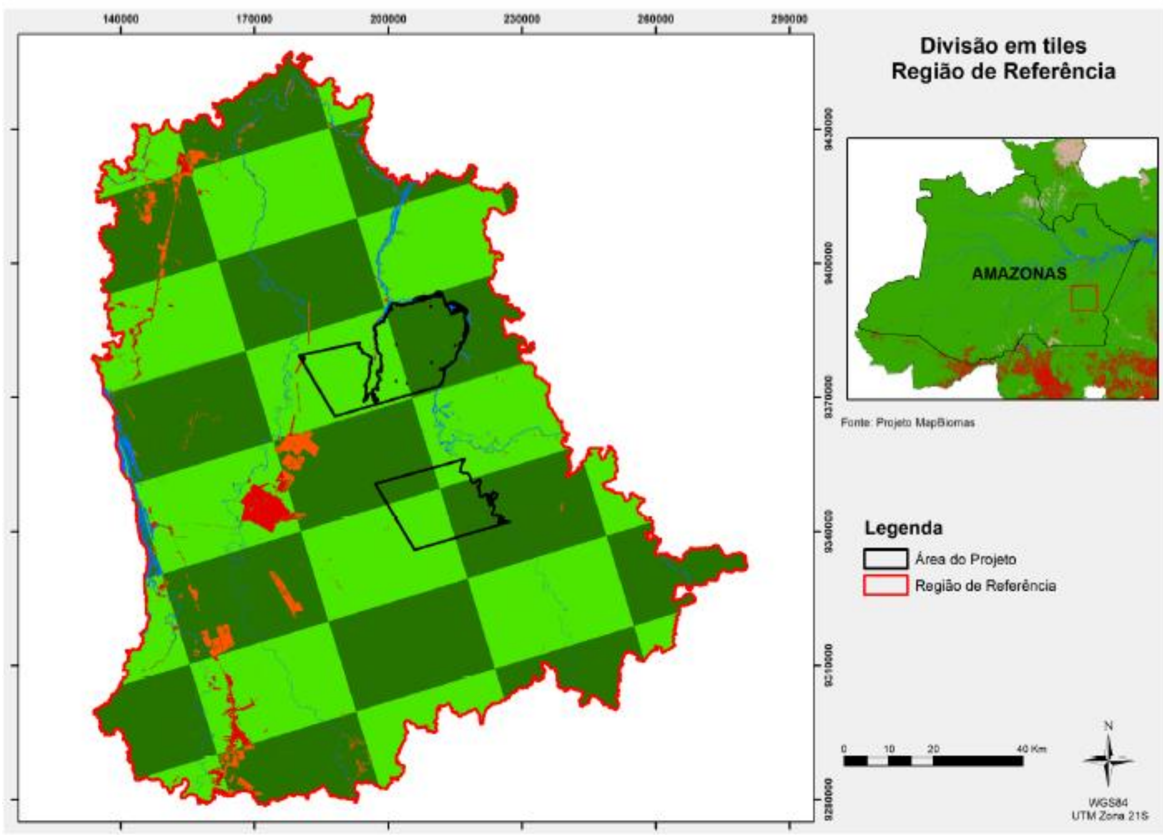

Figure 41. Reference Region divided into tiles, where half of the area was used to calibrate the models, and the other half to validate.

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, it was used the average of these two values.

Modelo	Similaridade 01	Similaridade 02	Média	Assentamento	Distância às estradas	Distância aos rios	Distâncias aos rios maiores	Declividade	Altitude	UCs
md12	0.478	0.421	0.449	0	1	1	1	0	1	1
md04	0.473	0.421	0.447	1	1	1	0	1	1	1
md11	0.473	0.416	0.444	0	1	1	1	0	0	1
md10	0.466	0.412	0.439	0	1	0	1	0	0	1
md01	0.462	0.417	0.439	0	1	1	1	1	1	1
md03	0.456	0.403	0.430	1	1	0	1	1	1	1
md00	0.451	0.405	0.428	1	1	1	1	1	1	1
md05	0.446	0.404	0.425	1	1	1	1	0	1	1
md06	0.444	0.402	0.423	1	1	1	1	1	0	1
md09	0.431	0.382	0.406	0	0	0	1	0	0	1
md02	0.407	0.367	0.387	1	0	1	1	1	1	1
md07	0.403	0.358	0.380	1	1	1	1	1	1	0
md08	0.353	0.343	0.348	0	0	0	0	0	0	1

Table 23. Deforestation projection models from 2009 to 2019. Each line corresponds to a model and was evaluated by the Similarity degree.

Therefore, all the variables and deforestation patterns were analysed together to produce the risk mao, which is ilustrated 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.

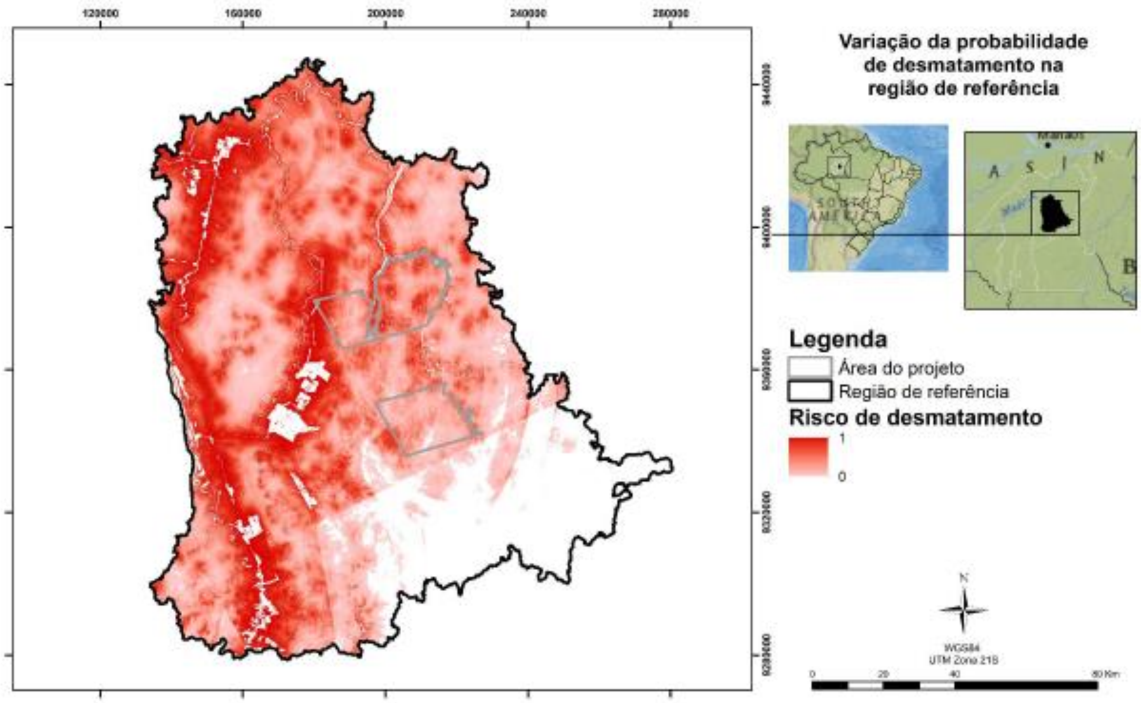

Figure 42. Potential risk map for the occurrence of deforestation in the reference region, using Dinâmica Ego Software.

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 20 years, until 2039 are illustrated in figures below:

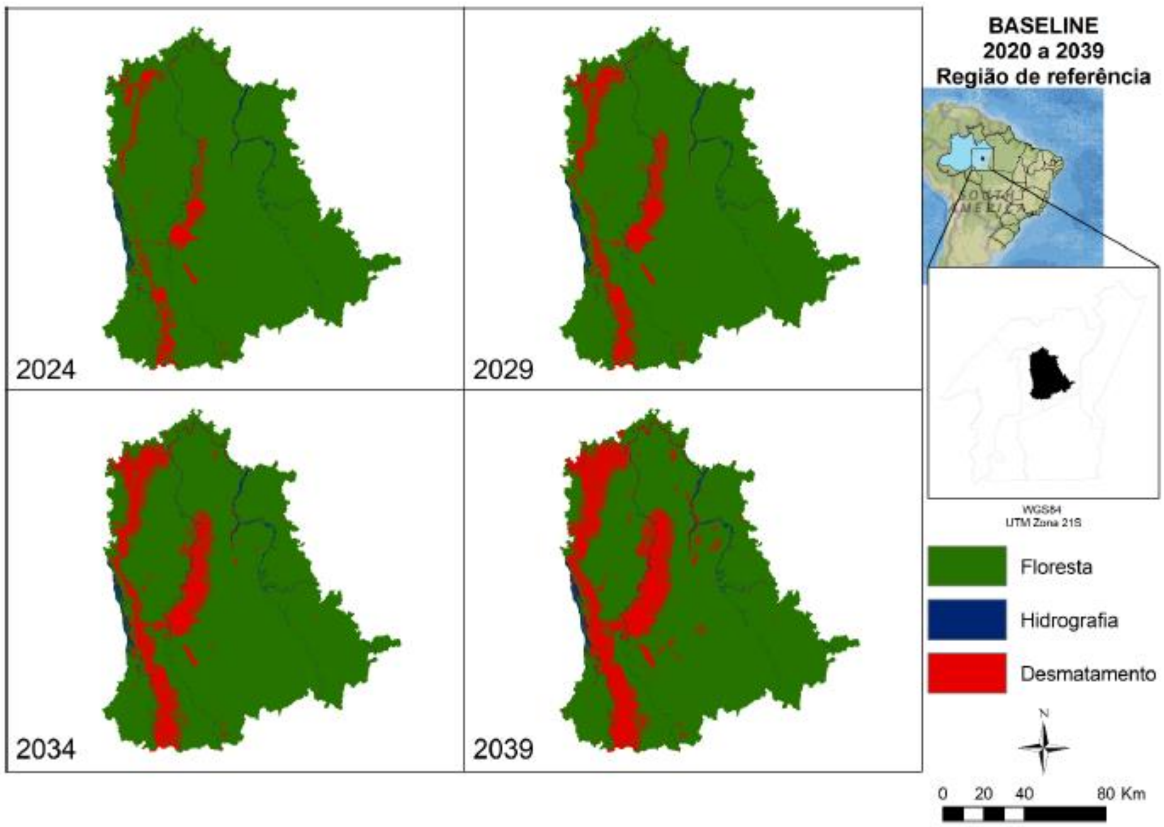

Figure 43 - Projection of deforestation in the reference region, using Dinamica EGO

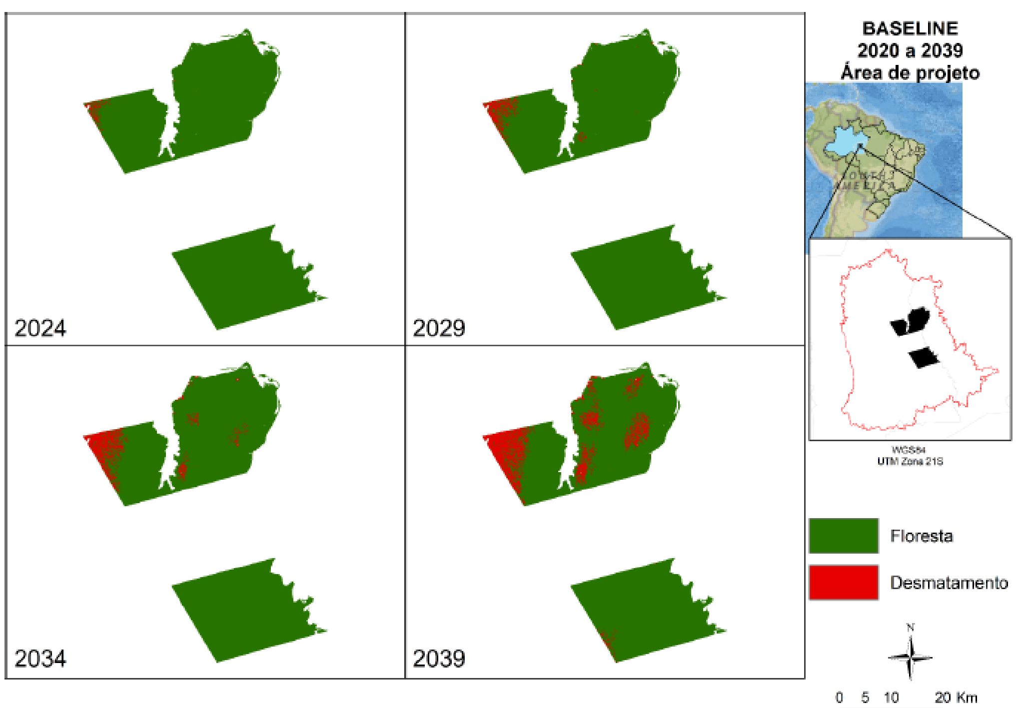

Figure 44 - Projection of deforestation in the project area, using Dinamica EGO

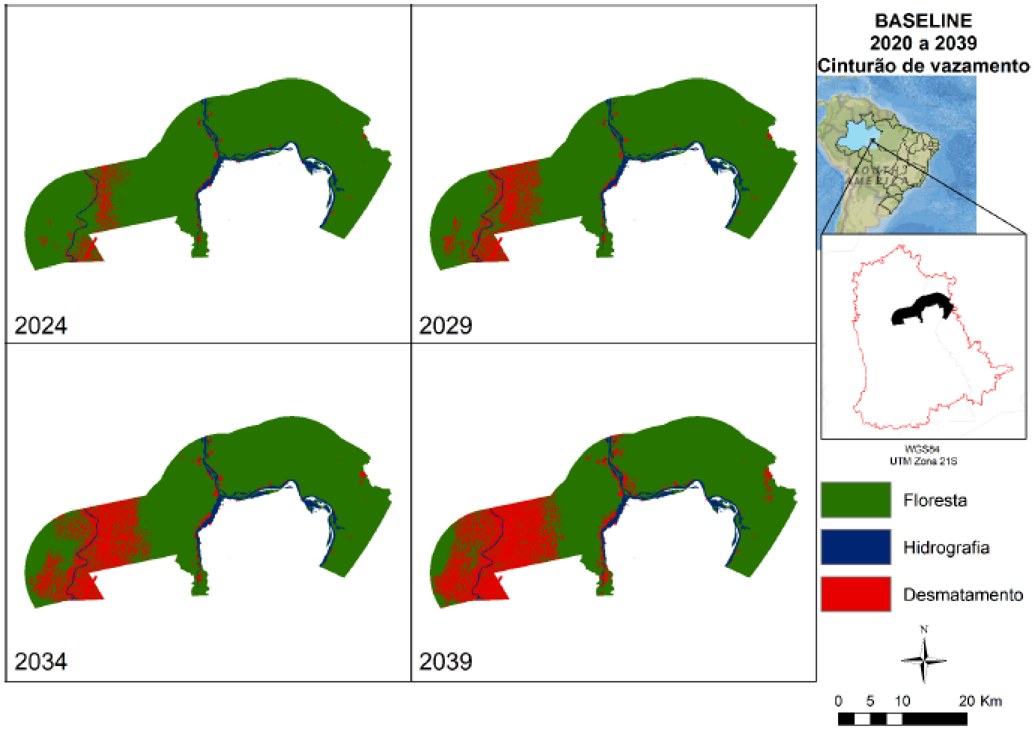

Figure 45- Projection of deforestation in the leakage belt, using Dinamica EGO

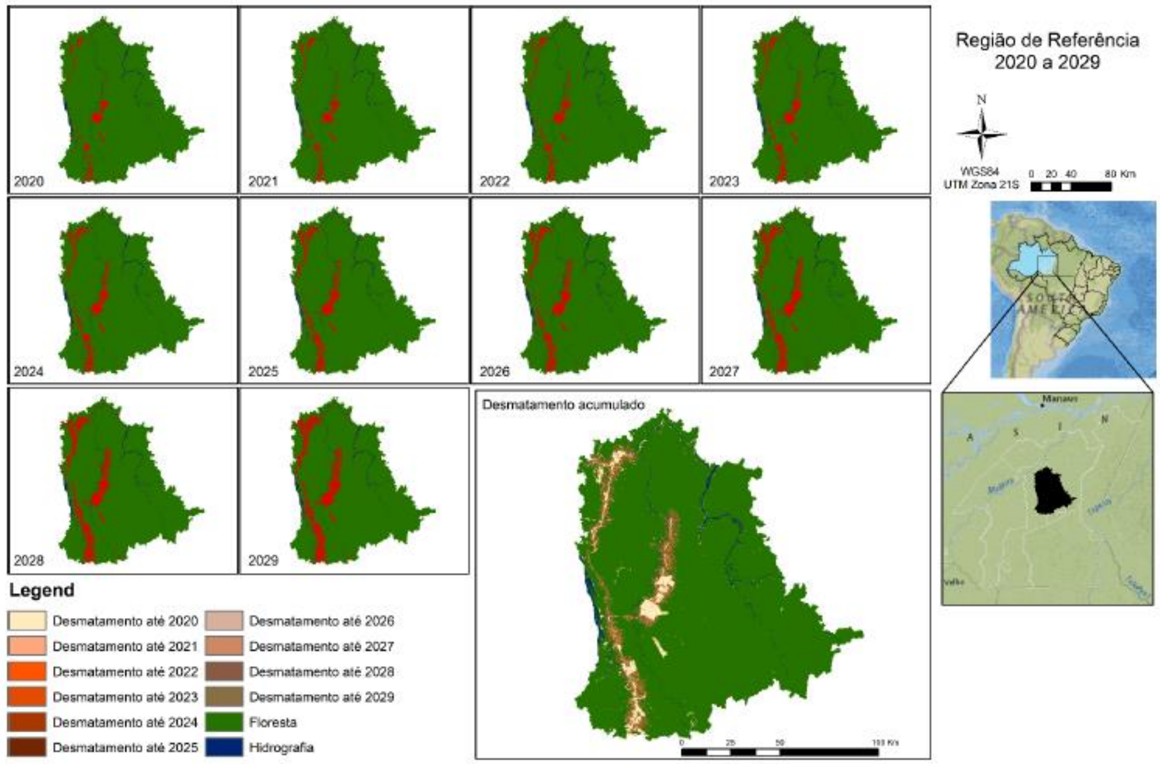

Figure 46 - Deforestation projection in the reference region, year by year, using Dinamica EGO.

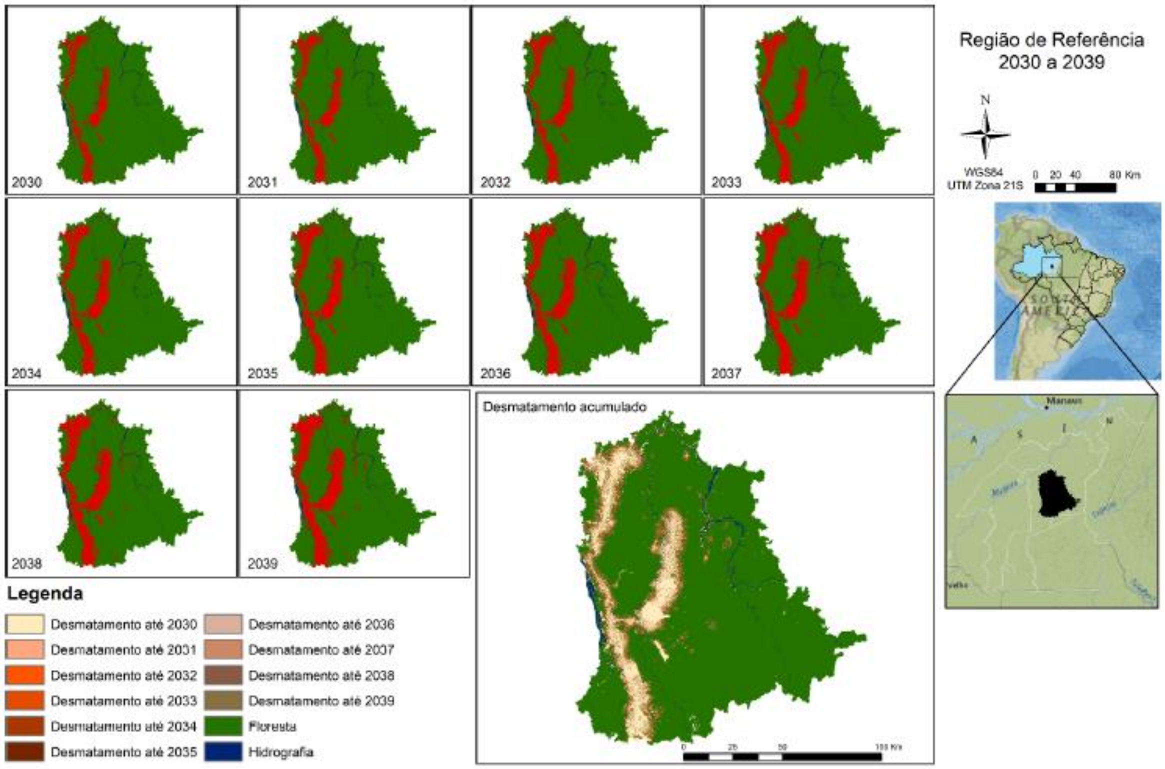

Figure 47 - Deforestation projection in the project area, year by year, using Dinamica EGO.

Figure 48 - Deforestation projection in the project area, year by year, using Dinamica EGO.

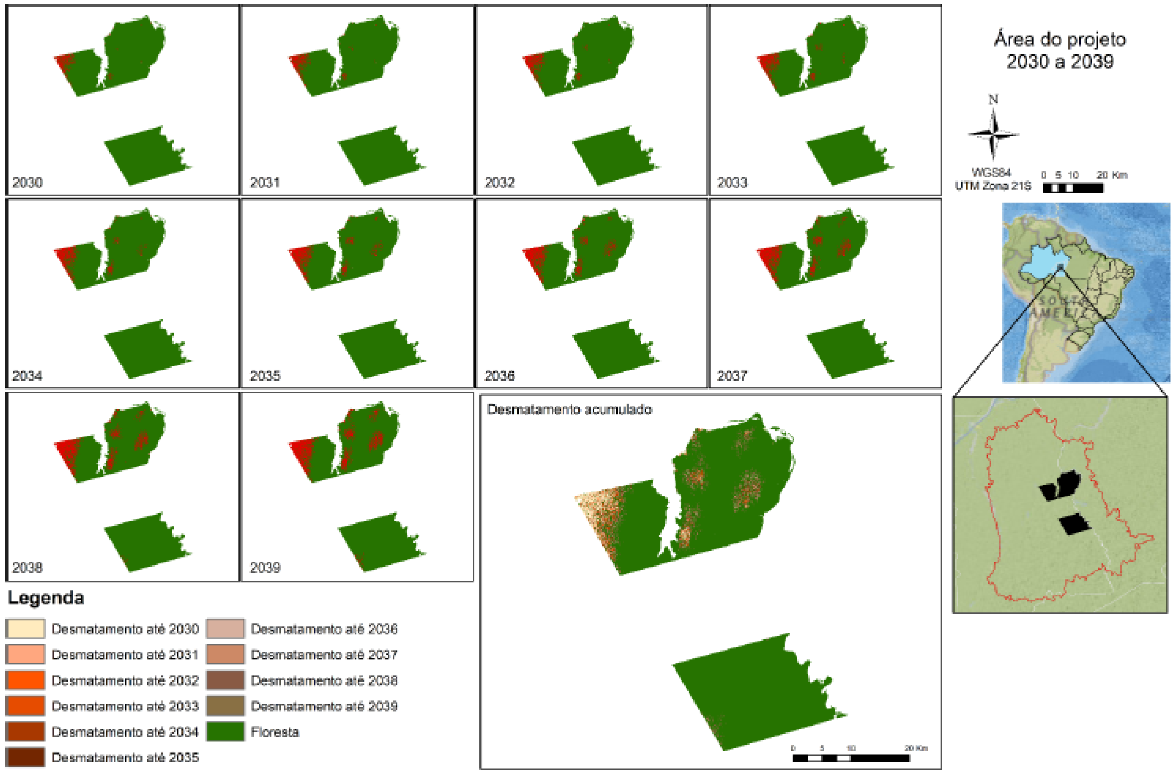

Figure 49 - Deforestation projection in the reference region, year by year, using Dinamica EGO.

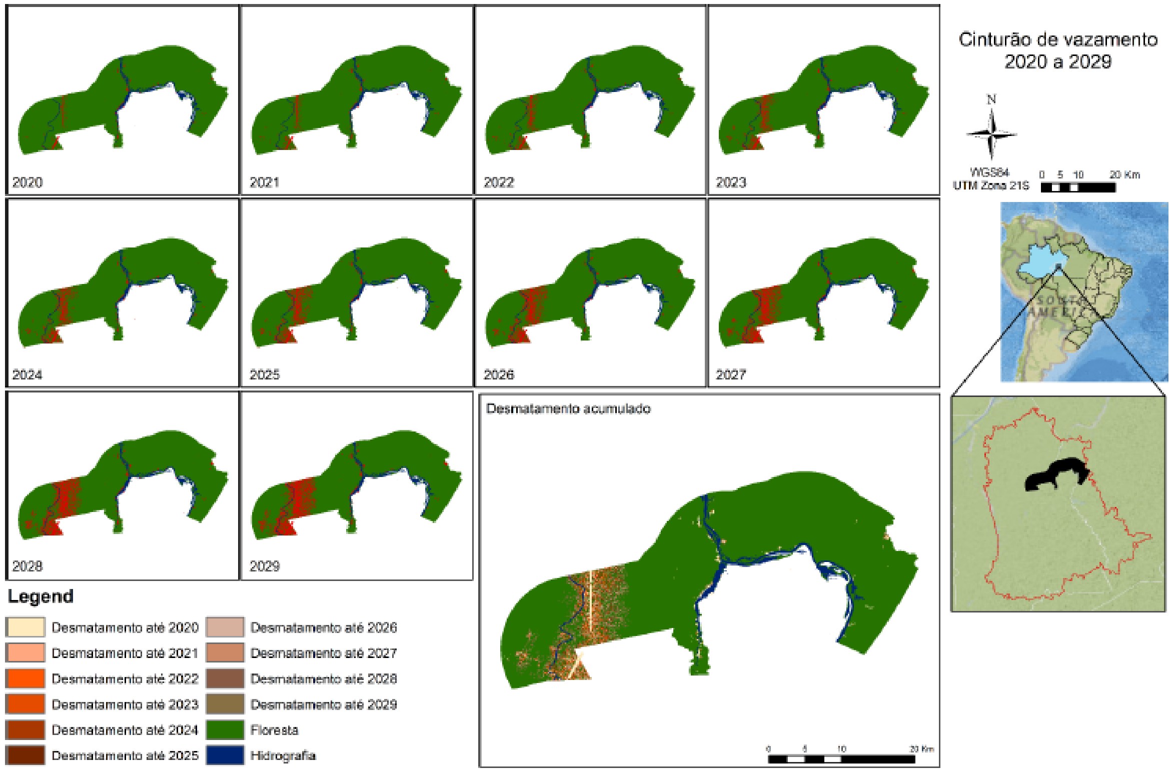

Figure 50 - Deforestation projection in the leakage belt, year by year, using Dinamica EGO.

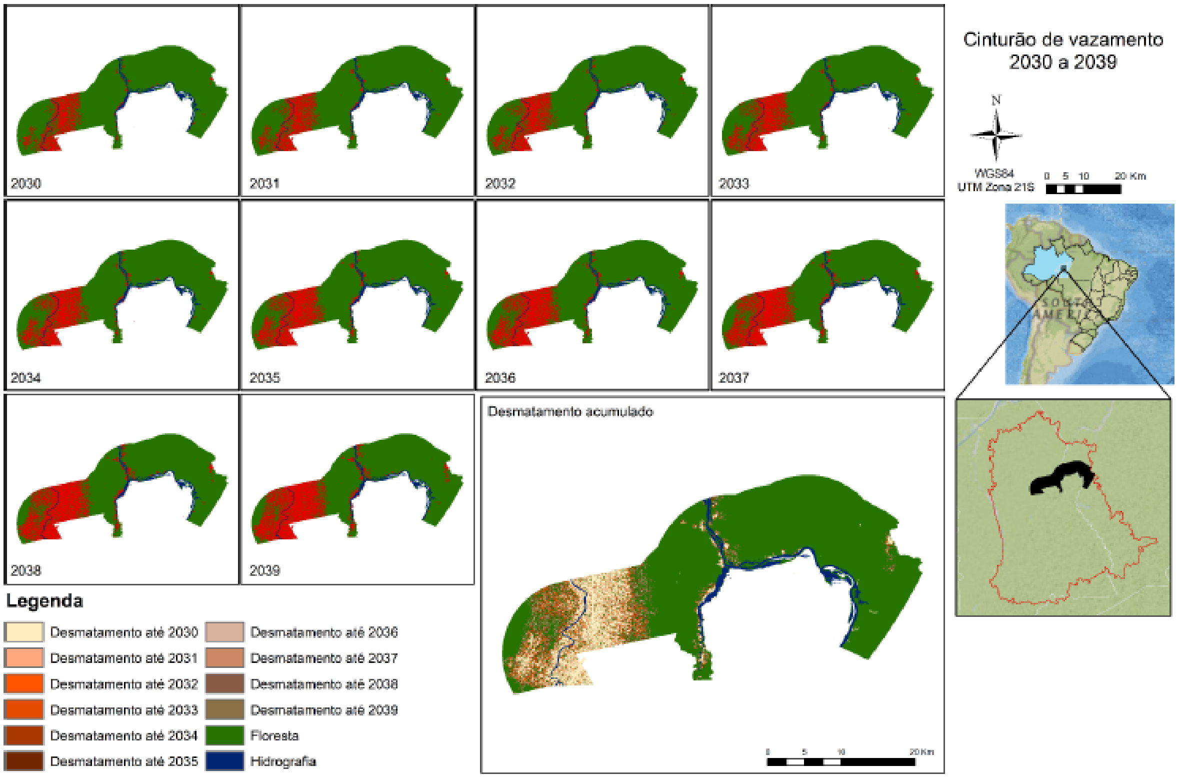

Figure 51 - Deforestation projection in the leakage belt, year by year, using Dinamica EGO.

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

3.5 Additionality

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[57] was applied below for the first project instance, i.e. Grupo Leão REDD project activity. Other instances shall perform the additionality analysis at the time of their conclusion 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, the considered alternatives to the project activity are:

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

- Timber production
- Cattle raising
- Continuation of pre-project land use

These activities are considered credible alternatives, as shown by official data[58]. 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 36% of the total value of production from the two municipality in which the project 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.

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.

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[59], 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.

[58] Sources: Instituto Brasileiro de Geografia e Estatística (IBGE)

[59] http://www.inpe.br/noticias/noticia.php?Cod_Noticia=5294

IPAM estimates that 44% of the deforestation in the period was illegal, registered in non-designated lands or protected areas[60].

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[61], 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[62], 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[63]. 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 authorization, are legal, although inefficient, with low productivity and high environmental impact[64].

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.

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:

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

[61] https://ipam.org.br/wp-content/uploads/2020/01/Fluxos-financeiros-pecu%C3%A1ria.pdf

[62] https://www.bcb.gov.br/pre/normativos/res/2014/pdf/res_4327_v1_O.pdf

[63] https://idesam.org/viabilidade-pecuaria-sustentavel-leite/

[64] https://idesam.org/publicacao/viabilidade-pecuaria-leite-apui.pdf

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.

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.

As described in section above, between 2010 and 2019 the deforestation in the reference region was of 39,464.62 ha, with an average rate of 3,946.42 ha/year.

STEP 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

Sub-step 2b. Simple Cost Analysis

The simple cost analysis was determined as the appropriate analysis method once the Yellow Ipê Grouped REDD Project 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:

	Estimated Annual Costs of Conservation (R$)
Monitoring: hiring of the riverside population living near the project area to supervise the property, including taxes) (2 employees)	R$ 45,144.00
Boat purchase, equipment maintenance and monitoring costs	R$20,000.00
Accountancy and taxes	R$39,120.00

Forest conservation and social environmental activities	R$ 12,000.00
TOTAL	R$116,264.00

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.

In the Verra Registry[65], there are 22 REDD projects registered in Brazil, 3 of them located in the State of Amazonas. Despite being located in Novo Aripuanã, the "Juma REDD+ Project[66]" 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"[67] 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:

[65] Available in: https://registry.verra.org/

[66] Available in: https://registry.verra.org/app/projectDetail/CCB/1596

[67] Available in: https://registry.verra.org/app/projectDetail/CCB/1147

- **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[68]. 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 maintenance of the forest[69]. 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 Yellow Ipê Grouped REDD Project 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

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

[68] Available in: http://sistemas.icmbio.gov.br/simrppn/publico/rppn/AM/

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

4.2 Project Emissions

4.3 Leakage

4.4 Net GHG Emission Reductions and Removals

5 MONITORING

1. APPENDIX